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Revised Draft Environmental Impact Statement for Revision of the Sequoia and Sierra National Forests Land Management Plans

Volume 1: Chapters 1 through 4, Glossary, References, and Index

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Cover Photo: Dogtooth Peak, Sierra National Forest

Revised Draft Environmental Impact Statement for Revision of the Sequoia and Sierra National Forests Land Management Plans

Fresno, Kern, Madera, Mariposa, and Tulare Counties, California

Lead Agency: **USDA Forest Service**

Responsible Officials:

TERESA BENSON, Forest Supervisor
Sequoia National Forest
1839 South Newcomb Street
Porterville, CA 93257

DEAN GOULD, Forest Supervisor
Sierra National Forest
1600 Tollhouse Rd
Clovis, CA 93611

For Information Contact:

Fariba Hamedani, Forest Plan Revision Team
Pacific Southwest Regional Office
1323 Club Drive
Vallejo, CA 94592
(707) 562-9121

Send Comments to:

https://tinyurl.com/USFS-r5planrevision
OR
Planning Team Leader, Forest Plan Revision
1323 Club Drive
Vallejo, CA 94592

Email: r5planrevision@fs.fed.us

Date Comments Must Be Received: Within 90 days following publication of the Environmental Protection Agency's notice of availability of the revised draft environmental impact statement in the Federal Register. It is the commenter's responsibility to calculate the end of the 90-day period.

Comments: It is important that reviewers provide their comments at such times and in such a way that they are useful to the preparation of this environmental impact statement. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative or judicial reviews. Comments on the revised draft environmental impact statement should be specific and should address the adequacy of the environmental impact statement or the merits of the alternatives discussed or both (40 CFR 1503.3).

Abstract

This revised draft environmental impact statement documents the analysis of five alternatives (A through E) developed by the Forest Service to revise the land and resource management plans, as amended, for the Sequoia National Forest (1988) and Sierra National Forest (1992). The revised land management plans would provide for the programmatic management of approximately 1.1 million acres administered by the Sequoia National Forest and approximately 1.3 million acres administered by the Sierra National Forest. The Giant Sequoia National Monument would be managed under the 2012 Monument Plan, with the exception of direction for recommended wilderness and eligible wild and scenic rivers.

The alternatives are described in chapter 2. Alternative A is the no-action alternative, and would keep in place the management direction from the individual land and resource management plans, as amended. Alternative B is a modified version of the original proposed action published in the 2016, and is the preferred alternative. As the preferred alternative, alternative B is reflected in the accompanying "Draft Revised Land Management Plan for the Sequoia National Forest," and "Draft Revised Land Management Plan for the Sierra National Forest," which would guide resource management activities on each respective national forest.

Alternatives B, C, D, and E address three revision topics that reflect the purpose and needs for the revised plans: (1) to reduce the risk of large high-intensity wildfires to communities and assets; increase the ability to manage wildfires to meet resource objectives; and reduce smoke impacts to communities; (2) to restore the resilience of vegetation and aquatic and riparian ecosystems to fire, drought and climate; restore wildlife and plant habitat and diversity; and reduce the risk of wildfire impacts to species and wildlife habitat; and (3) to provide sustainable and diverse recreation opportunities that consider population demographic characteristics; reflect desires of local communities, avoid overcrowding and use conflicts, and minimize resource damage; protect cultural resources; update direction for management of wilderness and wild and scenic rivers; and protect the values of the Pacific Crest National Scenic Trail. In addition, three areas identified as a need for change in the notice of intent are addressed but plan direction does not change between alternatives, to address benefits to people and communities; and to address tribal relations and uses. These areas are incorporated in various ways throughout the alternatives.

Alternatives B through E address new information and concerns that emerged during the implementation of the current forest plans. Each alternative complies with Federal laws, regulations, and policies. These alternatives also address significant issues (unresolved conflicts with the proposed action) that were identified from comments received during our public engagement sessions and formal comment period.

The Forest Service will use the "pre-decisional administrative review process," also referred to as the "objection process" described in the 2012 Planning Rule (36 CFR 219 Subpart B). This process gives an individual or entity an opportunity for an independent Forest Service review and resolution of issues before a final plan is approved. Subpart B identifies who may file objections to a plan revision, the responsibilities of the participants in an objection, and the procedures that apply to the review of the objection. Section 219.53 of the Planning Rule describes who may file an objection. Individuals and entities who have submitted substantive formal comments related to this plan revision during the opportunities for public comment for this decision may file an objection.

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Acronyms and Abbreviations

ACS	American Community Survey
AF	acre-feet
AUM	animal use month
BISON	biodiversity information serving our nation
BLM	Bureau of Land Management
BMA	backcountry management area
BMP	best management practice
CAR	critical aquatic refuge
CBA	challenging backroad area
CCD	census county division
CCSM	Community and Climate System Model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNDDB	California Natural Diversity Database
CNRM	Centre National de Recherches Météorologiques
CO	carbon monoxide
CWHR	California wildlife habitat relationship
CWPZ	community wildfire protection zone
CW	conservation watershed
DDT	dichlorodiphenyltrichloroethane
DEIS	draft environmental impact statement
DPS	distinct population segment
DRA	destination recreation area
EIS	environmental impact statement
ENSO	El Niño-Southern Oscillation
eNVC	expected net change value
EPA	Environmental Protection Agency
FAR	functional-at-risk
FEIS	final environmental impact statement
FERC	Federal Energy Regulatory Commission
FRID	fire return interval departure
FSH	Forest Service Handbook
GFDL	Geophysical Fluid Dynamics Laboratory
GFZ	general fire zone
GGO	great gray owl
GIS	geographical information systems
GRA	general recreation area
GSNM	Grand Staircase National Monument
GTR	general technical report
GWPZ	general wildfire protection zone

HRCA	home range core area
HUC	hydraulic unit code
HVRAs	highly valued resources and assets
IMPROVE	Interagency Monitoring of Protected Visual Environments
IRA	inventoried roadless area
KRRT	Kern River rainbow trout
LRMP	land and resource management plan
MIST	minimum impact suppression tactics
MMbf	millions of board feet
MMcf	millions of cubic feet
NEPA	National Environmental Policy Act
NOx	nitrogen oxide
NRHP	National Register of Historic Places
NRIS	Natural Resources Information System
NRV	natural range of variation
NVUM	National Visitor Use Monitoring
NWPS	National Wildlife Preservation System
OHV	off-highway vehicle
OSV	over-snow vehicle
PAC	protected activity center
PCT	Pacific Crest Trail
PG&E	Pacific Gas and Electric
PILT	payment in lieu of taxes
PM	particulate matter
PM_{10}	particulate matter less than 10 micrometers
$PM_{2.5}$	particulate matter less than 2.5 micrometers
POD	potential operational delineation
RCA	riparian conservation area
RDEIS	revised draft environmental impact statement
RMA	recreation management area
ROG	reactive organic gas
ROS	Recreation Opportunity Spectrum
SCC	species of conservation concern
SCE	Southern California Edison
SIO	scenery integrity objective
SMS	scenery management system
SOx	sulfur oxide
TMDL	total maximum daily load
TOG	total organic gas

UC	University of California
USC	United States Code
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WCF	watershed condition framework
WHMA	wildlife habitat management area
WMZ	wildfire maintenance zone
WRAP	watershed restoration action plan
WRZ	wildfire restoration zone
WSR	wild and scenic river

Preface

This revised draft environmental impact statement and supporting documents, which comprise the administrative record (also referred to as the project record) of the environmental analysis are on file at the Supervisor's Office of the Sequoia and Sierra National Forests and at the Regional Office in Vallejo, CA. Electronic copies of this document and other planning documents are available on the website for the Sequoia and Sierra National Forests plan revision.[1] This draft environmental impact statement is organized as follows:

Document Organization

Volume 1

Chapter 1. Purpose of and Need for Action. This section outlines the purpose and need for action, the scope of the analysis and the decision to be made.

Chapter 2. Alternatives, Including the Proposed Action. This section discusses the proposed action (draft revised forest plans), no action, and a range of reasonable alternatives. It also explains why other alternatives were dismissed from further consideration. It includes a summary comparison of the environmental impacts of the proposal and the alternatives in comparative form at the end of the chapter.

Chapter 3. Affected Environment and Environmental Consequences. This section describes the current condition of the affected resources and the environmental consequences of implementing each alternative.

Chapter 4. Consultation and Coordination. This section lists the credentials of those who prepared this EIS and identifies the agencies, government officials, and selected other parties who were consulted regarding the proposed action.

Glossary. This section provides a glossary of terminology.

References. This section reports full citations for the sources cited in the text.

Index. This section provides page numbers for various topics related to the analysis

Volume 2—Appendices

Appendix A—Comparison of Action Alternative Plan Components

Appendix B—Wilderness Recommendation Process for the Sequoia and Sierra National Forests

Appendix C—Wild and Scenic River Evaluation for the Sequoia and Sierra National Forests

Appendix D—Persistence Analysis for Species of Conservation Concern

Appendix E—Rangeland Management

Appendix F—Timber Suitability and Management

Appendix G—Consistency with Other Planning Efforts

[1] http://www.fs.usda.gov/detail/r5/landmanagement/planning/?cid=stelprdb5444003

Volume 3—Maps

This volume contains maps of the different alternatives as they relate to each resource analyzed. The maps are grouped by each national forest and then follow the order of the various analysis sections in chapter 3.

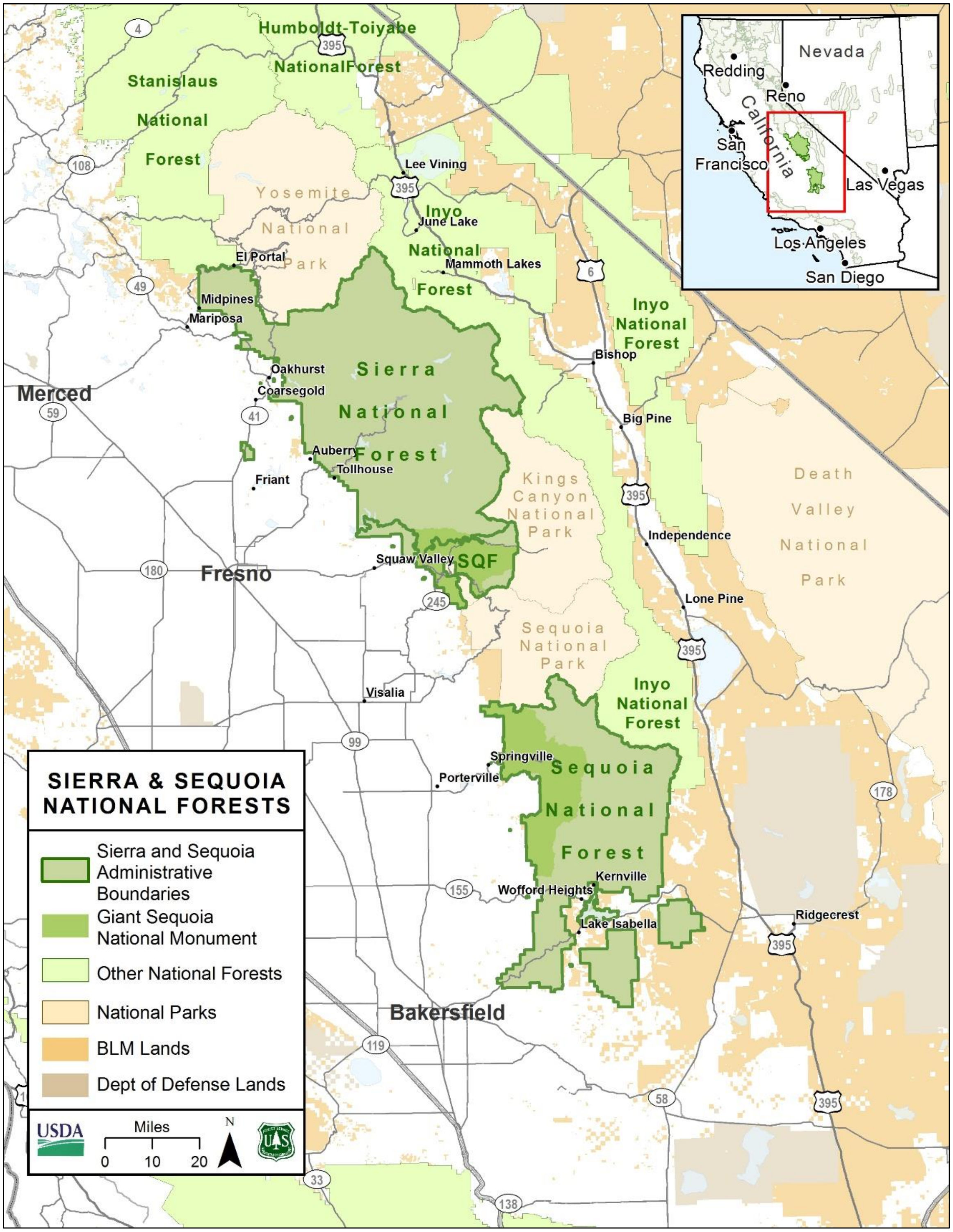

Figure 1. Map of the Sequoia and Sierra National Forests, which constitute the planning area for revising the forest plans for two national forests

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Chapter 1

Purpose of and Need for Revising the Sequoia and Sierra Land Management Plans

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Chapter 1.
Purpose of and Need for Revising the Sequoia and Sierra Land Management Plans

Introduction

The Forest Service has prepared this revised draft environmental impact statement (RDEIS) in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulation. The Forest Service is proposing to revising the Sierra National Forest Land and Resource Management Plan (1992) and the Sequoia National Forest Land and Resource Management Plan (1988) in compliance with the National Forest System (NFS) land management planning rule (36 CFR 219), herein after referred to as the 2012 Planning Rule.

The Planning Area

The Sequoia, and Sierra National Forests encompass nearly 2.4 million acres of National Forest System lands located at the southernmost extent of the Sierra Nevada mountain range (Figure 1). These national forests contain great diversity—they span an altitude range from less than 1,000 feet above sea level in the western foothills of the Sierra Nevada to over 14,000 feet at the crest of the mountain range. Both national forests share a border with Sequoia and Kings Canyon National Parks; the Sierra National Forest borders Yosemite National Park. Other adjacent federal lands include the Humboldt-Toiyabe, Inyo and Stanislaus National Forests and lands administered by the Bureau of Land Management's Bakersfield Field Office. The Tule River Indian Reservation is immediately west of the Sequoia National Forest. Many mountain communities are located within the planning area and are surrounded wholly or in part by National Forest System lands.

The Sequoia National Forest

The Sequoia National Forest is located at the southernmost end of the Sierra Nevada range in California within portions of Tulare, Kern, and Fresno Counties (Figure 1). The Sequoia lies between the Los Angeles Basin and San Francisco Bay population centers, and is accessible to these areas in 3 to 5 hours driving time. Within the national forest boundary, there are approximately 1.1 million acres of National Forest System lands and 54,155 acres of state, private and other ownerships. Elevations range from 790 feet in the Lower Kern River Valley, to 11,873 feet in the Golden Trout Wilderness.

The Sequoia National Forest contains the 328,000-acre Giant Sequoia National Monument (GSNM). Since the management plan for the GSNM was approved by the Regional Forester in 2012, there is no need to change plan direction, but is considered in the cumulative effects section. One exception is that recommended wilderness and Wild and Scenic River eligibility are evaluated in this planning process per direction within the 2012 Record of Decision for the GSNM.

The Sequoia National Forest Supervisor's Office is centrally located in Porterville, California. The Sequoia is divided into three ranger districts: the Hume Lake Ranger District on the north end, the Western Divide Ranger District just east of Springville, and the Kern River Ranger

District at the southern end near Lake Isabella. Several communities are within or adjacent to the Sequoia National Forest, such as those surrounding Lake Isabella (Kernville, Lake Isabella, Wofford Heights, Mountain Mesa, and many smaller communities) and several small foothill and mountain communities located on the Kern Plateau (Kennedy Meadows), and in the Greenhorn Mountains (Johnsondale, Alta Sierra, Sugarloaf, and Beartrap). There are six designated wilderness areas either wholly or partially within the administrative boundary of the Sequoia National Forest. These areas include Domeland, Golden Trout, Jennie Lakes, Kiavah (shared with the Bureau of Land Management), Monarch (shared with Sierra National Forest), and South Sierra.

The Sierra National Forest

The Sierra National Forest covers the eastern portions of Mariposa, Madera, and Fresno Counties. Elevations range from 900 feet at Pine Flat Reservoir to nearly 14,000 feet at the summit of Mount Humphreys along the Sierra Crest. The forest contains the 49,000-acre Kings River Special Management Area and the 3,200 acre Teakettle Creek Experimental Forest. Congress designated the Kings River Special Management Area to enhance its recreational opportunities. The Sierra National Forest administers the entire Kings River Special Management Area, even though a portion of it is within the Sequoia National Forest boundary.

The Sierra National Forest Supervisor's Office is located in Clovis, California. The Sierra has two administrative ranger districts, Bass Lake and High Sierra. The gateway communities identified for the Sierra National Forest include: Oakhurst, Coarsegold, Mariposa, Midpines, El Portal, Shaver Lake, Bass Lake, Fish Camp, Auberry, and Friant. Other communities include North Fork, Prather, Huntington Lake, and Tollhouse. There are five designated wilderness areas wholly or partially within the administrative boundary of the Sierra National Forest including: Ansel Adams, Dinkey Lakes, John Muir, Kaiser, and Monarch (shared with the Sequoia National Forest) Wildernesses.

2012 Planning Rule Requirements

In 2012, the U.S. Department of Agriculture (USDA) issued a new rule for forest planning. The 2012 Planning Rule emphasizes that forest plans are to guide management of the national forests so they are ecologically sustainable and contribute to social and economic sustainability. The national forests are managed to provide ecosystems and watersheds with ecological integrity and diverse plant and animal communities. In addition, they are managed to have the capacity to provide people and communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future.

The 2012 Planning Rule describes three phases to the planning process: assessment; development, amendment, or revision of forest plans; and monitoring.[1] In addition to these phases, there are other requirements of the 2012 Planning Rule when a revision is undertaken.

The 2012 Planning Rule requires the Forest to undertake a process to identify lands within the plan area that are suitable for timber production. The forest plan includes plan components for lands suitable for timber production and for lands where timber harvest is appropriate for purposes other than timber production (e.g., removal of hazard trees in campgrounds). These plan

[1] See the Planning Rule at 36 CFR 219.6; 219.7; 219.12; and 219.13.

components are intended to facilitate an active vegetation management program of work to meet ecosystem and socioeconomic objectives.

The 2012 Planning Rule requires the identification and evaluation of lands that may be suitable for inclusion in the National Wilderness Preservation System and of eligible rivers and streams for inclusion in the National Wild and Scenic Rivers System. The recommended wilderness evaluation and wild and scenic river eligibility study process resulted in management area allocations and forest plan components. Refer to appendix B for the wilderness recommendation process and appendix C for the wild and scenic river eligibility study process.

The proposed plan **monitoring programs** are based in the practice of adaptive management, which is broadly recognized as critical for managing natural resources. The adaptive management cycle includes: identifying the desired conditions (forest plan); activities to help us get there (project-level implementation); monitoring whether we are achieving the results we intended (monitoring program), and using those evaluations to improve our implementation activities or to amend the forest plans.

Purpose and Need for Action

The purpose of the proposed action is to revise the forest plans. The existing plans are over 30 years old and changes in resource demands, new scientific information and new policy including the 2012 Planning Rule form the basis for initiating plan revision. The need to revise the existing forest plans are to: (1) address the changing social and environmental conditions over time, and public issues described below; and (2) guide natural resource management activities on the two national forests for the next 10 to 15 years.

The Sequoia and Sierra forests began revising their plans in 2012 with the assessment phase joined with the Inyo National Forest. In May of 2016, the Inyo, Sequoia, and Sierra forests released a joint draft environmental impact statement (DEIS) disclosing the effects of revising their plans. The intent was for all three forests to move forward to the next stages of the planning process, but the west side of the Sierra Nevada experienced substantial drought induced tree mortality in the years between the start of the planning process and the release of the DEIS.

Tree mortality substantially changed ecological conditions on the Sequoia and Sierra National Forests in part due to the extended drought conditions from 2011 to present. When considering the ecological changes caused by tree mortality in the region, and reviewing comments received by interested stakeholders on the DEIS, the Sequoia and Sierra forests chose to update and revise their draft plans analysis. Given the substantive changes in both plan components, alternatives and analysis warrants a revision to the draft in order to allow for comments and additional public participation in the planning process.

Revision Topics

Revision topics are used in this (EIS) to organize the features of the alternatives and to compare and contrast the differences between alternatives. Each emphasis area we identified in the need for change was considered as a potential revision topic.

Three emphasis areas we identified in the need for change were not considered to be revision topics because plan direction was the same across alternatives. The needs for change to address benefits to people and communities and tribal relations and uses are fundamental requirements of the 2012 Planning Rule and were incorporated throughout desired conditions and other plan direction.

Each revision topic listed below provides a brief description and explanation of what the topic is and what needs to be revised in the plans to address the topic. Further explanations supporting the needs for changing the current plans are described in the project record.

Revision Topic 1: Fire Management

Symptoms of our changing climate and its impact to ecological integrity, such as years of prolonged drought and rising temperatures that leave plant life very dry, have changed fire behavior in California. At the same time, California's population has spilled into previously rural or remote locations in high-risk wildfire zones. The result: a dangerous combination of increasingly destructive wildfires that threaten wildlife, infrastructure, and communities throughout the region.

There is a need to change management direction to establish strategic fire management zones that reduce the risk of large, high-intensity wildfires to communities, their businesses and homes, and other assets such as recreation sites and infrastructure. There is a need to increase the agency's ability to safely manage wildfires to meet resource objectives that help reduce fire risk, maintain resilient wildlife habitat, and reduce smoke and air quality impacts to communities.

Revision Topic 2: Ecological Integrity

A history of past management actions suppressing fire on the landscape combined with rising temperatures and prolonged drought have radically altered our ecosystems, leaving them vulnerable to uncharacteristic disturbances such as insect and disease infestations and large, high-intensity wildfires.

There is a need to change management direction to build adaptive capacity in our ecosystems, restoring the resilience of terrestrial, aquatic, and riparian ecosystems to fire, drought, and climate change. There is a need to restore wildlife and plant habitat and diversity to better prepare for future management of these ecosystems and reduce the stressors which are driving impacts to at-risk species and wildlife habitat.

Revision Topic 3: Sustainable Recreation and Designated Areas

Recreation is a conduit that connects people with nature. Changes in population size and cultural shifts in recreation users and uses demonstrate that people choose to connect in nature in increasingly diverse ways, from recreating in solitude or as part of a social group to choosing motorized or non-motorized recreation opportunities.

There is a need to change management direction to establish ecologically, socially, and economically sustainable and diverse recreation opportunities that consider population demographic changes and reflect the needs of local, economically invested communities. There is a need to leverage our management direction, volunteerism, and partnership opportunities to achieve a balance between increasing visitation of renowned recreation sites and the related consequences of cultural resource impacts, overcrowding or conflicts in use, and impacts to natural resources, settings, and scenery.

The Draft Revised Plans

The draft revised Sequoia National Forest Land Management Plan and Sierra National Forest Land Management Plan, (also referred to as the "draft forest plans") are designed to provide strategic, program-level guidance for management of each national forest, including their natural resources and uses, over the next 10 to 15 years.

Specific details of the draft forest plans, as they evolved from the public collaborative process and internal evaluations and the most recent revision of the draft, are provided in chapter 2 and referenced as "alternative B." A copy of the draft revised forest plans are provided as companion documents to this RDEIS.

Decision Framework

The Forest Supervisors of the respective national forests will make the final decision on the selected alternative for their revised forest plan. After reviewing the results of the analysis evaluated in the final EIS, the responsible officials will each issue a record of decision, in accordance with agency decision making procedures (40 CFR 1505.2) that will:

- Disclose the decision (identify the selected alternative) and reasons for the decision,
- Discuss how public comments and issues were considered in the decision, and
- Discuss how all alternatives were considered in reaching the decision, specifying which one is the environmentally preferable alternative (defined in 36 CFR 220.3)

Approval of the revised plans will identify management areas and will include recommendations for areas that can only be designated by statute, such as wilderness and wild and scenic rivers.

Public Participation

The Sequoia and Sierra National Forests provided opportunities for public participation throughout the plan revision process. Both formal and informal collaboration methods were used to prepare for and carry out plan revision. We developed a Collaboration, Tribal and Public Involvement Plan to guide interactions with other agencies and the public.

Public Engagement Sessions—Informal collaboration began even before the final Planning Rule was released with a "Sierra Cascades Dialog" public engagement session held in Sacramento, California on the topic of "Preparing for Forest Planning" in December 2011. This was followed with additional dialog sessions on collaborative planning, adaptive management and recreation, social and economic opportunities and impacts, and monitoring.

The Forest Service Pacific Southwest Research Station produced a science synthesis (Long et al. 2014c) to examine the current science for a set of topics that were determined to have changed since the 1996 Sierra Nevada Ecosystem Project[2] (Centers of Water and Wildland Resources 1996 (Resources 1996)). In addition, although not required, a Bio-Regional Assessment (United States Department of Agriculture 2014c) was prepared to provide the context for examining resource across the entire Sierra Nevada range.

[2] The Sierra Nevada Ecosystem Project was requested by Congress as a scientific review of the remaining old growth in the national forests of the Sierra Nevada in California, and a study of the entire Sierra Nevada ecosystem by an independent panel of scientists, with expertise in diverse areas related to the issue.

In 2013, we held one Sierra Cascades Dialog session to discuss the science synthesis and two dialog sessions to discuss the Bio-Regional Assessment. To allow the public to directly provide information about conditions and trends for 18 resource topics outlined in the 2012 Planning Rule, we prepared both the Bio-Regional Assessment and the national forest assessments using an open wiki site called the "Living Assessment." We used public input received between January and September 2013 to create the Bio-Regional Assessment (United States Department of Agriculture 2014c), the Sequoia National Forest Assessment (United States Department of Agriculture 2014g), and the Sierra National Forest Assessment (United States Department of Agriculture 2014b), which were all released in December 2013.

Notice to Initiate Plan Revision—Following the assessments, we issued a notice to initiate plan revision on December 26, 2013 and developed a preliminary document outlining the need for changing the forest plans. We held tribal forums and public workshops in mid- to late-January 2014 in Fresno, Bakersfield, and Bishop to present and collect feedback on the preliminary need for change. Based on public feedback, we revised the need for change and presented an updated version along with draft desired conditions. We collected feedback at another set of tribal forums and public workshops in mid-June of 2014 in Fresno, Lake Isabella, and Bishop.

Notice of Intent and 30-Day Comment Period—A notice of intent to revise the forest plans for the three national forests and to prepare this EIS was published in the Federal Register[3] on August 29, 2014, initiating a 30-day public comment period. We circulated a detailed proposed action along with the notice of intent. The detailed proposed action provided potential plan components and other plan content focused on the revision topics of the purpose and need to revise the plans. Tribal forums and public meetings were held in Fresno, Porterville, and Bishop in mid-September 2014 to provide an update on the revision process and seek public input on the development of alternatives for the DEIS.

During the 30-day comment period, we received approximately 7,317 emails and letters from individuals, agencies, organizations, tribes and governments commenting on the purpose and need and proposed action. Of the comments received, approximately 6,603 represented form letters. All comments received were sorted, grouped by subject and analyzed to determine concerns and issues. In mid-November 2014, we held a set of tribal forums and public meetings in Fresno, Porterville, and Bishop to share a preliminary summary of the comments received and an initial set of conceptual alternatives.

Other public involvement occurred as required by the 2012 Planning Rule related to developing the list of species of conservation concern, evaluating the suitability of lands, and developing the monitoring program.

Consultation with Federally Recognized Indian Tribes—The responsible official for each national forest regularly met with federally recognized Indian tribes to discuss the plan revision process and to engage in consultation as needed.

A description of the public participation process for forest plan revision can be found in the Forest Plan Revision Collaboration, Tribal and Public Involvement Plan in the project record.

Draft EIS and Comment Period—A notice of availability was published in the Federal Register on May 27, 2016 announcing the availability of the DEIS and 90-day comment period for the

[3] 79 FR 51536

Revision of the Inyo, Sequoia and Sierra National Forests Land Management Plans. Legal notices were also published in the Fresno Bee, Inyo Register, and Porterville Recorder. Tribal forums and public meetings were held in Bishop, Mammoth Lakes, Porterville, Clovis, San Francisco, Bakersfield, and Los Angeles. Additionally, a webinar was held online. Over 30,000 comments were received on the DEIS and revised plans for the three national forest. Due to public comment and changed vegetation conditions on the Sierra and Sequoia National Forests, it was decided the Inyo National Forest would release a separate final EIS, while the Sequoia and Sierra National Forests would prepare a revised DEIS with consideration of the changed vegetation conditions and comments received from the public. The comments also identified other needed changes, for example, related to recreation and aquatic conservation; ultimately this input informed and helped improve the revised drafts.

Issues

The public, local and county governments, and State and Federal agencies submitted comments in response to the notice of intent during the 30-day comment period and at public meetings. We reviewed all the comments to identify issues and frame their associated cause-and-effect relationships. We then separated the issues into two groups: significant and nonsignificant. Significant issues are those used to develop alternatives and modify the proposed action. Nonsignificant issues are identified as those: (1) outside the scope of the proposed action; (2) already addressed by law, regulation, the proposed revised plan, or other higher level decision; (3) irrelevant to the decision to be made; or (4) conjectural and not supported by scientific or factual evidence.

Issues that Served as the Basis for Alternative Development

There are two broad categories of issues: (1) ecosystem or wildlife issues, and (2) management or use issues. Each category is followed by numbered issue topics, each of which are followed by a summarized issue statement and a description of the many concerns we heard during public comments and engagement sessions about the issue.

Ecosystem or Wildlife Issues

Issue 1: Ecological Resilience, Wildlife Habitats, and Wildfire

The amount, type, and location of thinning to improve ecosystem resilience to disturbances, such as large, high-intensity wildfires and insect and disease, and reduce the threat of wildfires to communities over the long-term, may not provide adequate habitat in the short-term for wildlife species that use forests with large trees and dense canopy cover.

There is a concern about the type and extent of proposed management activities, particularly mechanical thinning, for restoring ecological resilience. Public input is variable on this issue, and can be characterized by differing short-term and long-term perspectives captured in public comments. One perspective communicated is that the restoration proposal is too aggressive, with concerns that more active management, such as thinning trees to remove fuels, will in the short-term impact too much of the dense forest that provide wildlife habitats. Instead, they would prefer the agency use more prescribed burning and carefully managed wildfires to achieve resource objectives, limiting mechanical thinning to only when needed to protect communities. The other perspective is that the proposed management activities are not aggressive enough to restore ecological resilience in the long-term. They prefer a more active management approach that substantially increases areas thinned to reduce impacts from large, high-severity wildfires, insect and disease, and other disturbances to ensure forests are resilient to climate change. They agree that active management may have short-term impacts, but are willing to tolerate those short-term impacts to achieve sustainability of wildlife habitat and other ecosystem services in the long-term.

Issue 2: Forest Resilience and Forest Density

The limitations on effectively treating enough areas to reduce the density of trees and the level of fuels because of concerns for wildlife habitats will leave too much of the forest at risk of loss or unacceptable damage from wildfires or insect attacks during droughts exacerbated by climate change.

There is a concern that there are too many tightly packed trees in much of the current forests, which makes them susceptible to attacks by bark beetles and other insects when trees are stressed by droughts, leading to further tree mortality and increased fuels in the forests. The density of trees and high level of fuels that have accumulated also make it easier for wildfires to spread quickly into tree crowns, killing more trees than would be expected under more natural, lower tree density conditions. There is a concern that overemphasizing wildlife habitat needs in the short-term through limitations on mechanical thinning in dense stands will pose a direct risk of large, high-severity wildfires and conflicts with the need to improve ecological resilience and sustainability of the forest into the future.

Issue 3: Fuels Treatments and Fire Management

The amount of prescribed fire and managed wildfire used to meet resource objectives may not be sufficient to restore fire in frequent fire ecosystems. The amount of fire restored to the landscape may not be achievable without reducing existing fuels before treatment.

There is general agreement by the public about the need to restore fire as an ecosystem function more widely on forests. There are variable perspectives on the appropriate pace and scale (the rate at which we actively manage resources across a given landscape) of restoring fire on the landscape, the appropriate treatments for reducing fuels prior to managing wildfire, and the required cost and capacity to achieve a more resilient ecosystem. There is a concern that in most areas, unless existing fuels are first reduced through mechanical treatments, it will be difficult to conduct prescribed burning because the fire will burn hotter than desired and have too great a potential to escape control. There is also a concern that prescribed fire as a tool to reduce existing fuels may not be an adequate option for achieving greater ecosystem resilience, because fire managers will be limited to optimal weather where the conditions for burning and managing risks are acceptable, which already limits prescribed fire windows of opportunity. Similarly, there is a concern that wildfires that could be managed for resource conditions will continue to be suppressed unless there are strategic pre-treated locations that provide confidence to fire mangers that the fire can be safely managed without undue risks to communities or unacceptable impacts to resources.

Issue 4: Watershed Restoration

The proposed amount of watershed restoration may not keep pace with the increased stresses to aquatic and riparian systems from drought and climate change, which could result in species endangerment and possible extinction.

Climate change impacts including prolonged drought are increasing stress to aquatic and riparian ecosystems in need of restoration to become more resilient to future stressors. These persistent stressors include:

- Threats of uncharacteristically large, high-severity wildfires that affect large portions of watersheds and riparian areas;
- Decreases in available water and a resulting increase in water temperature due to increased forest density where more trees draw water to grow; and
- Drying of meadows and unique features like fens and springs.

Aquatic and riparian systems are an essential component to sustaining ecosystem integrity. The concern is that without an increased pace and scale of restoration to address these stressors, aquatic ecosystems will continue to degrade with less water and warmer temperatures that reduce viable habitats, making it difficult or impossible for aquatic organisms to survive.

Issue 5: Protecting Aquatic Diversity

The proposed management direction may not adequately protect areas of high aquatic species diversity.

There is general agreement by the public about the need to restore aquatic and riparian systems to ensure ecological resilience, which is an important adaptive strategy to address climate change. There is a concern that without additional protections to areas of high aquatic species diversity, those areas will be adversely affected by an increased pace and scale of restoration, particularly mechanical thinning. A balance is preferred where management activities allow for restoration, while also allowing for maintaining and improving the resilience of these areas.

Management or Use Issues

Issue 6: Recommended Wilderness

The proposed management direction offers an opportunity to manage more areas as recommended wilderness to protect them from development for future generations. However, recommending additional wilderness areas in the proposed revised plans might unnecessarily prohibit and further geographically constrain management activities and uses, including restoration activities and tribal uses that would otherwise be allowed.

The 2012 Planning Rule and Forest Service manual and handbook provide direction for inventorying and evaluating lands that may be identified as recommended for inclusion in the National Wilderness Preservation System. There are variable perspectives on recommending addition wilderness areas as part of the revised plans. Some commenters identified areas to consider in the wilderness inventory and suggested they become recommended wilderness areas. They asked that these or other additional areas be recommended for wilderness designation to protect the values they attach to those wilderness areas. Other commenters requested that no additional areas be proposed for wilderness designation, because they are concerned that designation will prevent them from participating in the activities that they currently enjoy within those areas. There is a concern from Tribal groups and traditional cultural practitioners that their access will be restricted to sites where they gather resources and hold ceremonies if those areas are managed as wilderness. There is also a concern that sacred sites and cultural resources will be damaged or vandalized if recreation use increases as a result of wilderness designation. There is a concern by some commenters that wilderness designation will limit management activities such as other forms of recreation that provide economic benefits to local communities or mechanical treatments to reduce the risks of disturbances, such as uncharacteristic wildfires, insect, and disease.

Issue 7: Smoke

Increasing the amount of prescribed burning, and allowing the management of wildfires to meet resource objectives would produce more smoke that might impact human health and affect the tourism-based and resource-based economies of counties and rural communities.

In recent years, very large wildfires in the Sierra Nevada region have demonstrated that smoke can affect not only local communities but also communities far from the fire. Smoke can affect human health and recreation opportunities. These impacts may affect other uses of the forest and can be substantial for communities dependent upon a recreation-based economy. There is a concern that increasing the amount of prescribed burning and managing more wildfires to meet resource objectives in the short-term will produce too much smoke that will affect human health and, if not carefully planned and managed, could affect local economies that depend on tourism. There is also a concern that if prescribed fire or managing fire to meet resource objectives is not allowed to the extent needed for increasing forest resilience, the risk of future large, high-severity wildfires will increase, which have greater smoke impacts to human health, recreation opportunities, and local economies.

Issue 8: Forest Products

The proposed pace and scale of forest management activities and forest product outputs may not adequately contribute to sustaining local and regional industry infrastructure needed to accomplish restoration objectives.

Many commenters emphasized the importance of economic and social contributions of the national forests to the surrounding communities. There is a concern that the proposed pace and scale of restoration is not aggressive enough to maintain infrastructure (such as mills, roads, equipment, and skilled labor force) in local communities, so that the Forest Service can draw upon that infrastructure to accomplish restoration goals as well as contribute to the economic and social well-being of communities.

Chapter 2

Alternatives, Including the Proposed Action

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Chapter 2.
Alternatives, Including the Proposed Action

Introduction

This chapter describes the proposed action for revising the forest plans and the alternatives to the proposed action. We have developed and analyzed five alternatives in this environmental impact statement; the proposed action is referenced as alternative B. Alternatives are defined by the different ways they address revision topics and the relevant needs for change. They provide a framework for analyzing different ways of achieving the needs for changing the forest plans and for addressing the issues described in chapter 1. The alternatives show a range of options for guiding land and resource management in the national forests during the life of each plan. A summary table provides the environmental consequences associated with each alternative.

Because one environmental impact statement is being prepared for both national forests, the theme of each alternative applies to both national forests; however, some aspects vary, due to differences in vegetation, existing settings, sites, infrastructure, and opportunities. In this case planning components are differentiated where appropriate. The details of the proposed draft forest plans (alternative B) are provided in the separate draft land management plans prepared for each national forest.

Throughout this document, there may be small differences in the calculated acreage numbers. The reason for this varies; examples are slightly mismatched boundaries, differences in mapping techniques, and rounding errors. In the context of this large-scale land management planning and programmatic analysis, which covers hundreds of thousands or millions of acres, these relative differences in reported acreage would be less than 0.1 percent; therefore, we consider these differences to be negligible.

Alternatives Considered in Detail

Five alternatives are analyzed in this environmental impact statement. The no action alternative (alternative A), represents the existing planning (as amended) and accounts for current laws, regulations, and current conditions of biological opinions. The draft forest plans (alternative B [the preferred alternative]) considers issues identified by the public and reasonably balances multiple-use with ecological, social, and economic sustainability. Alternatives C, D, and E respond to the issues identified by the public. While alternatives C and E place a greater emphasis on passive ecological management of the forests, alternative D places a greater emphasis on economic sustainability, while protecting resources. These alternatives present a range of options for the responsible officials, as required by National Environmental Policy Act regulations.[1]

Alternative Development Process

Alternatives represent a range of possible management options from which to evaluate the comparative merits of the proposed action. Each alternative emphasizes specific land and resource uses and de-emphasizes other uses in response to the significant issues (see chapter 1).

[1] See 40 CFR 1502.14

All reasonable alternatives to the proposed action must meet the purpose and need for change and address one or more of the significant issues.

Plan Components

A forest plan is a general framework to guide the national forest staff when they propose, analyze, and decide on projects and activities. The five required components of a forest plan are desired conditions, objectives, standards, guidelines, and suitability of lands. A plan may also include goals as an optional component.

A **desired condition** is a description of specific social, economic, or ecological characteristics of the plan area, or a portion of the plan area, toward which management of the land and resources should be directed. This description is specific enough to allow progress toward achieving a goal, but it does not include a completion date.

An **objective** is a concise, measurable, and time-specific statement of a desired rate of progress toward one or more desired conditions. Objectives are based on reasonably foreseeable budgets.

A **standard** is a mandatory constraint on project and activity decisionmaking. It is established to help achieve or maintain the desired condition, to avoid or mitigate undesirable effects, or to meet applicable legal requirements.

A **guideline** is a constraint on project and activity decisionmaking that allows for departure from its terms (more flexibility), so long as its purpose is met. Guidelines are established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements.

The **suitability of lands** is determined for specific lands within the plan area. The lands are identified as suitable or not suitable for various uses or activities, based on desired conditions applicable to those lands. The suitability of lands is not identified for every use or activity. A plan's identification of certain lands as suitable for a use is not a commitment to allow such use but only an indication that the use might be appropriate. If a plan identifies certain lands as not suitable for a use, then that use or activity may not be authorized unless a change in the plan is made.

A **goal** describes an outcome that is not at the sole control of a national forest, such as the result of a partnership.

Other Plan Content

Other content in the forest plans is background information, general descriptions of areas for providing context to plan components, identification of watersheds that are a priority for maintenance and restoration, and proposed and possible actions. It also includes potential management approaches, which describe the principal strategies and program priorities each national forest intends to use to carry out projects and activities under the plan. Proposed and possible actions, as well as potential management approaches, describe *potential* future activities and strategies; they are not a commitment to take any action and do not fall under the proposal, as defined by the Council on Environmental Quality regulations for implementing NEPA.

The proposed plan monitoring programs are based in the practice of adaptive management, which is broadly recognized as critical for managing natural resources. The adaptive management cycle includes identifying the desired conditions (forest plan); activities to help us get there (project-level implementation); monitoring to determine if we are achieving the results we intended (monitoring program), and using those evaluations to improve our implementation activities or to amend the forest plans.

Table A-1, Action Alternative Plan Components, in Volume II, Appendix A, compares the plan direction for each action alternative, displaying the range of alternatives.

Features Common to All Alternatives

All five alternatives have features in common, which are described below.

Giant Sequoia National Monument (in the Sequoia National Forest)

Under all alternatives, the Giant Sequoia National Monument (GSNM) would be managed under the 2012 Monument Plan. Exceptions would be direction for recommended wilderness and eligible wild and scenic rivers.

Wild and Scenic Rivers

Under all alternatives, wild and scenic rivers would be managed to protect the outstanding remarkable values of each eligible segment.

Features Common to Alternatives B, C, D, and E

Revision Topic 2: Ecological Integrity

Terrestrial Ecosystems

Complex Early Seral Habitat

Alternatives B, C, D, and E include desired conditions for managing key characteristics associated with complex early seral habitat. Plan components vary between alternatives so as to achieve consistency with the overall theme of the alternative, consistent with the long-term ecological integrity of forest ecosystems.

Giant Sequoia Groves Outside the National Monument

For the plan revision alternatives, the Forest Service developed specific management of giant sequoia groves for McKinley and Nelder Giant Sequoia Groves in the Sierra National Forest. We did this to be consistent with management direction inside the GSNM and to protect this species. Proposed management is the same under alternatives B, C, D, and E except the width of the buffer changes between alternatives (see volume 3 maps for the two groves in Sierra National Forest).

Invasive Species

All plan revision alternatives include an approach to controlling invasive species and preventing the introduction of new invasive species. The Forest Service updated and expanded its current direction under alternative A to recognize the threats to ecosystem resilience from all nonnative invasive aquatic and terrestrial plants and animals likely to harm ecosystems. There is also an increased emphasis on managing invasive species by increasing objectives for the extent of area that we treated for nonnative invasive plants.

Climate Change

The desired conditions for alternatives B, C, D, and E include adaptation strategies for climate change, where relevant. An example is the climate adaptation strategy that promotes habitat connectivity to facilitate animal movements across forest ecosystems. Although climate adaptation strategies are largely absent from the current forest plans, alternatives B, C, D and E contain many broadly defined adaptation strategies that are considered during ongoing project development.

South Fork Wildlife Area

The plan revision alternatives include management area direction for the South Fork Wildlife Area that supports habitat for several federally listed species and species of conservation concern.

At-Risk Species

Based on public comment on the initial DEIS and more thorough analysis of species occurrence and best available science, the Regional Forester reevaluated the 2016 lists of species of conservation concern for the Sequoia and Sierra National Forests. The Regional Forester's 2019 lists of species of conservation concern (Moore 2019) have some changes, particularly for the Sequoia National Forest; some species were added to the list while other species were removed. The details on changes to the list are provided in chapter 3, "Wildlife, Aquatic, and Plants," "Revision Topic 2," which is further described in the animal and plant species rationale documents for each national forest (United States Department of Agriculture 2019e, b, c, d).

Alternatives B, C, D, and E identify desired conditions for vegetation that do not change across alternatives. These alternatives are designed to provide overall ecological integrity, including habitat for all associated species; specifically, they would provide the ecological conditions necessary to maintain viable populations of species of conservation concern in the plan area.

As part of the plan revision process, we developed coarse-filter plan components, such as desired conditions, that describe the desired outcomes and conditions for terrestrial vegetation, riparian habitats and features, and aquatic habitats and features in the plan area. For many at-risk species, plan direction (including desired conditions) is the same under all alternatives.

Consideration of the Southern Sierra Nevada Fisher Conservation Strategy and the Draft California Spotted Owl Conservation Strategy

Plan direction for alternatives B, C, D, and E incorporates the findings and recommendations of the "Southern Sierra Nevada Fisher Conservation Strategy" (Spencer, Sawyer, Rosmos, et al. 2016), the "Draft Conservation Strategy for the California Spotted Owl: Version 1.0," released in December 2018 (United States Department of Agriculture 2018b), and the preliminary updated version available in March 2019[2] (United States Department of Agriculture 2019a). Revised plan direction provides for maintaining or restoring habitat in California spotted owl territories. Protected Activity Centers (PACs) are defined by occurrence and occurrence is defined by regional survey protocol.

The Forest Service would change plan direction of identifying large southern Sierra fisher conservation area and den site buffers. Instead, it would favor a strategy that uses habitat and

[2] The Forest Service prepared the RDEIS alternatives B, C, D, and E while the conservation Strategy was being finalized. We developed alternatives C and E using the December 2018 version and adjusted alternatives B and D using a March 2019 version. We had updated the latter to consider comments on the strategy but had not yet finalized it. We will adjust the alternatives in the FEIS to consider the most current available version of the conservation strategy.

occupancy modeling to identify areas important to maintain and restore fisher habitat and to support a persistent population in the southern Sierra Nevada. The fisher conservation strategy area is based on a refined analysis of habitat likely to contribute substantially to the fisher population over the next 15 to 30 years; it would increase habitat resilience and restore habitat quality (heterogeneity).

Consistent with the fisher conservation strategy area findings, we would apply additional desired conditions and plan direction to 2,500-acre fisher hexagon grid areas and fisher linkage areas. Direction for fisher den site buffers would be replaced by management of fisher denning habitat in larger occupied fisher habitat core areas.

Willow Flycatcher

Revised plan standards address grazing impacts on willow flycatcher through seasonally limiting grazing in willow flycatcher occupied sites.

Bighorn Sheep

Alternatives B, C, D, and E have the same species-specific desired conditions, goals, standards, and suitability to protect bighorn sheep from disease and disturbance and to maintain suitable habitat.

Yosemite Toad

The Forest Service has updated species-specific plan direction under alternatives B, C, D, and E for Yosemite toad from existing plans for the Sierra National Forest. This species does not occur in the Sequoia National Forest. Standards and guidelines mainly address grazing impacts on breeding toads and their habitat. The plan revision alternatives also use indicators to adjust grazing management practices.

At-Risk Fish Species

Species-specific plan direction for Lahontan cutthroat trout, Paiute cutthroat trout, California golden trout, and Little Kern golden trout protects habitat from livestock grazing and vegetation treatment impacts.

At-Risk Bat Species

A potential management approach is included to protect known bat hibernacula and maternity colonies. This would come about by installing bat gates at mines or caves or by restricting access by other means.

At-Risk Plant Species

The plan revision alternatives include the same direction for whitebark pine. They also include the same direction for special habitats. These are habitats or vegetation types that support many plant species of conservation concern. The alternatives include direction to design projects to help maintain and improve key ecological conditions.

Revision Topic 3: Sustainable Recreation and Designated Areas

Wilderness

Under all alternatives, the Forest Service developed desired conditions and guidelines to provide for restoration in wilderness, invasive species, a trails component, and the undeveloped quality of wilderness character.

For the Sierra National Forest, new plan components (desired conditions and standards) apply to the Kaiser Wilderness. This direction was not part of the 1992 plan; however, this direction reflects how the Sierra National Forest has been managing the Kaiser Wilderness for several years.

Wild and Scenic Rivers

Consistent across all alternatives are protective measures for managing rivers identified as eligible for inclusion in the National Wild and Scenic River System. They also would protect rivers that have been found to be eligible or suitable in previous wild and scenic river studies.

Scenic Integrity

Scenic character would be managed using the direction of the scenery management system, which replaces the older visual management system in the existing forest plans. The system provides a systematic approach to inventory, analyze, and monitor scenic resources on National Forest System lands. It recognizes that landscapes are not static, so objectives for scenery are grounded by naturally changing and evolving conditions that are described in the scenic character. We also developed planning components that require desired scenic integrity objectives to be considered in restoration project design.

Tribal Relations and Uses

Desired conditions, goals, and potential management approaches in the plan revision alternatives address and encourage working with tribes to manage resources of tribal importance. Plan components focus on managing some sites for tribal uses, such as oak stand improvements for acorn gathering, and other gathering site improvements and considerations.

Partnerships

In the plan revision alternatives, we emphasize increasing workforce capacity through the use of partnerships and volunteers. A variety of strategies and tools would be used to increase the use of private, public, and tribal partnerships and volunteers.

Alternative A: Existing Plan Direction

Alternative A represents current management of both forests to date. That management is included in the existing land management plans, as amended,[3] and is largely based on single-species protection and vegetation treatments near communities.

The following sections discuss existing plan direction as it relates to each of the revision topics and needs for change.

Revision Topic 1: Fire Management

Strategic Fire Management Zones

Current forest plan management prioritizes hazardous fuels reduction treatment in the wildland-urban intermix defense zone and threat zone. In the defense zone (the area closest to structures and communities), there are fewer restrictions on the intensity of thinning. In the wildland-urban intermix defense and threat zones, where fuels are heavy and could contribute to high-intensity

[3] In accordance with the 1982 Planning Rule, plans were called “land and resource management plans”, while the 2012 Planning Rule uses the term land management plans. Throughout this document, we refer to both existing and revised plans as land management plans.

fire, thinning is allowed in protected activity centers for California spotted owls and northern goshawks. This would be the case in situations where prescribed burning designed to reduce fire risk could not be effectively conducted. (See chapter 3, “Revision Topic 1: Fire Management” for a map and more information, and volume 3 for maps of the strategic fire management zones in each national forest.)

Managing Wildfire to Meet Resource Objectives

The concept of managing wildfire to meet resource objectives refers to managing wildfires, in order to benefit resources. The current forest plans encourage the restoration of fire to the ecosystem. This would occur through increased use of prescribed fire and by allowing some wildfires, when they are beneficial to resources. The existing plans provide general direction for resource objectives related to vegetation conditions; however, they do not explicitly identify resource objectives to be accomplished using wildfire as a natural process.

Revision Topic 2: Ecological Integrity

Terrestrial Ecosystems

Ecosystem Resilience and Adaptation to Climate Change

Current plan direction focuses on vegetation management and fuels conditions at small spatial and temporal scales. It does not explicitly provide a framework for increasing landscape-level treatments or considering the longer term impacts of climate change. Plan direction generally focuses on a narrow range of ecosystem desired conditions that reinforce vegetation structural homogeneity across the landscape. There are specific requirements on vegetation management, including limiting the diameter of trees that can be removed and requiring that certain amounts of tree canopy cover be retained. The landscape management approach is to strategically place fuel reduction treatments to interrupt the spread of uncharacteristic wildfires.

The current plans recognize the desire to lower the stand density of forests to reduce the risk of trees dying due to stresses related to prolonged droughts. However, single species-specific habitat management direction limits the amount of treatment that can occur. There is also little current plan direction that addresses adaptation to climate change, especially changed conditions associated with large and severe disturbances, such as uncharacteristic wildfires, bark beetle outbreaks, and drought.

Old Forests

The current forest plans contain old forest emphasis areas and provide standards and guidelines to generally retain all large trees and to minimize treatments in patches of dense-canopy forests with larger trees wherever they occur. The desired conditions for old forest emphasis areas provide for high levels of horizontal and vertical canopy diversity. They also provide for variability in size, species composition, and structure of roughly even-aged vegetation groups of generally less than 5 acres. However, these desired conditions conflict in part with the desired conditions, standards, and guidelines for the California spotted owl, fisher, and Sierra marten. These generally favor retaining large contiguous canopy cover and limit the ability to create a lot of horizontal and vertical canopy diversity. In some cases, the prescriptive plan direction for one species conflicts with direction for another species. In these situations, habitat restoration may be limited because the most restrictive direction is applied to projects.

Wildlife and Plant Habitat Diversity

Risks to terrestrial habitat are mitigated in part by using restoration treatments to reduce the impact of future large, high-intensity wildfires on key habitats. Examples of such treatments are thinning, prescribed fire, and wildfires managed to meet resource objectives.

Aquatic and Riparian Ecosystems

The aquatic and riparian management strategy relies on desired conditions, goals, and a set of standards and guidelines organized around a set of riparian conservation objectives. These include the delineation of riparian conservation areas around streams, rivers, lakes, meadows, and a variety of other wetland types and a set of critical aquatic refuges (CARs). The current standards and guidelines generally limit disturbance and impacts in riparian conservation areas and call for consideration of impacts on aquatic and riparian systems and resources in CARs. Current plan direction limits the use of prescribed fire in riparian conservation areas. Timber harvest is suitable in riparian conservation areas under current plan direction.

Critical Aquatic Refuges

The current plans identify a set of CARs focused on areas with threatened and endangered species or areas of other species with population concerns. The direction that applies to riparian conservation areas applies to the CARs. In addition, CARs are to be evaluated for withdrawal for mineral entry; mining-related plans of operations are to contribute to aquatic management goals. There are six CARs in the Sequoia National Forest plan area and seven in the Sierra National Forest. These do not take into account newly listed or other aquatic species of conservation concern.

Water Quality, Water Quantity, and Watershed Resilience

The current plans do not focus on restoration at the watershed scale to improve resilience to wildfire, changing hydrologic regimes, or drought. However, the Forest Service is implementing its Watershed Condition Framework; this is a national program that establishes priority watersheds[4] on every national forest, and we are using it in the two forests to focus watershed restoration activities. The plan does not take into account changes in timing of flow and increases in water temperature due to the change in the snow-rain interface.

At-Risk Species

At-risk species under alternative A are listed under the Endangered Species Act and are Regional Forester's sensitive species. The current forest plans focus on providing habitats for species associated with old forest ecosystems and with aquatic and riparian systems. These two of the issue areas identified in 2001 as needing new or amended plan direction. The current plans primarily focus on limiting management in wildlife management areas, especially protected activity centers for California spotted owl, northern goshawk, and great gray owl; home range core areas for California spotted owl; and den and rest sites for fisher and Sierra marten.

The single-species restrictions in the current direction focus mainly on breeding habitat elements; they limit effectiveness of treating and restoring large areas of habitat. Specific direction to retain large trees and dense high canopies creates homogenous forest stand structures; these are large areas of similar age trees that reduce tree replacement and habitat structural diversity.

[4] Priority watersheds are designated watersheds where restoration activities concentrate on maintaining or improving watershed condition.

California Spotted Owl

Species-specific plan direction for California spotted owl under the current plans provides for 300-acre protected activity centers. These are designated around territorial locations and are intended to provide sufficient habitat to support nesting owls. A surrounding home range core area encompassing an additional 300 acres in the Sierra and Sequoia National Forests is identified to provide sufficient foraging and roosting habitat to support the home range needs of California spotted owls.

Fisher

The current forest plans minimize disturbance and activities near den sites for forest carnivores, such as fisher and marten. They also include a southern Sierra fisher conservation area that maintains dense canopy cover over at least half of the fisher home ranges. The plans minimize impacts on preferred fisher habitat elements, such as trees with cavities that could serve as den sites and large snags and downed logs.

Yosemite Toad

The current plan for the Sierra National Forest exclude livestock grazing in toad-occupied areas during breeding and rearing season. A standard and guideline allows the livestock exclusion to be waived if a site-specific management plan is approved and incorporated into allotment plans and relevant special-use permits.

Willow Flycatcher

The current plans guide livestock management by defining three categories of site occupancy: occupied willow flycatcher sites, historically occupied willow flycatcher sites, and conditionally occupied willow flycatcher sites.

Great Gray Owl

The current plans designate protected activity centers and standards and guidelines that provide for follow-up surveys, a limited operating period during the breeding season, and maintenance of herbaceous vegetation for both the Sequoia and Sierra National Forests.

Sierra Marten

The current forest plans minimize disturbance and activities near den sites for forest carnivores, such as marten.

Bats

The current plans do not provide specific direction for bats.

Revision Topic 3: Sustainable Recreation and Designated Areas

Sustainable Recreation

The existing plan direction for recreation varies across each national forest. This direction was based on recreation uses and recreation demand from the late 1970s to 1980s, when the plans were first developed. Existing plans emphasize improving recreation opportunities by focusing on the maintenance, development, adaptation, or alteration of dispersed and developed recreation sites. The plans were consistent with the recreation opportunity spectrum (ROS) class assigned to each area.

Existing plan direction also emphasizes continuing partnerships and volunteer programs. The plans also emphasize evaluating opportunities to develop new partnerships and volunteer programs to increase the amount of trails and facilities managed to desired standards.

Scenery

Existing plans do not include specific guidance for designing projects to improve scenic character and scenic character stability in the desired landscape character. Scenic character is managed using Agriculture Handbook 701, "Landscape Aesthetics, a Handbook for Scenery Management." It replaced the visual management system, which provides guidance that applies to all national forests (United States Department of Agriculture 1995b).

Designated Wilderness

Existing plan direction for wilderness varies by forest. The Ansel Adams, John Muir, Dinkey Lakes, South Sierra, and Golden Trout Wildernesses all have management plans that provide more specific management guidance.

Pacific Crest National Scenic Trail

In the existing plans, the Pacific Crest National Scenic Trail is managed according to direction provided by a 1982 comprehensive management plan (United States Department of Agriculture 1982) Direction is focused on the trail tread and immediate surroundings. In the plan area, most of the trail is in designated wilderness, except for 13 miles in the Sequoia National Forest. There is limited specific plan direction to guide activities that may impact the scenic and recreational values near these 13 miles of trail.

Alternative B: Proposed Revised Plans

Alternative B was developed to address the needs for changing the forest plans (as identified in chapter 1), as well as to carry forward existing forest plan direction that is still relevant. This alternative was designed to consider the changed condition with respect to the tree mortality which occurred contemporaneously with the development of the draft plans. Alternative B balances the need for a greater focus on landscapes and processes with protection for wildlife and their remaining quality habitat with the need for more active management.

Revision Topic 1: Fire Management

Alternative B provides a management direction framework to improve ecological fire resilience and restore fire as an ecosystem process at a landscape scale. Alternative B establishes strategic fire management zones and emphasizes active management in the form of vegetation treatments, mechanical thinning, and prescribed burning. These actions would support the natural starts of wildfires, which would benefit the resources in areas where it can be safely managed.

Proposed plan direction for both national forests emphasizes treating vegetation along key roads and ridges and connecting natural openings, such as rock outcrops. This could make it easier to implement larger prescribed burns and manage or suppress fires. Treatments would focus on drier sites near the roads and ridges, where restoration would move vegetation toward desired conditions. In addition, plan direction emphasizes reducing the threat of wildfire near communities and community assets.

Strategic Fire Management Zones

Direction under alternative B would replace the current two distance-based land allocations in the wildland-urban intermix and the remaining areas that are not wildland-urban intermix. These areas would be replaced with four management areas, based on a fire risk analysis consistent with the National Cohesive Fire Strategy. (See chapter 3, figure 16, page 126, for a broad-scale map and more information, and volume 3 for maps of the strategic fire management zones in each national forest.)

These management areas are as follows:

- The **community wildfire protection zone** would replace the wildland-urban intermix defense zone of alternative A. It includes larger geographic areas where wildfire would likely threaten communities. This zone is based on modeled potential wildfire spread and intensity having a very high likelihood of burning into, and negatively impacting, communities and community assets. This zone is irregular in shape, unlike the uniform shape of the wildland-urban intermix defense zone of alternative A.

  Alternative B direction emphasizes using thinning and prescribed fire to reduce fuels in this zone. Most wildfires would be actively suppressed to protect communities and assets, although in some instances, wildfires may be managed to meet resource objectives; this would happen if conditions allow and when it could be done in a safe manner. Plan direction identifies community buffers in proximity to structures, where fuel conditions, snags, and logs would be managed to facilitate safe wildfire operations.

- The **general wildfire protection zone** would replace the wildland-urban intermix threat zone of alternative A; it is irregularly shaped, covering a larger area. This zone is based on modeled potential wildfire spread and intensity having high likelihood of burning toward and negatively impacting communities, assets, and natural resources in the zone.

  Alternative B direction emphasizes active fuel reduction treatments along ridgetops, roads, and other natural and human-made features. Such features can serve as strategic anchor points for larger prescribed burns and create areas of low fuel that can be used to manage wildfires. Wildfires would most often be suppressed to reduce the threat to communities and assets. This would be due to the high likelihood of wildfire in this zone, possibly spreading into the community wildfire protection zone. In some instances, wildfires could be managed to meet resource objectives if conditions allow and when it could be done safely.

- The **wildfire restoration zone** identifies areas with low to moderate risk for communities, structures, and other resource values. This zone is based on the modeled potential wildfire spread and intensity. These conditions pose a mix of positive and negative effects on resources and some isolated assets. Thinning or prescribed burning may be needed before wildfires can be safely managed to meet resource objectives.

  Proposed plan direction emphasizes active fuels management treatments in strategic locations. The purposes would be to enable larger prescribed burns and to aid wildfire management that focuses on restoring fire to the ecosystem. Many wildfires in this zone would be managed to meet resource objectives under specific conditions and when it could be done in a safe manner, although in some instances wildfires may be suppressed.

- The **wildfire maintenance zone** would be a new zone of areas with very low risk. This zone is based on modeled potential wildfire spread and intensity that would have mostly positive effects on resources. The wildfire maintenance zone is typically in the higher elevations, wilderness, and remote areas where mechanical treatments are often not a management option; thus, restoring the role of fire is important to achieve ecological sustainability. Most wildfires in this zone would be managed to meet resource objectives under specific conditions and when it could be done safely. Prescribed burning would be used where it increases the opportunity to manage wildfires and restore fire-adapted ecosystems.

Managing Wildfire to Meet Resource Objectives

Alternative B direction allows unplanned wildfire starts to be managed to meet resource objectives in all zones when it is safe to do so. More important, new direction provides desired conditions and resource objectives that describe desired outcomes from wildfires managed to meet resource objectives to inform decisionmaking. The conditions and opportunities to manage wildfires would vary by strategic fire management zone, and plan direction emphasizes designing projects to reduce fuels in strategic locations, such as roads and ridgelines.

Revision Topic 2: Ecological Integrity

Terrestrial Ecosystems

Ecosystem Resilience and Adaptation to Climate Change

Alternative B direction incorporates the concepts of ecological restoration expressed in recent scientific publications, such as “An Ecosystem Management Strategy for Sierran Mixed-Conifer Forests” (North, Stine, O’Hara, et al. 2009) and “Managing Sierra Nevada Forests” (North 2012a). Alternative B creates a management framework to allow an increase in the amount of restoration treatments. It would use thinning, prescribed fire, and wildfires managed to meet resource objectives and handle the increased fuel loads from widespread tree mortality. This all would be done to progress toward desired conditions across the landscape.

Alternative B includes desired conditions and direction for improving the resilience and capacity of terrestrial ecosystems to adapt to climate change and other stressors. This includes specific direction for terrestrial ecosystems, including unique vegetation types, impacted by altered fire regimes, increased insect and disease risk, drought, and climate change. For example, there is additional direction in subalpine ecosystems that focuses on the impacts of climate change and other stressors on long-lived and slow-growing white pines, such as whitebark pine or foxtail pine. Alternative B also includes management direction to address changed conditions associated with large and severe stand-replacing disturbances.

Alternative B adds desired conditions for old forests, including the desired densities of large trees and large snags, and the desired proportion of the landscape that should be in old forest condition. The conditions include direction to increase the resilience of old forests and large or old trees to drought, climate change, and uncharacteristically large and severe wildfires. There would be some flexibility in management for improving the resilience of different forest types under changing climate conditions.

Alternative B focuses on managing for the key characteristics of ecological integrity for certain at-risk species, such as the California spotted owl and fisher. It includes species-specific guidance to provide for such habitat elements as structural heterogeneity and large trees, snags, and downed logs as important attributes of old forest structure.

Complex Early Seral Habitat

Alternative B includes plan components to provide for key characteristics that are important for two reasons: the ecological integrity of complex early seral habitats after large stand-replacing fires and in other areas where trees have been killed by drought, insects, pathogens, wind, or other stand-replacing events.

Wildlife and Plant Habitat Diversity

Alternative B would provide for ecological diversity and ecological integrity of habitat as the primary means to ensure the persistence of most species. As with the existing plans, alternative B contributes to the recovery of federally listed threatened and endangered species and does not jeopardize proposed or candidate species. In its plan direction, this alternative incorporates the relevant provisions of the "Southern Sierra Nevada Fisher Conservation Strategy" (Spencer, Sawyer, Romsos, et al. 2016) and the "Draft Conservation Strategy for the California Spotted Owl: Version 1.0" (United States Department of Agriculture 2018b).

Proposed objectives moderately increase terrestrial habitat toward the desired conditions at a moderate pace. There is an increased emphasis on restoring fire as an ecosystem process in fire-adapted ecosystems with frequent fire-return intervals; examples are ponderosa and Jeffrey pine and mixed conifer stands.

Additional desired conditions for vegetation provide for increased habitat heterogeneity for multiple species at both the fine scale and landscape scale. Specific desired conditions and guidelines for individual vegetation types, old forest, and sagebrush improve habitat for multiple species.

Wildlife Habitat Management Area

The Forest Service established a wildlife habitat management area (WHMA) under alternative B (see the WHMA map in Volume 3), to conserve old forest-dependent species, primarily California spotted owl and fisher. We developed the WHMA to recognize that, while these species require mature forest conditions, much of the mature forest habitat is at significant risk of loss. This would be due to uncharacteristically high-severity fire and insect and disease outbreaks, worsened by drought, climate change, and excessive stand density. Plan direction for WHMAs and other plan direction[5] would provide the backbone of plan direction. This, in turn, would provide for species of conservation concern persistence. This network would include suitable habitat, and habitat connectivity, for at-risk species, including those of conservation concern.

We identified WHMAs for large contiguous blocks of mature forest habitat (CWHR [California Wildlife Habitat Relationship] 5, 4M, 4D types). For this we used tree mortality-adjusted vegetation mapping. We ensured that the WHMAs would be outside designated wilderness and not fragmented by large blocks of private lands. We did not exclude the recent large fires, Railroad in 2017 and Ferguson in 2018. This is because we recognize that old forest habitat must be recovered over the long term where it has been lost on productive sites. This is essential if we are to maintain this important habitat into the future.

Identified fisher linkage areas are also included in WHMAs, due to their importance for fisher conservation; however, these areas often do not contain mature, high canopy forests with large

[5] See "Terrestrial Ecosystems, Animal and Plant Species, Watersheds, Riparian Conservation Areas, Management Areas, and Designated Areas."

trees. WHMA direction is intended to balance retaining the best habitat where it is most sustainable with treatments to improve resilience to fire, drought, and insects. This is meant to retain mature forests, consistent with desired conditions and based on the natural range of variability.

We clarified plan components in areas where WHMAs and community buffers areas overlap, so as to avoid duplication or contradicting management. (See Appendix A for specific planning components for WHMAs.)

Aquatic and Riparian Ecosystems

Alternative B also improves watershed conditions, aquatic species diversity, and riparian ecosystems. It does this through plan components addressing watersheds and riparian conservation areas. In addition, plan direction supports State-designated beneficial uses of water and long-term high watershed integrity. Conservation watersheds protect water quality and aquatic at-risk species. Many elements remain similar to alternative A, such as the delineation of riparian conservation areas around streams, rivers, lakes, meadows, and a variety of other wetland types.

Ecosystem and Watershed Resilience and Adaptation to Climate Change

Proposed direction for riparian conservation areas and other aquatic habitats is updated from the existing plans, with the following changes:

- Conservation watersheds and direction is added to restore watersheds, including habitat connectivity. These large-scale conservation watersheds allow for connectivity of habitat, where appropriate, for species to shift their distributions in response to climate change.
- Plan direction addresses biodiversity, including persistence and resilience of habitat to climate stressors
- "Riparian conservation objectives" incorporated into other plan components, because of the potential for confusion with plan component "objectives"
- Direction added to allow prescribed burn ignitions and, where necessary, mechanical and hand treatments to restore ecological integrity and improve the resilience of riparian ecosystems to fire, drought, and climate change.
- Riparian conservation areas are now identified as lands of specific character, a type of management that is delineated by the character of the land, not static boundaries; plan components apply with the areas, but they could change over time through stream channel dynamics

In choosing these watersheds, the Forest Service included the following:

- Conservation watersheds as management areas
- High quality habitat for aquatic, riparian, at-risk species
- Water quality

Watershed Resilience

Plan direction addresses watershed conditions and improve their functioning, soil productivity, and resilience to changes in snowpack, timing of runoff, and other effects of climate change. In conservation watersheds, we included the improvement of roads and other infrastructure to improve water quality. The watershed condition framework is complementary to conservation watersheds. Priority watersheds focus on restoration at a smaller watershed scale and shorter time frame. They could be used for the sub-watersheds in each conservation watershed.

At-Risk Species

Alternative B balances the need to treat larger landscapes, with increased pace and scale for habitat resilience and forest health, with short-term at-risk species protection. Single-species restrictions are less rigid than current plans, so as to allow for more effective landscape restoration. Flexibility to protect at-risk species habitat and to reduce fire threat is provided through exceptions to species protection established by the different strategic fire management zones (see “Topic 1,” above).

For each species of conservation concern, a species persistence analysis evaluates proposed direction identified for both forests and determines their persistence outcome. The persistence analysis is summarized in the “Wildlife, Aquatics, and Plant Species, Species of Conservation Concern” analytical conclusion sections for terrestrial wildlife, aquatic wildlife, and plant species. The complete persistence analysis is in Appendix D of Volume 2.

California Spotted Owl

Alternative B would reduce wildfire and insect and disease risks in densely vegetated areas. The Forest Service could treat vegetation, for example, using mechanical equipment, in spotted owl protected activity centers. However, treatments that affect habitat quality would be limited to no more than one-third of these centers. Plan direction allows for departure from some plan components within the community buffers and in the community wildfire protection zone. This would be the case where these areas do not overlap the WHMA.

Fisher

Plan direction allows for departures of some plan components within the community buffers to provide for public and firefighter safety. Up to 30 percent of any fisher hexagon could be mechanically treated within a 5-year period, provided that resilience goals for reproductive habitat are achievable. The Forest Service could use additional mechanical treatments after considering the short-term and long-term benefits and costs.

Plan direction avoids creating new permanent linear features such as roads or trails that predators could use to more easily access fisher habitat. Plan direction also avoids activities that might sever fisher linkage areas. These are important to allow fishers to move between core areas and maintain genetic diversity. Additional plan direction emphasizes reducing other contributing sources of fisher mortality, especially risks associated with rodenticides and collisions with vehicles.

Great Gray Owl

In addition to desired conditions that are the same under all plan revision alternatives, alternative B includes the following direction:

- Manage meadows in protected activity centers to enhance habitat for prey species
- Minimize disturbance that may lead to breeding failure, during the nesting and breeding season, except in community buffers where they do not overlap WHMAs

- Provide habitat for fledglings around nests (activity center), except in the community wildfire protection zone, including community buffer areas, that do not overlap with WHMAs

Northern Goshawk

All plan revision alternatives provide that protected activity centers have habitat conditions that support nesting and successful reproduction. An example of such conditions is high canopy cover, with large trees and old forest characteristics. Alternative B also would minimize disturbance that may lead to breeding failure. It would prioritize necessary treatments in protected activity centers, except in community buffers that do not overlap with WHMAs.

Sierra marten

Alternatives B would retain favorable ecological conditions in marten core habitat, except in community buffers.

Revision Topic 3: Sustainable Recreation and Designated Areas

Sustainable Recreation

In response to the draft EIS, members of the public expressed concern that the management for recreation was not clear enough. Relying on the ROS, a framework that is over 40 years old, does not adequately address contemporary recreation uses and management needs. It also can create confusion between plan level management and travel management, which is a project level decision.

Alternative B includes three distinct recreation management areas (RMAs) as described below. This framework focuses management where it is most needed and manages recreation based on an area's distinct desired conditions, such as high concentration versus low density.

The RMA types are as follows:

1. **Destination recreation areas (DRAs)—**These areas would have high levels of recreation, supported by more facilities, amenities, and services than other areas. Iconic destinations or well-known features attract visitors to specific locations. DRAs provide the most developed recreation opportunities in the national forest. The public will find high densities of visitors with a variety of activities available. DRAs emphasize such facilities as roads, parking lots, and restrooms. Conservation education and interpretation focus on developing a land ethic as part of the recreation experience. ROS classes in DRAs would be primarily rural, roaded modified, and roaded natural, with some semiprimitive motorized and semiprimitive nonmotorized.
2. **General recreation areas (GRAs)—**These areas would be less developed, with fewer facilities, amenities, and services than DRAs. There would be opportunities for a range of activities for visitor participation, with moderate levels of use. Over time, GRAs may become more developed if necessary to accommodate changing use levels and types and to protect resources.

   In GRAs, multiple uses, other than recreation, are more evident than in DRAs and in challenging background areas (see below). Recreationists may be near areas with working landscapes, maintained for multiple uses. These are areas where there are such multiple uses as fuelwood gathering, vegetation management, livestock grazing, utility infrastructure, and mining. Some lands may be modified to meet social, economic, and ecological objectives. ROS classes in GRAs would be primarily rural, roaded natural, and roaded modified, with some semiprimitive motorized and semiprimitive nonmotorized.

3. **Challenging backroad areas (CBAs)—**These areas would be undeveloped, natural, and suited for dispersed recreation and more challenging activities. CBAs would be maintained for low visitor use and density and limited Forest Service presence. They would be generally in remote areas with few amenities and limited recreation management. The Forest Service may allow the continuation of such multiple uses as fuelwood gathering, vegetation management, livestock grazing, existing utility infrastructure, and mining. Motorized and nonmotorized uses would both be expected in CBAs, but they would be challenging, due to the terrain and the low density of roads and trails. Use levels would be low and users would be spread out, minimizing opportunities for conflict. ROS classes in CBAs would be primarily semiprimitive motorized and semiprimitive nonmotorized, with some roaded natural and roaded modified.

ROS classes are corrected and updated and are complementary to the recreation framework described above. The Forest Service would use ROS for decisions on facility and infrastructure design and development, while DRAs, GRAs, and CBAs more comprehensively address the other aspects of visitor use.

Recommended Wilderness

Alternative B would recommends including one area of the Sequoia National Forest in the National Wilderness Preservation System: 4,906 acres within the GSNM, contiguous with the existing designated Monarch Wilderness. Alternative B would make no recommendations to include additional areas of the Sierra National Forest in the National Wilderness Preservation System.

Pacific Crest National Scenic Trail

Alternative B creates a management area for the Pacific Crest National Scenic Trail. It does this by defining a corridor of the visual foreground landscape zone, as defined by the scenery management system. The area would be up to one-half mile from the centerline of the trail, where visibility is not obscured by terrain.

Management area-specific desired conditions, standards, and guidelines and a management approach protect the nature, purposes, and resource values of the trail from degradation by activities and development. No new roads (roads that are not designated and there is no existing footprint) within the corridor are permitted unless required by law to provide access to private lands or documented as the only prudent and feasible alternative. New motorized recreation and mountain biking trails in the Pacific Crest National Scenic Trail management area may be authorized by site-specific travel management decisions. The Forest Service would design the trails to minimize the visual, sound, and resource impacts on the Pacific Crest National Scenic Trail.

Alternative C

Alternative C was developed to focus management on addressing Issues 1 (Ecological Resilience, Wildlife Habitats, and Wildfire) 5 (Protecting Aquatic Diversity), and 6 (Recommended Wilderness). The public and other agencies raised these issues, as identified in chapter 1.

Revision Topic 1: Fire Management

Strategic Fire Management Zones

Under alternative C, the fire management zones would retain the same distance-based, wildland-urban intermix defense zone around communities as alternative A. It would include a risk-based wildfire maintenance zone similar to alternative B; the remainder of the forest would be managed as the general fire zone. (See chapter 3, figure 17, page 128 for a map and more information, and volume 3 for maps of the strategic fire management zones in each national forest.)

- Similar to alternative A, the **wildland-urban intermix defense zone**, which is the zone closest to communities, would remain a high priority for hazardous fuel reduction treatment. It would reduce the intensity of wildfires in these areas, while avoiding or minimizing mechanical thinning treatments in habitats for the spotted owl and fisher. Maintenance treatments using prescribed fire instead of mechanical treatments would be the preferred management method, whenever possible.
- Similar to alternative B, the wildfire maintenance zone is made up of areas with very low risk, based on modeled wildfire potential spread and intensity, which would have mostly positive effects on resources. In this zone, restoring the role of fire is important to achieve ecological sustainability. Most wildfires in this zone would be managed to meet resource objectives under specific conditions and when it could be done safely. Prescribed burning would be used in areas where it would increase the opportunity to manage wildfires and restore fire-adapted ecosystems.
- The remainder of the forest would be the general fire zone, which would be managed to meet desired conditions that are a combination of the general wildfire protection zone and wildfire restoration zones under alternative B. Since the general fire zone includes a range of modeled fire risk, the associated uncertainty makes it less helpful as a planning aid to inform fire management decisionmaking. Wildfires in the general fire zone, where fuel conditions are close to desired conditions, may be managed to meet resource objectives. This would be done when conditions allow and when it could be done in a safe manner. There would be less strategic treatment using mechanical methods as a precursor to larger prescribed burns.

Managing Wildfire to Meet Resource Objectives

Alternative C provides desired conditions and resource objectives that allow more wildfires to be managed to meet resource objectives when it is safe to do so. The conditions and opportunities to manage wildfires vary by strategic fire management zone and the condition of fuels on the landscape. Plan direction for the wildfire maintenance zone is the same as under alternative B. Species-specific plan direction to provide for habitat conditions for certain wildlife species would override direction for strategic treatments designed to make it easier to manage wildfires to meet resource objectives.

Revision Topic 2: Ecological Integrity

Terrestrial Ecosystems

Ecosystem Resilience and Adaptation to Climate Change

Alternative C focuses vegetation and fuel reduction treatments in the wildland-urban intermix defense zone. It would restore vegetation desired conditions in the larger landscape with limited, strategic use of mechanical thinning and a heavier emphasis on prescribed fire and wildfire managed primarily for resource objectives. This is contingent on it being safe and consistent with desired conditions. Alternative C includes management direction focused on wildlife habitat considerations to address changed conditions associated with large and severe disturbances; examples are uncharacteristic wildfires, bark beetle outbreaks, and drought.

Complex Early Seral Habitat

As with alternative B, alternative C would include plan components that contribute to the ecological integrity of complex early seral habitats after high-severity fires and other stand-replacing events. Management under alternative C would vary from alternative B; it would leave most burned areas to recover naturally with no planting, even after large and severe wildfires. Where possible, 10 to 15 years after the initial fire, the Forest Service would treat half of the burned areas (including those burned at low to moderate severity) with prescribed fire. It would do this to reduce accumulations of fuels and restore forest ecosystem function.

Wildlife and Plant Habitat Diversity

The Forest Service would use other plan components to keep desired landscape conditions in the upper end of the moist mixed-conifer vegetation. This is in contrast to alternative B, which calls for desired conditions that are within the natural range of variation for all habitat types.

Aquatic and Riparian Ecosystems

Ecosystem and Watershed Resilience and Adaptation to Climate Change

In addition to the CARs identified under alternative A, the Forest Service added conservation watersheds and additional CARs to alternative B. Proposed direction for riparian conservation areas has increased protections for aquatic habitats from certain forest activities; specifically it would exclude equipment in the riparian conservation area. Alternative C allows prescribed fire to be used in riparian areas to restore desired riparian and fuel conditions.

Riparian vegetation in the two national forests are adapted to disturbance, including that from fire. Reintroducing fire as a tool, as proposed under alternative C, could improve riparian conditions for many native plants.

Watershed Resilience

Much of the plan direction for watersheds does not vary between alternatives B and C; however, alternative C includes CARs and conservation watersheds. The Sequoia National Forest conservation watersheds include almost all CARs in the plan area; it does not include a small portion of Mill Flat Creek CAR.

At-Risk Species

Alternative C was developed to address concerns about whether alternative B provides adequate short-term protections for wildlife habitat. It includes direction to minimize the effects of vegetation management and fuels reduction on habitats. It would limit disturbance during the breeding season and preserve specific structural components, such as large trees and high canopy cover for at-risk species. Exceptions to single-species restrictions are minimal under this alternative, compared with alternatives B and D.

Alternative C allows fewer exceptions in protected activity centers for species of conservation concern, territories, and core habitat. There are more restrictions on where mechanical thinning can occur, and limited operation periods have no exceptions in different fire management zones.

For wildlife associated with old growth forests, alternative C would retain larger trees, minimize reductions in dense canopy cover, and retain high densities of large snags, downed logs, and larger trees with cavities or deformities important for wildlife.

California Spotted Owl

Much of the plan direction is similar to that under alternative B, but a few plan components are substantially different. Specifically, vegetation would be treated primarily using prescribed fire and hand treatments. Mechanical treatments would be limited to no more than one-third of a spotted owl protected activity center. Alternative C does not include exceptions to the species-specific plan direction for spotted owls in the community buffers or other areas. Under one scenario, salvage harvest would not be allowed in protected activity centers: unless the fire is so severe that the center would have insufficient habitat, and spotted owls would no longer use the area.

Fisher

Alternative C would use the same fisher strategy area, hexagon grid areas, linkage areas, and core areas as alternative B. Alternative C allows more waivers of the limited operating periods to facilitate the greater amount of prescribed burning that would occur and mechanical treatment would be limited to less than 13 percent of fisher hexagon grids within any given 5-year period. As under alternative B, additional plan components would emphasize reducing other contributing sources of fisher mortality, especially risks associated with rodenticides and collisions with vehicles.

Plan direction would not allow exemptions from some plan components near communities and structures. Alternative C would also retain and promote more connectivity of fisher habitat.

Great Gray Owl

Alternative C would manage meadows in protected activity centers to enhance habitat for prey species. It also would minimize disturbance that may lead to breeding failure during the nesting and breeding season and direction to provide habitat for fledglings around nests (activity center). There are no protected activity center areas that are excepted from this direction. In addition, under the meadow direction for prey species, there would be vegetation height standards and range condition and trend standards appropriate to the meadow type.

Northern Goshawk

Alternative C includes direction to limit the total number of acres mechanically treated in protected activity centers. It would minimize disturbance that may lead to breeding failure during the nesting and breeding season. The Forest Service would use information on occupancy and resiliency (or departure from the natural range of variation) when prioritizing protected activity centers for treatment. There are no protected activity center areas that are excepted from this direction.

Sierra Marten

Alternative C would retain favorable ecological conditions in core habitat, with no exceptions for community buffer areas. It would maintain or increase understory heterogeneity in marten denning habitat.

Revision Topic 3: Sustainable Recreation and Designated Areas

Sustainable Recreation

Alternative C includes the same RMA framework as alternative B, with a different configuration of lands in each management area. There is more land in the CBA and generally less in the DRAs and GFAs.

Recommended Wilderness

Alternative C includes the most area of recommended wilderness of all alternatives, including many areas that the public identified for consideration. Alternative C would recommend including 36 areas in the National Wilderness Preservation System. In the Sierra National Forest, this would include 12 areas (133,922 acres) that are contiguous with designated wilderness and 5 areas (83,793 acres) that are not contiguous, for a total of 217,715 acres. In the Sequoia National Forest, this would include 12 areas (114,179 acres) that are contiguous with designated wilderness and 7 areas (120,733 acres) that are not contiguous, for a total of 234,912 acres.

Pacific Crest National Scenic Trail

Alternative C also increases the size of the management area for the Pacific Crest National Scenic Trail to up to 4 miles from the centerline of the trail. This would better provide for the scenic values of the trail and viewpoints. The plan direction assigned to the corridor would be the same as under alternative B, except new utility rights-of-way would be prohibited across or along the Pacific Crest National Scenic Trail.

Alternative D

Alternative D emphasizes increased pace and scale of restoration to improve resilience to fire, drought, climate change, insects, and diseases, while enhancing economic and social sustainability. To a greater degree than alternative B, it emphasizes long-term habitat conservation and ecosystem resilience, accepting short-term impacts on at-risk species associated with mature forests to reduce the risk of habitat damage or loss from large high-intensity wildfire. This alternative uses focus landscapes (see below) to strategically use fire and vegetation treatments over large areas. Alternative D emphasizes leveraging appropriated funding with grant and partner funding to better ensure projects are economically feasible and more likely to be implemented.

Focus Landscapes

Focus landscapes are areas, generally from 40,000 to 100,000 acres, where mechanical thinning and prescribed burning are used strategically to treat enough of the landscape to change potential wildfire behavior. Another use of focus landscapes is to improve the resilience of vegetation there. Focus landscapes are selected near community wildfire protection zones that contain mature forest or fisher linkage areas (similar to alternative B WHMAs) and have moderate or high fire risk. Focus landscapes are defined by strategic ridgetops, roads, and other features that break up the landscape into units that managers might tactically use to manage fires. The focus landscape areas include a 1,000-foot-wide buffer, from the boundary ridgetops and roads, for effective fuelbreak treatment. The Forest Service will focus especially on areas most departed from vegetation desired conditions. These are typically drier sites that have grown denser than is sustainable and areas that are not moving toward vegetation desired conditions.

Revision Topic 1: Fire Management

Strategic Fire Management Zones

Alternative D uses the same strategic fire management zones and the same direction as alternative B. To reduce safety risks to firefighters, especially in strategic fuelbreaks, there is no requirement to leave clumps of snags and down logs in treatment units in the focus landscapes; however, vegetation desired conditions still apply. (See chapter 3, figure 16, page 126 for a map and more information, and volume 3 for maps of the strategic fire management zones in each national forest.)

Managing Wildfire to Meet Resource Objectives

Alternative D uses the same approach as alternative B to emphasize an increased management of wildfires to meet resource objectives when it is safe to do so.

Revision Topic 2: Ecological Integrity

Terrestrial Ecosystems

Ecosystem Resilience and Adaptation to Climate Change

Alternative D is similar to alternative B, except that it prioritizes treatments in focus landscapes. It uses the same landscape strategies and approaches as alternative B with the following changes:

- It includes focus landscapes, where concentrated restoration treatments would be used, such as variable density thinning, strategic fuelbreaks, and fuels reduction. The Forest Service would facilitate greater use of landscape-scale prescribed burning by providing more fuel treatment anchor points and containers. Also, the Forest Service would design focus landscape treatments to move vegetation structure and composition toward desired conditions. The treatments would improve treated forest ecosystems' resilience to stressors, such as uncharacteristic wildfires, insect and disease outbreaks, drought, and climate change.
- Where it is physically and economically feasible to do so, alternative D emphasizes the strategic use of mechanical treatments. This would facilitate greater management of wildfire, by using prescribed burning at greater landscape scales and managing wildfires to meet resource objectives, when conditions allow and when it can be done in a safe manner.
- Alternative D allows more treatments in Community Wildfire Protection Zones, especially in the community buffers, with few restrictions.
- It would provide more emphasis on creating structural variability with management treatments.
- There would be more exceptions to diameter limits for removing large trees across the two national forests. There would be higher diameter thresholds to retain large hardwood trees and exceptions in the community wildfire protection zone and focus landscapes.

Alternative D would manage old forests in ways similar to alternative B. It would restore old forest stand structure and composition, increase the resilience of old forests to stressors, and increase the relative representation of old forests on the landscape.

Alternative D has direction similar to alternative B for managing large, stand-replacing events, such as uncharacteristically large and severe wildfires. It offers greater potential for economic salvage and fuels reduction and for reforesting areas of large, high-severity fires.

Alternative D also includes specific management direction to address changed conditions associated with large, stand-replacing disturbances, such as uncharacteristic wildfires, bark beetle outbreaks, and drought.

Complex Early Seral Habitat

As under alternative B, alternative C would include plan components that contribute to the ecological integrity of complex early seral habitats after high-severity fires and other stand-replacing events. However under alternative D there are exceptions for management direction in the entire community wildfire protection zone.

Wildlife and Plant Habitat Diversity

Alternative D incorporates most of the same forestwide direction regarding at-risk species as alternative B. The difference is that alternative D prioritizes constructing firelines around old trees high wildlife value for at-risk species.

Alternative D focuses on the long recovery time for habitats of many at-risk species. The level of restoration treatments would increase so that the desired conditions in terrestrial habitats be achieved at a moderate to high pace.

Aquatic and Riparian Ecosystems

Ecosystem Resilience and Adaptation to Climate Change

Alternative D does not identify management areas, such as critical aquatic refugia or conservation watersheds; instead, it identifies forestwide direction for protecting aquatic and riparian resources, including upland portions of watersheds, and at-risk species. Direction for riparian conservation areas includes the riparian conservation areas around ephemeral streams in lands suitable for timber production.

Watershed Resilience

Watershed planning components are similar to those under alternative B, but there are no conservation watersheds under alternative D.

At-Risk Species

Alternative D contains forestwide plan direction for at-risk species. It includes more exceptions for limited operating periods, higher percentages of allowable disturbance in protected activity centers and core habitats, and exceptions in community buffers, community wildfire protection zones, and focus landscapes.

California Spotted Owl

Direction would be similar to that under alternative B; however, the exceptions that apply to only portions of the community wildfire protection zone would apply to the entire zone. In some cases, exceptions are expanded to the focus landscapes or to the construction of a system of fuelbreaks in the focus landscapes.

Fisher

Outside of focus landscapes, direction for fisher would be the similar to the forestwide fisher direction and fisher-related direction of the WHMA. In focus landscapes, it would be similar, except it would allow up to 50 percent of a fisher hexagon grid area to be treated within a 5-year period. The limited operating periods in focus landscapes apply to areas known to support, or likely to support, denning, instead of all modeled denning habitat.

Great Gray Owl

Alternative D would manage meadows in protected activity centers to enhance habitat for prey species. It would minimize disturbance that could lead to breeding failure, during the nesting and breeding season, except in community buffers. Finally, it would provide habitat for fledglings around nests (activity center), except in the community wildfire protection zone and community buffers.

Northern Goshawk

Alternative D would minimize disturbance that could lead to breeding failure during the nesting and breeding season, except in community buffers. It would use information on occupancy when prioritizing protected activity centers for treatment, except in the community wildfire protection zone and community buffers.

Sierra marten

Alternative D has the same direction as alternative B.

Revision Topic 3: Sustainable Recreation and Designated Areas

Sustainable Recreation

Alternative D includes the same RMA framework as alternative B. In the Sequoia National Forest, compared with the other plan alternatives, more total area would be allocated to GRAs and DRAs and less total area would be allocated to CBAs. In the Sierra National Forest, compared with the other plan alternatives, more total area would be allocated to GRAs and less total area would be allocated to DRAs and CBAs.

Recommended Wilderness

There is no recommended wilderness under alternative D.

Pacific Crest National Scenic Trail

Alternative D would create a management area allocation for the Pacific Crest National Scenic Trail. It does this by defining a corridor of the visual foreground landscape zone, as defined by the scenery management system. The area would be up to one-quarter mile from the centerline of the trail where visibility is not obscured by terrain. The plan direction assigned to the corridor would be the same as under alternative B.

Alternative E

Alternative E is similar to alternative C; it includes less total area recommended for inclusion in the National Wilderness Preservation System and it would not use the recreation management framework in Alternatives B, C, and D. Instead, alternative E would manage for recommended wilderness, GRAs and BMAs.

Revision Topic 3: Sustainable Recreation and Designated Areas

Recommended Wilderness

Alternative E was developed to respond to concerns over the effects that mechanized and motorized uses would have on recommended wilderness (Issue 6). This alternative recommends less wilderness than alternative C and creates a BMA that allows for mountain biking and motorized uses on existing authorized roads.

Alternative E would recommend including 12 areas in the National Wilderness Preservation System. This would include six areas in the Sierra National Forest, five areas in the Sequoia National Forest, and one area that would include land within both forests. The Monarch Wilderness Kings River Addition would include a total of 70,657 acres (56,356 acres within the Sierra National Forest and 14,301 acres within the Sequoia National Forest), would be contiguous with existing designated wilderness, and would include 36,553 acres within GSNM.

In the Sierra National Forest, recommended wilderness would include one other area (37,057 acres) contiguous with existing designated wilderness and five areas (70,661 acres) that are not. Alternative E would recommend including a total of 164,074 acres in the National Wilderness Preservation System, including 22,336 acres of the Monarch Wilderness Kings River Addition that would be within the GSNM.

In the Sequoia National Forest, recommended wilderness would include two other areas (70,622 acres) contiguous with existing designated wilderness and three areas (76,620 acres) that are not. Alternative E would recommend including a total of 161,543 acres in the National Wilderness Preservation System, including 14,217 acres of the Monarch Wilderness Kings River Addition and 10,188 acres of the Golden Trout Wilderness Addition that would be within the GSNM.

Backcountry Management Areas

Alternative E would also allocate areas as BMAs, primarily for semiprimitive recreation. BMAs would be composed of a large portion of the lands recommended as wilderness under alternative C, as well as other lands. Current recreation and access, including mechanized transport and motorized recreation on existing routes, would not be restricted as a result of BMA designation. Recreation would be managed for less development and less concentration of use.

Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required by the National Environmental Policy Act to rigorously explore and objectively evaluate reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received during the plan revision process provided suggestions for the proposed revised plan. Some of these suggestions may not have been part of identified needs for change, were duplicative of the alternatives considered in detail, or were determined to contain components that would cause unnecessary environmental harm.

A number of alternatives were considered, but dismissed from detailed consideration for reasons as summarized in the following paragraphs.

Eliminated Alternative 1: Restore over half of the landscape within 10 to 15 years

One suggested alternative called for substantially more vegetation management, including thinning and using selective harvesting and prescribed fire to restore the national forests' resilience to fire, drought, insect and pathogen outbreaks. This alternative was not considered in detail because it would require an increased workforce and budget, more than is feasible for the Forest Service, given budgets received in recent years. More than half of the landscape in the national forests is in special designated areas, such as wilderness, monuments, or wild and scenic river corridors; in these areas the use of motorized equipment or mechanical transport may be restricted. Another 25 percent of the total area of the national forests have restrictions on road access, such as inventoried roadless areas managed under the 2001 Roadless Rule[6]. These restrictions require more management to transport staff and equipment needed to restore these areas.

There are areas of particularly steep grades where restoration using equipment can be difficult. This is because restoration must be designed to avoid unacceptable ecological damage, due to accelerated erosion risks. There are other areas where sensitive ecological conditions and endangered species require restraint and caution in the level of treatment and the rapidity of that treatment. Scientific knowledge is continuing to provide new insights into the biology of at-risk species in these forests; there is a concern about the consequences of rapid change in habitat.

Another limitation to rapid restoration related to forest thinning is the industry's capacity to do the work and use materials. Currently there is limited infrastructure to process the timber resulting from restoration. If restoration outpaces infrastructure capacity, then the Forest Service's costs would increase and our capability to fund restoration would decrease. Therefore, there is a limitation on the capability of the Forest Service to restore forests; this is directly related to the limited capacity of the industry infrastructure.

The alternatives being considered increase the use of prescribed fire over current levels. The Forest Service recognizes that there are limits to conducting more prescribed burning, imposed by air quality restrictions, forest conditions, and forest capacity and resources. Smoke and its impact on the health of rural communities is also a concern and can be a limitation on the number of acres and timing of prescribed burning.

One of the identified needs for plan revision is "to improve recreation facilities, settings, opportunities and access and their sustainability." Rapidly addressing landscape restoration would contribute to long-term recreation sustainability; nevertheless, during the time of rapid restoration there would be an impact on recreation and the recreation experience. This would be the result of more smoke or fire on the landscape from prescribed fire, more crews and big trucks, or closed and restricted access to campgrounds while tree cutting and equipment operations are going on. The proposed level of restoration would limit the Forest Service's ability to meet the purpose and need for recreation. This is because access and recreation opportunity would be substantially diminished during the plan period.

Alternatives B and D increase the amount of restoration, but the amount would still affect only about 20 to 40 percent of the treatable portions of the national forests per decade. The amount of

[6] The 2001 Roadless Rule establishes prohibitions on road construction, road reconstruction, and timber harvesting in inventoried roadless areas on National Forest System lands. See 36 CFR Part 294 for details.

restoration accomplished by managing wildfires to meet resource benefits would increase this, but it would depend entirely on actual wildfires, which could only be estimated and not planned. We expect that this pace may adjust in the future, if capacity for active management increases.

Eliminated Alternative 2: Include all areas identified by the public as recommendations for additions to the National Wilderness Preservation System

Various groups and individuals submitted feedback specific to the wilderness inventory and evaluation processes. They suggested additional areas that should be included in the preliminary administrative recommendations for additions to the National Wilderness Preservation System. The Forest Service considered these areas during the inventory and evaluation following the 2012 Planning Rule and associated implementation directives, as described in Appendix B.

Forest supervisors used the wilderness evaluation narratives and public input to identify which specific areas, or portions thereof, to carry forward as recommended wilderness into the draft environmental impact statement analysis. Although the Forest Service included in alternatives B and C many areas suggested by the public, we did not analyze in detail all lands in the inventory or suggested by the public. This is because we determined that the areas lack wilderness characteristics, had substantially noticeable human impacts, represented a departure from apparent naturalness due to improvements, had pervasive impacts that would influence a visitor’s opportunity for solitude including pervasive sights and sounds from outside the area, or are unmanageable to preserve their wilderness characteristics. In particular, we considered areas with motor vehicle designations from recent travel management decisions but then excluded from polygon boundaries carried forward for analysis in the draft environmental impact statement. See Appendix B for the full description of the inventory, evaluation, and analysis processes and findings.

Eliminated Alternative 3: Identify critical aquatic refuges around all areas of high aquatic species diversity

One suggested alternative identifies areas of high aquatic species diversity; these areas would be delineated and managed as CARs. Some of these areas were included in at least one alternative that we considered in detail. The remaining areas were not included due to one or more of the following:

- They were a proposed expansion that would not substantially increase the habitat protection of the CAR
- They were in portions of the national forest with a complex landownership pattern
- They were located primarily on lands owned or managed by others
- They were identified for terrestrial and not aquatic species
- They were already in watersheds that are a priority for maintenance or restoration

Eliminated Alternative 4: Evaluate an alternative that has minimal active management and "let nature take its course"

An alternative was suggested that has minimal management of vegetation and allows nature to take its course in shaping the vegetation and conditions in the forest. It was suggested that wildfires would reduce built up fuels and regenerate forests, while creating early seral habitats for species that depend on them. It was also suggested that natural mortality would thin weakened trees, leaving more resources for the remaining trees and vegetation. However, this type of hands-off approach is contrary to the best available science. It recommends restoration efforts for many of the ecosystems that are outside their natural range of variation in the two national forests.

Alternatives B, C, and D address long-term vegetation health in the desired condition statements of how the various vegetation types in the national forests should look and function. Management action is necessary to advance these ecosystems toward the desired conditions and strengthen ecosystem resilience, in the face of expected climate changes.

This alternative also would not meet the requirements of the 2012 Planning Rule, which requires plans to be developed that are ecologically, socially, and economically sustainable. Nor would this alternative achieve various aspects of the purpose and need. For example, it would not accomplish the following:

- Improve ecosystem resilience to fire and climate change
- Decrease the threat of large undesirable fires
- Increase the ability of forests to store and sequester carbon
- Support local economies by maintaining levels of forest product and biomass production that support an economically viable forest products industry and encourages local hiring
- Support economic opportunities in tribal communities, incorporate traditional ecological knowledge, or increase collaboration with the agency to meet restoration goals
- Improve recreation facilities or improve and protect scenic character

This alternative was not analyzed in detail. This is because it is not in alignment with the best available science to achieve desired conditions and it does not meet the stated needs for revision.

Eliminated Alternative 5: Apply the Aquatic Conservation Strategy from the 2001 Sierra Nevada Forest Plan Amendment

Under one suggested alternative, the revised plans would incorporate the aquatic conservation strategy from the 2001 Sierra Nevada Forest Plan Amendment (United States Department of Agriculture 2001d). The fundamental principle of the 2001 Sierra Nevada Forest Plan Amendment aquatic management strategy was "to retain, restore, and protect the processes and landforms that provide habitat for aquatic and riparian-dependent organisms, and produce and deliver high-quality waters for which the national forests were established."

In order for the aquatic management strategy to function as a comprehensive strategy there are a suite of interrelated actions that work together to manage and conserve aquatic habitats, as follows:

- A description of the desired condition of aquatic, riparian, and meadow habitats developed from the aquatic management strategy goals
- An array of land allocations, such as CARs and riparian areas, that delineate aquatic, riparian, and meadow habitats and emphasize specific actions in these areas
- A set of standards and guidelines that specify appropriate land uses and activities in different land allocations
- An ecosystem analysis that enables managers to collect and evaluate relevant data and information over nested geographic zones, such as watersheds in river basins, for the purpose of considering current landscape conditions and results in appropriate, site-specific management decisions, including restoring degraded areas
- An adaptive management program that includes monitoring and research to assess planned management activities and provide information needed to adjust future management activities

The 2001 Sierra Nevada Forest Plan Amendment aquatic management strategy was incorporated into the 2004 Sierra Nevada Forest Plan Amendment (United States Department of Agriculture 2004e). Together they amended the existing forest plans with only a few changes: clarifications and simplifications to eliminate repetition of law, regulation, and policy. These changes were analyzed in the 2004 Sierra Nevada Forest Plan Amendment, so the essential components of the original 2001 aquatic management strategy are included under alternative A.

Eliminated Alternative 6: Consider the document “National Forests in the Sierra Nevada: A Conservation Strategy” as an Alternative

A group of respondents submitted a Conservation Strategy for National Forests in the Sierra Nevada, with a request that it be analyzed as an alternative. It contains several concepts and strategies related to sustainability and resilience of forests in the Sierra Nevada. Some of these concepts are already in place under the current forest plans, such as community fire planning, various collaborative efforts, and completion of travel analysis. Some of the concepts will be incorporated into the planning process and documents; for example, the Forest Service will conduct a science consistency review before we prepare the final environmental impact statement. Other concepts are largely consistent with alternative B. In most instances where alternative B is not in agreement with the conservation strategy, similar concepts and direction were included in alternative C or D and were analyzed in detail.

The Multiple Use Sustained Yield Act[7] states “it is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes.” Similarly, the 2012 Planning Rule requires that plans “provide for social, economic, and ecological sustainability.”[8] This is accomplished by including plan

[7] Public Law 86-517
[8] 36 CFR 219.8

components, including standards and guidelines, "to guide the plan area's contribution to social and economic sustainability."[9]

While the conservation strategy would meet many of the requirements for ecological sustainability, it does not adequately meet the requirements of the Multiple Use Sustained Yield Act or the 2012 Planning Rule requirements for social and economic sustainability. This is because it does not include plan components for sustainable recreation, range, timber and other renewable and nonrenewable energy, and mineral resources.

For these reasons, the Forest Service concluded that a detailed analysis of an alternative based on the conservation strategy was not needed.

Eliminated Alternative 7: Allow Motorized and Mechanized Uses to Continue in Recommended Wilderness

In the feedback on the recommended wilderness inventory and evaluation, the public asked the Forest Service to consider an alternative that allowed motorized and mechanized recreation to continue in recommended wilderness areas. Although Forest Service policy allows decisionmakers to consider letting existing uses continue, we can do so "only if such uses do not prevent the protection and maintenance of the social and ecological characteristics that provide the basis for wilderness designation."[10] By controlling the setting, including the environmental, social, and managerial conditions, managers influence the nature and quality of wilderness experiences to a substantial degree (Cole 2010). Thus, this environmental impact statement assesses the impacts of forest management on the wilderness characteristics of recommended areas and that could detract from future consideration of the area as wilderness.

The use of motorized and mechanized transportation in recommended wilderness areas affects their undeveloped wilderness quality and opportunities for solitude or primitive and unconfined recreation. In addition, motorized and mechanized transport is not compatible with the primitive recreation, which, specifically in designated wilderness, has largely been interpreted as travel by horse, foot, and canoe (Landres et al. 2005). Also, the public have identified the presence, volume, and type of other users and the sounds and smells associated with motorized vehicles as affecting solitude.

We considered a management approach, to allow motorized and mechanized transportation to continue in recommended wilderness areas, as long as we protect and maintain the ecological and social characteristics that provide the basis for the area's suitability for inclusion in the National Wilderness Preservation System. However, this requires monitoring a number of factors, including the level of existing use at the time of recommendation, levels of use over time (increase, decrease, or neutral), and the effects of the continued use on wilderness characteristics. This is a challenging monitoring effort in a fiscally constrained environment.

We eliminated this alternative from detailed analysis. This was because of its potential impacts on wilderness character qualities and wilderness characteristics, which may prevent the protection and maintenance of the social and ecological characteristics that provide the basis for future

[9] 36 CFR 219.8(b)
[10] Forest Service Handbook 1909.12, chapter 74.1

wilderness designation. Also, monitoring continued motorized and mechanized uses in recommended wilderness would be difficult.

Eliminated Alternative 8: Modifications to Existing Wilderness

An alternative was submitted that included three proposals involving adjustments to the boundaries of the Golden Trout Wilderness, designated in 1978, and the South Sierra Wilderness, designated in 1984. According to the proponent of these proposals, these boundary adjustments would restore roughly 5 miles of multiple use trails, which would reconnect more than 70 miles of loop trails.

The Forest Service does not have the authority to make boundary adjustments to existing wilderness areas; only Congress can do that. This plan and accompanying analysis would only be recommending a change to currently designated boundaries. There would be no change in management direction as the agency cannot change management of currently designated areas.

Rincon Trail: One of the proposals is to recommend that Congress remove approximately 750 acres from the Golden Trout Wilderness. It would adjust the boundary to exclude the historic Rincon Trail (33E23), which, according to the proponent, would allow for motorized multiple use loop trail opportunities for the Schaefer 33E24 and Rattlesnake 34E22 multiple use trails.

Forest Service maps from 1975 and 1977, just before the Golden Trout Wilderness was designated, show that an official route limited to motorcycle use did exist along the Kern River in the area proposed for boundary modification. Trail 33E20 east of the Little Kern River was a designated two-wheel vehicle route from which users could travel to the Little Kern River from the east; however, users had to return the same way. This official motorcycle route was not part of a trail loop. Trail 33E20 continued west of the Little Kern River as a nonmotorized trail to the Soda Springs area. Trail 33E23, from its intersection with 33E20 to the south, was also nonmotorized. Trail 33E22 from its intersection with 33E23 to its intersection with the Sacratone Trail and 33E24 from 33E22 to Stony Meadow are shown on the 1975 maps as infrequently maintained, nonmotorized trails. No authorized motorized trail loops through this area existed in the years before wilderness designation.

Little Horse Meadow Road: The second proposal recommends that Congress remove approximately 42 acres from the Golden Trout Wilderness. It would do this by realigning the wilderness boundary 500 feet from the west side of Little Horse Meadow Road. According to the proponent, this modification would restore the historic Little Horse Meadow Road 21S42 multiple use road opportunities and also would facilitate needed vegetation management and forest health projects. Forest Service maps from both 1975 and 1977, just before the Golden Trout Wilderness was designated, do not show any official motorized routes in the area proposed for boundary modification; any existing trails before wilderness designation were unauthorized and user-created.

Hooker Meadow Trail: The third proposal would modify approximately 1,465 acres on one side of the South Sierra Wilderness. According to the proponent, this modification would restore the historic Hooker Meadow Trail 35E05 and Broder Meadow Trail multiple use loop trail opportunities to both Jackass Creek Trail 35E13 and Jackass Peak Trail 35E03 multiple use trails. Forest Service maps from 1983, just before the South Sierra Wilderness was designated, indicate that this area was closed to wheeled vehicles traveling cross-country, except on designated routes.

No authorized motorized trail loops included the historic Hooker Meadow Trail, 35E05. On the 1983 map, Trail 35E02, the Broder Meadow Trail, is an authorized motorcycle trail. A small segment of it existed in the area that would later be designated as part of the South Sierra Wilderness. Current maps show that it has been realigned farther west from the 1983 alignment to be outside of wilderness. It no longer passes through Broder Meadow, but the realigned trail still provides the same loop opportunity as it did historically.

If Congress modified the boundary of the Golden Trout Wilderness and the South Sierra Wilderness, it would allow for the possibility of the Forest Service considering multiple use trails in future planning decisions. This would provide for additional motorized use opportunities. Under this scenario, the wilderness character, including opportunities for solitude or primitive and unconfined recreation, that has been protected since 1978 and 1984 would be impacted. In the case of the Rincon Trail proposal, there would also be potential impacts on the North Fork Kern River segment of the Kern Wild and Scenic River. Congress designated this segment for protection and classified it as a wild segment. It requires protection of its outstandingly remarkable values for cultural, fish (populations and habitat), geologic, recreation, scenery, and botany resources.

Eliminated Alternative 9: Discontinue Livestock Grazing in the Forests

The Forest Service considered, but did not analyze in detail, an alternative that would make all land it administers in the plan area unavailable for livestock grazing. This is one of the multiple uses to be managed on national forests; in accordance with 16 USC 528, "It is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, ***range*** [emphasis added], timber, watershed, and wildlife and fish purposes."

During this planning process, including public scoping, the Forest Service did not identify issues or conflicts that could be resolved only by eliminating all livestock grazing throughout the decision area. We have incorporated plan components into the action alternatives to address issues with livestock grazing, thereby eliminating the need to analyze in detail a no-grazing alternative.

Comparison of Alternatives

This section summarizes the differences between the alternatives with respect to the issues to be resolved and their key indicators.

Comparison of Management and Other Areas by Alternative

Table 1 and the Table 2 describe management areas, designated areas, or other areas by alternative for each of the two forests. Under alternative A, areas with specific plan components were called land allocations. The action alternatives—alternatives B, C, D, and E—follow the 2012 Planning Rule instead; as such, plan components apply either forestwide, to lands of specific character, or to specific parcels of land. Plan components for lands of specific character—such as vegetation types or California spotted owl protected activity centers—apply where the characteristics that define these lands exist in the forest, which can naturally change over time.

Rows in Table 1 and Table 2 that refer to lands of specific character are identified with an asterisk. Plan components that apply to specific mapped parcels of land include management areas and designated areas. The boundaries of management areas and designated areas are static, unless changed through statutory or administrative procedures.

A management area is established through the planning process. In this area, the same set of plan components apply to convey a certain management emphasis, such as a WHMA. A management area may or may not be spatially contiguous across the forest. The management areas for wilderness, wild and scenic rivers, and the Pacific Crest National Scenic Trail are also designated areas.

A designated area or feature established by statute, such as a wild and scenic river, or administrative process, such as a research natural area, is managed to maintain its unique special character or purpose.

Table 1 and Table 2 indicate which other designated areas occur.

Table 3 provides a summary of environmental consequences for the major topics addressed in this revised draft environmental impact statement.

Table 1. Management and other areas by alternative, Sequoia National Forest

Area	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Wildland-urban intermix defense zone (acres)	18,503	N/A	18,503	N/A	18,503
Wildland-urban intermix threat zone (acres)	169,971	N/A	N/A	N/A	N/A
Non-wildland-urban intermix zone (“other”) (acres)	622,137	N/A	N/A	N/A	N/A
Community wildfire protection zone (acres) *	N/A	69,558	N/A	69,558	N/A
General wildfire protection zone (acres) *	N/A	60,442	N/A	60,442	N/A
Wildfire restoration zone (acres) *	N/A	211,379	N/A	211,379	N/A
Wildfire maintenance zone (acres) *	N/A	469,202	504,775	469,202	504,775
General fire zone (acres)	N/A	N/A	287,333	N/A	287,333
Wildlife habitat management area (acres)	N/A	227,350	N/A	N/A	N/A
Focus landscapes (acres)	N/A	N/A	N/A	84,669	N/A
Critical aquatic refuges (acres)	188,825	0	248,205	0	248,205
Conservation watersheds (acres)	N/A	381,113	381,113	0	381,113
Riparian conservation areas (acres) *	345,052	345,052	345,052	345,052	345,052

Area	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Designated wilderness (acres)	313,663 (13,289 in GSNM)	313,663 (13,289 in GSNM)	313,663 (13,289 in GSNM)	313,663 (13,289 in GSNM)	313,663 (13,289 in GSNM)
Existing recommended wilderness (acres)	15,110 (entirely in GSNM)	15,110 (entirely in GSNM)	15,110 (entirely in GSNM)	15,110 (entirely in GSNM)	15,110 (entirely in GSNM)
New recommended wilderness (acres)	N/A	4,906 (entirely in GSNM)	234,912 (82,032 in GSNM)	0	161,543 (24,405 in GSNM)
Designated wild and scenic rivers (miles)	105.3	105.3	105.3	105.3	105.3
Existing recommended wild and scenic rivers (miles)	1.0 (0 in GSNM)	1.0 (0 in GSNM)	1.0 (0 in GSNM)	1.0 (0 in GSNM)	1.0 (0 in GSNM)
Eligible wild and scenic rivers (miles)	59.9 (7.9 in GSNM)	329.6 (67.4 in GSNM)	329.6 (67.4 in GSNM)	329.6 (67.4 in GSNM)	329.6 (67.4 in GSNM)
Pacific Crest National Scenic Trail (miles)	47	47	47	47	47
Pacific Crest National Scenic Trail (acres)	116	20,883	46,384	12,261	46,384
Destination recreation area (acres)	N/A	28,005	24,520	33,156	N/A
General recreation area (acres)	N/A	214,646	158,832	229,668	163,848
Challenging backroad recreation area (acres)	N/A	269,128	170,741	249,269	N/A
Backcountry management area (acres)	N/A	N/A	N/A	N/A	208,186
Range suitable (acres)	676,864	676,864	676,864	676,864	676,864

*Rows refer to lands of specific character.

Note: This table does not include lands in the GSNM, except as noted and related to recommended wilderness and eligible wild and scenic rivers. The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision, indicating the recommended wilderness process for the GSNM would occur during the forest plan revision.

Table 2. Management and other areas by alternative, Sierra National Forest[1]

Area	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Wildland-urban intermix defense zone (acres)	50,963	N/A	50,963	N/A	50,963
Wildland-urban intermix threat zone (acres)	273,160	N/A	N/A	N/A	N/A
Non-wildland-urban intermix zone (“other”) (acres)	967,783	N/A	N/A	N/A	N/A
Community wildfire protection zone (acres)*	N/A	155,034	N/A	155,034	N/A
General wildfire protection zone (acres)*	N/A	117,010	N/A	117,010	N/A

Area	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Wildfire restoration zone (acres)*	N/A	310,457	N/A	310,457	N/A
Wildfire maintenance zone (acres)*	N/A	709,405	718,270	709,405	718,270
General fire zone (acres)	N/A	N/A	522,673	N/A	522,673
Wildlife habitat management area (acres)	N/A	455,687	N/A	N/A	N/A
Focus landscapes (acres)	N/A	N/A	N/A	232,300	N/A
Critical aquatic refuges (acres)	42,387	0	198,625	0	198,625
Conservation watersheds (acres)	N/A	422,180	422,180	0	422,180
Riparian conservation areas (acres)*	718,066	718,066	718,066	718,066	718,066
Designated wilderness (acres)	553,056 (0 in GSNM)	553,056 (0 in GSNM)	553,056 (0 in GSNM)	553,056 (0 in GSNM)	553,056 (0 in GSNM)
Existing recommended wilderness (acres)	0	0	0	0	0
New recommended wilderness (acres)	N/A	0	217,715 (13,213 in GSNM)	0	164,074 (22,356 in GSNM)
Designated wild and scenic rivers (miles)	43	43	43	43	43
Existing recommended wild and scenic rivers (miles)	38 (0 in GSNM)	38 (0 in GSNM)	38 (0 in GSNM)	38 (0 in GSNM)	38 (0 in GSNM)
Eligible wild and scenic rivers (miles)	11.4 (8.7 in GSNM)	46.9 (8.7 in GSNM)	46.9 (8.7 in GSNM)	46.9 (8.7 in GSNM)	46.9 (8.7 in GSNM)
Pacific Crest National Scenic Trail (miles)	27	27	27	27	27
Pacific Crest National Scenic Trail corridor (acres)	42	15,033	86,631	8,084	86,631
Destination recreation area (acres)	0	129,229	45,533	50,022	N/A
General recreation area (acres)	0	552,413	448,051	636,116	502,971
Challenging backroad recreation area (acres)	0	73,452	45,603	68,346	N/A
Backcountry management area (acres)	N/A	N/A	N/A	N/A	144,550
Range suitable (acres)	855,425	855,425	855,425	855,425	855,425

*Rows refer to lands of specific character.

[1] This table does not include lands in the GSNM, except as noted and related to recommended wilderness eligible wild and scenic rivers. The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision, indicating the recommended wilderness process for the GSNM would occur during the forest plan revision.

Summary of Consequences for the Major Topics

Table 3. Summary of consequences for the major topics addressed in this revised draft environmental impact statement

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Agents of Change Combined effects of climate change, uncharacteristic fire, insects, and pathogens	Relatively low restoration treatment rates would somewhat reduce the combined impacts of climate change, uncharacteristic fire, insects, and pathogens, but only in a limited number of treated areas in the larger landscape. Conservation of moderate- to high-density canopy cover in late seral forest habitat would result in low resilience to stressors.	Moderate restoration treatment rates would reduce the combined impacts of climate change, uncharacteristic fire, insects, and pathogens in more areas than under alternative A. Treated terrestrial ecosystems would have enhanced capacity to resist the interactive effects of multiple stressors.	Similar to alternative A but with greater resilience of terrestrial ecosystems to combined stressors resulting from higher fire restoration (prescribed fire, wildfire managed for resource objectives) treatment rates.	Similar to alternative B but would have more restoration across the landscape, resulting in the lowest combined impacts of climate change, uncharacteristic fire, insects, and pathogens. Treated terrestrial ecosystems would have a higher capacity to resist the interactive effects of multiple stressors.	Similar to alternative C but with slightly less uncertainty in restoration treatment rates because of less recommended wilderness. This would provide greater certainty that terrestrial ecosystems, over a slightly greater area, would be resilient to interacting stressors.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Wildland Fire Management	Average annual burned acreage, large fire size, and fire intensity are expected to continue to increase. Limited vegetation restoration, including mechanical thinning, prescribed fire, and wildfire managed to meet resource objectives, would occur in most areas. Based on the projected trends with climate change, burned areas would increase by 2 to 4 times, with much of this increase attributed to larger, more severe wildfires.	Changes in fire management toward a risk-based approach would result in more wildfire that is managed to meet resource objectives, especially in the wildfire maintenance zone and in some portions of the wildfire restoration zone. The increased flexibility and better defined resource desired conditions and objectives, compared with alternative A, would improve the Forest Service's ability to treat prioritized areas. This would decrease the likelihood of large, high-intensity and high-severity future fires. There is moderate uncertainty that the levels of projected prescribed fire treatments would occur, due to smoke management and air quality concerns, agency capacity and budgets, and potential impacts on natural and cultural resources	The proposed area treated with prescribed fire and wildfire managed for resource objectives would increase and could more than double, on average, compared with alternative A. there are greater uncertainties associated with potential restoration rates and outcomes under this alternative, resulting from less flexibility in restoration approaches. The limited use of pre-fire fuels reduction under alternative C would increase the risk or impacts on public and firefighter safety, air quality, wildlife habitat, and other concerns. This increased risk would result in fewer opportunities for prescribed burning or wildfires managed for resource objectives, especially in the foothill and montane zones next to communities or those that experienced high levels of tree mortality following the 2012–2016 drought.	Alternative D is proposed to have the greatest level of restoration of all types. Proposed plan direction guiding restoration and fire management would be mostly similar to alternative B. However, alternative D emphasizes restoration in focus landscapes that primarily occur in or near the community wildfire protection zone and areas that provide habitat for California spotted owl, fisher, and other forest-dependent species. Given the high rates of restoration under alternative D, there would be a decrease in the amount of crown fire, resulting in smaller patches of high-severity fire that is closer to the natural range of variation.	The consequences of alternative E would be similar to alternative C, because restoration treatment rates (mechanical thinning, prescribed fire, and wildfire managed for resource objectives). Uncertainties in these rates would be similar between these alternatives. There is slightly less uncertainty in treatment rates under alternative E, compared with alternative C, because less recommended wilderness under alternative E would provide greater flexibility in wildfire management options over a greater proportion of the landscape.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Air Quality	Increases in emissions and other cumulative effects would make long-term attainment of emissions goals unlikely.	Restoration activities would increase emissions and affect air quality in the short term, but the degree of increase depends on the amount of treatment. In the long term, restoration would reduce emissions from wildfires.	Same as alternative B, except, given the focus on managed and prescribed fire for restoration, there could be higher expected short-term emissions. To the extent that prescribed burning and wildfires managed to meet resource benefits occur, a reduction in wildfire smoke would make long-term attainment of visibility goals more likely than under alternative A but less likely than under alternatives B and D.	Same as alternative B except, given the highest pace and scale of restoration activity, in the long-term, alternative D has the greatest potential to reduce emissions from wildfires. The restoration treatments would result in the greatest reduction in wildfire emissions. This alternative has the greatest likelihood of long-term attainment of visibility.	Similar to alternative C.
Terrestrial Ecosystems— Montane and Upper Montane zones	Fewer opportunities for restoration, including use of wildfire to achieve resource objectives. This would result in slower return to desired conditions in ecosystem structure, composition, and resilience than in the other alternatives.	There would be higher restoration rates across larger landscapes than alterative A, primarily through increased use of wildfire to meet resource objectives. This would result in greater restoration of desired conditions for ecosystem structure, composition, and resilience over a moderate portion of the montane and upper montane zones.	Higher restoration rates than under alternative A would result in faster return to desired conditions in the montane and upper montane zones. However, greater emphasis on prescribed fire and wildfire managed for resource objectives would create greater uncertainty, and restoration rates of desired ecosystem conditions would be slower than under alternative B, due to relatively lower treatment rates.	Similar to alternative B, except with greater restoration of ecosystem structure, composition, and resilience in the montane and upper montane zones, especially in focus landscapes.	Similar to alternative C, but with slightly less uncertainty in restoration treatment rates because of less recommended wilderness. This would provide greater certainty that the structure, composition, and resilience of ecosystems in the montane and upper montane zones would return to desired conditions.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Terrestrial Ecosystems— Foothill, subalpine and alpine, and arid shrublands and woodlands zones	Lower rates of restoration than the plan revision alternatives and slower to achieve desired conditions across foothill, subalpine and alpine, and arid shrublands and woodland zones.	Greater restoration treatment rates, compared with alternative A, would move ecosystems in these ecological zones toward desired conditions. The main effects would be less dense and more heterogeneous structure and reduced nonnative invasive plants. These changes would increase ecosystem resilience to stressors throughout foothill, subalpine and alpine, and arid shrublands and woodland zones.	Greater restoration rates than under alternative A would result in quicker return to desired conditions in these ecological zones. However, greater emphasis on fire for restoration would create greater uncertainty, and restoration rates of desired ecosystem conditions would be slower than under alternative B, due to relatively lower treatment rates in foothill, subalpine and alpine, and arid shrublands and woodland zones.	Given the higher pace and scale of restoration, this alternative would be expected to move the greatest amount of terrestrial ecosystems in these zones toward the desired conditions, especially in focus landscapes and in foothill and arid shrublands and woodland zones.	Similar to alternative C, but with slightly less uncertainty in restoration treatment rates in the foothill zone, because of less recommended wilderness in this zone. This would provide slightly greater certainty that the structure, composition, and resilience of ecosystems in the foothill zone would return to desired conditions.
Terrestrial Ecosystems— Landscape connectivity	Provides low to moderate connectivity for forest-associated and other wildlife species in both the short and long term. Alternative A would result in lower restoration treatment rates; it lacks some management approaches that are specifically focused on habitat linkage and dispersal corridor areas.	Provides for moderate levels of short- and long-term habitat connectivity, especially for forest-associated species, such as fisher and marten. Includes a greater number of management approaches focused on maintaining habitat linkages than alternative A.	Provides the greatest short-term connectivity but at the cost of higher exposure or sensitivity to uncharacteristic fire, climate change, and other stressors that reduce long-term habitat connectivity.	Supports somewhat greater long-term habitat connectivity than alternative B, but at the cost of significantly reduced short-term habitat connectivity from elevated mechanical and prescribed fire treatment rates in the next 10 to 20 years, especially in focus landscapes.	Similar to alternative C, but with slightly less uncertainty in restoration treatment rates, because of less recommended wilderness in this zone. This would provide slightly greater certainty that alternative E would provide for long-term landscape connectivity.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Terrestrial Ecosystems— Old forest	Lower rates of old forest restoration would result in a slower return to desired conditions than in the other alternatives.	There would be more old forests restored to desired conditions than under alternative A, because of increased restoration treatment rates and intensity under alternative B. In treated areas, large, old trees would have substantially increased resilience to moisture stress, drought, insects and pathogens, ozone, and uncharacteristic wildfires.	Similar to alternative A, except there would be slightly lower restoration of old forest structure and resilience. This is because treatments would be less extensive (slightly lower restoration treatment rates) and less intensive (less structural restoration per unit area).	Similar to alternative B, except there would be higher restoration treatment rates and intensity in old forests, resulting in greater restoration of old forest structure and resilience, particularly in focus landscapes. However, there would be a greater short-term loss of large and old trees from mechanical thinning.	Similar to alternative C, but with slightly less uncertainty in restoration treatment rates, because of less recommended wilderness in this zone. This would provide slightly greater certainty that alternative E would restore desired conditions in old forests.
Terrestrial Ecosystems— Complex early seral forest	There would be a low to moderate increase in complex early seral forest under alternative A. The proportion of complex early seral forest would be slightly higher than the natural range of variation.	There would be a moderate increase in complex early seral forest that is greater than under alternative A but less than under alternative C. Specific plan components would provide for greater protection of complex early seral forest. The proportion of complex early seral forest will be more similar to natural range of variation than under alternative A.	The increase in complex early seral forest would be highest. The proportion of complex early seral forest may be within or may exceed the natural range of variation in many forest landscapes.	Same as under alternative B.	Same as under alternative C.
Terrestrial Ecosystems— Climate, ecological vulnerability, and adaptation	Limited forest plan direction in support of climate adaptation that results in low adaptive capacity of ecosystems. Provides less support of climate adaptation strategies than the other alternatives.	Moderate support of climate adaptation strategies that would result in greater adaptive capacity of ecosystems than under alternative A.	Low to moderate support of climate adaptation strategies that would result in greater adaptive capacity of ecosystems than under alternative A but less than under alternative B.	Similar to alternative B, except with slightly greater application of climate adaptation strategies, especially in focus landscapes.	Same as under alternative C.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Aquatic and Riparian Ecosystems	Management direction does not explicitly address climate change. There would continue to be limited restoration of riparian vegetation due to restrictive plan direction and limited ability to adequately reduce fuel volumes in riparian conservation areas. As a result, aquatic habitat would be at a greater risk of degradation from untreated stressors and large-scale disturbances.	This alternative added conservation watersheds and plan direction to address ecological connectivity, species diversity and resilience to climate change at the watershed scale. Direction would help create a fire regime more aligned with historical patterns, thus improving riparian area species composition, structure, function, and resilience to climate change, while reducing soil disturbance and sedimentation. Direction emphasizes desired conditions and management of aquatic habitat and riparian conservation areas to restore ecological functions and services. Emphasis on partnerships would assist the Forest Service in increasing the pace and scale of restoration of riparian and aquatic habitats.	Alternative C adds both conservation watersheds and additional CARs. It would have fewer mechanical treatment disturbances to the riparian conservation areas than under alternatives B and D. Effects on riparian vegetation resilience would be variable across the landscape, depending on the Forest Service's ability to conduct prescribed burning or manage wildfires to achieve resource benefits. Improved resilience of watersheds would be similar to alternative B where landscape-scale restoration of aquatic and riparian habitats can occur through partnerships.	The higher amount of treatment proposed in the focus landscapes could result in a higher risk of disturbance to aquatic systems in the short term and an improvement in riparian vegetation structure and function in the focus landscapes, but not across the forest.	Same as under alternative C.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Water Quality, Water Quantity, and Watershed Condition— Water quality	Short-term effects on water quality would be similar to current conditions. Long-term effects on water quality resulting from increased fire activity include increased erosion and soil loss and increased sedimentation during low flow periods.	Potential for short duration water quality impacts in focused treatment areas (e.g. urban interface). Short duration impacts are unlikely by adhering to best management practices. Long-term improvements in water quality due to decreased uncharacteristic fire activity and less erosion, soil loss, and sedimentation. Trend toward improved water quality in conservation watersheds.	Short duration water quality effects would decrease due to increased protections from ground-disturbing activities in recommended wilderness, CARs, and conservation watersheds and fewer mechanical treatments across watersheds. Long-term impacts on water quality would be similar to or greater than under alternative A and greater than under alternative B. The risk of water quality impacts would increase due to the uncertainties associated with implementing prescribed burns not preceded by mechanical treatments. Restoration, such as prescribed burns, may not be applied to the extent needed, which could lower long-term benefits to water quality, compared with the other alternatives.	Increases in short duration water quality effects with respect to the other alternatives, due to increased mechanical treatments in ephemeral streams. Similar to alternative B, short duration impacts would be minimized by adhering to best management practices. Alternative D would improve RCAs in focus landscapes. Water quality would improve in the focus landscapes due to the decreased risk of uncharacteristic wildfire and the restoration of forest conditions that are resilient to changes in climate.	Effects on water quality would be similar to alternative C.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Water Quality, Water Quantity, and Watershed Condition— Water quantity	Water quantity would continue to be affected by changing climate. Hotter and dryer conditions in the Sierra Nevada would affect water quantity by increasing evapotranspiration, reducing recharge, increasing peak flows, and extending the duration of low flow periods. Increased fires could offset increases in evapotranspiration and decreases in recharge in affected watersheds.	Localized improvement in runoff conditions in watersheds targeted for restoration activities. Effects from restoration activities include increased summer base flows and increased groundwater infiltration and storage if sufficient treatments are implemented in a watershed. Effects similar to alternative A in watersheds that are not treated, trending toward more flashy flows, higher peak flows, and lower summer base flows.	Effects on water quantity would largely depend on the amount of prescribed burning or managed wildfire in a watershed. Limited use of mechanical treatments before burning could reduce the opportunity for prescribed burning or to result in hotter burns that could increase mid- and overstory tree mortality, especially in additional recommended wilderness areas. The effects on water quantity would be similar to alternative A.	Effects on water quantity would be similar to alternative B, however runoff conditions would be improved over a larger extent in the focus landscapes, particularly if sufficient treatments are completed to reduce vegetation conditions toward the natural range of variation.	Effects on water quantity would be similar to alternatives A and C.
Water Quality, Water Quantity, and Watershed Condition— Watershed condition	Watersheds would be targeted for maintenance or improvement. Long-term declines in watershed condition in most watersheds due to increased fire severity caused by hotter and dryer conditions.	Maintenance or improvement in more watersheds than under alternative A, in part due to establishment of large conservation watersheds. Similar effects as alternative A in watersheds not targeted for restoration.	Potential short-term benefits to watershed condition in conservation watersheds and CARs and wilderness areas, due to fewer mechanical treatments. Similar effects as alternative A. Long-term potential for impacts on watershed condition in areas where prescribed burns are not feasible, due to absence of mechanical treatments.	Increased treatments in watershed could impact watershed condition in the short term. Over the long term, restoration treatments would reduce the risk of uncharacteristic fire and maintain water and soil quality. Watershed conditions would improve as restored watersheds become more resilient to fire and changing climate.	Effects on watershed condition would be similar to alternative C.
Wildlife, Fish, and Plants—At-risk terrestrial species	Would continue to manage federally listed species through project-level consultation and consideration of recovery actions in approved recovery plans. Manages for Regional Forester sensitive species through project-level design	Stronger emphasis on coordination with U.S. Fish and Wildlife Service and the California Department of Fish and Wildlife for implementing species protection and recovery than under alternative A. Manages for species of conservation concern	Effects would be similar to alternative B for federally listed species. Effects would be similar to alternative A for terrestrial wildlife species of conservation concern, due to the Forest Service's limited ability to mitigate the continuing increase in large, high-intensity wildfires and its limitation to build	Effects would be similar to alternative B for federally-listed species. Effects would be similar to alternative B for terrestrial wildlife species of conservation concern, except that the pace and scale of restoration would more quickly achieve resilience of the landscape to large-scale disturbances,	Effects would be similar to alternative C for terrestrial wildlife species of conservation concern.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Wildlife, Fish, and Plants—At-risk terrestrial species *(continued)*	and analysis of consequences. Has the most limited ability to mitigate the continuing increase in large, high-intensity wildfires and to build adaptive capacity of ecosystems to climate change. Therefore, presents a greater risk to the quantity and condition of habitat to contribute to the recovery of threatened and endangered species, to conserve proposed species, and to maintain the viability of sensitive species.	through a combination of ecosystem level plan components and some species-specific plan components to provide ecological conditions and reduce impacts from threats. Alternative B is designed to achieve desired conditions in less time than alternatives C and E. It would do this by focusing on restoring large landscapes using a variety of tools, decreasing the expected amount of crown fire and moving high-severity fire effects toward natural range of variation. Alternative B would provide a more cautious approach than alternative D by tempering the pace of restoration with minimizing change in remaining high quality habitat and limiting disturbance during the breeding season. Habitat for these species would continue to be at risk due to large, high-intensity wildfires, but there would be less risk of effects on breeding.	adaptive capacity of ecosystems to climate change. Designing and implementing prescribed burns in the amount and locations to reduce the risk of negative habitat effects on at-risk species has more uncertainty than under alternatives B and D.	such as insect outbreaks, high-severity wildfire effects, and drought-related tree mortality, in the focus landscape areas. This would provide a greater long-term benefit to terrestrial wildlife habitat quantity and condition. However, the management approach has greater potential for short-term impacts, allowing more habitat change and more activities to occur during the breeding season that may affect breeding.	(see above)

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Wildlife, Fish, and Plants—At-risk aquatic species	At-risk aquatic species would be restored on a case-by-case basis. Limited implementation of vegetation restoration overall, especially in or near riparian conservation areas that have accumulated fuels outside of the natural range of variation, would leave many native at-risk aquatic species vulnerable to such impacts as sedimentation from large uncharacteristic fires.	Expanded direction related to invasive species should benefit aquatic species across all alternatives. While the negative effects of large-scale wildfires would be reduced, compared with alternative A, the increased pace of treatments translates to a higher risk of short-term disturbance to aquatic species and habitat conditions from mechanical and prescribed fire treatment in the riparian conservation areas. Plan direction for riparian conservation areas, soil and groundcover requirements for watersheds, and the use of best management practices would minimize or reduce short-term effects on aquatic species. In the long term, the direction is expected to improve the resilience of the overall landscape to wildfire, resulting in more long-term beneficial effects on aquatic species by better promoting the long-term sustainability of aquatic habitats and greater ability of these habitats to adapt to climate change.	Expanded direction for invasive species would have the same effects as under alternative B. The conservation watersheds and additional CARs are intended to provide species protections by emphasizing restoration and reduction in sedimentation of streams. This may help prioritize restoration actions when needed, compared with alternatives A, B, and D. However, alternatives B and D also include management direction to consider effects on at-risk species and to consider effects of treatments in upland portions of watersheds on aquatic at-risk species. Unless partners assist the Forest Service in substantially improving watershed conditions and habitats for at risk species in CARs, the effects on at-risk species would likely be minimal. Similar to at-risk terrestrial species, completing the amount of prescribed burning that would reduce threats to watersheds with at-risk aquatic species has more uncertainty than under alternatives B and D.	Expanded direction for invasive species would have the same effects as alternative B. Alternative D does not identify CARs or conservation watersheds. The priority for restoration for aquatic at-risk species would be determined by priority watersheds and through individual planned projects, emphasizing stewardship and partnership opportunities. There would be long-term benefits to these habitats by moving riparian areas toward desired conditions and restoring fire's ecological function to the landscape. The emphasis on restoring low- and medium-intensity fires across the landscape, particularly in the focus landscapes, would improve the long-term potential for improved habitat for aquatic species. Since there are more ground-disturbing activities from mechanized treatments in the focus landscapes, there would be a greater risk of impacts on aquatic systems. However, the effects would be limited by using plan direction for watersheds, riparian conservation areas, and best management practices.	Same as under alterative C.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Wildlife, Fish, and Plants—At-risk plant species	The forests provide the necessary ecological conditions to maintain viable populations of plant sensitive species by relying primarily on project-level surveys and mitigating adverse effects. The current forest plans for the Sequoia and Sierra National Forests do not call for developing a whitebark pine conservation and restoration strategy. In the Sequoia and Sierra National Forests, the Forest Service manages whitebark pine as a sensitive species.	Provides long-term benefits to plant species of conservation concern habitat extent and quality. This would be the result of ecological and hydrologic restoration, invasive species control, recommendation of wilderness that would protect some plant species of conservation concern, and from the emphasis on ecosystem resilience to climate change. Alternative B would also provide for persistence of plant species of conservation concern in special habitats, and it includes plan direction to address identified threats to special habitats. Restoration aimed at maintaining a viable population of whitebark pine that would provide for the persistence of that species would be limited, because most of the occurrences would be in designated wilderness areas. Species monitoring from the regional ecology program would assist with developing management strategies.	Same as under alternative B.	Same as under alternative B.	Same as under alternative B.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Sustainable Recreation	Recreation management would be reactive and generally would involve incremental changes. Over time, this may lead to more recreation development, with limited integrated planning to determine where development makes the most sense. Use conflicts, crowding, and resource impacts associated with visitor use would likely to continue, as recreation use increases and visitor use patterns and popular activities continue to evolve. Without proactive management, the types, locations, and intensities of use may not be predictable.	RMAs would provide a well-defined approach for managing visitor use because uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation. There would be the most CBAs among all alternatives. Sierra National Forest: Large DRAs at the north end, in the vicinity of the gateway to Yosemite National Park. Planning and developing specific high use areas before use levels increase would help avoid conflicts and create opportunities for multiple uses collaboratively. This would enable overflow visitors to use Yosemite National Park but would require substantial investment.	RMAs and recommended wilderness would provide a well-defined approach for managing visitor use as uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation uses. Lands in recommended wilderness areas would not be allocated to any one of the three RMA types; DRAs would be smaller.	RMAs would provide a well-defined approach for managing visitor use, as uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation uses. There would be the most GRAs of all alternatives. Sierra National Forest: DRAs would be smaller than under alternative B but larger than under alternative C. Sequoia National Forest: DRAs would be largest under alternative D.	GRAs, 20 distinct BMAs, and recommended wilderness would provide a well-defined approach for managing visitor use, as uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation uses. Does not include DRAs or CBAs.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Recommended Wilderness— Protection of wilderness characteristics	Areas identified in the wilderness evaluation would be managed under existing plan direction. In these areas, wilderness characteristics may increase or decrease over time due to recreation, ecological restoration, and other management actions. Lowest protection of wilderness characteristics.	Similar to alternative A, except in Monarch Wilderness Addition-South (4,906 acres), where wilderness characteristics, such as naturalness, would be protected.	Wilderness characteristics of naturalness and opportunities for solitude or primitive and unconfined recreation would be more protected, across the largest total area of all alternatives.	Areas identified in the wilderness evaluation would be managed under the same plan direction as under alternative B, except for the Monarch Wilderness Addition-South, which would not be a recommended wilderness area. In these areas, wilderness characteristics may increase or decrease over time due to recreation, ecological restoration, and other management actions. Lowest protection of wilderness characteristics.	Similar to alternative C, except wilderness characteristics of naturalness and opportunities for solitude or primitive and unconfined recreation would be protected across less total area. Wilderness characteristics would be protected across more total area than under alternatives A, B, and D.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Recommended Wilderness— Vegetation, fire, watershed, and wildlife habitat management	Management in areas identified in the wilderness evaluation would not be limited.	Management would be limited in the Monarch Wilderness Addition-South. This would not be a significant change in management because it is such a small area and the effect would likely be minimal.	Management would be limited in recommended wilderness areas, across the largest total area among all alternatives. However, many of the recommended wilderness areas have steep slopes and would be difficult to access and treat if management were not limited. Ecological restoration for at-risk species habitat, including use of motorized equipment, may occur if it is temporary. Due to the level of tree mortality and conditions outside the natural range of variation, there may be greater demand from the public for management to restore fire-adapted ecosystems in recommended wilderness. While the public debate about prescribed fire in recommended wilderness continues, there is unlikely to be much vegetation management in recommended wilderness.	Areas identified in the wilderness evaluation would be managed the same as under alternative B, except for the Monarch Wilderness Addition-South, which would not be a recommended wilderness area.	Similar to alternative C, except management would be limited across less total area. Management would be limited across more total area than under alternatives A, B, and D.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Recommended Wilderness— Special use permit authorizations	Authorizations may increase because there would be no limitations based on recommended wilderness.	There may be some additional limitations on authorizations in the Monarch Wilderness Addition-South.	Authorizations would be limited in recommended wilderness areas, across the largest total area among all alternatives. Existing special use permit authorizations would be allowed to continue in recommended wilderness areas, including commercial services, such as outfitting and guiding, and livestock grazing, tribal uses, water uses/rights, and mining claims, as well as maintenance of supporting facilities. However, new installations, structures, motorized equipment, and mechanical transport would be prohibited. As a result, permit holders would generally not be able to use motorized equipment or mechanical transport for access in recommended wilderness or to maintain supporting facilities in recommended wilderness. This may increase the cost and complexity of special uses in recommended wilderness, including maintenance of supporting facilities. The extent of potential cost increases is uncertain at programmatic level. Also, new installations, structures, motorized equipment, and mechanical transport would be prohibited for new special use permit authorizations.	Authorizations may increase, and there are no limitations based on recommended wilderness. Areas identified in the wilderness evaluation would be managed under the same plan direction as alternative B, except for the Monarch Wilderness Addition-South, which would not be a recommended wilderness area.	Similar to alternative C, except authorizations would be limited across less total area. Authorizations would be limited across more total area than alternatives A, B, and D.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Recommended Wilderness— Recreation and access	All activities in areas identified in the wilderness evaluation would continue under current management. Access to areas by the existing road and trail system would not be affected. There may be opportunities for motorized recreation and mountain biking, and additional roads and trails may be designated or constructed, providing additional access and use opportunities. Existing trails and roads may be maintained using motorized equipment and mechanical transport. Opportunities specifically for wilderness-based recreation would not increase significantly and may decrease in some areas.	Existing access would not be affected. Mountain biking and motorized recreation would be prohibited in the Monarch Wilderness Addition-South. However, this area has no authorized motorized routes or mountain bike trails, so access for these uses would not change. Opportunities for motorized recreation and mountain biking would not be developed in the Monarch Wilderness Addition-South, and opportunities specifically for wilderness-based recreation would increase in this area. Otherwise, similar to alternative A.	Mountain biking and motorized recreation would be prohibited in recommended wilderness areas, across the largest total area among all alternatives. However, there is limited data about mountain bike use in these recommended wilderness areas, so the extent of the impact on mountain biking is unclear. Opportunities for motorized recreation and mountain biking would not be developed in recommended wilderness areas, and opportunities specifically for wilderness-based recreation would increase in these areas.	Existing access would not be affected. Areas identified in the wilderness evaluation would be managed under the same plan direction as alternative B, except for the Monarch Wilderness Addition-South, which would not be a recommended wilderness area under alternative D.	Similar to alternative C, except mountain biking and motorized recreation would be limited across less total area, and opportunities specifically for wilderness-based recreation would increase across less total area. Mountain biking and motorized recreation would be limited across more total area than under alternatives A, B and D. Opportunities specifically for wilderness-based recreation would increase across more total area than under alternatives A, B, and D.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Pacific Crest National Scenic Trail	No Pacific Crest National Scenic Trail management area.	The Pacific Crest National Scenic Trail management area would protect the resources, qualities, values, and associated settings and primary uses of the Pacific Crest National Scenic Trail. It would be smaller than under alternative C, but larger than under alternative D.	The Pacific Crest National Scenic Trail management area would be largest and would provide the most protection for the resources, qualities, values, and associated settings and primary uses of the Pacific Crest National Scenic Trail.	The Pacific Crest National Scenic Trail management area would be smallest. Short-term negative effects on scenic resources would be the largest because the most acres would be treated mechanically and with wildfire and prescribed fire. Likewise, long-term positive effects may be larger if treatment activities successfully maintain or enhance scenic integrity, scenic character stability, and resiliency to insects, disease, and large-scale wildfire.	Same as under alternative C.
Forest Products	Management would continue at near current levels of mechanical treatments, with limited improvements in forest health and resilience to disturbance agents and climate change at the stand level. Treatment levels would likely decrease somewhat due to existing constraints and continued loss of mature forest from severe fires, insects, and drought-related mortality. Landscape resilience would continue to decline.	Would maintain or increase somewhat treatment levels involving commercial thinning, incrementally improving forest health and resilience to disturbance agents and climate change. Production near upper end of range forecast for alternative B would likely maintain forest products industrial infrastructure.	Would decrease the pace and scale of mechanical treatments, thereby decreasing forest products production. However, small improvements in forest health and resilience would occur in the short term at the stand level, similar to alternative A. Harvest levels would not likely be adequate to sustain local industrial infrastructure.	Would increase the pace and scale of mechanical treatments, improving forest health and resilience to disturbance agents and climate change. However, the limited capacity of industrial infrastructure may limit achievement of desired objectives.	Same as under alternative C.

Resource	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Production Livestock Grazing	Modest improvement in ecological conditions in allotments would likely continue.	Alternative B would provide modest improvements in riparian conservation areas and resilience to disturbance and climate change at the allotment level.	Same as under alternative B.	Same as under alternative B.	Same as under alternative B.
Economic Conditions	The continuation of current management in the face of current resource conditions (such as vegetation) and trends would result in more disruptive events, such as uncharacteristic wildfire, and additional declines in forest health. This could have adverse short- and long-term effects on economic benefits to local communities. It also could affect opportunities in terms of forest products, recreation, and other economic benefits.	Alternative B would help moderate current trends and would improve the long-term sustainability of national forest benefits. In the short term, would be additional disruption of some of these benefits from increased forest project restoration.	Alternative C would have some long-term beneficial effects on the sustainability of economic conditions in local communities. However, there would be a long-term loss of the opportunities for developing local forest product and biomass industries. Continued declines in these industries can lead to greater challenges to restoration in the area.	Alternative D would be similar to alternative B. The increased pace and scale of restoration could provide even greater sustainability of forest benefits to people; however, it could also lead to additional potential increases in the short-term adverse effects resulting from increased restoration.	Alternative E would have effects similar to alternative C. The exception is some of the additional areas recommended for wilderness that are included in alternative C are included in alternative E as backcountry management areas, so associated potential impacts on grazing would be lessened.
Social Conditions	Would contribute to sustaining a diverse set of forest-related values in the long term but would not be as integrated as the other alternatives.	Supports a diverse set of forest-related values in the long term through increased ecological restoration that moves forest conditions closer to ecosystem desired conditions and fire-resilient landscapes. By moving toward these desired conditions, aesthetic, biodiverse, cultural, economic, learning, recreation, and well-being values are sustained over the long term.	Values are more at risk to negative impacts over the long term, given limited ecological restoration treatments.	Same as under alternative B.	Same as under alternative C.

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Chapter 3

Affected Environment and Environmental Consequences

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Chapter 3.
Affected Environment and Environmental Consequences

Introduction

This chapter summarizes the physical, biological, social, and economic environments of the plan area and the potential environmental consequences that may occur on those environments by implementing each alternative. It also presents the scientific and analytical basis for the comparison of alternatives presented in Chapter 2. In some cases where indicated, more detailed information, including methodology, assumptions, and effects analyses, can be found in the specific resource supplemental report contained in the planning record. This record is maintained at the Pacific Southwest Regional Office in Vallejo, California.

The Relationship between Forest Plans and Site-Specific Activities

The focus of this analysis is to examine the implications or longer-term environmental consequences of managing the national forests under the programmatic framework provided by the draft revised forest plans and alternatives. Forest plans do not authorize, fund, or carry out any project or activity described in the effects analyses. Instead, they provide a programmatic framework that guides site-specific actions that may be carried out in the future.

Because a land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions), there are no direct effects of land management plans. The draft forest plans set the stage for what future management actions are needed to achieve desired outcomes (for example, desired conditions and objectives) and provide the sideboards (such as suitability, standards, and guidelines) under which future activities may occur to manage risks to ecological, social, and economic environments. The draft forest plans also identify potential management approaches that may be used to help achieve desired conditions. To proceed with a site-specific project, project-level planning, environmental analysis, and decisions must first occur (for example, the draft forest plans contain direction to thin vegetation and reduce fuels to benefit ecosystem resilience; however, a subsequent site-specific analysis and decision must be made for each proposal that involves vegetation treatment or fuel reduction activity in a chosen area).

Science and Assumptions Used in the Environmental Analyses

During development of the environmental analyses that follow, the planning team used the best available scientific information, which is documented in the planning record. The environmental analyses focus on the needs for changing the existing plans and the issues identified through the scoping process; they also examine potential effects on programs and resources in the Sequoia and Sierra National Forests.

The discussions in chapter 3 refer to the potential for consequences to occur, realizing that in many cases, they are only estimates. To estimate the consequences of alternatives at the programmatic plan level, we must assume that the kinds of resource management activities allowed under the prescriptions will occur to the extent necessary to achieve the objectives and move toward or achieve the desired conditions of each alternative. In many cases the consequences would be similar across each national forest but the magnitude of the consequences would vary by the difference in plan objectives or opportunity. In these cases, the shared consequences are presented first and then individually for each national forest, as appropriate. This method of analysis is useful when comparing and evaluating alternatives on a forestwide basis, but it will not be applied to specific locations on a national forest.

The following assumptions are made in the analyses of alternatives:

- Law, policy, regulations, and applicable best management practices would be followed when planning or implementing site-specific projects and activities.
- Plan components (desired conditions, objectives, standards, guidelines, management areas, and suitability) would be followed when planning or implementing site-specific projects and activities.
- Goals and potential management approaches would influence collaborative efforts and be considered in developing programs of work.
- Plan objectives are generally stated as a range (from low to high). The actual level of accomplishment would depend on environmental conditions, budgets, and staffing.
- Implementation of a land management plan would facilitate progress toward the attainment of desired conditions for each resource. As movement toward or achievement of desired conditions is made, forest ecosystems would become healthier and more resilient and would continue to provide for species diversity, goods, and services.
- The planning period is 10 to 15 years; other time frames may be used to compare expected future trends. Plans are expected to be revised at least every 15 years.
- Plan monitoring will occur, and the land management plan will be amended, as needed.

Throughout this document, there may be small differences in the calculated acreage numbers. The root causes of these small differences in acreage calculations vary (for example, slightly mismatched boundaries, differences in mapping techniques, rounding errors). In the context of this large-scale land management planning and programmatic analysis, which covers hundreds of thousands or millions of acres, these relative differences in reported acreage would be less than 0.1 percent, therefore, we consider these differences to be negligible.

How this Chapter is Organized

First, a general analysis of environmental consequences of drivers and stressors of climate, fire, insects, and pathogens are described since they can affect many resource areas. Then, environmental consequences are organized under each revision topic. Finally, an analysis of the benefits to people and communities and consequences to tribal relations and uses is provided at the end of this chapter to evaluate how the alternatives contribute to economic and social well-being.

Agents of Change: Climate, Fire, Insects, and Pathogens

Drivers and stressors are recurring events, processes, or actions that affect ecosystems. These effects are important to ecosystem condition. For example, fire creates variation in habitat, which is important for biodiversity—it keeps vegetation density and surface fuels low and patchier; it is a “driver” of ecosystem condition. Fire can be a stressor when it is more severe than usual and outside its natural range of variation, occurring either less frequently or more frequently than in the past.

The context in which fire occurs is also important. For example, because the scenery around recreation facilities and areas affects the quality of associated recreation opportunities, high-severity fire can decrease the scenic character and lower the recreation value. Scenery impacts from fire can be short term if they cover small areas and are visually absorbed as vegetation recovers, or they can be long term if they cover wide visible expanses dominated by burned forest.

Other important drivers and stressors are insects and pathogens, climate change, and air pollution. Climate is a fundamental process that strongly influences other drivers and stressors in the Sierra Nevada, including fire, invasive species, insects, pathogens, water availability, air pollution, and land use patterns.

In this section, three aspects of drivers and stressors are covered broadly. These include climate, trends in fire with climate, and insects and pathogens. In later sections, response of specific vegetation types, habitats (such as old forest), and ecosystem functions (such as carbon storage) to drivers and stressors is discussed. Invasive plants are one of the most important widespread stressors in the lower elevations of the Sequoia and Sierra National Forests. Invasive animals, water availability, and insects are increasingly important stressors that are addressed in “Terrestrial Ecosystems,” “Aquatic and Riparian Ecosystems” and “Wildlife, Fish and Plants.” Fire management is covered in revision topic 1. Air pollution impacts are covered in “Air Quality.”

Although climate change is an important theme in this section, it is also woven throughout many sections in the document because it influences and affects many aspects of national forests. There is a specific subsection focused on climate vulnerability and analysis of the effects of climate adaptation strategies proposed for each alternative at the end of “Terrestrial Ecosystems.”

Climate Change

Background

Climate change is anticipated to have lasting, large-scale impacts on a variety of ecological, social, and economic resources in national forests of the southern Sierra Nevada. Carbon sequestration and greenhouse gas emissions are not covered in this section but are addressed in “Air Quality” and “Terrestrial Ecosystems.” The effects of climate change on specific social, cultural, and biological resources (such as cultural resources and species of special concern) are also covered in each relevant section of this chapter. This section summarizes current and future climate trends to form a foundation for other analyses in this chapter.

This section summarizes the more detailed analysis of climate, ecological vulnerability, and adaptation found in the final bioregional and forest assessments (United States Department of

Agriculture 2013d, a, b, c) and the snapshots of the Living Assessment used to develop the final assessments (United States Department of Agriculture 2013h, i, j).

Recent Past and Current Trends

Mean annual temperatures in the plan area have increased in the last several decades, mostly with increased nighttime temperatures (Meyer et al. 2012, Mallek et al. 2012). Unlike much of the rest of the Sierra Nevada, overall precipitation has remained steady at higher elevations but there have been some decreases at lower elevations. There has been a decrease in the amount of snow at low to mid elevations and an increase in year-to-year variability (wetter wet years and drier dry years). At higher elevations, overall snowfall and spring snow water equivalent (amount of water in snowpack) have remained steady in most southern Sierra Nevada areas, but snowmelt occurs earlier in the year.

Changes in temperatures and amounts and timing of precipitation have led to earlier peak stream flow rates in most Sierra Nevada streams, with earlier spring flows (Hunsaker et al. 2012, Bales et al. 2018) and lower summer flows. Warming temperatures are leading to glacial recession across the southern Sierra Nevada.

Projected Future Trends in Climate and Hydrology

Although climate change models vary in their projections for the latter half of the 21st century, all predict significant and continued warming in the Sierra Nevada. Most expect precipitation to remain similar or slightly reduced, compared with today, although there is uncertainty in precipitation projections for the region (Safford et al. 2012a). Most models also agree that summers will be drier (causing higher evapotranspiration rates) on average. Although snowpack in the higher elevations (higher than 7,500 feet) of the southern Sierra Nevada has generally remained steady (or risen) over the past half-century (Meyer et al. 2012, Mallek et al. 2012), continued warming is likely to decrease snowpack in much of the high southern Sierra Nevada.

Most models project a continuously increasing rain-to-snow ratio and earlier runoff dates for the next century, especially at higher elevations. Under most climate scenarios, models project higher winter-to-early spring runoff and lower spring-to-summer runoff, as higher temperatures hasten the onset of snowmelt. This could increase downstream flood potential due to earlier peak flow rates and the increased proportion of precipitation falling as rain. If overall precipitation increases over time, streamflow volumes during peak runoff will increase even more, leading to notably higher flood risk in downstream areas.

The recent exceptional drought event in California (2012-2016) is unprecedented in the last 1,000 to 10,000 years for California, especially in southern and central California and including the plan area (Griffin and Anchukaitis 2014, Robeson 2015). The exceptional nature of this drought is a consequence of consecutive record low levels of precipitation perpetuated by a persistent atmospheric ridging system in the North Pacific. Recent evidence suggests that Arctic sea-ice loss has increased the potential for a North Pacific atmospheric ridge development that blocks precipitation-inducing winter storms from reaching California (Cvijanovic et al. 2017). Consequently, warming temperature trends associated with climate change may produce more extreme drought events in California (increased frequency or severity of drought) through the alteration of climatic systems over the Pacific Ocean (Cvijanovic et al. 2017). Although there is uncertainty inherent in these climatic systems and their effect on precipitation patterns, it is clear that climatic warming has exacerbated drought events in California through increased water stress associated with decreased soil moisture, increased runoff, and higher rates of evapotranspiration (Vose et al. 2016c, Vose et al. 2016a, Intergovernmental Panel on Climate Change 2014).

Fire Trends

This section summarizes trends in fire with climate and general vegetation conditions. These trends are important to understanding conditions and fire effects on terrestrial, riparian, and aquatic ecosystems, and social and economic conditions.

Background

Fires have been increasingly large and severe throughout the western U.S. (Calkin et al. 2005, Westerling et al. 2006) and California (Miller et al. 2009b, Miller and Safford 2012) over the last several decades. The effects of these fires are often seen by people as overwhelmingly negative. In much of the wildlands of the western U.S. and the analysis area, fire has played a central role in shaping ecosystems. Both the beneficial and destructive aspects of fire are important to understand for forest management and planning. The analysis examines different characteristics of fire, which can have implications for the wildlands in areas we live in and use.

In this section, the trends in burned area and fire size are addressed in response to climate change and scenarios that represent different levels of vegetation restoration. The fire responses to the scenarios are used to describe the consequences of the alternatives on large fire size and burned area. The impacts of fire to vegetation and other ecological aspects of fire are covered in more detail in “Terrestrial Ecosystems.” Aspects of fire related to impacts on communities, people, and infrastructure (such as water systems or power lines) are covered in “Fire Management,” “Economic Conditions,” and “Social Conditions.” The projected trends in fire in this section provide a common basis for assumptions on fire trends for all other analysis sections in this document.

Analysis and Methods

This section is based primarily on a quantitative analysis of fire-climate trends conducted by the University of California (UC) in Merced as part of a cooperative agreement with the Forest Service (Westerling et al. 2015). Additional scientific literature relied on in this analysis can be found in the fire-climate supplemental report.

Climate scientists at UC Merced conducted a study to predict trends in wildfire with climate change under a broad range of different levels of vegetation restoration. The predictions are based on data from past wildfires (recent and historic), associated vegetation condition, and climate data. The methods were established in previously published research by Westerling and others (Preisler et al. 2008, Holmes et al. 2008, Bryant and Westerling 2014, Preisler et al. 2015). This research applies a statistical approach to predicting wildfire, in contrast to mechanistic models, such as FARSITE. They are well suited for broad analysis that takes into account trends in wildfire with climate change.

Scientists made projections of climate using several different climate models, since common trends in different models would indicate a more certain trend. The results presented here are primarily for the Geophysical Fluid Dynamics Laboratory A2 climate scenario, as well as some results from the Centre National de Recherches Météorologiques (CNRM) and Community Climate System Model (CCSM) A2 climate scenario (Westerling et al. 2015). The differences between wildfire predictions for the selected climate scenarios were small, compared with the effects of the restoration treatments scenarios. The Geophysical Fluid Dynamics Laboratory climate model was emphasized because it yielded mid-century increases in wildfire activity between the CNRM and CCSM models.

Vegetation conditions used in the study were based on LANDFIRE vegetation condition class data (LANDFIRE 2012). Condition classes are derived from remote sensing data on existing vegetation density and species composition and derived differences with historic conditions based on fire history research and biophysical models of vegetation type and historic fire regime groups.[2] Where there is a large departure in historic fire regime (fire patterns and intensities are very different from what they used to be) and vegetation conditions are different than what they would have been under a historic fire regime, then the condition class would reflect high departure. The range of classes include:

- vegetation condition class 1: no to low departure;
- vegetation condition class 2: moderate departure; and
- vegetation condition class 3: high departure.

An example of high departure conditions would be ponderosa pine or Jeffrey pine that is currently dense but historically would have been maintained as open forests due to frequent, historic fire. Exploratory analysis revealed that fire patterns (large fire size, extent and burned area) varied with vegetation condition class. The vegetation condition class is a broad classification and was determined to be well suited to the programmatic plan and array of different combinations of individual vegetation desired condition components that would be the result of restoration.

Restoration treatments were modeled by changing potential treatment areas that are currently in vegetation condition class 3 or 2 to vegetation condition class 1. This is needed because previous exploratory analysis showed that it was too difficult to discern differences in predicted fire trends between vegetation condition class 3 and class 2 (Westerling 2015). The restoration treatments were not modeled in a specific spatial pattern but as a broad-level pattern to assess impacts at a programmatic level, except where high condition classes occurred near roads, which were assumed to be priority treatment areas. These treatment models are referred to as "restoration scenarios" that included different types of restoration treatments (for example, mechanical thinning, prescribed fire) or a combination of them applied over several decades. The restoration scenarios included 15 percent, 30 percent, 60 percent, and 100 percent of the area restored (changed from vegetation condition class 2 or 3 to vegetation condition class 1), with an emphasis in the Sierra Nevada foothill and montane ecological zone and the arid shrublands and woodlands (sagebrush/pinyon-juniper) ecological zone (see "Terrestrial Ecosystems"). Estimated restoration treatment rates by alternative are based on estimated values presented in chapter 2. More detail on the analysis can be found in the final report (Westerling et al. 2015).

A summary of fire impacts in "Affected Environment" was based on a combination of recent observed and future projected changes in fire in the plan area and entire bioregion. Recent fire trends were based on data assembled for the bioregion from the National Fire and Aviation Management database and include the time periods from 1961 to 1990. This baseline from 1961 to 1990 was intended to capture recent bioregional wildfire size and severity trends for this period that: (1) occurred during a period when active fire suppression and vegetation management was in

[2] http://www.landfire.gov/NationalProductDescriptions12.php

effect (and not representative of the Natural Range of Variation); (2) was characterized by lower historic temperatures that preceded most current warming climate trends that began in the 1980s; and (3) reflected more accurate and reliable regional climate, hydrology, and fire data than earlier decades (primarily 1920-1960). In addition, this time period does not take into account recent large fires, including the 2013 Rim Fire, 2014 King Fire, 2015 Rough Fire, and 2018 Ferguson Fire. However, these fires were incorporated into the analysis using other information. Future projected changes focus on three periods, including early-century (2010 to 2040) and mid-century (2040 to 2070) projections. These longer time periods are ideal in the analysis of climate change-related fire effects in land management planning efforts (Peterson et al. 2011).

Indicators and Measures

The primary indicators measured in this analysis are burned area, large fire size (>494 acres[3]), and smoke and carbon emissions. Smoke and particulate emissions are described in "Air Quality" and carbon emissions are described in the carbon supplemental report. Other important indicators that are based on inferences on large fire size, burned area, and vegetation conditions (like density and fuel levels) include fire intensity, fire type, and large areas of vegetation burned at high severity. A combination of a qualitative assessment using scientific literature and quantitative analysis using fire behavior modeling and sensitivity analysis of the statistical fire-climate model for selected areas were used to make inferences on fire intensity, fire type, and occurrence and size of large patches of high severity.

Fire intensity refers to how hot a fire burns, or the amount of heat per unit area. Fire type refers to how the fire burns in relation to the height and type of vegetation it is burning in. A surface fire, for instance, burns in the understory of forests or shrub lands or chaparral. In contrast, a crown fire spreads in the tops, or crowns, of trees and shrubs. Fire severity refers to the effects of fire on vegetation or soil or other ecosystem components and is often measured at the landscape scale using remote sensing data (Miller et al. 2009b). For vegetation, fires that result in higher levels of tree or plant mortality and canopy loss are considered relatively more severe, with high-severity fire often associated with stand-replacing conditions (greater than 75 percent basal area or canopy cover loss). See "Terrestrial Ecosystems" for more details.

Assumptions

The analysis of fire includes several assumptions:

- The use of models predicting fire trends based on past climate-fire patterns may under-predict future trends in fires because the models are based on observations occurring under milder fire weather conditions. Because future climate is expected to exceed these conditions, there is uncertainty in the fire projections. Moreover, although drought conditions were simulated in model projections of wildfire size and frequency based on recent and historic wildfires (1970-2014) (Westerling et al. 2015), these model simulations did not specifically include increased fuel inputs associated with recent tree mortality that developed following the 2012-2016 drought.
- Some fires exhibit a fire-atmospheric interaction where the fire influences the local weather affecting the fire. There is uncertainty around the extent that this may occur but it can dramatically alter fire size, intensity, and large patches of high severity, such as that which

[3] Selection of 494 acres (200 hectares) as the threshold value for large fire size is based on the mean historical fire size of montane forests in the Sierra Nevada (~200 hectares) and fit the analysis criteria used by Westerling et al. (2015) in their analysis of large fire size.

occurred in the 2013 Rim Fire and in the 2014 King Fire (Coen et al. 2015) in the central Sierra Nevada. These phenomena may be increased with continued drought and climate trends.

- High fire intensity in dry, hot conditions is expected to be reduced to moderate or low intensity or a mosaic of intensities when at least 40 percent of a landscape area is in a low or reduced fuel condition. A variety of landscape theory, fire modeling, and fire behavior case studies support this (Turner 1989, Parisien et al. 2007, Parisien et al. 2010, Parisien et al. 2012, Fites-Kaufman 2014, Coen et al. 2015). Based on this information, for this analysis we assume that at least 12,000 acres or more needs to have at least 40 percent of its area restored to result in changes in fire probability, extent, and large fire size. See the fire-climate supplemental report for more detail.
- The analysis area for modeled climate-fire trends includes the entire Sierra Nevada bioregion. However, modeled outputs and climate-fire trends for the bioregion are assumed to be proportionately similar for the Sequoia and Sierra National Forests, because these two forests are fairly characteristic of recent fire and fuels trends in the bioregion (North et al. 2012b, Safford and Van de Water 2014).

Affected Environment

Recent Past and Current Trends

Prior to European settlement, fire was widespread throughout the bioregion and California (Sugihara et al. 2006, Stephens et al. 2007). The frequency, spatial pattern, and severity varied by ecosystem (van Wagtendonk and Fites-Kaufman 2006, Brooks and Minnich 2006). Most fires were low to moderate in intensity over large areas. This resulted in a mosaic of mostly surface fire, sweeping into the understory shrubs, herbs, small trees, and grasses, with small clumps or patches of fire making its way into the crowns of trees (crown fire). In chaparral and sagebrush, larger patches of crown fire would occur that reached the tops of the plants, killing them outright or top-killing them and stimulating new sprouts. Pinyon-juniper forests also typically experienced crown fire. See “Terrestrial Ecosystems” for more details on the historic and current fire regimes by major ecological zone and vegetation type. Overall, in the last century far less area has burned than did historically (Stephens et al. 2007), but the severity has increased (Collins and Skinner 2014, Mallek et al. 2013).

For thousands of years, Native Americans used fire to manage the landscape for a variety of beneficial uses (Anderson 2006). European settlement in the bioregion greatly intensified with discovery of gold in the Sierra Nevada in 1848 (Beesley 1996). At the same time, there was intensive logging to fuel steam-generated equipment and to build housing, along with extensive grazing by livestock. These early settlers affected fire directly and indirectly in numerous ways (Safford 2013). Overall, widespread fire decreased.

Prior to the advent of modern fire suppression capability, fire was more widespread and less intense (van Wagtendonk and Fites-Kaufman 2006, Stephens et al. 2007). In the last 45 years, fires have become larger and more frequent across the western U.S. (Calkin et al. 2005, Westerling and Bryant 2006). In the Sierra Nevada (including the analysis area), the area burned annually in federally managed forests has increased by more than 24,700 acres per decade during this period (Westerling et al. 2015). Fire size has also changed, especially in recent years where some extremely large fires (such as the 2002 McNally Fire, 2013 Rim Fire, 2014 King Fire, 2015 Rough Fire, and 2018 Ferguson Fire) have burned,, compared with the historical record. Since

1990, 9 out of the 10 largest recorded fires have occurred and 8 of those have been since 2000 alone (Steel et al. 2015).

Over 100 years of fire exclusion (fire suppression and lack of extensive intentional burning), along with other land uses, changed how fire burns. Now fires burn with higher intensity, greater amounts of crown fire, and with larger areas of high severity (Miller et al. 2009b, Miller and Safford 2012, Mallek et al. 2013, Steel et al. 2015). Most recently, some fires have moved very rapidly, burning at high intensity, in single days, across large swaths. This includes the 2013 Rim Fire in the Stanislaus National Forest and Yosemite National Park, and the 2014 King Fire in the Eldorado and Tahoe National Forests. These types of fire behavior are more likely when the fire burns over large areas with multiple fire fronts and creates its own "fire weather." Extensively burning areas create their own high winds that accelerate the fire, and multiple fire fronts burn toward each other (Coen 2005, Viegas et al. 2012). In the case of the 2014 King Fire, the very dry, uniformly dense overstory and understory vegetation across large areas combined to create three separate fronts or heads of the fire and an actively burning area of over 6,000 acres (Fites-Kaufman 2014). The heat from the three separate areas interacted and became one very large, several-miles-wide actively burning front and created winds of more than 40 miles per hour in front of the fire. After that, it grew to 50,000 acres burning intensely and fast. Similar vegetation conditions (such as large areas of dense understory and overstory vegetation and fuels) are common and with drought, longer fire seasons, and increasing temperatures, very large fires are likely to repeat. It is not certain exactly where and when similar fires will occur, but it is highly likely that they will occur and that the impacts will be similar to those seen in recent very large fires that burned in similar conditions.

During and following the 2012-2016 drought in California, the addition of hazardous canopy and surface fuels associated with dead and dying trees has increased the potential for large and severe wildfires in the southern Sierra Nevada (see "Changed Forest Conditions associated with Tree Mortality"). For example, in the Sierra National Forest the total acres burned in wildfires per year during and following the drought (2012-2018) is 23 times higher than that burned prior to this drought event (1971-2011)[4]. Coupled with the effects of climate change and increased forest densification, the combined effects of these factors have led to an increased potential for large-mass fire events that can burn large acres of vegetation in the Sierra Nevada (including the Sequoia and Sierra National Forests), with negative repercussions for terrestrial vegetation, wildlife habitat, communities, and other resources and assets (Stephens et al. 2018). The effects of combined stressors (including drought) on fire regimes and terrestrial ecosystems are addressed in more detail in "Combined Effects of Climate, Fire, Insects, and Pathogens."

Climate (precipitation and temperature) and fire have always been linked (Swetnam 1993). Today, changes in land use and associated changes in vegetation (that is, fewer fire-tolerant species and denser vegetation) magnify the effects of a warming climate on fire behavior. Nonnative annual grasses are more flammable and create more continuous fuel conditions that make fire spread more extensively, especially with warming climate trends (Brooks and Minnich 2006).

Projected Future Trends

Wildfire ignitions are anticipated to increase in the Sierra Nevada with increased population growth (including increased human development in the wildland-urban intermix) and climate

[4] Fire and Resource Assessment Program (FRAP) Website, California Department of Forestry and Fire Protection,.

change. However, future projections in human-caused ignitions and lightning-strike density are highly uncertain (especially the latter). Although some regions of the western U.S. may experience declines in wildfire extent and severity with climate change (due to reduced plant productivity in the later 21st century), total burned area and fire severity are projected to increase or remain moderately high through the coming decades in the Sierra Nevada (Lenihan et al. 2008, Parks et al. 2016). Moreover, fire seasons are expected to lengthen with warming climate trends (Westerling et al. 2006), resulting in a decrease in the available window (generally spring and fall) to safely conduct prescribed burns to meet burn objectives.

Projected future wildfire trends based on the statistical fire-climate models for the Sierra Nevada (Westerling et al. 2015) are presented below.

Burned Area

There has been a trend of increased burn area associated with low winter snowpack in the western U.S. in recent decades (Westerling et al. 2006). Predictions for the analysis area and all of the Sierra Nevada are that the burned area will double or quadruple over the next 20 to 30 years (Westerling et al. 2015). This would not be detrimental if the fires were low intensity, but much of the area is expected to burn at high intensity due to the current vegetation density patterns and drier, longer fire season weather. Most of this increase in burn area and fire intensity is associated with larger fires.

The greatest increases are expected in the upper montane and subalpine areas. The montane zone, where mixed conifer, ponderosa, and Jeffrey pine forests occur show double to triple area burned. The least changes are in the lowest elevations on the west and east slopes, in the foothills on the west, and in the arid shrublands and woodlands (sagebrush and pinyon-juniper) on the east. These areas are shown in orange and still have one and a half to two times the area burned (Figure 2).

Fire Size and Likelihood of Very Large Fires

Average fire size is expected to increase by 13 to 20 percent by mid-century with climate change in the absence of additional treatments to restore vegetation and reduce density and surface fuels (Westerling et al. 2015). The likelihood of very large fires is increasing as well. The probability of fires becoming larger than 24,700 acres increases between 23 and 52 percent by mid-century. The average size of large fires is projected to increase between 15 and 25 percent in the coming decades. None of these predictions account for the growing prevalence of very large fires (>494 acres) driven by fire-atmospheric interactions, as discussed above. Increases in fire-atmospheric interactions would contribute to an even greater increase in the size and probability of large fires.

Figure 3 shows a line graph of the expected change in large fire size with different future climate scenarios. This is based solely on changes in climate as no changes in vegetation from restoration treatments were included in this calculation. The first graph shows the predicted trends in large fire size between 2035 and 2064 for the three different climate models.

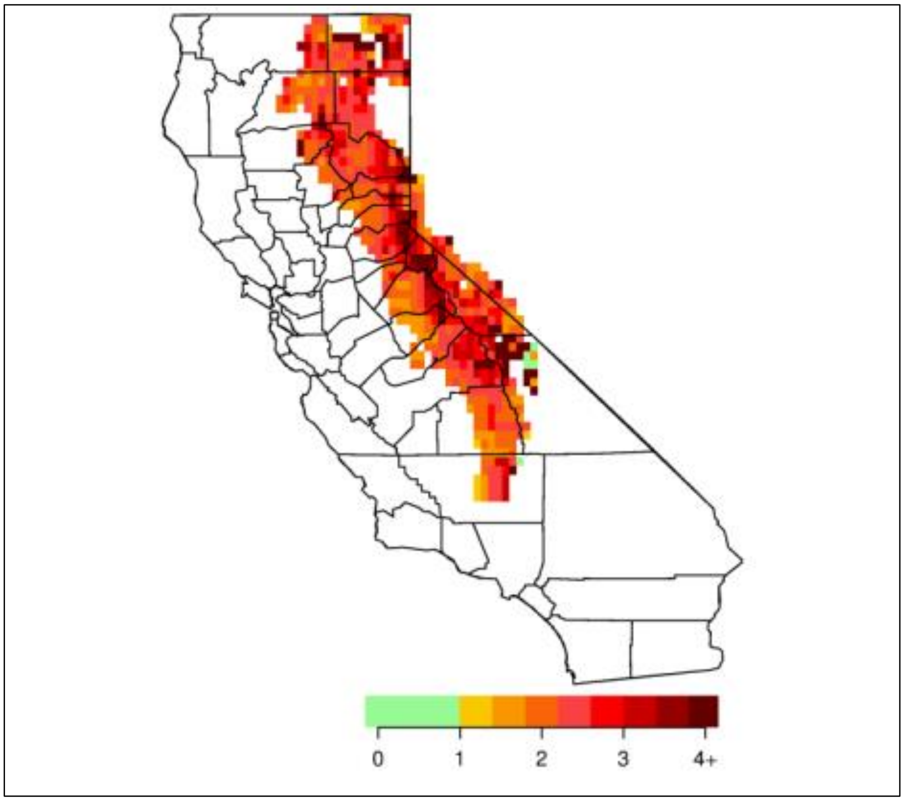

Figure 2. Map of changes in the predicted burned area in the next mid-century, 2035 to 2064, compared with 1961 through 1990[5]

[5] Figure 2 displays changes in the predicted burned area in the next midcentury period, 2035 to 2064, compared with 1961 through 1990, a period prior to the advent of widespread very large high-intensity wildfires. The change is shown in colors labeled on a scale at the bottom of the figure, below the outline map of California. Light green depicts no change or a decrease in the amount of burned area. Yellow to orange represents an increase of more than 1 to 2 times the amount of burned area. Red colors depict a tripling of burned area, and the darkest maroon colors represent a quadrupling of burned area.

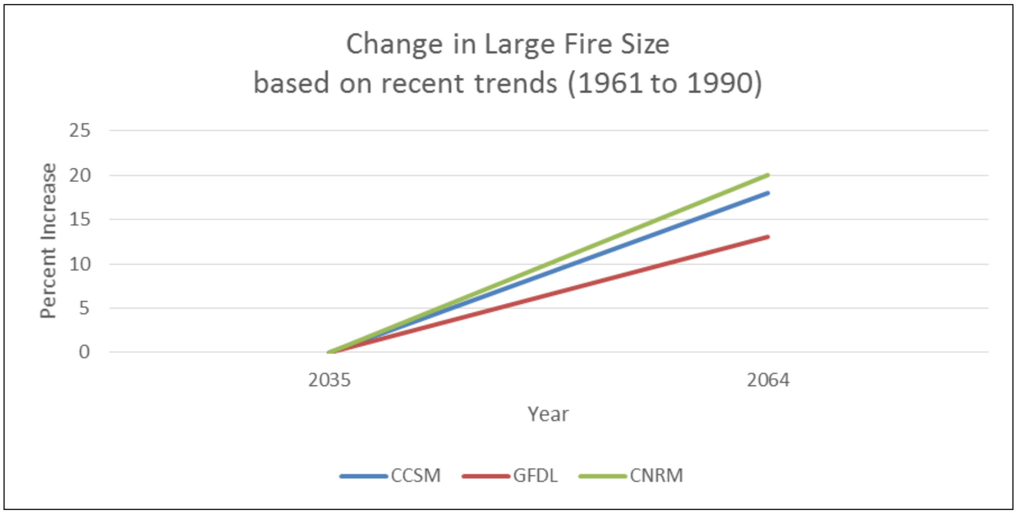

Figure 3. Predicted change in large fire size from recent (1961 to 1990) rates based on three climate models[6]

The second line graph in Figure 4 shows predicted trends when different amounts of the mid- and low-elevation landscapes are modeled as restored (from vegetation condition class 2 or 3 to class 1).[7] There is a predicted trend of increasing large fire size for all restoration scenarios except for 60 percent, which stays nearly constant with current large fire size, and 100 percent, which shows a decrease in large fire size. This is consistent with other research predicting increases in fire with climate change (Moritz and Stephens 2008).

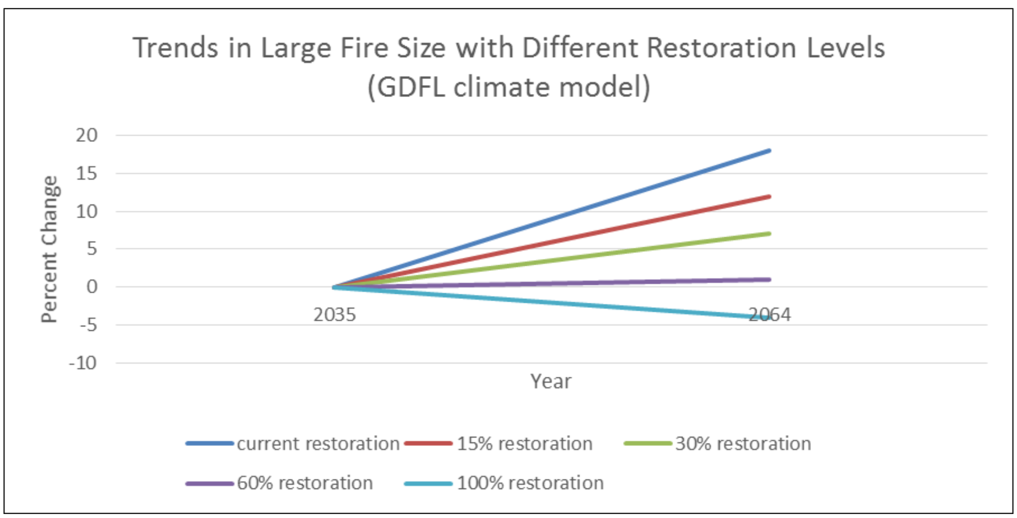

Figure 4. Line graphs showing the expected change in large fire size with different future climate and vegetation restoration scenarios

[6] The blue line is based on the Community Climate System model (CCSM). The red line is based on the Geophysical Fluid Dynamics Laboratory (GFDL) model and the green line is based on the Centre National de Recherches Météorologiques (CNRM) model. The y-axis shows the percent change in large fire size, which is predicted to increase by 13 to 20 percent over the time period.

[7] Using the Geophysical Fluid Dynamics Laboratory or GFDL model

The amount of predicted change in area burned in large fires varies across the plan area somewhat aligned with differences in ecological and elevational zones. The montane and upper montane landscapes have the greatest increase in likelihood of large fires, with a 30 to 55 percent increase, respectively.

Figure 5 shows predicted trends in area burned in large fires separated out by ecological zone as modeled by the Geophysical Fluid Dynamics Laboratory (GFDL) A2 model. It is only shown for one climate scenario because the relative differences between the ecological zones are the same across the other climate models. The increase in probability of large fires remains above 10 percent for the montane zone until the 60 percent scenario, where the trends decrease for all ecological zones except for the upper montane zone. This is because climate will have more effect on increasing fire in the upper montane zone, and most treatments were prioritized in the lower elevation montane and foothill zones because these zones are closer to communities and have the more values at risk (homes and infrastructure). These lower-elevation areas are most deviated from the desired condition and natural range of variation.

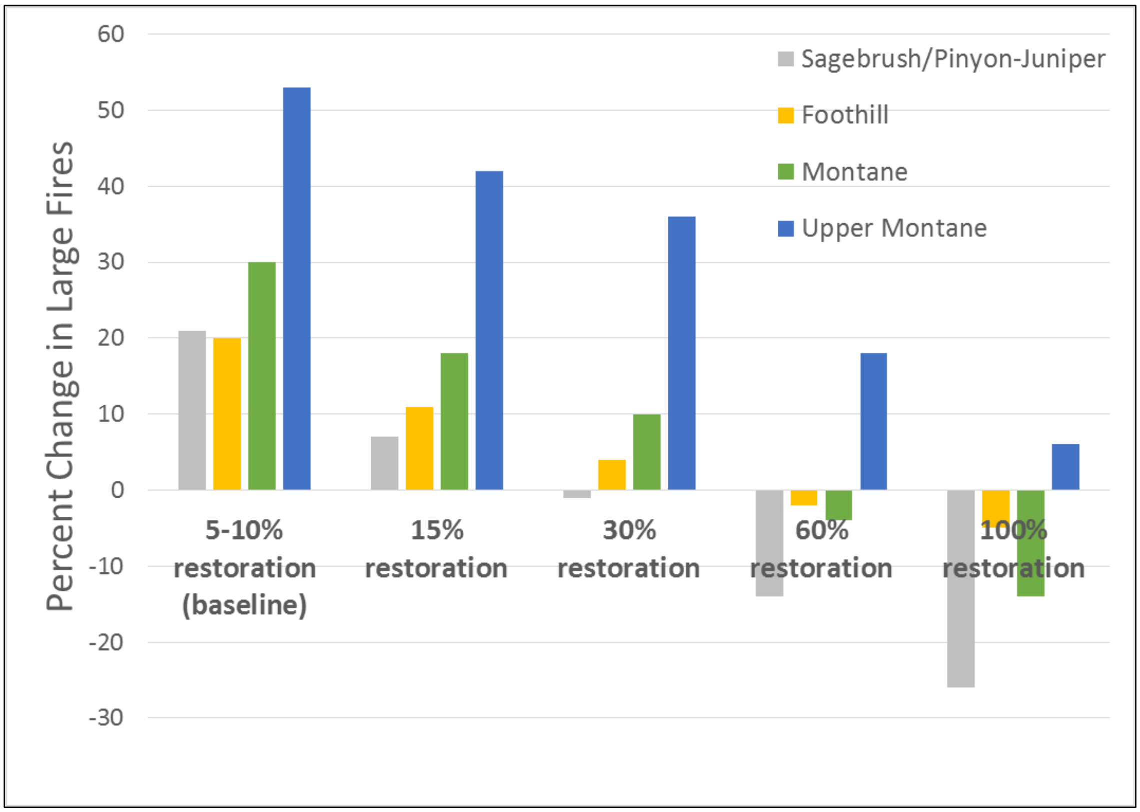

Figure 5. Bar graph showing the change in large fire size by ecological zone and level with different levels of modeled restoration in the Sierra Nevada

Fire Intensity, Fire Type and Severity

Changes in fire extent and large fire size will likely be correlated with higher intensity and higher levels of crown fire. Increased crown fire is expected because of large areas of the landscape with dense vegetation and fuels that can cause more intense and larger fires (Collins and Skinner 2014); such fires have the potential for more fire-atmospheric interactions (Coen 2005, Werth et al. 2011) and predicted drier and warmer fire weather conditions (Westerling et al. 2015). Warmer and drier environments cause lower fuel moisture levels and more intense fires. Once a crown fire starts, it is likely to spread in nearby areas with dense crown fuels. As described above, this can accelerate rapidly and cover very large areas in a short time if fire-atmospheric interactions occur (Werth et al. 2011), or if one part of the fire interacts with another causing a “mass fire” (Finney and McAllister 2011, Viegas et al. 2012). More information on potential fire types, including crown fire, are found in “Terrestrial Ecosystems,” under “Ecological Fire Resilience.”

The amount and patch size of high-severity fire is most important for evaluating the consequences to ecosystems, particularly in vegetation types that historically had low- and mixed-severity fire regimes. High-severity fire is difficult to predict because it depends on the interaction of vegetation composition (size and species) and structure, and fire intensity and duration. Available research on predicting high fire severity at the landscape scale focuses on statistical analysis of fire size with fire severity (Westerling and Keyser 2016). An analysis of fires and large areas and patches of high fire severity in the Sierra Nevada (Fites-Kaufman 2015) found that there is a correlation between very large fires (such as the 2013 Rim Fire) and both the amount and size of large patches of high severity. This may partly be because larger fires can have larger patches of high severity, whereas smaller fires constrain the size of high severity patches (since it can’t exceed the actual size of the fire). However, short but intense fire runs can burn a lot of area, particularly under extreme weather conditions, such as on the 2013 Rim Fire and 2014 King Fire. Statistical modeling shows that high fire severity areas show similar trends with climate to the trends in burned area (Westerling et al. 2015, Westerling and Keyser 2016). The model predicted that fire severity was more sensitive to changes in restoration scenarios than burned area alone. In other words, with restoration, fire severity declines more sharply than burned area.

Modeling of trends in high fire severity with climate change and restoration scenarios by UC Merced show increasing total area burned with higher fire severity (greater than 50 percent of overstory vegetation killed) and increasing size of high fire severity patches.

Environmental Consequences to Fire Trends

The consequences of the alternatives were based largely on the UC Merced fire-climate modeling and how the results varied with four different restoration scenarios. Table 4 provides a summary comparing restoration levels by alternative, and Table 5 and Table 6 provide an overall summary of the consequences of the alternatives on future fire trends.

Each alternative has proposed restoration levels of different treatment types (mechanical, prescribed fire, wildfire managed to meet resource objectives) that are described in acres that would be treated and fire ignitions that would be managed. These proposed restoration levels fall in between the restoration scenarios used in the fire-climate modeling. For example, proposed restoration objectives for alternative B are mostly expressed in ranges that correspond to a restoration of 30 percent of the low- and mid-elevation landscape. The proposed restoration levels for the alternatives vary by ecological zone. For example, there is little restoration planned in the subalpine/alpine zone except for wildfires managed to meet resource objectives. Table 4 below describes how the restoration levels in the scenarios were cross-walked to the restoration levels in the alternatives for this analysis.

In general, alternative A is represented by the historic “baseline” scenario, with restoration rates remaining the same at 5 to 10 percent of the landscape. Alternative B is represented by the 30 percent restoration scenario. Alternatives C and E are represented by the 15 percent restoration scenario. Alternative D is primarily represented by conditions in the 60 percent scenario. The

Table 4. Summary comparison, by alternative, of proposed restoration levels for vegetation types that are currently departed from desired conditions[8]

Restoration Modeling Scenario	Alternative A	Alternative B	Alternatives C and E	Alternative D	Kern River Drainage (Alternatives A, B, C, D, E)
Current levels (historic or baseline scenario, 5 to 10 percent)	**Yes**	No	No	No	No
15 percent	No	No	**Yes**	No	No
30 percent	No	**Yes**	No	No	No
60 percent	No	No	No	**Yes**	**Yes**
100 percent	No	No	No	No	**Yes**

amount of restoration depends on the location and is described in the narrative below. For example, more remote areas may receive higher levels of managed fire, such as the Kern River drainage. In areas where there is a prevalence of both California spotted owl and fisher habitat, the level of restoration would be lower under alternatives where more restrictive plan direction limits the intensity (alternatives C and E, and to a lesser extent alternative B and outside of focus landscapes under alternative D) or extent (alternatives C and E) of restoration.

Table 5 below summarizes the expected changes in fire burned area, large fire size, fire intensity and type, and large patches of high severity fire with projected climate trends by alternative. The information is based primarily on the analysis by UC Merced (Westerling et al. 2015). The values are for the GFDL model, which represents the median model projections amongst the three climate models described earlier. More details on all three simulations are contained in this study (Westerling et al. 2015). Table 6 shows the change in likelihood of large fires by alternative and by ecological and elevational zone for all areas. Both tables are referenced in the analysis of environmental consequences by alternative below.

Table 5. Summary of expected changes in burned area, large fire size (and likelihood of large fires), fire intensity, and likelihood of large patches of high severity fire (and high severity patch size) with projected climate trends by alternative

Indicator	Alternative A	Alternative B	Alternatives C and E	Alternative D
Burned area (percent increase)	97 percent	74 percent	83 percent	64 percent
Size and likelihood of large fires (percent change)	23 percent increase	12 percent increase	16 percent increase	5 percent increase

[8] Desired conditions refer to the historical fire regime and vegetation conditions (see the analysis and methods section for more detail). In the Kern Drainage, alternative A would result in a range of 60 to 80 percent, and alternatives B, C, D, and E would result in a range of 80 to 100 percent.

Indicator	Alternative A	Alternative B	Alternatives C and E	Alternative D
Fire intensity in hot, dry conditions	Very high, decreased in some areas (10% of most ecological zones) of recent large wildfires	High, except decreased to moderate in some areas (30% of most ecological zones) of large prescribed fires or managed fire areas	High, except decreased to moderate in few areas (15-20% most ecological zones) of large prescribed fire and managed fire areas	Moderate to high, decreased in some areas (50% of most ecological zones) of concentrated restoration, such as focus landscapes, large prescribed fires, managed fire areas, some other areas
Size and likelihood of large high-severity patches (more than 1,000 acres; based on increases in large fire size)	At least 23 percent increase	At least 10 percent increase	At least 16 percent increase	At least 4 percent increase

Table 6. Percent change in likelihood of large fires by alternative and ecological/elevational zone

Ecological/Elevation Zone	Alternative A	Alternative B	Alternatives C and E	Alternative D
Foothill	18 to 22 percent increase	2 to 6 percent increase	9 to 13 percent increase	No change to 4 percent decrease
Montane	27 to 33 percent increase	8 to 12 percent increase	16 to 20 percent increase	2 to 6 percent decrease
Upper Montane	50 to 56 percent increase	34 to 38 percent increase	39 to 45 percent increase	16 to 20 percent increase
Kern River Drainage, Sequoia National Forest	9 to 14 percent increase	11 percent increase to 9 percent decrease	Same as alternative B	Same as alternative B
Sagebrush/Pinyon-Juniper	18 to 24 percent increase	2 percent increase to 3 percent decrease	4 to 9 percent increase	10 to 16 percent decrease

Consequences Common to all Alternatives

In all alternatives, we anticipate that management direction would support planned levels, but there are several uncertainties in treatment rates associated with prescribed fire and wildfire managed to meet resource objectives (Chapter 2). First, drier fuel conditions and longer fire seasons decrease the available window (generally spring and fall) to conduct prescribed burns to safely meet burn objectives. Second, following the 2012-2016 drought, extensive tree mortality in the southern Sierra Nevada has led to a significant increase in the amount of hazardous crown and surface fuels (see “Changed Forest Conditions associated with Tree Mortality”), including dense patches of snags and large logs that can constrain prescribed burn operations in these areas. Third, limited operating periods for the California spotted owl, fisher, great gray owl, and deer fawning would make spring burning challenging in many areas in the montane and some foothill and upper montane areas. Similarly, restrictions on burning in riparian area habitat for federally listed species such as yellow-legged frog and Yosemite toad would make spring burning more difficult in many areas. Lastly, there are uncertainties about the ability to conduct prescribed burning because of air quality constraints.

Because of these uncertainties, the amount of restoration using prescribed fire may be overestimated for all alternatives.

Increases in visitors to the national forests in general are likely to result in more human-caused ignitions. Over 90 percent of wildfires (unplanned ignitions) are ignited by people (see "Fire Management"). Some of the fires with the largest size and highest intensity that have occurred in the analysis area and nearby were caused by human ignitions. This includes the 2013 Rim Fire and 2014 King Fire in the central Sierra Nevada. The increase in human-caused ignitions may result in an increase of large, fast-burning, high-intensity fires because of the combined effects of uniformly dense vegetation and high fuel loads (including increased fuel inputs from widespread tree mortality), warming climate, drought, and invasive grasses.

Consequences Specific to Alternative A

Average annual burned acreage, large fire size, and fire intensity are expected to continue to increase under alternative A. Limited amounts of vegetation restoration, including mechanical thinning, prescribed fire, and wildfire managed to meet resource objectives would occur in most areas. Based on the projected trends with climate change, burned area would increase by two to four times, with much of this increase attributed to larger, more severe wildfires. Future wildfires are likely to be more intense during hotter and drier conditions and create larger patches of high-severity fire. This is expected because of projected increases in temperature, more variable precipitation (for example, longer or more severe droughts), increased levels of tree mortality that contribute to greater surface fuel loads, and a resulting longer fire season. The greatest changes would be in the montane and upper montane forests and portions of the foothill zone, except in most of the Kern River drainage (including the Kern Plateau) in the Sequoia National Forest. Here, there would be similar patterns of burned area but decreased fire sizes and intensities as fires burn into other recent fires that burned at low to moderate severity from the last 15 years. There would be a continued trend of increased fire in pinyon-juniper and sagebrush ecosystems. Fire size and likelihood of large fires would continue to increase in these arid shrublands and woodlands, especially where extensive invasions of the nonnative cheatgrass or red brome have occurred.

Consequences Specific to Alternative B

Under alternative B, there would be an increase in the amount of vegetation restoration that would reduce the likelihood of large fires, burned area, fire intensity, and large patches of high fire severity, compared with alternative A. There would be a continued trend of increasing burned area, large fire size, and fire intensity with climate trends (Figure 6); however, the rate of increase is lower (12 percent increase) than current rates of increase (23 percent) represented by alternative A (Figure 6, Table 5). The proposed restoration levels would vary with location in the landscape. Treatments would be prioritized in the montane and upper montane zones but would also include many foothill and some arid shrubland and woodland zones especially in the community wildfire protection zone (CWPZ). In addition to restoration objectives, the following potential management approaches in this alternative emphasize priorities in these areas:

> Areas that historically supported more frequent fire, such as ponderosa pine, Jeffrey pine, and mixed conifer forests, and areas with high existing levels of fuels are prioritized for treatment.
>
> Prioritize fuel treatments in areas that pose the greatest threat to communities and highly valued resources.
>
> In the Wildlife Habitat Management Area, identify opportunities to develop future suitable (and resilient) wildlife habitat more quickly through targeted treatments (such as thinning treatments in plantations).

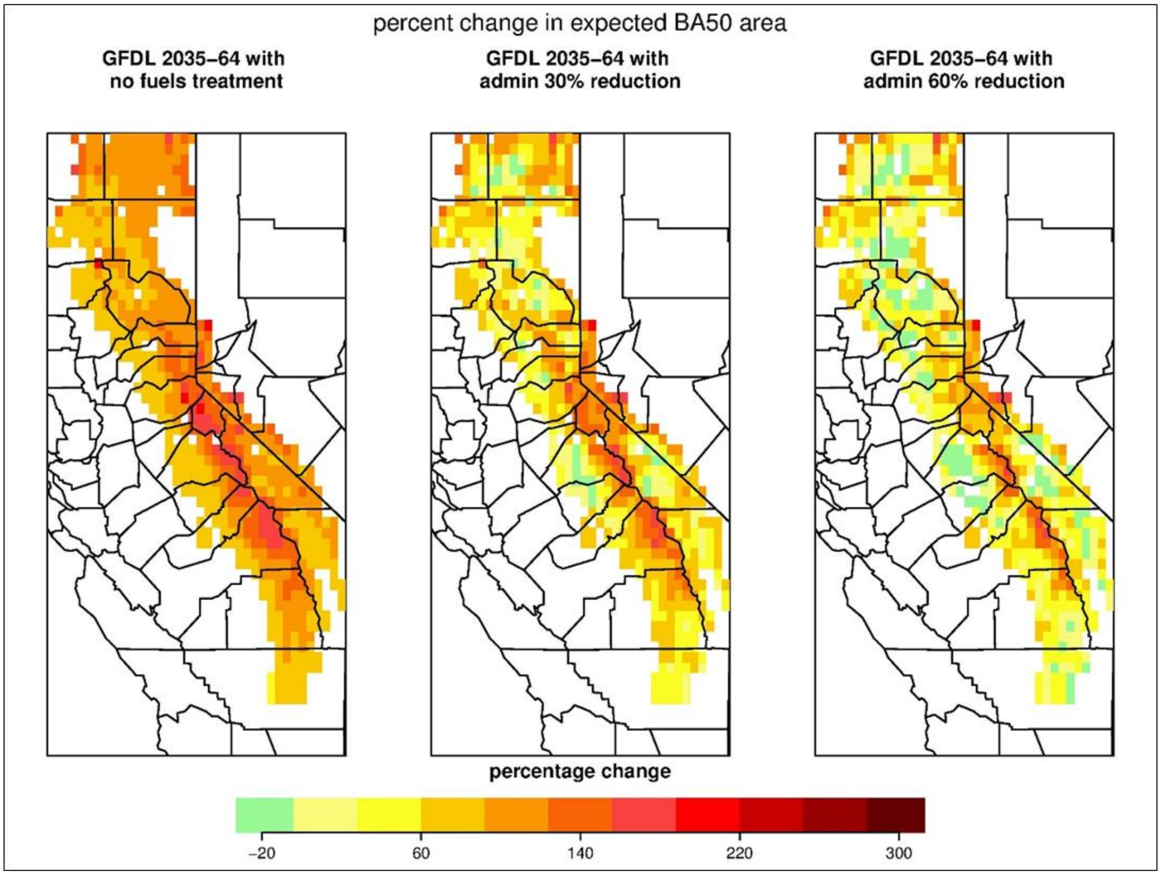

Figure 6. Percent change in area burned at high severity (defined as greater than 50 percent overstory mortality) with future trends in climate[9]

In the Sequoia and Sierra National Forests, at least half of the restoration would occur in wildlife habitat management areas. In some areas, there would be increases in restoration over current levels (chapter 2). These areas would represent approximately 30 to 35 percent of forests in the montane zone. In these areas, assuming about a third of the area would be restored to desired conditions, there would be a decrease in fire intensity (Coen et al. 2015), high severity fire (Wimberly et al. 2009), and the size of high severity fire patches. There would be some decrease in large fire size when fires burn into treated areas, but this is more likely when larger treatments areas are concentrated in a landscape (that is, greater than 12,000 acres; see analysis assumptions above). Goals, potential management approaches, and proposed and possible actions emphasize treating larger landscape areas by working cooperatively with agency and other partners, using mechanical treatments, and larger prescribed fires:

> Work with adjacent land management agencies and other landowners to treat fuels, reduce costs, and increase effectiveness in restoring fire to the landscape.

[9] Figure 6 shows that in the map on the left with no fuels treatments, the area burned at high severity is expected to increase between 100 and 200 percent across most of the analysis area. The map in the middle shows the 30 percent restoration scenario, where most areas show decreases in the trend, but overall there is still a 50 to 100 percent increase in predicted area burned at high severity across the analysis area. High elevation areas show little change with the restoration scenario because most of the areas are in wilderness and wildfire managed to meet resource objectives was not modeled. The map on the right shows the 60 percent restoration scenario, where there are large landscape areas that show levels less than 20 and 40 percent growth, and some with reductions. The reductions are in areas where larger concentrations of simulated restored areas occurred. The legend on the bottom ranges from a reduction of 20 percent (green) to an increase of 300 percent (dark red) on the right.

> Increase the pace and scale of ecological restoration on the national forest through potentially larger-scale planning and implementation processes.

The ability to conduct treatments in these prioritized areas affects the likelihood that sufficient treatments would occur to result in changes in large, high-intensity and high fire severity areas from future fires. There is a moderate level of uncertainty that the levels of projected prescribed fire treatments would occur due to smoke management and air quality concerns, agency capacity and budgets, and potential impacts on natural and cultural resources (for example, limited operating periods for wildlife described above in consequences for all alternatives) especially in areas of substantial tree mortality (such as the lower montane zone). However, most limited operating periods for California spotted owl and fisher are waived or more flexible in the community buffers and the CWPZ (especially where they do not overlap with wildlife habitat management areas), so there may be an increased likelihood of prescribed fire and mechanical treatments in these areas. Further, there are reduced limitations for both prescribed fire and mechanical treatments on the number of fisher hexagons and spotted owl protected activity centers that can be treated in community buffers. Without prescribed fire in mechanical treatment areas, it is less likely that all of the desired conditions for vegetation structure and composition are attained, particularly for surface and ladder fuels reduction. This may mean that mechanical treatment restoration activities are less effective in changing fire behavior and restoring ecological pattern and process when these treatments are not combined with prescribed fire (Wimberly et al. 2009).

Changes in fire management toward a risk-based approach (strategic fire management zones, see “Fire Management”) would result in more wildfire that is managed to meet resource objectives, especially in the wildfire maintenance zone and in some portions of the wildfire restoration zone. This would result in decreased fuels and increased vegetation resilience and has been shown to reduce future fire size and severity (Collins et al. 2009, Ewell et al. 2012, Vaillant 2009), but most of these fires would occur at higher elevations in more remote locations. Implementing the plan management strategy of emphasizing ecological restoration along ridges and some roads and landscape-scale restoration based on topography (North et al. 2009b, North 2012) would improve forest ecological integrity and reduce the intensity and spread rate of wildfires, manage fires to meet resource objectives, and conduct prescribed fires. It would contribute to fire suppression success and allow more wildfires to be managed to meet resource objectives but to an unknown degree, because there are other factors influencing fire management decisions, including weather, fuel conditions (dryness of fuels), and proximity to communities and other values at risk (see “Fire Management”). Additionally, vegetation plan components under alternative B would provide better direction for the management of fire in fire-adapted landscapes, and a plan monitoring program would assist in evaluating wildfire trends more effectively to enhance treatment effectiveness over time.

Under alternative B, there would continue to be large, high-intensity fires, with large patches of high intensity and severity, driven by increased surface fuel loading associated with tree mortality and fire-atmospheric interactions where fires can generate their own weather conditions and accelerate wind speeds that result in amplified fire intensities and spread rates (Coen et al. 2015, Stephens et al. 2018). The likelihood of this would be reduced in the Kern River drainage and other areas greater than 12,000 acres where at least 40 percent of the area has been restored (see assumptions above). Greater effectiveness of vegetation restoration is projected in the sagebrush and pinyon-juniper areas, where model projections show that treating one-third of landscape areas has benefits in reducing the likelihood of large fires across the analysis area (Figure 6). However, there is uncertainty in the effects of restoration treatments, because continued invasion and establishment of nonnative, annual grasses can increase fire spread and fire size in other untreated areas.

There is no anticipated effect of recommended wilderness on treatment rates under alternative B compared with alternative A, because this recommended wilderness is in a portion of the Giant Sequoia National Monument (near existing the Monarch Wilderness) where current management activities (especially mechanical thinning) and road access are limited and restoration treatment options are more restrictive under the Giant Sequoia National Monument Plan.

Consequences Specific to Alternative C

Under alternative C, the proposed area treated with prescribed fire and wildfire managed for resource objectives would increase and potentially more than double, on average, compared with alternative A (Table 4). However, there are greater uncertainties associated with potential restoration rates and outcomes under alternative C (chapter 2) resulting from less flexibility in restoration approaches. First, there would be a greater uncertainty in restoration treatment rates under alternative C compared with alternative A, because of the lower mechanical treatment rates under alternative C (about 25 percent lower than alternative A) and greater reliance on wildland fire as a restoration tool. Mechanical treatment prepares forest stands for burning by reducing fuel loading and creating fuel treatment containers that facilitate the safe and effective application of wildland fire in Sierra Nevada forest landscapes. The more limited use of pre-fire fuels reduction under alternative C would increase the risk or impacts on public and firefighter safety, air quality, wildlife habitat, and other concerns. In turn, this increased risk would result in fewer opportunities for prescribed burning or wildfires managed for resource objectives, especially in the foothill and montane zones that are next to communities or experienced high levels of tree mortality following the 2012-2016 drought. In arid shrublands and woodlands, there are few acres that would be restored in pinyon-juniper and sagebrush using mechanical treatment, prescribed fire, or wildfire managed to meet resource objectives, and these would be limited to where nonnative invasive grasses are absent. There would continue to be increases in the size and area of large, high-intensity fires in this zone.

There would be a greater uncertainty in fire effects and likely a greater frequency of undesirable fire effects (for example, fire severity patterns outside the natural range of variation) under alternative C compared with A. This is because the more limited use of pre-fire fuels reduction under alternative C (using mechanical thinning) would result in greater fire intensity and severity. These greater fire effects associated with alternative C could also constrain future opportunities for fire restoration in some areas that burned too severely, particularly in montane and upper montane forest stands that experienced high levels of tree mortality following the 2012-2016 drought.

There is slightly more uncertainty in treatment rates under alternative C compared with alternative A, because the greater amount of recommended wilderness under alternative C would provide lower flexibility in wildfire management options over a greater proportion of the landscape. This is particularly the case for recommended wilderness areas in close proximity to communities (such as the Devil Gulch and Ferguson Ridge recommended wilderness areas in the Sierra National Forest under alternative C) that would provide greater uncertainty in restoration treatment rates involving prescribed fire and wildfire managed for resource objectives.

Consequences Specific to Alternative D

Alternative D is proposed to have the greatest level of restoration treatments of all kinds (chapter 2). Proposed plan direction guiding restoration treatments and fire management would be mostly similar to alternative B. However, alternative D emphasizes restoration in focus landscapes that primarily occur in or near the CWPZ and areas that provide habitat for California spotted owl, fisher, and other forest-dependent species. Restoration treatment rates outside of focus landscapes under alternative D would also be greater than alternative B, but lower than in focus landscapes.

An estimated 50 percent of landscape areas under alternative D would be restored in much of the foothill, montane, and upper montane landscapes, with greater percentages expected in focus landscapes following the application of landscape-scale prescribed burning or wildfires managed for resource objectives (60 percent of the landscape or higher). In focus landscapes, the use of connected ridgetop fuelbreaks, fuel treatment containers, and other strategically placed fuel treatments would be especially effective at reducing trends in fire size, likelihood of large fires, and high-severity patch size.

In arid shrublands and woodlands, a greater area is also restored, up to 30 percent in the analysis area. These large increases in restoration rates would result in a leveling off or decrease in trends of fire size, likelihood of very large fires, and high severity patch size (Table 5) (Westerling et al. 2015). Given the high rates of restoration under alternative D, there is expected to be a decrease in the amount of crown fire, resulting in smaller patches of high-severity fire that is closer to the natural range of variation.

There would be substantially more ecological restoration of ridges and roads that can provide more opportunities to conduct large prescribed fires in steep areas (like in canyons) and to manage wildfire to meet resource objectives, including in areas of increased tree mortality. This would increase the likelihood that more area is burned under low- to moderate-intensity conditions that decrease fuels, provide ecological benefits, and further decrease the likelihood of large, high-intensity fires beyond the natural range of variation. There is uncertainty about how much smoke regulations and air quality management would affect this potentially greater amount of prescribed fire and wildfires managed to meet resource objectives in alternative D.

Consequences Specific to Alternative E

The consequences of alternative E would be similar to alternative C, because restoration treatment rates (mechanical thinning, prescribed fire, wildfire managed for resource objectives) and uncertainties in these rates would be similar between these alternatives. There is slightly less uncertainty in treatment rates under alternative E compared with alternative C, because the lower amount of recommended wilderness under alternative E would provide greater flexibility in wildfire management options over a greater proportion of the landscape (especially in the Sierra National Forest where there is about half as much designated wilderness under alternative E as under alternative C). This is particularly the case for recommended wilderness areas in close proximity to communities (such as the Devil Gulch and Ferguson Ridge recommended wilderness areas in the Sierra National Forest under alternatives C and E) that would provide greater uncertainty in restoration treatment rates involving prescribed fire and wildfire managed for resource objectives. Management direction for backcountry management areas under alternative E would provide similar forest management options to restore natural fire regimes to montane, upper montane, and some foothill landscapes compared with alternative C.

Cumulative Effects

There are several past, present, and reasonably foreseeable future actions of adjacent landowners that can cumulatively influence future fire trends in the Sierra Nevada bioregion over the next 15 to 30 years. The southern Sierra Nevada contains large contiguous areas of Federal landownership where Federal agencies may cooperatively manage wildland fire for resource objectives (Meyer et al. 2015). The National Park Service manages Sequoia, Kings Canyon, and Yosemite National Parks, which, along with national forest lands, cover over 90 percent of the montane and upper montane zones in the southern Sierra Nevada.

In addition, the BLM manages many lower-elevation arid shrubland and woodland landscapes (and some foothill and montane areas) located primarily south and east of Sequoia National Forest. There are also larger areas of private land next to and in the national forests in the analysis area, especially to the west in the foothill zone. The National Park Service emphasizes fire restoration and for the past 15 to 20 years has cooperated with the Sequoia and Sierra National Forests on the management of wildfires to meet resource objectives in the southern Sierra Nevada (Meyer 2015a).

Moreover, the Sequoia National Forest has conducted prescribed fires and managed several wildfires for resource objectives in the Giant Sequoia National Monument in recent years, including the 2016 Slate Fire and 2016 Meadow Fire. These combined fire restoration actions have reduced fuel loads and decreased the cumulative probability of large, high-intensity fires in some portions of the southern Sierra Nevada; most areas in the region still contain a significant fire deficit (see “Terrestrial Ecosystems”).

The Inyo National Forest and BLM manage wildfires similarly to the Sequoia and Sierra National Forests, with a general emphasis on fire restoration in montane and upper montane forests when feasible and suppression objectives in arid shrublands and woodlands and foothill vegetation. Trends in large, high-intensity fires are the same on lands managed by the Forest Service and the BLM, and there is little difference in the cumulative effects on lands next to BLM land as a result.

Several foreseeable future actions could influence fire trends in the southern Sierra Nevada. First, the Sierra National Forest is proposing a forestwide prescribed burn project that focuses on restoring historic fire regimes, minimizing the potential for uncharacteristic wildfires (including reducing wildfire risk to public and firefighter safety), and reducing potential fire effects on natural resources especially in areas of high tree mortality. If implemented, this project would increase rates of prescribed fire and reduce hazardous fuels in the Sierra National Forest that would contribute to declines in the likelihood of large, high-severity wildfires in the southern Sierra Nevada. Second, Yosemite National Park is amending its Fire Management Plan to align it with current Federal wildland fire policy. This amendment process would provide greater flexibility to manage wildfires for resource objectives and increase the number of partnership opportunities with neighboring land management administrative units such as the Sierra National Forest. This could increase restoration treatment rates in the region to a level above that anticipated under alternatives B, C, D, and E, which would further reduce trends in large, high-intensity wildfires (especially on the northern boundary of the Sierra National Forest). Third, a recent revision to the Inyo National Forest Land Management Plan provides greater alignment with fire management zones with the Sequoia and Sierra National Forests, thereby providing more opportunities to manage wildfire for resource objectives along the Sierra Nevada crest. Lastly, ongoing fuel treatments in smaller private in-holdings and adjacent private lands would contribute toward reduced wildfire size and severity in the region. All of these foreseeable future actions would reduce regional trends in total burned area, large wildfire size, fire intensity, and high-severity patch size, even though these fire trends would be exacerbated by climate change.

Alternatives B, C, D, and E would emphasize an all-lands-management and shared-stewardship approach that would increase the ability of Federal land managers in the southern Sierra Nevada to work cooperatively in reducing hazardous fuels, restoring low- to moderate-severity fire regimes to the landscape, and reducing the likelihood of uncharacteristically large and severe wildfires. Alternatives B, C, D, and E include many plan components to increase partnership opportunities, including the following potential management approaches:

> Work with adjacent land management agencies and other landowners to treat fuels, reduce costs, and increase effectiveness in restoring fire to the landscape.
>
> Prior to and during the fire season, assess conditional thresholds under which desired conditions can be met for the strategic fire management zones. Work with Tribes and adjacent landowners to identify areas and resources of value considered in the assessments.
>
> The fire prevention program is coordinated with local and State agencies. These efforts are coordinated across jurisdictions and supports a unified message. Target audiences include local residents and out-of-area national forest users.

Although alternative A would encourage partnership efforts for wildland fire management in the southern Sierra Nevada, these efforts would be more narrow in scope due to limited plan direction in current forest plans for the Sequoia and Sierra National Forests (Meyer et al. 2015). The cumulative effect under alternative A would be more limited application of fire restoration in the region, which would result in higher occurrences of uncharacteristically large or severe wildfires in the analysis area, particularly in areas spanning administrative boundaries.

Analytical Conclusions

Although trends in climate are the same for all alternatives, restoration treatment rates and intensities and their resultant effects on vegetation and fuels vary considerably by alternative. As a result, the likelihood of large, high-intensity fires differs among alternatives, even with warming climate trends that project more severe fire weather in the future. The likelihood of large high-intensity fires continues to increase under all alternatives in the foothill, montane, and upper montane zones, although this likelihood is lowest under alternative D followed by alternative B (the trend would decline in arid shrublands and woodlands under alternative D and possibly under alternative B). Under alternative D, levels of large, high-intensity fires may increase slightly or remain unchanged, because of the higher proportion of landscapes that are restored (Table 5).

The likelihood of large, high-intensity wildfires and wildfire size are lowest in alternatives D and B, because these alternatives emphasize: (1) higher restoration treatment rates; (2) greater flexibility in restoration treatment approaches (greater use of mechanical thinning for fuels pretreatment, more flexible standards and guidelines for mechanical thinning and prescribed burning, and more variation in desired conditions that emphasize structural heterogeneity and habitat diversity based on natural range of variation and other concepts); (3) strategic prioritization of restoration treatment areas, such as emphasis on treatment of Wildlife Habitat Management Area, fire protection zones, or ridgetops to increase vegetation and habitat resilience across entire landscapes; and (4) increased restoration treatment effectiveness. Aside from the reasons stated above, restoration treatment effectiveness is greatest under alternatives B and D (and to a similar extent under alternatives C and E) based on: (a) strategic fire management zones; (b) ecological principles described in General Technical Report (GTR)-220 and 237 (North et al.

2009b, North 2012) to manage montane forests; (c) vegetation plan components that provide better direction for the management of fire in fire-adapted landscapes; and (d) a plan monitoring program to evaluate terrestrial ecosystem condition and wildfire trends. With both alternatives B and D, there is a high likelihood that the trend in large, high-intensity fires in arid shrublands and woodlands may not get any worse in the analysis area (Table 6). In the foothill zone and montane forest zone, there is a reduction in the likelihood of large high-intensity fires in community buffers with alternative B, but the trend is still increasing with climate change. Under alternative D, higher rates of restoration treatments in focus landscapes reduce the likelihood of large, high-intensity fires in montane and upper montane portions of the Sequoia and Sierra National Forests.

In all alternatives, there is uncertainty in the degree that landscape-scale prescribed burning can occur in areas of moderate to high tree mortality following the 2012-2016 drought (montane, upper montane, and part of the foothill zones) or after large and severe wildfires (such as areas burned in the 2018 Ferguson Fire). This uncertainty is greatest under alternatives A, C, and E and lowest under alternatives B or D. This is because fewer acres would be treated with mechanical thinning prior to prescribed burning, resulting in understory fuels that are too high (dense ladder fuels, heavy and continuous surface fuel loads) to permit the safe and effective reintroduction of wildland fire in terrestrial ecosystems except under ideal circumstances (for example, suitable weather and burn windows, lower fuel loading, more accessible locations, gentler topography).

Under alternatives A, C, and E, there would be fewer available days for prescribed burning from limited operating periods established for wildlife species (especially in comparison to focus landscapes of alternative D). This increases the uncertainty that there would be enough treatment to decrease the trend in large fire size or area burned in large fires in alternatives A, C, and E (especially alternative A). In these alternatives, there is a high likelihood that the current trend of increasing occurrence of large, high-intensity fires would continue or worsen.

Under all of the alternatives, any large area (greater than 12,000 acres) that has extensive restoration (greater than 30 to 40 percent) is likely to have a substantially lower probability of large, high-intensity fires and high-severity fire effects (Turner 1989, Wimberly et al. 2009, Parisien et al. 2007, Parisien et al. 2010, Parisien et al. 2012, Fites-Kaufman 2014, Coen et al. 2015, Westerling et al. 2015). This situation currently occurs in many parts of the Kern Plateau (excluding areas burned in uncharacteristically large and severe wildfires) and is likely to continue and expand across more of that area.

Insects, Pathogens, and Changed Conditions Associated with Recent Tree Mortality

Background

This section focuses on two interrelated topics: (1) forest insects and pathogens that affect trees, and (2) tree mortality patterns associated with the recent (2012-2016) exceptional drought conditions in the southern Sierra Nevada. The linkages and interrelated effects of climate (including hotter droughts), fire, insects, and pathogens are covered in “Combined Effects of Climate, Fire, Insects, and Pathogens.”

Native insects and pathogens are an integral part of forest dynamics and process of change in the southern Sierra Nevada. Pathogens, often called “diseases,” are naturally occurring fungi or plants and can play an important role in modifying forest structure and composition, such as creating cavities or snags used by wildlife. Environmental factors such as drought, wildfires, or vegetation conditions strongly influence behavior of native insects and pathogens. While native insects and pathogens affect their host plants to varying degrees, some are considered key species due to their ability to cause widespread or severe losses. Species that can kill the most trees are listed in Table 7. White pine blister rust is a nonnative invasive pathogen that is very deadly to white pines. Bark beetles are the leading cause of dying trees (especially pines), and the recent outbreaks across western North America are the largest and most severe in recorded history (Bentz 2005).

Table 7. Key forest insect and pathogen species of the southern Sierra Nevada

Key Pest Species	Host Tree Species (and Potential to Kill)	Recent outbreaks (2012–2017)
Western pine beetle	Ponderosa pine (high)	Yes
Mountain pine beetle	Sugar pine, lodgepole pine, whitebark pine, western white pine (high) ponderosa pine, foxtail pine (low)	Yes
Jeffrey pine beetle	Jeffrey pine (high)	No (some localized)
Fir engraver	White fir, red fir (high)	Yes
Pinyon ips	Single-leaf pinyon pine (high)	Yes
Pine engravers *(Ips* spp.*)*	Ponderosa pine, Jeffrey pine, 5-needled pines,[1] single-leaf pinyon pine, lodgepole pine (high)	No (strongly associated with other bark beetles)
California flatheaded borer	Jeffrey pine (high)	No (some localized)
Red turpentine beetle	Ponderosa pine, Jeffrey pine, 5-needled pines,[1] single-leaf pinyon pine, lodgepole pine (low[2])	Yes
Douglas-fir tussock moth	White fir (moderate to high)	No
Dwarf mistletoes	Ponderosa pine, Jeffrey pine, sugar pine, lodgepole pine, white fir, red fir (moderate) low: 5-needled pines,[1] single-leaf pinyon pine (low)	Possible increases in red fir
Heterobasidion root disease	White fir, red fir (high) ponderosa pine, Jeffrey pine, sugar pine, 5-needled pines[1] (low)	No
Black stain root disease	Single-leaf pinyon pine (high)	No
Armillaria root disease	5-needled pines,[1] lodgepole pine, white fir, red fir, incense cedar, giant sequoia, California black oak (low); ponderosa pine, Jeffrey pine (occasional)	No
White pine blister rust	5-needled pines[1] (high)	No

[1] In the Sequoia and Sierra national forests, these include sugar pine, whitebark pine, foxtail pine, and western white pine.
[2] Potential to kill is typically low but could be moderate during extreme drought conditions.

In the southern Sierra Nevada, bark beetle outbreaks during and immediately following the recent (2012-2016) drought have also been extraordinarily severe (Preisler et al. 2017), with several bark beetle species exhibiting substantial outbreaks throughout the region (right column of Table 7). A 2009 update report from Western Forestry Leadership Coalition stated that between 2002 and 2003, acres affected by bark beetles increased from 4 million to 10 million acres across the West (Western Forestry Leadership Coalition 2009 (Coalition 2009)). In western forests (including the Sierra Nevada), future projections estimate that bark beetle and other forest insect activity will increase because of climate change trends (elevated temperatures, more frequent or severe drought) and current high risk conditions associated with vegetation that is far denser than the NRV (Bentz et al. 2010, Hicke et al. 2006).

In 2011, the Forest Service produced a western bark beetle strategy to develop future prevention management strategies to mitigate the widespread epidemic of bark beetle-killed trees occurring all through the western states (United States Department of Agriculture 2011g). The strategy is based on three primary goals: human safety, forest recovery, and long-term forest resiliency. High levels of bark beetle-killed trees create public safety concerns, due to the risk of hazardous trees falling on the public and damaging property. The rapid loss of trees affects ecosystem integrity, dramatically altering the structure and composition of vegetation and distribution of trees, which decreases stability of forests, and alters ecological function. After significant bark beetle infestations, forest stands may or may not return to original conditions, dead trees can increase wildfire potential, and loss of keystone tree species affects associated wildlife or vegetation (Stephens et al. 2018). Thinning treatments to reduce forest density toward the natural range of variation can make stands more resilient and reduce the likelihood of high levels of bark beetle mortality (Fettig 2012, Kolb et al. 2016).

Analysis and Methods

There have been numerous research studies examining how forest conditions affect the likelihood and level of insect and pathogen impacts on trees. This includes measures of stand density, suitable diameter classes, or forest composition as potential risk factors for pest attack, especially bark beetles. Higher numbers of dying trees are often correlated with areas of densely growing trees for most bark beetles and their respective hosts. Drought conditions (such as the 2012-2016 drought) are included as a factor of likelihood that attacks will occur.

Despite measures that gauge insect and pathogen activity, discussions of environmental consequences of alternatives will be qualitative assessments. Insect and pathogen activity viewed at forest-level scales is addressed qualitatively since monitoring information is primarily based on general trends across larger forested landscapes. The levels of insect and pathogens were compared with information on reference conditions, as indicated by the natural range of variation (Safford 2013, Safford and Stevens 2017); see “Terrestrial Ecosystems.” These are referred to as background levels. There is little information pertaining to pre-settlement (natural range of variation) estimates of insect and pathogen activity and associated tree mortality in the Sierra Nevada, including the Sierra and Sequoia National Forests. However, some inferences related to insect- and pathogen-related tree mortality can be drawn from the comparison of recent past, current (contemporary forests in the Sierra and Sequoia National Forest and modern reference sites with intact disturbance regimes), and projected future conditions.

Measures of recent drought-related tree mortality are generally based on the percentage of trees (by basal area or density) that occurred over or immediately following the 2012-2016 drought (2012-2017). These mortality estimates are based on recent published and unpublished literature (Brodrick and Asner 2017, Paz-Kagan et al. 2017, Pile et al. 2018a, Stephenson et al. 2018) or monitoring and research plot data in the southern Sierra Nevada with an emphasis in the Sierra or Sequoia National Forests (Meyer et al. 2017, Axelson and Battles 2017, United States Department of Agriculture 2016a). More recent tree mortality data derived from USDA Forest Service Forest Health Protection aerial detection surveys in 2018-2019 were not included in the analysis, because these recent estimates were: (1) negligible for most conifer species in the Sequoia and Sierra National Forests compared with tree mortality levels that occurred during the 2012-2017 period; and (2) lacking available field data for validation and comparison in 2018-2019. For all tree mortality estimates, there is an inherent degree of uncertainty due to the delayed responses of trees to stressors (such as insect attack); irregular rates of decay among tree species; and limitations in field, aerial, and satellite-derived estimates that can often underestimate the extent or severity of tree mortality, particularly in dense forest stands.

Indicators and Measures

The effects of forest insects and pathogens are often measured by several factors: affected acres, trees killed per acre, or percentage of trees affected (severity). Annual aerial surveys are conducted by the Forest Health Monitoring Program under the Forest Service's State and Private Forestry Program, which visibly detects and records areas of dying trees caused by forest insects and diseases on the landscape. The Forest Service's Forest Health Protection Program has multiple tools in which to evaluate measures. Numbers of trees dying that are higher than background levels are often indicators of increasing insect activity or areas of growing infection by pathogens. Unusual patterns of dead trees with particular host plants can also indicate pest presence. Compilation of acres affected or trees killed can provide indications of trends emerging on the landscape.

Forest Health Technology Enterprise has developed computer modeling tools that assess the risk of forests from insects based on recent (prior to 2012-2016 drought) stand conditions (United States Department of Agriculture 2012b). Gradations of risk are assessed up to greater than 25 percent basal area loss, which is considered the highest risk over a span of 15 years. Maps of specific locations or forests can be developed to assess levels of risk.

The combined effects of insects and pathogens with other stressors (such as uncharacteristic wildfires, climate change, and drought) on terrestrial ecosystems is addressed in "Combined Effects of Climate, Fire, Insects, and Pathogens" and "Terrestrial Ecosystems."

Assumptions

Most forest insects and pathogens are native. Current conditions of dense forested stands or predominance of shade-tolerant trees have significantly changed forests from the natural (historic) range of variation (Meyer 2013a, Safford and Stevens 2017). In general, bark beetles target dense stands because the host trees in these conditions are often stressed and weakened due to high competition for water. Drought further stresses trees, triggering increased bark beetle attack. These trees are less able to produce resins that they use to fend off bark beetles that drill into the bark. For ponderosa pines in California, studies determined that stands with highest densities are most often first infested (Oliver 1995, Hayes et al. 2009). If droughts become more frequent, of greater intensity, or last longer in the future, higher levels and more widespread bark beetle-caused mortality should be expected (Millar and Stephenson 2015).

Trees killed by insects and pathogens do provide important contributions to ecosystem function when they are at levels in the natural range of variation. Bark beetles and wood-boring insects provide forage for wildlife (such as woodpeckers). Dead trees, standing or down, create essential habitat structures and organic biomass for forests. Trees killed by native insects and pathogens can result in small-scale disturbances that keep forests dynamic and regularly changing by creating small openings and increasing heterogeneity (Fettig 2012). Bark beetle outbreaks can have positive, negative, or neutral effects on ecosystems, such as increasing water yield, improving grazing habitat and understory cover, temporarily increasing foraging habitat for cavity-excavating species, diminishing habitat quality of mature-forest-associated species, amplifying surface fuel loading, or degrading air and water quality and increasing surface fuel loading (Morris et al. 2018).

Forest restoration treatments designed to restore forest stand structure and composition similar to the natural range of variation can minimize the impacts of insects and pathogens (Fettig 2012). Reduced tree density, more varied structure, and diverse tree composition will significantly reduce susceptibility of trees to attack and infection and improve individual resistance mechanisms (Smith 2007, Fettig et al. 2007). One measure of forest density that is used to evaluate susceptibility to bark beetles is stand density index. This measure is weighted by tree size and tree density, so stands containing a higher density of trees and that are dominated by small trees have higher index levels. This is partly because more small trees can "crowd" into the same space as fewer large trees.

Other useful forest density measures include basal area and total tree density. Light thinning, and especially thinning limited to small trees, may not reduce stand density index sufficiently to alter conditions that attract bark beetles (Oliver 1995). Prescribed fires alone may not reduce stand density index sufficiently if they are low intensity and leave many unburned patches, creating situations that make trees more vulnerable to attack in the short term (Fettig et al. 2008). However, large wildfires managed to meet resource objectives can result in significant reductions in forest density, more heterogeneous stand structure, and greater vegetation diversity that decreases susceptibility to insect attack (see "Affected Environment" below). This is evident in the current and previous drought events in the Sierra Nevada and Baja California where lower levels of dying trees are positively associated with areas that have burned in wildfires managed for resource objectives in the last 15 to 30 years (Boisrame et al. 2017, Stephens et al. 2018).

Heterogeneity across the landscape can also disrupt the expansion of insect activity. Variation of tree size, age, or species composition may limit the amount of suitable host material and, thus, reduce the number of dying trees (Fettig 2012).

The effects of forest thinning treatments on insect and pathogen levels and susceptibility vary some by treatment type and combinations. Stands where combinations of mechanical treatments and prescribed fires were implemented have been found to be less attractive to bark beetles than stands where only prescribed fire treatments occurred, as the combined treatments improved overall tree health and growth (Feeney et al. 1998, Wallin et al. 2008). Fire may result in heightened bark beetle activity in the short term due to the nature of injury that fire causes. Crown and bole scorch severity are two of the primary factors used to gauge tree survival but also susceptibility to bark beetle attack (Hood et al. 2007, Smith and Cluck 2011).

Studies on bark beetle impacts followed by prescribed fires have determined that the likelihood of bark beetle infestation significantly increases with burning alone (Fettig et al. 2008, Fettig and McKelvey 2010). Therefore, it is important to recognize potential subsequent effects of bark beetles following a prescribed fire or wildlife when drought events or underlying resource stress (such as decreased moisture availability associated with high tree densities) are also present.

Affected Environment

Recent forest conditions (stand densities, especially in small diameter classes) are considered outside of the natural range of variation and prone to insect and pathogen outbreaks beyond background levels (Safford and Stevens 2017).

Recent and ongoing widespread, high levels of tree mortality reflect these conditions, magnified by recent (2012-2016) drought (Asner et al. 2015) and temperature increases (Van Mantgem et al. 2009). Past management activities have changed forest structure, leading to changes in tree species composition, age classes, structural variation, and density. Reliable historic reference information pertaining to tree mortality and insect and pathogen outbreaks are limited for the Sierra Nevada (Safford and Stevens 2017). However, based on this limited information it is likely that recent elevated rates of tree mortality and associated bark beetle activity in the Sierra and Sequoia National Forests following the 2012-2016 drought are outside the natural range of variation (Allen et al. 2015, McDowell et al. 2016) and beyond a "threshold of sustainability" (Millar and Stephenson 2015). This pattern of amplified tree mortality is anticipated to recur with future hotter droughts associated with climate change (Allen et al. 2015, McDowell et al. 2016) and other interacting stressors (Millar and Stephenson 2015). During the recent extreme drought (2012-2016), levels of drought stress and associated tree mortality were most severe and extensive on the west slope of the southern Sierra Nevada, centered in the Sierra and Sequoia National Forests (Preisler et al. 2017, Young et al. 2017).

Bark Beetles

Currently, there are extensive areas of very high drought and insect-related mortality occurring on the lower slopes of the Sierra and Sequoia National Forests (see Figure 7, Figure 8, and Figure 9). These levels are greater than what has been recorded in the last 50 years or more, but there have been other notable outbreaks. Over the past four decades, California has experienced significant drought events that have triggered unprecedented levels of bark beetle-associated tree mortality. More than 1,430,000 acres (primarily true firs) were affected in 1992 to 1994 and over 6,670,000 acres were affected in 2002 to 2005. Of those 6,670,000 acres, nearly 900,000 acres were in southern California forests; affected is defined as having some detectable level of tree mortality). In 2006 to 2009, some subalpine whitebark pine forests have lost over 75 percent of overstory trees, with new patches of dead trees developing annually in subsequent years (Meyer et al. 2016, Millar et al. 2012).

Defoliators

Other insects that cause noticeable and significant damage have been defoliators (insects that eat the needles or leaves of trees and can kill the trees when attacks are severe). The native Douglas-fir tussock moth cycles in population boom and bust every 7 to 10 years. White firs are its primary host, but other neighboring species can be affected if populations are high. From 1996 to 1999, 44,000 acres in Sequoia-Kings National Park and Sequoia National Forest were defoliated; about 5,800 acres were severe (exceeding 10 dead trees per acre) (United States Department of Agriculture 2015a). Pandora moth outbreaks are infrequent but can cause severe localized damage. Both insects become public safety hazards: Douglas-fir tussock moth larvae have stinging hairs that cause severe respiratory problems in sensitive individuals; Pandora moth larvae can become so numerous on roads or other public settings to create treacherous conditions. Pandora moth, however, is also a valued resource collected by tribal members.

Figure 7. Photo of dead and dying ponderosa pines in the foothill and lower montane zones of the Sierra National Forest, fall 2015

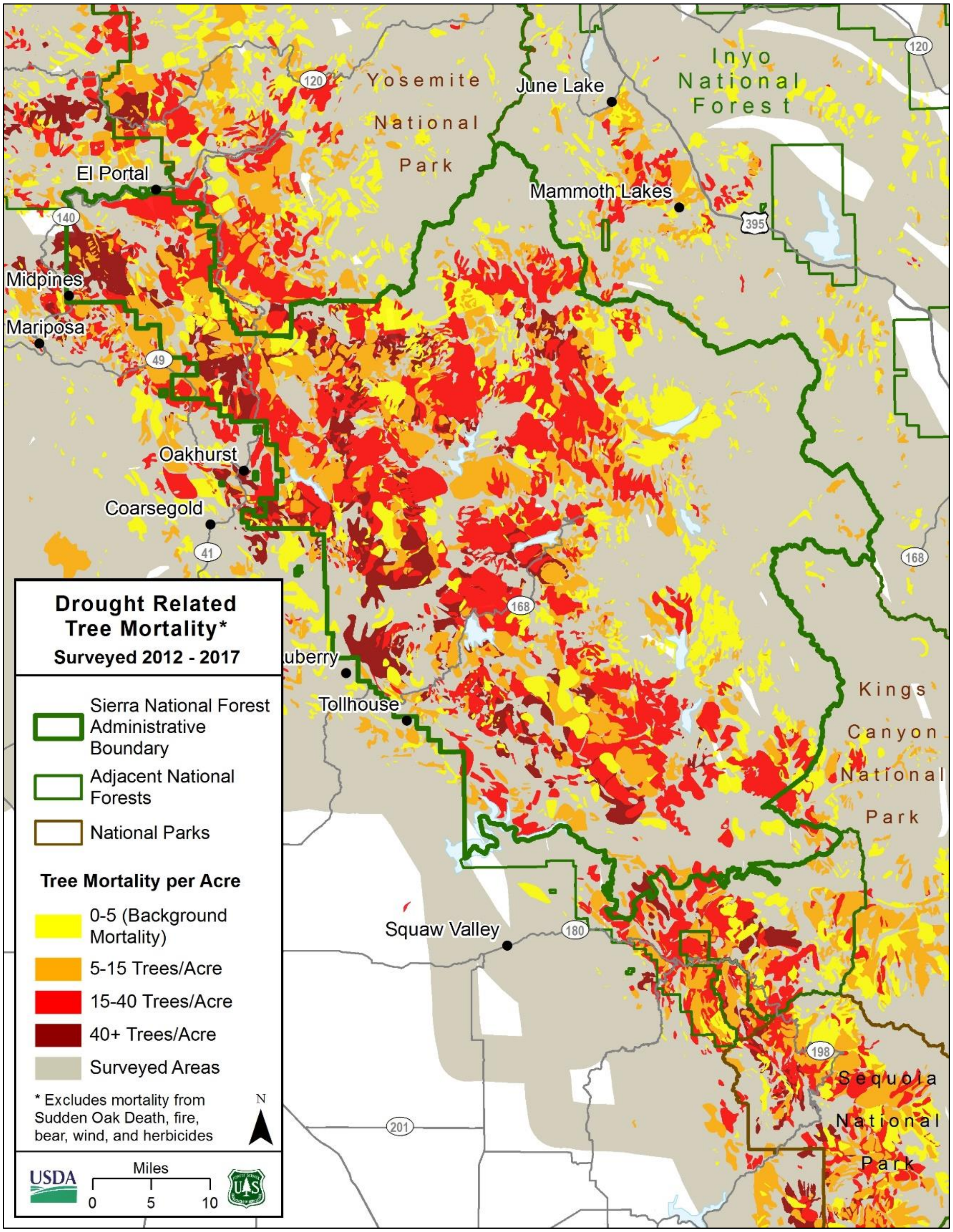

Figure 8. Recent (2012-2017) cumulative drought and insect-related mortality in the Sierra National Forest based on aerial detection surveys by the USDA Forest Service Forest Health Protection

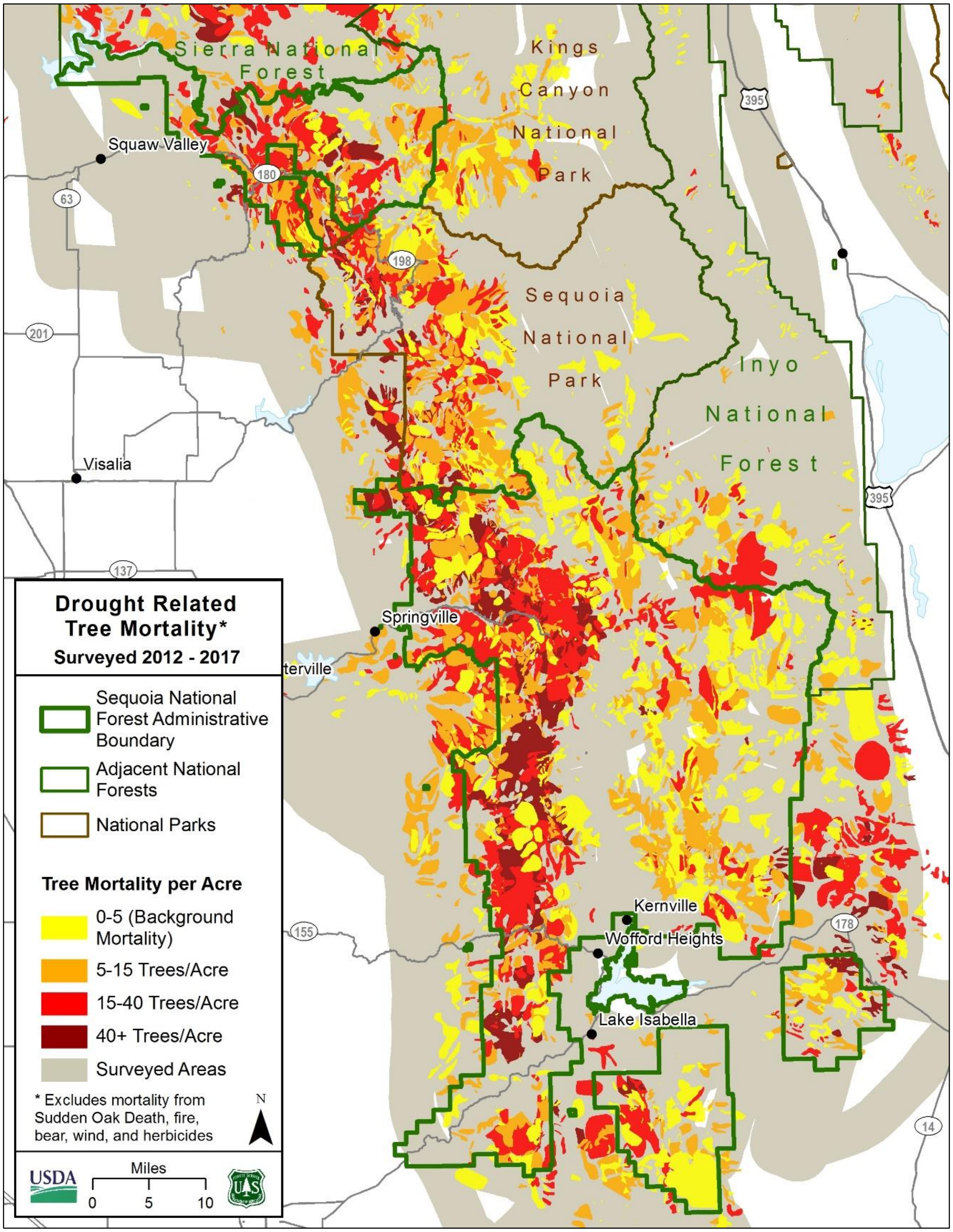

Figure 9. Recent (2012-2017) cumulative drought and insect-related mortality in the Sequoia National Forest based on aerial detection surveys by the USDA Forest Service Forest Health Protection

Dwarf Mistletoes and Root Diseases

Dwarf mistletoes and root diseases can have profound long-term effects on forest structure and composition in the southern Sierra Nevada. Forest pathogens work more slowly than insects in killing individual tree hosts by extracting water and photosynthates (sugars and other chemical products of photosynthesis), crippling and deteriorating tree metabolism and vigor. Infected hosts are thereby more susceptible to structure failure or attack by secondary pests that eventually kill the tree. Dwarf mistletoes are highly evolved parasitic plants that persist on individual trees for decades, causing dieback or severely reducing growth and development. In recent years, dwarf mistletoe and associated foliage loss has been prevalent in red fir forest canopies throughout the southern Sierra Nevada (Meyer 2017, Meyer et al. 2019). *Heterobasidion* spp. is the most common root disease found in the southern Sierra Nevada forests. True firs are highly susceptible to *Heterobasidion* infection. Pinyon pine trees infected with black stain root disease are susceptible to mortality from *Ips confusus* bark beetle. Black stain root disease is more prevalent in eastern Sierra Nevada pinyons.

Nonnative Insects and Diseases

The most damaging conifer pathogen in California, white pine blister rust, was introduced to the west coast of North America in 1910 on infected imported plant seedlings. White pines are all susceptible to white pine blister rust in laboratory studies, but only sugar pine and western white pine have been confirmed with infections so far. Recent surveys of white pine blister rust have found very low incidence in the southern Sierra Nevada national forests (Maloney 2011). However, preliminary research from Sequoia and Kings Canyon National Parks found a doubling to 45 percent white pine blister rust infection levels in western white pines since the initial survey conducted in the early 1990s (Cahill 2013). The pathogen has not yet been found on eastside forests, but it is continually expanding its range as observed in northwestern forests and in the Rocky Mountains. It continues to be a serious threat to white pines as climate conditions change and pathogens are easily transported through other pathways.

Pre-Drought Risk of Insects and Pathogens

Forest Health Monitoring risk maps prior to the 2012-2016 drought (United States Department of Agriculture 2012a) showed substantial risk of increased tree mortality (greater than 25 percent basal area lost) due to bark beetles and other pest complexes during the 2012-2016 drought. Data from these maps are summarized in Table 8.

Table 8. Summary of percent area at risk by basal area loss categories for the Sequoia and Sierra National Forests

Percent Basal Area Loss (%)	Percent Area at Risk Sequoia National Forest	Percent Area at Risk Sierra National Forest
1-4	8%	7%
5-14	27%	24%
15-24	20%	20%
>25	45%	49%

Similar to the 2012-2016 drought, future hotter droughts may become frequent, intensive, and prolonged, and it can be expected that mortality will be proportional, especially in areas not as heavily impacted by the recent drought event (Smith 2007, Kolb et al. 2016). Warming and drying climate are expected to greatly increase the likelihood and risk of widespread and elevated insect and pathogen outbreaks (Fettig 2012).

Changed Forest Conditions Associated with Tree Mortality

Forest structure, composition, and function changed substantially in the southern Sierra Nevada in response to the 2012-2016 drought event. These patterns occurred at multiple spatial scales from entire landscapes to localized forest stands. At the geographic scale, tree mortality patterns and associated canopy water content varied over broad moisture and precipitation gradients, especially elevation and latitude (Figure 8, Figure 9). The greatest levels of tree mortality generally occurred at lower elevations and at more southern latitudes (centered in the Sierra and Sequoia National Forests) that were indicative of areas of greater moisture stress and climatic water deficit (Young et al. 2017, Asner et al. 2015). As a consequence, the greatest levels of tree mortality (density and biomass of recently dead and dying trees) occurred in the low- to mid-elevation ponderosa pine and dry mixed conifer forests (Brodrick and Asner 2017, Paz-Kagan et al. 2017), although some upper montane forests (for example, red fir) also exhibited widespread mortality in the region (Table 9). Tree mortality also tended to increase with topographic dryness, such as southwest-facing slopes, shallower soils, and greater distances from perennial water sources (Paz-Kagan et al. 2017).

Table 9. Cumulative acres with tree mortality in the Sequoia and Sierra National Forests (2012–2017)[1] based on aerial detection surveys by the USDA Forest Service Forest Health Protection

Vegetation type	Sequoia National Forest	Sierra National Forest
Hardwoods[2]	12,000	17,000
Ponderosa pine	110,000	312,000
Mixed conifer	619,000	177,000
White fir	64,000	120,000
Red fir	52,000	259,000
Jeffrey pine	31,000	105,000
Lodgepole pine	32,000	45,000
Subalpine	800	9,000
Pinyon-juniper	38,000	—

[1]Includes stands containing at least 1 dead tree per acre, with values exceeding one thousand rounded to the nearest thousand acres

[2]Includes blue oak, interior live oak, canyon live oak, and black oak

At the landscape scale, tree mortality patterns are highly spatially variable, with patches of recently dead trees occurring in scattered, clumped, and random configurations (Figure 7). The size of tree mortality patches also vary considerably in size from less than an acre to more than 100 acres. Most tree mortality patches (especially moderate to large sized) are interspersed with few to numerous live trees that vary with landscape environmental gradients and history of bark beetle activity (Paz-Kagan et al. 2017, Preisler et al. 2017). Consequently, few tree mortality patches are completely lacking in all overstory or at least some midstory trees, except in relatively even-aged stands dominated by a single species (for example, ponderosa pine plantations) or areas recently burned at stand-replacing severity (for example, portions of the 2017 Railroad Fire in the Sierra National Forest).

At smaller spatial scales (for example, forest stand), tree species that experienced the highest mortality levels tended to be shade-intolerant pines in montane forests of the southern Sierra

Nevada (ponderosa pine and sugar pine; Table 10). Except in the smallest size classes (<5 inches dbh), nearly all dead and dying ponderosa and sugar pines exhibited recent attack by irruptive bark beetles (Fettig et al. 2019). Shade-tolerant conifers in the montane and upper montane zones such as white fir, red fir, and incense cedar had the next highest mortality levels, followed by singleleaf pinyon pine (especially in the Piute and Scodie Mountains of the Sequoia National Forest), gray pine (foothill zone), Jeffrey pine, and lodgepole pine (upper montane zone).

Table 10. Tree mortality patterns by species following the 2012-2016 drought in the southern Sierra Nevada

Tree Species[1]	Mortality (Percent)[2]	Size Classes with Highest Mortality[3]	Primary Mortality Agent(s) during Drought[4]
Blue Oak	Low (moderate in some areas)	All	Drought stress
Gray Pine	Low to moderate	Medium to large	Drought stress and insect-pathogen complex
Interior Live Oak	Low	All	Drought stress
Canyon Live Oak	Low	All	Drought stress
Black Oak	Low	All	Drought stress
Ponderosa Pine	High	Medium and large	Western pine beetle
Sugar Pine	High	Medium and large	Mountain pine beetle
Incense Cedar	Moderate	Small	Drought stress
White Fir	Moderate	All	Drought stress, insect and pathogen complex
Giant Sequoia	Very low	Very large	Drought stress
Pinyon Pine	Moderate (high in some areas)	All	Pinyon Ips beetle
Jeffrey Pine	Low (moderate in some areas)	Large	Jeffrey pine beetle, California flatheaded borer
Red Fir	Moderate (low at higher elevations)	All	Drought stress, insect and pathogen complex
Lodgepole Pine	Low	Medium to large	Mountain pine beetle
Western White Pine	Very low	Unknown	Unknown
Mountain Hemlock	Very low	Unknown	Drought stress
Whitebark Pine	Very low (low in some patches)	Medium to large	Mountain pine beetle
Foxtail Pine	Very low	Medium to Large	Mountain Pine Beetle

[1] Species approximately ordered over an elevational gradient from low (foothill) to high (subalpine)

[2] Tree mortality rates over the drought period (2012-2016) include: high (>50% mortality by tree basal area or density), moderate (26-50% mortality), low (5-25% mortality), and very low (<5% mortality)

[3] Tree size classes include: small (>10 inches dbh), medium (10-20 inches), large (>20 inches), and very large (>40 inches dbh)

[4] Assumes drought stress is an important mortality agent for all species, including those impacted by bark beetles

Relatively lower levels of mortality occurred in oaks (with some localized areas of higher blue oak mortality in the foothill zone), and the lowest mortality levels were observed in giant sequoia and subalpine conifers such as whitebark pine and foxtail pine (Bentz et al. 2017, Paz-Kagan et al. 2017). Most of these finer-scale patterns of tree mortality matched those observed at larger geographic scales (Table 9).

Extreme moisture stress during the 2012-2016 drought contributed substantially to the higher mortality rates observed in all major tree species in the region, with additional impacts resulting from bark beetle outbreaks and forest pathogens that may benefit from drought conditions (Table 10) (Preisler et al. 2017, Young et al. 2017, Kolb et al. 2016). The interactive effects of climate warming were also evident in tree species exhibiting increased crown loss and tree mortality rates prior to or at the onset of the 2012-2016 drought, such as red fir, whitebark pine, and giant sequoia (Millar et al. 2012, Mortenson et al. 2015, Stephenson et al. 2018). Drought impacts on southern Sierra Nevada forests were progressive, with increasing canopy water loss and drought-induced water stress evident over time (Asner et al. 2015, Potter 2016). Tree mortality levels in ponderosa pine and sugar pine were most pronounced in the middle of the drought (2013-2015), and impacts on white fir and incense cedar were more prominent during late drought conditions (2016-2017) (Preisler et al. 2017, Pile et al. 2018b).

The 2012-2016 drought resulted in significant changes to forest stand composition in the southern Sierra Nevada. In ponderosa pine and dry mixed conifer stands, this includes a shift in stand dominance (>50 percent tree basal area or density) from shade-intolerant pines (ponderosa pine, sugar pine) to shade-tolerant conifers (incense cedar and white fir) and oaks (especially canyon live oak and black oak) (Fettig et al. 2019, Young et al. 2019). For example, by the end of the drought many ponderosa pine stands shifted in dominance from pines to incense cedar in areas of high ponderosa pine mortality, such as in lower elevation or denser stands (Figure 10). In dry and mesic mixed conifer stands, substantial mortality rates in sugar pine and ponderosa pine have reduced overstory diversity and increased the dominance of shade-tolerant conifer species such as incense cedar and white fir (Fettig et al. 2019). In the transition zone between lower and upper montane zones, the loss of red fir in mesic mixed conifer and red fir-white fir stands has reduced overstory diversity in these mixed coniferous forests (Brodrick and Asner 2017). In the lower margins of the montane zone, mixed pine-oak stands have shifted in dominance to oak woodlands following high mortality of ponderosa pine in these stands (Figure 7), especially in areas that were recently thinned (Young et al. 2019). In some parts of the lower foothill zone (such as the lower Kings River drainage), high blue oak mortality may be converting blue oak woodlands to open oak savannas or annual grasslands, particularly where there is insufficient blue oak regeneration and recruitment for stand replacement at lower elevations and south-facing slopes (Davis et al. 2016). Many of these trends in stand composition are consistent with projected changes in climate and vegetation for Sierra Nevada forests (Safford and Stevens 2017, Meyer 2013a).

More dramatic than changes in stand composition are shifts in stand structure with the recent drought. Drought-induced changes in montane forest stand structure include reduced density and basal area of live trees (especially large trees), reduced canopy cover (particularly higher canopy strata), lower average tree diameter, less structural class diversity and heterogeneity (especially with the loss of the large tree component), increased snag density (particularly medium- to large-sized conifers), and increased surface fuel loading (ranging from fine fuels to coarse woody debris) associated with greater foliage loss and stem breakage rates in dead and dying trees (Fettig et al. 2019, Young et al. 2019). These changes are particularly evident in ponderosa pine stands in the Sierra and Sequoia National Forests with high levels of bark beetle activity (Figure 10). However, most of these drought-induced patterns were also evident in the foothill zone, upper montane zone (for example, red fir forests), and limited portions of the subalpine zone where conifers experienced higher mortality rates resulting from mountain pine beetle outbreaks in the southern Sierra Nevada (Meyer et al. 2016). Increased stem and branch breakage rates in dead trees are particularly evident in larger mid-elevation pines, resulting in an increased public and firefighter safety hazard in the southern Sierra Nevada (United States Department of Agriculture 2016b).

Figure 10. Ponderosa pine stand in the lower montane zone of the Sierra National Forest experiencing high mortality in the late summer 2015, resulting in substantial changes in stand composition and structure such as the loss of large pines in the stand (dead overstory trees in photo) and shift in dominance from ponderosa pine to incense cedar and black oak (sub-canopy green trees in photo)

Despite significant losses in large overstory trees, the density of tree regeneration (one indicator of potential forest resilience to the impacts of extreme drought) in ponderosa pine and dry mixed conifer stands of the southern Sierra Nevada are relatively intact and similar to or exceeding the natural range of variation (Young et al. 2019). Even in montane forest stands with high levels of tree mortality (generally greater than 75 percent basal area mortality), tree regeneration densities average between 500 to 2,600 seedlings and saplings per acre (65 percent of this regeneration being conifers), which is well above the Forest Service regional stocking criteria for conifers in ponderosa pine and mixed conifer forests (150-200 stems/acre) (Fettig et al. 2019, Young et al. 2019).

In dense forest stands that were untreated prior to drought, shade-tolerant species mostly dominate this tree regeneration (about 80 percent total), including incense cedar (38 percent), white fir (15 percent), black oak (15 percent), canyon live oak (11 percent), and other hardwood species (1 percent) (Fettig et al. 2019). More shade-intolerant species (ponderosa pine and sugar pine) constitute only 12 to 18 percent of tree regeneration in high mortality montane stands (Young et al. 2019). In contrast, relatively open and low density stands (those treated with mechanical thinning or prescribed fire prior to drought) that experienced high levels of tree mortality in the southern Sierra Nevada have higher proportions of shade-intolerant pine regeneration and hardwoods (about 75 percent) relative to shade-tolerant conifers (about 25 percent) (Young et al. 2019).

Based on current post-drought tree regeneration densities, most forest stands in the Sequoia and Sierra National Forests are unlikely to experience significant conifer regeneration failure (the inability of coniferous forests to rebound from disturbance due to a lack of sufficient conifer regeneration densities and recruitment), unless other interacting disturbances (for example, stand-replacing wildfire) eliminate existing conifer regeneration stocks (Coppoletta et al. 2016). In this respect, tree regeneration patterns following the 2012–2016 drought are notably different than those observed following uncharacteristically large and severe wildfires in montane forests, where conifer regeneration may be absent or heavily reduced in high-severity burned areas located far from live conifer seed sources (Welch et al. 2016, Collins and Roller 2013).

Nevertheless, many dense forest stands that were untreated prior to the drought (and experienced high levels of tree mortality) are currently dominated by shade-intolerant species that are departed from the natural range of variation with respect to stand composition; for example, too many shade-tolerant conifers and too few shade-intolerant conifers, and structure; for example, total stem densities are too high but basal area and canopy cover are too low. In these denser, high-mortality stands, forest management activities would be required to restore shade-intolerant pines and hardwoods and align future stand conditions closer to the natural range of variation and desired conditions (Young et al. 2019).

There are several factors associated with higher levels of tree mortality in the southern Sierra Nevada during the exceptional drought. At the geographic and larger landscape scale, tree mortality and canopy water stress are positively associated with: (1) lower elevations; (2) southwest facing slopes; (3) greater distance to rivers and streams; (4) shallower soils and slopes; (5) reduced soil moisture availability (based on topography); and (6) time since last fire (an indicator of fire regime interval departure) (Asner et al. 2015, Paz-Kagan et al. 2017). On the whole, these associations indicate that, on large spatial scales, tree mortality and physiological water stress are primarily influenced by topographic features related to decreased water availability and increased water demand (such as increased evaporative water loss at lower elevations where it is relatively warmer) (Stephenson 1998, Restaino et al. 2019), and secondarily affected by fire regime integrity (increased tree mortality was associated with greater fire return interval departure). At the stand to landscape scale, stand basal area, tree density, and climatic water deficit are positively related to tree mortality (Young et al. 2017, Restaino et al. 2019). The positive association between stand density (or basal area) and tree mortality is supported by numerous studies in coniferous forests throughout western North America (Kolb et al. 2016, Fettig et al. 2007, Fettig et al. 2019). Moreover, the negative effects of high stand basal area on forest ecosystems is exacerbated by rising temperatures associated with climate change (Bradford and Bell 2017). Reducing stand basal area and density in managed stands (through mechanical thinning, prescribed fire, or wildfire managed for resource objectives) can reduce tree mortality rates even during extreme drought events (van Mantgem et al. 2016, Young et al. 2017, Restaino et al. 2019), especially when treatments are implemented on large landscape scales (entire watersheds or firesheds) (Boisrame et al. 2017, Stephens et al. 2018).

Long-term resilience of southern Sierra Nevada forests impacted by severe drought and bark beetles is dependent on management of live and dead trees and forest fuels that contribute to increased potential of uncharacteristically large and intensive wildfires (Stephens et al. 2018). Addressing this issue will require several forest management approaches that address different levels of drought-induced tree mortality. In green forests (those with relatively lower levels of tree mortality), increased forest restoration treatment rates will be needed to reduce stand densities and biomass commensurate with historic fire return regimes (North et al. 2012b).

In relatively small patches of tree mortality, the reintroduction of fire may be effective in reducing stand densities and surface fuels. In more extensive patches of tree mortality, strategic management will likely be required to address both safety and forest sustainability concerns. Strategic approaches could include the delayed use of prescribed fire (implementation after most snags have fallen), removal of hazard trees from high risk areas; for example, campgrounds, structures, roads, facilities, or the use of strategically placed fuel treatments designed to facilitate the expanded use of prescribed fire or wildfires managed for resource objectives (North et al. 2015).

Additional approaches include the facilitation of drought and insect-tolerant tree species; for example, oaks, in drier portions of the landscape, such as lower elevations, that experienced high levels of tree mortality, and the restoration of fire and drought-tolerant pines in many montane and upper montane forests (especially yellow pine and mixed conifer).

Collectively, these approaches can increase forest landscape resilience and reduce the risk of uncharacteristic wildfires by breaking up the continuity of surface and crown fuels, increasing spatial heterogeneity at stand and landscape scales, and retaining essential tree regeneration and forest structures (residual large trees) for future stand development (Stephens et al. 2018). However, there is scientific uncertainty regarding the feasibility and effectiveness of different management strategies in addressing increasing fuel loads and future wildfire impacts associated with areas of widespread and severe tree mortality.

Although trees of all sizes and ages are susceptible to drought, insects, pathogens, air pollution, and climate change, large and old trees can be particularly vulnerable to these stressors when combined (Allen et al. 2015, Anderegg et al. 2015, Clark et al. 2016). During periods of extreme drought stress (such as during the 2012-2016 drought), large trees (especially those exceeding 30 inches in diameter) can be more susceptible to drought and temperature increases than small trees because of some physiological differences and preferences by bark beetles, including: (1) greater vulnerability to hydraulic stress because water needs to be “pumped” from roots to greater heights in large trees; (2) higher sun exposure and water loss in large tree crowns, compared with small ones; and (3) greater preference of bark beetles for larger diameter trees that contain greater carbohydrate stores for successfully raising broods. During the 2012-2016 drought, the mortality of larger-diameter trees was especially evident in shade-intolerant pines, which are primary host species for irruptive bark beetles (Table 10). However, medium diameter trees (generally 10 to 24 inches) can also be highly susceptible to mortality from the combined impacts of drought, bark beetles, and warming climate (Pile et al. 2018a).

The health and susceptibility of large and old trees to drought- and insect-related mortality is influenced by tree density at the stand or immediate tree neighborhood scale (Kolb et al. 2016, Fettig et al. 2007). Increased tree densities, especially in close proximity to large and old trees (particularly shade-intolerant species), reduces availability of water and nutrients and can decrease growth (York et al. 2015) and increase susceptibility to insects and pathogens (Smith et al. 2005). Although many of these trees have roots that go far down into fractures of bedrock to obtain water (Arkley 1981, Hubbert et al. 2001), their survival is more likely with lower densities of trees around them (McDowell et al. 2003, Franklin and Johnson 2012). They may have access to more water that can also increase resistance to insect attack, but this may be insufficient under severe drought and bark beetle outbreak conditions that can overwhelm tree defenses (Kolb et al. 2007). In addition to density-related mortality, mortality rates in old forests of the Sierra Nevada and western U.S. have increased in recent years due to elevated moisture stress associated with climate warming trends (Van Mantgem et al. 2009, Lutz et al. 2009).

Environmental Consequences to Insects and Pathogens

Consequences Common to all Alternatives

All forested lands are affected by native insects and diseases. With the exception of a few introduced insects and pathogens, forests in the Sierra Nevada have the same insect and disease associates they had 100 to 150 years ago. Every tree species has its complement of pest hosts that cause natural mortality and generate small-scale ecosystem disturbances. When favorable conditions arise, bark beetle-associated activity can be expected to increase if current forest conditions remain unchanged or limited, especially under drought conditions. If bark beetle attack potential is not mitigated, stands categorized as high risk may experience undesirable levels of dead and dying trees during times of drought or other conditions that are conducive to insect population growth and expansion. Climate change, large wildfires, drought, and chronic elevated ozone pollution levels all influence forest resilience to insects and pathogens in addition to the proposed restoration treatments.

The 2012-2016 drought dramatically increased bark beetle activity and tree mortality in the southern Sierra Nevada, but the long-term ecological consequences of these impacts are partially uncertain. In all alternatives, it is expected that montane forest landscapes with high mortality (particularly areas dominated by ponderosa pine and sugar pine) and some upper montane landscapes (such as red fir or lodgepole pine) may continue to experience elevated bark beetle activity in the future, with the exception of areas where pines have been largely replaced by hardwoods and other species less susceptible to bark beetle attack (such as incense cedar) (see “Changed Forest Conditions Associated with Tree Mortality”). It is expected that future periods of extreme drought will continue to facilitate bark beetle outbreaks in forest landscapes where stand densities exceed desired conditions and structural homogeneity is commonplace.

All alternatives have measures to limit the spread and infection of nonnative invasive insects and pathogens. This includes white pine blister rust and other species not yet present in the southern Sierra Nevada (such as the gold spotted oak borer or polyphagous shot hole borers).

Consequences Specific to Alternative A

Alternative A would have limited areas of restoration (chapter 2), including thinning from mechanical treatment or moderate-intensity prescribed fire that would reduce the risk of bark beetle outbreaks. There would continue to be large areas at high risk of bark beetle-caused tree mortality beyond desired condition levels. Trees in dense stands, outside of the natural range of variation, would continue to experience high tree-to-tree competition for water and other essential resources. Water stress from dense, competing trees as well as potential drought, compounded with pathogens such as root disease or dwarf mistletoes would combine to further weaken trees, inciting secondary insect attacks (beetles). Current elevated levels of tree mortality would be likely to continue now or develop again in the near future with drought and temperature increases.

Consequences Specific to Alternative B

Under alternative B, more forested acres are proposed to be treated whether with mechanical thinning, prescribed fires, and wildfires managed to meet resource objectives. This reduction of overall tree density across the landscape should reduce the likelihood of bark beetle infestations growing to epidemic levels in treated areas, particularly in stands that experienced less tree mortality during or following the 2012-2016 drought. This is because increased restoration treatment rates under alternative B would reduce stand densities, increase heterogeneity, and restore tree composition to conditions aligned with the natural range of variation. Reducing density would reduce moisture stress to individual trees (trees have greater capacity to resist insect attack via pitching response) and reduce the likelihood that stands would support pathogen spread and insect eruptions.

Greater heterogeneity in the forests, species diversity, and variations in spacing and structure may limit pathogen spread through root-to-root contact or canopy-aided dispersal. Under alternative B, increased mechanical treatments along ridges and roads would be particularly effective at enhancing the resilience of forest ecosystems to undesirable impacts by insects or pathogens, especially in montane and some upper montane forests, such as mixed conifer, ponderosa pine, and Jeffrey pine forests (see management approaches discussed in “Fire Trends”). During future drought events, increased restoration treatment rates and restoration treatment effectiveness; for example, greater structural heterogeneity and stand diversity, under alternative B would result in fewer impacts of future bark beetle outbreaks and less drought-related tree mortality.

Consequences Specific to Alternative C

Alternative C would have lower levels of mechanical thinning than alternatives A and B, with more emphasis on prescribed burning and wildfire managed to meet resource objectives (chapter 2). As a result there would continue to be high levels of forest stands at risk to bark beetle-associated mortality under alternative C compared with alternatives A or B. However, overall restoration treatment rates under alternative C (combined mechanical, prescribed fires, and wildfires managed for resource objectives) would be lower than alternative B but greater than alternative A. However, it is uncertain whether restoration treatments under alternative C can effectively mitigate the impacts of insects and pathogens to forest ecosystems.

First, if most areas treated with fire restoration under alternative C are not sufficiently effective at reducing tree densities to levels within the natural range of variation (vegetation burn severity is limited to the removal of only a few understory trees), then the risk of bark beetle-associated tree mortality would be lower under alternative C than alternative A (but still higher risk than alternative B).

Second, if forest stands treated with fire restoration become the focus on bark beetle activity during subsequent drought events (due to the attraction of bark beetles to recently burned areas where trees are more susceptible to attack; (Raffa et al. 2008), this could reduce the effectiveness of fire restoration treatments at mitigating insect risk.

Third, less intensive mechanical treatments that focuses on removing smaller-diameter trees (alternative C) would result in limited changes to current forest conditions and may serve to perpetuate the risk of insect and pathogen outbreaks in many areas, especially during future drought conditions. The exception includes the wildland-urban intermix defense zone, where mechanical treatment rates under alternative C would be similar to alternative A; both alternatives would experience sufficient stand density reduction near communities. There may be increased levels of bark beetle attack and subsequent tree mortality in areas treated with burning alone, particularly when it occurs in dense stands where the trees are already stressed (Fettig et al. 2008, Fettig and McKelvey 2010).

Consequences Specific to Alternative D

Alternative D would have similar consequences as alternative B but over substantially more area. Increased levels of thinning, prescribed fire, and wildfire managed to meet resource objectives proposed under alternative D (chapter 2) would result in decreased levels of bark beetle activity in forest ecosystems. Alternative D would increase the pace and scale of forest restoration toward desired conditions and greatly improve forest resilience over larger spatial and longer temporal scales. Insect and pathogen outbreaks under this alternative would be more limited to localized levels that closer resemble historic conditions (Savage 1994), even during drought conditions (Kolb et al. 2016, Fettig et al. 2007). Trees in restored stands would have improved access to water and resources and lower competition for water. This would allow trees in restored stands to more rapidly recover after drought or wildfire, and gradually adjust if climate conditions continue upward trends (North 2012, Fettig et al. 2007).

Consequences Specific to Alternative E

The consequences of alternative E would be similar to alternative C, because mechanical and fire restoration treatment rates will be similar between these two alternatives. There is slightly less uncertainty in treatment rates under alternative E compared with alternative C, because the lower amount of recommended wilderness under alternative E would provide greater flexibility in wildfire management options over a greater proportion of the landscape (especially in the Sierra National forest where there is about half as much designated wilderness under alternative E compared with alternative C). Similar to alternative C, alternative E would have lower levels of mechanical thinning than alternative A with more emphasis on prescribed burning and wildfire managed to meet resource objectives. Consequently, there would continue to be high levels of risk to bark beetle-associated mortality in stands where tree densities exceed desired conditions, especially during drought conditions. In the wildland urban interface defense zone, mechanical treatment rates under alternative E would be similar to alternatives A and C, resulting in some reduction in bark beetle infection areas close to communities.

Cumulative Effects

There can be cumulative effects resulting from management of nearby lands under different ownerships. Under all alternatives, insects and pathogens can increase on adjacent lands and spread to national forest lands. Similarly, insect and pathogen outbreaks can spread from national forest lands to adjacent lands.

There are three different types of landownership next to national forest lands, each with varied capacities and likely forest management approaches that affect insect and pathogens. First, there are other Federal lands, including Sequoia and Kings Canyon and Yosemite National Parks. Second, there are urbanized or developed areas. Third, there are larger private landowners that actively manage the forests, including private timberlands, and utility companies.

The National Park Service primarily uses prescribed fires and managed wildfires in their management of forest vegetation and fuels in national parks. Although the National Park Service occasionally uses mechanical thinning to reduce stand densities, treatment intensity and extent are lower than on the neighboring national forests and state and private lands. Nevertheless, overall restoration treatment rates in forest ecosystems tend to be similar between the national parks and national forests in the Sierra Nevada (North et al. 2012b), leading to similar levels of insect and pathogen activity and associated tree mortality between administrative units in the southern Sierra Nevada (see Figure 8, Figure 9). Consequently, the potential for insect and pathogen spread from national forest lands to national park lands to cause additional tree mortality (or vice-versa) is relatively low to negligible under all alternatives. Bark beetle activity and insect-related tree mortality may have declined in treated forest stands along the boundary between national parks and national forests, particularly where both agencies have reduced stand densities near this boundary.

Forests on small private lands are often very dense, because trees are retained as natural screening or shading. There is a higher likelihood of root damage near structures and roads that can increase susceptibility to pathogens. Under all alternatives, this can increase the likelihood of insect and pathogen attack and may increase the spread to national forest lands, but the amount of area in this condition is relatively small. On the other hand, the recent bark beetle outbreaks in and surrounding Sequoia and Sierra National Forests may result in spread and elevated insect and pathogen levels in forests on those private lands. This spread may also occur to forests managed by larger private landowners.

Analytical Conclusions

Under all alternatives native and invasive insect and disease activity would continue to persist, and effects on trees would occur regardless of treatments. The differences lie in the levels of intensity and severity of outbreaks particularly in levels of tree mortality. The southern Sierra Nevada will experience varying degrees of mortality as insects and pathogens continue to target stands of highest risk (stands with highest stand densities and greatest moisture stress), with increased impacts from bark beetles occurring during future droughts.

Under alternative B, restoration treatments (mechanical thinning, prescribed fires, and wildfires managed for resource objectives) will minimize the impacts of insects and pathogens in treated portions of the forest landscape. However, alternative D will more rapidly prepare for future bark beetle outbreaks associated with climate change, extreme drought, and other stressors. For instance, the trend of increasing size and severity of wildfires in California underscores the need to reduce forest densities in the near future to mitigate the impacts of elevated forest insect levels associated with conditions outside the natural range of variation (especially unnaturally dense and homogenous forest stands).

Management direction of alternatives A, C, and E would not sufficiently reduce stand density, vegetation biomass, or other structural conditions that are conducive to bark beetle-associated tree mortality, especially during periods of drought (Smith 2007). Montane and upper montane forest stands in California need lower stocking thresholds to prevent losses beyond background levels (Oliver 1995). The level of treatments proposed for alternative D followed by alternative B would be most effective to prevent bark beetles, such as western pine beetle and mountain pine beetle, from achieving explosive exponential growth as observed in the southern Sierra Nevada during the 2012-2016 drought.

Combined Effects of Climate, Fire, Insects, and Pathogens

Terrestrial Ecosystems

Climate, fire, insects, and pathogens all influence and interact each other. Various aspects of how they influence each other are discussed in the individual subsections above. It is important to also consider them as a whole, since they all affect vegetation and are affected by vegetation condition. For the forest plans, the primary means of altering ecosystems is management of vegetation condition. In this subsection, the interactive effects and analytical conclusions for climate, fire, and insects and pathogens on vegetation condition and management are considered. More detail on the combined effects of climate, fire, insects, and pathogens is described in the vegetation resilience supplemental report.

The conceptual diagram below (Figure 11) shows how each of these agents of change influence each other and vegetation condition. In the diagram, the direction and weight of arrows show how each agent of change and vegetation relate to each other. Although the way fire is managed may vary, fire will occur regardless at some point in time because the plan areas are dry and fire prone, with regular ignition sources (lightning and human-caused).

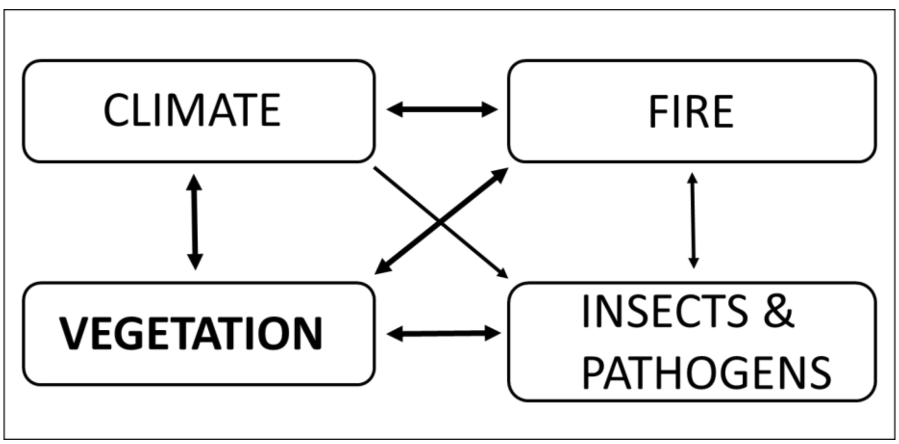

Figure 11. Conceptual diagram of the interactions among climate, fire, insects/pathogens, and vegetation

Starting with vegetation and moving clockwise around the diagram:

- Vegetation is in bold, because this is a natural resource and primary element in the diagram influenced by forest plan direction.
- Climate influences vegetation, fire, and insects and pathogens directly through temperature and moisture changes. Vegetation and fire influence climate through the natural carbon cycle that produces carbon emissions (decomposition of dead vegetation and respiration or combustion of live or dead fuels) or carbon sequestration (photosynthesis or tree growth in vegetation). Increased rates of carbon emissions relative to carbon sequestration (permanent conversion of forest to non-forest vegetation) contributes to long-term greenhouse gas (carbon dioxide) production that contributes to climate change (Intergovernmental Panel on Climate Change 2014). In this diagram, climate includes directional patterns in climate (such as warming trends associated with increases in atmospheric greenhouse gases), cyclic atmospheric phenomena, such as periodic droughts associated with the El Niño-Southern Oscillation events, or their combination, such as hotter droughts observed in recent years.
- Fire influences vegetation through the process of combustion (including heat, smoke, charcoal, and ash production). Vegetation influences fire by modifying the availability and accessibility of fuels necessary to produce combustion. The arrow between fire and vegetation is bold because there is a strong influence of vegetation on fire and vice versa.
- The density and biomass of vegetation (trees) influences insect and pathogen populations and dispersal through the availability and susceptibility of host species, especially during drought and the increasing effects of climate change (Preisler et al. 2017, Young et al. 2017). Increased tree densities and biomass above the natural range of variation increases the susceptibility of forest stands to bark beetle outbreaks (Kolb et al. 2016). Increased tree moisture stress associated with greater stand densities (and greater competition) or drought can also increase the likelihood of tree mortality following fire, resulting in greater fire severity in denser forest stands independent of fire intensity (van Mantgem et al. 2018).
- The arrow that goes from fire to insects and pathogens is thinner because most of the influence of insects and pathogens is through the changes it causes in vegetation. However, fire can also influence insects and pathogens by potentially making trees more susceptible to bark beetle or pathogen activity and possibly by producing chemical signals (via charring of bark or scorching of foliage) that are attractive to specific bark beetle species. Conversely, insects may increase fire severity and extreme fire behavior (active crown fire spread), especially if trees experience high levels of beetle-related mortality and are in the red stage (first few years following bark beetle attack) (Hicke et al. 2012, Jenkins et al. 2008, Jenkins et al. 2012). Recent observations of wildfires in the southern Sierra Nevada during or following the 2012-2016 drought have confirmed these patterns of increased fire behavior (increased torching, fire intensity, fire spread rates) and fire severity (percent tree basal area killed by fire) in areas of recent high levels of tree mortality (Reiner et al. 2017, Stephens et al. 2018).
- The changes insects and pathogens have on vegetation also affects fuels and fire behavior over time (Hicke et al. 2012, Stephens et al. 2018). These changes can be summarized in three stages or phases:
    - ♦ Red stage (1-4 years following bark beetle attack): There is an elevated crown fire potential and increased torching potential due to increased flammability and ignition

potential of dead and dying tree crowns with reduced moisture content. Fire spread rates and intensity increase during this phase.

- Gray stage (generally 4-10 years after beetle attack): Torching potential remains high, but crown fire potential declines as dead foliage is deposited from tree canopies to the forest floor. Increased surface fuel deposition (needles become litter on forest floor) raises the probability of surface fires with increased fuel continuity and bed receptivity.
- Regrowth stage (generally decades following beetle attack): Increased snag fall results in elevated coarse woody debris and fine fuels that amplify surface-fire intensity and spread rates. Coupled with vegetation regrowth (such as tree regeneration and recruitment, and shrub sprouting and growth), these conditions can lead to excessive surface and crown fuel loads that contribute to uncharacteristically large and severe wildfires. Importantly, the emergence of long-burning high fuel loads over extensive areas can set the stage for exceptionally large and severe wildfires that exhibit signs of extreme fire behavior, including long-distance spotting (production of firebrands that are transported by air movement causing spot fires ahead of the main fire perimeter), rapid fire spread rates, and increased fire-atmospheric interactions.

These interrelationships mean that the effects of climate, fire, vegetation, and insects and pathogens are complex, especially in forest ecosystems with a frequent fire regime (Stephens et al. 2018). As described above in the previous subsections, there has been and will continue to be a trend of warming climate, increased fire, and increased insect, pathogen, and disease levels and vegetation-related mortality. Effects on vegetation are magnified where vegetation structure and composition are outside the natural range of variation. There is a large proportion of montane and upper montane forest landscapes that are outside the natural range of variation and are highly departed from the vegetation desired conditions (see the "Terrestrial Ecosystems"). Dense vegetation has a low resilience to climate change, fire, insects, and pathogens. Composition that has shifted toward dominance of less drought- and fire-tolerant species has decreased resilience. Nonnative plant species may increase with climate change and changing fire regimes, especially in sagebrush and pinyon-juniper ecosystems. This is beginning to cause a negative feedback with increased nonnative plant invasions causing more fire, which reinforces the dominance of invasive plant species.

Analytical Conclusions

Three factors most important in changing ongoing and reasonably foreseeable future effects of climate, fire, insects, and pathogens on vegetation condition include the pace, scale, and intensity of restoration to change vegetation conditions toward desired conditions. The alternatives vary in the pace, scale, and intensity of restoration, particularly in the montane and upper montane zones, including ponderosa pine, mixed conifer, Jeffrey pine, and red fir forest types.

Alternative D has the greatest rate of restoration treatment (pace), across the largest area (scale), with the greatest certainty of moving vegetation toward or achieving desired conditions (intensity) in treated areas. This would be through more opportunities for extensive mechanical thinning, prescribed fire, and wildfires managed for resource objectives. Focus landscapes would permit additional flexibility under alternative D, where limiting wildlife plan direction is waived or reduced to allow more intensive treatments that produce a higher likelihood of fully achieving vegetation desired conditions. Up to half of the landscape most departed from desired conditions would be restored within the next 15 years under alternative D and be moderately to highly resilient to fire, climate, drought, insects, and pathogens. However, areas of extensive tree mortality arising from the 2012-2016 drought would require additional time (decades) to achieve terrestrial vegetation desired conditions.

Alternative B would have the second most amount of restoration, but it would be concentrated in a less extensive portion of the national forests, in about 30 percent of the forested areas of the montane and upper montane zones and part of the foothill zone. In most areas (outside of community buffers), there would be limitations on the intensity of restoration from canopy cover retention requirements for California spotted owl and fisher. In these areas (captured mostly in the wildlife habitat management areas), only part of the desired conditions would be achieved. There is a moderate level of uncertainty that only some of the prescribed fire objectives under alternative B would be achieved because of more limitations on prescribed fire in old forest wildlife habitat. At least half of the landscape would continue to have low to moderate resilience to climate change, fire, and insects and pathogens. Similar to alternative D, areas of extensive tree mortality arising from the 2012-2016 drought would require additional time (decades) to achieve terrestrial vegetation desired conditions under alternative B.

Alternatives A, C, and E (especially alternative A) would likely have the lowest pace, scale, and intensity of restoration because they have the least amount of active mechanical and potentially prescribed fire treatments. Although more area would be treated with prescribed fire under alternatives C and E compared with alternative A, there are more limitations and uncertainties with prescribed burn acreage estimates because of: (1) air quality regulations; (2) public and firefighter safety considerations; (3) sufficient agency resources; and (4) greater vegetation retention requirements for the California spotted owl and fisher that make prescribed fire more costly and difficult. There would be less mechanical treatment and less resulting restoration of ridges and roads that could be used as fuel treatment anchors or containers for facilitating large prescribed fires. Most of the landscape under alternatives A, C, and E would continue to have low resilience to stressors, especially in areas of extensive tree mortality following the 2012-2016 drought. However, alternatives C and E would have moderately higher resilience in some limited areas of increased fire restoration (areas of increased pace, scale, and intensity such as the Kern Plateau).

Overall, alternative D would alter vegetation conditions to the greatest extent by restoring vegetation structure, composition, and function, and limiting the negative impacts of climate change, large high-intensity wildfires, and elevated insect and pathogen levels. This includes in forest landscapes impacted by the 2012-2016 drought, where elevated tree mortality levels may require increased pace, scale, and intensity of restoration and adequate time to achieve terrestrial vegetation desired conditions. Alternative B would restore some landscapes to the point where negative impacts of stressors would be moderated, but more than half of the landscape would be still be vulnerable under this alternative. Alternatives A, C, and E would be the least effective (especially alternative A) at aligning vegetation conditions with desired conditions and reducing the vulnerability of terrestrial vegetation to stressors.

Revision Topic 1: Fire Management

Introduction

Wildfire has and will continue to affect vegetation and ultimately be a primary driver of change to ecosystems in the Sequoia and Sierra National Forests. Historically wildfire has been a vital ecological process, shaping ecosystems of the Sierra Nevada range for millennia. Today, many ecosystems in the Sierra Nevada show the impacts from fire exclusion due to 100 years of highly effective fire suppression. Fire management has gone through several changes over the last few decades, transitioning from a more suppression-focused approach toward a more managed approach. While there is agreement in the need to change focus to more managed fire, little has actually changed. Revision of forest plans hope to provide direction that encourages increased use of managed wildfire and bring about the needed change to fire management.

Decades of fire exclusion, buildup of vegetation and forest debris, and more recently, drought and climate change, have led to larger and more destructive wildfires (see “Climate Change” and “Fire Trends”). Limited funding for prevention programs and many challenges to implementation of fuel reduction projects have impeded progress toward reducing the effects of decades of suppression. These effects are dire and undeniable as witnessed by the increase in the frequency of large, high-intensity wildfires over the past few years. Wildfire seasonal severity in the western U.S. is driven by natural factors such as fuel availability, temperature, precipitation, wind, humidity, and the location of lightning strikes, as well as human factors. It is well known that climate fluctuations significantly affect these natural factors. Thus, climate affects the severity of the western wildfire season at a variety of temporal and spatial scales (Westerling et al. 2003). Unwanted wildfires are those that have the potential to damage forests and wildlife habitat, negatively affect stream and watershed quality, reduce air quality, and destroy homes and communities in the wildland-urban intermix. Other wildfires burning under more desirable conditions provide an opportunity for management to meet resource objectives.

Historically, fire season in the Sierra Nevada was from May to October. Recently, fires have occurred throughout the year, resulting in a nearly year-round fire season. Additionally, fires are becoming much more intense, causing more severe and long-lasting damage to the vegetation and soils. Further, large-scale and long-duration droughts will increase the potential for fires to burn larger and with uncharacteristic higher intensity. The recent (2012-2016) exceptional drought has included large areas and amounts of tree mortality, which greatly exacerbates the potential for high-severity fire effects. These conditions are likely to impact our ability to manage wildfires to meet resource objectives, and to conduct prescribed burns. For more detailed information and background on drought, mortality, and wildfire interactions, see “Agents of Change: Climate, Fire, Insects, and Pathogen.”

Increasing efforts to restore fire to the landscape will necessitate consideration of societal trade-offs, such as accepting more moderate levels of smoke from prescribed fires and managed wildfires versus continuing to live with high wildfire risk and associated pulses of unhealthy air quality. When evaluating tradeoffs, such as short-term versus long-term air quality impacts, the costs to society must be weighed against the risks of continued increasing wildfire severity and air quality degradation (Hurteau et al. 2014). Emissions from prescribed fires are typically lower than those from wildfires burning the same area (Wiedinmyer and Hurteau 2010). Prescribed fires are planned with careful consideration of smoke to limit impacts on human health, transportation corridors, and smoke-sensitive populations. Wildfires that are managed to meet resource objectives will likely burn over many days. Thus, they may burn during unfavorable conditions such as days with elevated ozone concentrations. However, long-term benefits provide favorable tradeoffs since future wildfires will burn through reduced fuel condition and produce lower emissions. See “Air Quality” for more information.

Wildfire suppression costs have increased significantly over the last decade (Meyer et al. 2015). This fact, coupled with decreasing or static budgets for fuels management, presents serious challenges to fire managers. The application of a risk-based approach to guide future wildfire management provides a framework to address these issues. The concept of managing fire risk is similar to the concept of the financial risk to investing. If presented with a wide range of financial investment options, but no risk information, the level of uncertainty would be a serious deterrent. In both financial investing and investing to change wildfire outcomes, timely upfront information on risk is essential to making informed decisions.

Wildland Fire Management

Background

Wildland fire is any unplanned non-structure fire that occurs in the wildlands. Strategies and actions employed in management of wildland fire may occur both before and during wildland fires. Actions and strategies implemented during an incident include a spectrum of responses from full suppression to managing a fire to meet resource objectives. Suppression is a management action used to extinguish or confine an unwanted wildfire at its discovery. Wildland fires’ impacts on communities or values (negative or positive), such as water quality, air quality, habitat, and recreation opportunities, are influenced by these fire management strategies and actions. Naturally ignited wildfires that are managed to reduce fuels and improve ecosystem health are called “managed wildfires to meet resource objectives.” This term is used throughout the document. These fires tend to have effects that are similar to, or trend toward, those that occurred historically under more natural conditions. The benefits of managing wildfires to meet resource objectives include reducing fuels so that future fires burn with lower intensity, lower impacts, and reduced smoke. These wildfires are more manageable, and pose lower threat to communities. Managing wildfires to meet resource objectives allows fire to resume its natural role in the ecosystem under pre-identified objectives and conditions. By allowing this to occur, the results are safer communities, healthier ecosystems and habitats, recycling of nutrients into the soil, and improving vegetation health.

Managing wildfires can be difficult because of smoke impacts, proximity to human communities, liability, and cost constraints (Quinn-Davidson and Varner 2012). In addition, policy and management requirements also factor into how wildfires are managed. For example, Forest Service fire policy (Forest Service Manual 2320) states that in wilderness, fire should be allowed to play its natural role as nearly as possible. However, this presents challenges if the fire has the potential to burn outside of the wilderness area and threaten communities or other resource values. Mechanical treatments have their own set of legal, operational, and administrative constraints, limiting the location and extent of treatment (North et al. 2015). With the revision of the forest plans, forest and wildland fire managers in the southern Sierra Nevada will have the opportunity to manage wildfire more holistically, with the management of wildfires to meet resource objectives (Meyer 2015a).

Fuel reduction treatments are fire management actions that occur before wildfire. These include prescribed fire and mechanical treatments designed to change the amount, configuration, and spacing of live and dead vegetation. Prescribed fires are intentionally ignited by managers to achieve specific objectives. These are implemented in accordance with applicable laws, policies, and regulations, and under environmental conditions described in the prescribed fire implementation plan. Mechanical fuel treatments are changes made to vegetation composition and structure (by cutting, thinning, or pruning) of vegetation to reduce the amount of fuel and fire hazard. Mechanical treatments are often followed up with prescribed burning to reduce treatment residual fuels, and to maintain the effectiveness of previous treatments. The costs, environmental impacts, and effectiveness of different fuel treatment types vary. The desired outcomes of fuel treatments are reduced fire behavior and severity, moving the area toward the natural range of variation with lower postfire tree mortality, and reduced smoke emissions. Strategically located fuel reduction treatments also provide more opportunities to proactively manage the size and costs of future wildfires and facilitate strategies to manage wildfires to meet resource objectives.

Funding and operational resource limitations make it highly unlikely that mechanical and prescribed fire treatments alone will be sufficient to restore forests, or achieve desired conditions. Managing wildfire to meet resource objectives will be an essential tool to reduce fuels, effectively reduce the risk to communities and resources (such as water sources or habitat), and restore and maintain landscapes. Fire-adapted ecosystems derive ecological benefits from fires; vegetation health is improved, habitat is improved, and species benefit.

Holistic wildland fire management is an approach that simultaneously considers the role of fire in the landscape, the ability of humans to plan for and adapt to living with fire, and the preplanning to be prepared to respond to fire when it occurs. There are multiple factors that make it difficult for forest managers to incorporate a more holistic approach into fire management. Some of these factors are risk aversion, sociopolitical pressures, and a resulting propensity to choose the status quo fire response of suppression. These factors do not improve resource conditions and create a positive feedback loop known as the "fire paradox." This is described as using aggressive suppression today, which leads to accumulation of fuels, which in turn exacerbates the wildfire problems of the future (Arno and Brown 1991). Thus, the current situation is propagated along with continued excessive suppression expenditures (Thompson et al. 2013b). Society's expectation that fires are aggressively suppressed is culturally ingrained, regardless of the potential that fires might meet the objectives of current policy. Thus, the revised forest plans will provide managers the direction and tools needed to break out of the fire paradox and implement holistic fire management, in line with the National Cohesive Wildland Fire Management Strategy.

National Cohesive Wildland Fire Management Strategy

Due to the elevated risk, compounding losses, and increasing costs associated with wildfire, Congress mandated development of a national cohesive wildfire management strategy (Cohesive Strategy hence forth) consistent with recommendations in the General Accountability Office reports regarding management strategies (United States Government Accountability Office 2009). In 2014, the final phase of this effort culminated in the National Cohesive Wildland Fire Management Strategy (USDA Forest Service and Department of Interior agencies) referred to hereafter as the Cohesive Strategy. This strategy defines goals, describes wildfire challenges, identifies opportunities to reduce wildfire risk, and is the basis for comparison of fire management strategies in the alternatives considered for revising the forest plans.

There are three primary goals to the Cohesive Strategy: (1) restore and maintain landscapes; (2) create fire-adapted communities; and (3) respond to wildfires safely and effectively. These three goals provide indicators forming the basis for the analysis of environmental consequences for the alternatives. A risk-management approach serves as the foundation for all fire management activities. To restore and maintain resilient landscapes, risks and uncertainties relating to fire management must be understood, analyzed, communicated, and managed as they relate to the cost of doing or not doing an activity. To create fire-adapted communities, it is imperative to work with partners and use a risk management approach to identifying communities at risk and help protect these communities. A safe and effective response to wildfire requires moving beyond an emphasis to suppress all wildfires, to a more holistic approach that considers the full spectrum of responses from full suppression to managing a fire to meet resource objectives.

Wildfire Risk Management

Wildfire risk management requires managers to implement strategies and tactics that commit responders only to operations where and when they can be successful, and under conditions where important values actually at risk are protected with the least exposure necessary while maintaining relationships with people we serve. This statement is of critical importance given the high levels of tree mortality in the plan area, and the increasingly severe fire seasons experienced over the past several years. Several key factors must be considered regarding expected future fire management. First, if firefighters are going to be expected to defend communities surrounded by high levels of tree mortality, a concentrated pre-fire season hazard mitigation and fuel reduction effort will be needed to substantially reduce the risks from falling trees and fire behavior to an acceptable level. Second, we must accept the fact that, in some cases, due to the elevated risk and exposure that firefighters face while operating in the high tree mortality areas, firefighters may not be deployed in these areas. Thus, wildfires will likely grow larger than in the past. Third, as wildfires grow larger and more intense, impacts on natural resources likely will also increase. These emergent factors must be included in order to conduct a robust comparative analysis of alternative strategies. The strategies described in the action alternatives propose varied approaches to achieve desired conditions that, if attained, will provide a safer and more effective environment for firefighters, reduce risk, and facilitate fire management decisions that restore resilient ecosystems. Responders to any incident in a high tree mortality area should be mindful of the first principle of the Forest Service Foundational Fire Suppression Doctrine: No resource or improvement is worth the loss of human life.

Wildfire risk management is the process whereby management decisions are made and actions are taken to mitigate risk, while understanding and accepting the remaining risk. It involves identifying, assessing, and prioritizing risks, followed by the coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events (Thompson and Calkin 2011). Wildfire risk management is often supported by a scientific assessment that can be used to determine where individual wildfires are likely to have negative or positive outcomes. It is based on a detailed analysis of the location of values at risk (such as water sources, communities, or recreation sites) and the location and likelihood of fire starts, fire spread, and fire intensity. For the forest plans and alternatives analyzed in this revised draft environmental impact statement, we conducted a quantitative wildfire risk assessment. This analysis informed the development of science-based strategic fire management zones to assist with evaluation of each alternative’s relative capacity to achieve desired conditions. The strategic fire management zones for the alternatives are described briefly in chapter 2 and in more detail in the environmental consequences below. A brief description of the underlying analysis for the wildfire risk assessment is described in “Analysis and Methods,” below. For details of the analysis, see (Scott et al. 2015). In the next section we briefly describe the fire management considerations necessary to understand and frame the issue of changing fire management.

Fire Management Considerations

A strategy to address the need to change fire management includes recognizing constraints, acknowledging the ecological role of fire, aligning procedures with policy, and managing risk to the extent possible.

Recognize Constraints to Fire Management

There are a very large number of burnable acres of National Forest System lands that cannot be actively managed by mechanical means due to access limitations. There are an even larger number that cannot be economically treated with prescribed fire. To increase the pace and scale of ecosystem restoration, it will be essential to utilize opportunities for managing fire for resource objectives in many areas, especially those areas with constraints to mechanical treatments and prescribed fire.

Acknowledge the Ecological Role of Fire

Sierra Nevada landscapes have been shaped by wildfire for millennia. Vegetation and wildlife communities, and the habitat in which they reside, have all evolved and adapted to the natural fire regimes. However, we must be cognizant of the fact that many fire regimes in the southern Sierra Nevada are highly altered. Further, human communities have continued to expand into the wildlands, with elevated sociopolitical concerns related to how wildfires are managed and how fuels are treated. These concerns can further restrict efforts to restore these altered landscapes. Accepting the fact that natural conditions are no longer intact is not a defeat; rather, it is an acceptance of the world we live in. The wildfire situation today requires recognition that while some outcomes may not be optimal, they are less impactful than the worst wildfires.

Align with Policy

The 2009 “Guidance for Implementation of Federal Wildland Fire Management Policy” directs Federal agencies to manage wildfires to accomplish protection and resource objectives. Objectives for wildfires are affected by changes in fuels, weather, and topography; varying social understanding and tolerance; and involvement of other governmental jurisdictions having different missions and objectives. This guidance requires land managers to address the location and conditions under which resource benefits and protection objectives can be met in forest plans.

The “wildfire management continuum” was created to visually depict how wildfires may be managed for one or more objectives (Thompson et al. 2016). Using the results of risk management along the dimensions of the continuum (Figure 12) allows for the landscape to be zoned according to broad categories. The strategic fire management zones (summarized under “Overview of the Proposed Strategic Fire Management Zones”) highlight where the objectives can be met under a wide range of fire season conditions. The basics of the wildfire management continuum can be described according to four dimensions (Figure 12).

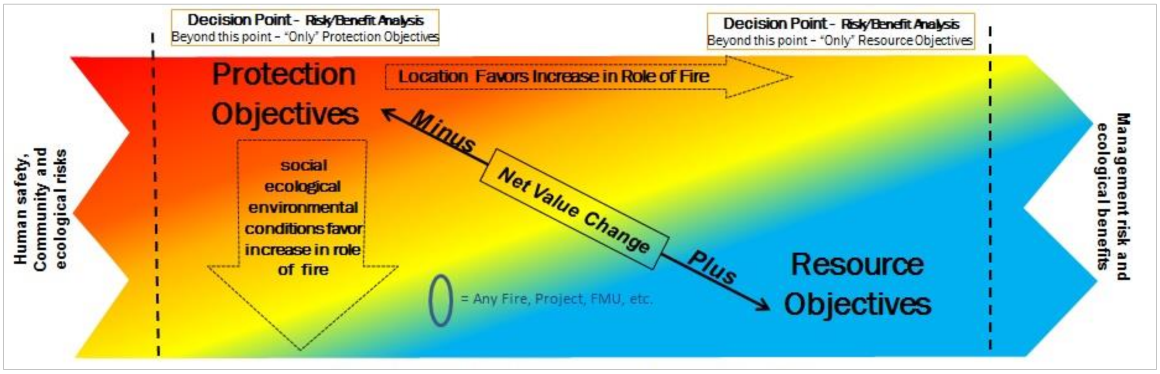

Figure 12. The wildfire management continuum. Interpretation instructions are found in the bulleted text below.

- The length of the continuum shows the spatial component, or the location on the landscape, that affects the mix of objectives: on the left, it favors protection objectives, whereas on the right it favors resource objectives.
- The height of the continuum illustrates the different social, ecological, or environmental conditions affecting the mix of objectives. On the top, protection objectives prevail, whereas on the bottom, resources objectives are easier to obtain.
- The colors depict the range of objectives, taking in the combination of both location and conditions. Red (upper left) represents how the combination of conditions and landscape location where higher risks to communities or ecological resources exist. These conditions often result in negative wildfire outcomes, so protection is the predominate objective. Blue (lower right) has the combination of low-risk conditions and landscape location where wildfires lead to mostly benefits. These conditions make managing for resources the primary objective.
- The teeth on each end of the continuum indicate that it wraps around to form a cylinder. A wildfire on the far left could be near an area with high risk, and management of that portion of the fire would be to meet protection objections. A wildfire on the right side being managed primarily for resource objectives may change to a fire managed for protection objectives due to environmental changes that caused it to grow and threaten resources and assets.

Manage Risk

Effective management of wildfire addresses the nature of wildfire and its contributing factors. It also recognizes the positive and negative consequences of fire, addresses uncertainty, and develops plans that reduce the chances of catastrophic losses (USDA and USDI 2014). Risks and uncertainties relating to fire management activities must be understood, analyzed, and communicated. Risk is managed by forest and fire managers, both in the short and long terms. If the potential positive and negative consequences of fire are recognized, and management actions are taken to obtain positive outcomes, then in the long term the risk to communities and assets will be reduced, fire will be restored to the landscape as an ecosystem function, and smoke impacts on communities will be reduced.

Synopsis

Past management practices combined with the effects of climate change are culminating in unprecedented risk to communities and natural resources. The former and current management strategies have been unable to keep up with the rate that these risks are increasing. New forest and fire management strategies and direction are needed to increase the resilience of the forest so they are sustainable into the future. Protecting lives, property, and cultural and natural resource values requires moving forward with new fire management guidance emphasizing the need for all decisions to be based in sound risk management, while recognizing the constraints and limitations that exist. The best way to accomplish these outcomes is to manage all wildfires on a continuum between meeting protection and resource objectives. The mix of these objectives are based both on the location of a wildfire (or a portion of a wildfire) and the conditions under which it is burning. These objectives will come from the revised forest plans, mainly in the form of desired conditions.

Analysis and Methods

A quantitative wildfire risk assessment was conducted across the Sequoia and Sierra National Forests (Scott et al. 2015) using the methods outlined in the publication "A Wildfire Risk Assessment Framework for Land and Resource Management" (Scott et al. 2015). The wildfire risk assessment identified the distribution of potential risks and benefits to highly valued resources and assets across the landscape. The mapping of these risks and benefits informed creation of the strategic fire management zones. These zones form the management areas for analysis of environmental consequences, with some variations in boundaries and management direction described in plan components of the various alternatives. The risk assessment provides a current snapshot of likely wildfire risks and benefits. The analyses of environmental consequences of each alternative are evaluated based on implementation of the described strategies over the 15-to 20-year life of the plan.

As previously stated, the goals from the Cohesive Strategy formed the basis for developing the fire management strategies in the alternatives and analyzing environmental consequences. Using the wildfire risk assessment as a tool, the three goals from the Cohesive Strategy are evaluated as indicators for each alternative:

- Restore and maintain landscapes through the use of wildfire. Landscapes are resilient to fire-related disturbances, and the risk of undesired effects on landscapes is diminished. *Managing wildfire to meet resource objectives is vital to meeting this goal*, especially in areas where active management is limited.
- Support fire-adapted communities. Human populations and infrastructure in and next to the national forest can withstand a wildfire without loss of life and property. Risk of wildfire impacts on communities is diminished. *Assess the level of risk* and establish roles and responsibilities for mitigating both the threat and the consequences of wildfire.
- Improve safe and effective fire response. All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions. *Assessing wildfire risk upfront is essential to safe and effective response.* Risk exposure to firefighters is based on a balanced consideration of values protected and the probability of success. Injuries and loss of life to the public and firefighters are diminished.

Two measures rate how well each alternative addresses the indicators:

- **Managing Uncertainty:** Managing uncertainty aids in making more holistic wildland fire management decisions. Uncertainty is measured by how well strategic fire management zones in each alternative categorize the potential damages and benefits to highly valued resources and assets from simulated wildfires. A zone that is quantitatively categorized with mostly benefits to values would have low uncertainty, while a zone with a high mix of both damages and benefits would have moderate uncertainty. A zone delineated without a quantitative assessment and categorization of risk would have the highest uncertainty.

- **Facilitating Wildland Fire Management:** This measures each alternative's ability to identify and enhance strategic fire management features on the landscape. Identification of these features provides greater ability to enhance them through fuel reduction and vegetation treatments, and thereby compartmentalize the landscape and facilitate safe fire management decisions. Thus, an alternative that facilitates actions that reduce fuels along ridges, roads, and other strategically located potential control features will get a higher rating than an alternative that provides fewer opportunities.

Two figures (Figure 21 and Figure 22) summarizing the percentages of expected damages versus benefits in each zone by alternative are provided at the end of "Environmental Consequences." In order to provide quantitative comparisons of each alternatives' performance at addressing the indicators, Table 11 contains a simple numerical ranking of the alternatives' effectiveness at addressing the indicators. This table is also at the end of "Environmental Consequences."

Assumptions and limitations

- Fire management zone creation under alternatives B and D, and partially under alternatives C and E, were created with a probabilistic fire modeling simulating 20,000 seasons using a static landscape, historic weather, and ignitions distribution. It does not account for future magnitude or distributions of these factors.
- Highly valued resources and assets applied in the fire modeling do not reflect the full suite of values and assets that may be affected by wildfire. These were selected based on policy priorities, social concerns, stakeholder engagement, and local knowledge. The magnitude of negative and positive wildfire impacts on the highly valued resources and assets were based on weighting and response functions that estimate fire effects on each value to various fire intensity levels.
- Given the recent tree mortality events and increasing evidence that climate change is leading to larger and higher-intensity wildfires, consideration for alternatives that enhance long-term adaptation to climate change and increase resilience to stands of remaining green forests are emphasized.

Affected Environment

Current situation related to tree mortality

Severe drought in California from 2012-2016 and subsequent bark beetle infestations have killed approximately 130 million trees. Most of this tree mortality is concentrated in the Sierra Nevada, with substantial portions in the Sierra and Sequoia National Forests, as well as on surrounding state and private lands. Further, the warming climate and associated extreme fire burning conditions over the past several years have led to unprecedented fire behavior. These factors have combined into very high hazards in the tree mortality areas. Without substantial hazard mitigations, safety to firefighters will preclude direct fire engagement in these areas. Thus, in this regard, the current situation for fire response looks different than it did just a few years in the past.

Historical Wildfires and Wildfires Managed to Meet Resource Objectives

Wildfires on Sierra and Sequoia National Forests (including the Giant Sequoia National Monument) burned about 780,000 acres during the period from 1992 and 2017, averaging about 30,000 acres per year (Figure 13). The amounts fluctuate from year to year depending on conditions and the number of fire ignitions. Fire ignitions are either from lightning or human-caused sources. Over the 26-year analysis period, 2,113 lightning-caused fires (average 81 per year) burned approximately 334,000 acres (average 12,800 per year), whereas 2,498 human-caused fires (average 96 per year) burned approximately 445,000 acres (average 17,000 per year)[10]. All human-caused wildfires are managed with a fire suppression strategy.

Currently, only lightning-caused wildfires are managed to meet resource objectives on the national forests.

Fuel Reduction Treatments

Most mechanical treatments are a combination of mechanical thinning of understory trees and mastication or piling and burning of small trees and other debris created by treatment operations. These are designed to reduce fire intensity and spread potential. Project design criteria often include requirements to retain more canopy cover for wildlife and to retain patches of shrubs and small trees for wildlife cover, and to provide more natural scenery. However, overall amounts of treatments have not been extensive enough at landscape scales to substantially affect large wildfires.

The prescribed fire treatments conducted to date have had minimal impact on reducing large wildfire intensity or restoring the desired fire-return frequency.. Most prescribed burning has occurred in areas either previously mechanically treated to reduce fuels or areas that have previously been prescribed burned. Because prescribed burning is dependent on weather and fuel conditions, seasonal timing, availability of resources, and acceptable conditions for managing smoke, many areas, especially in the Sierra and Sequoia National Forests, have been mechanically treated but have not yet been burned.

Fire Management Coordination

The Forest Service coordinates with local fire districts and state fire agencies, interagency partners (especially the National Park Service and BLM), and tribal liaisons during wildfire incidents. Continual coordination efforts between these entities occur for development of prevention programs in high wildfire risk areas. Fire managers work with local communities to decide where and how to apply fuel reduction projects on Federal lands through a community wildfire protection plan.

[10] 1992-2015 data from Short (2017). 2016-2017 data from NWCG FAMWEB (https://fam.nwcg.gov/fam-web/)

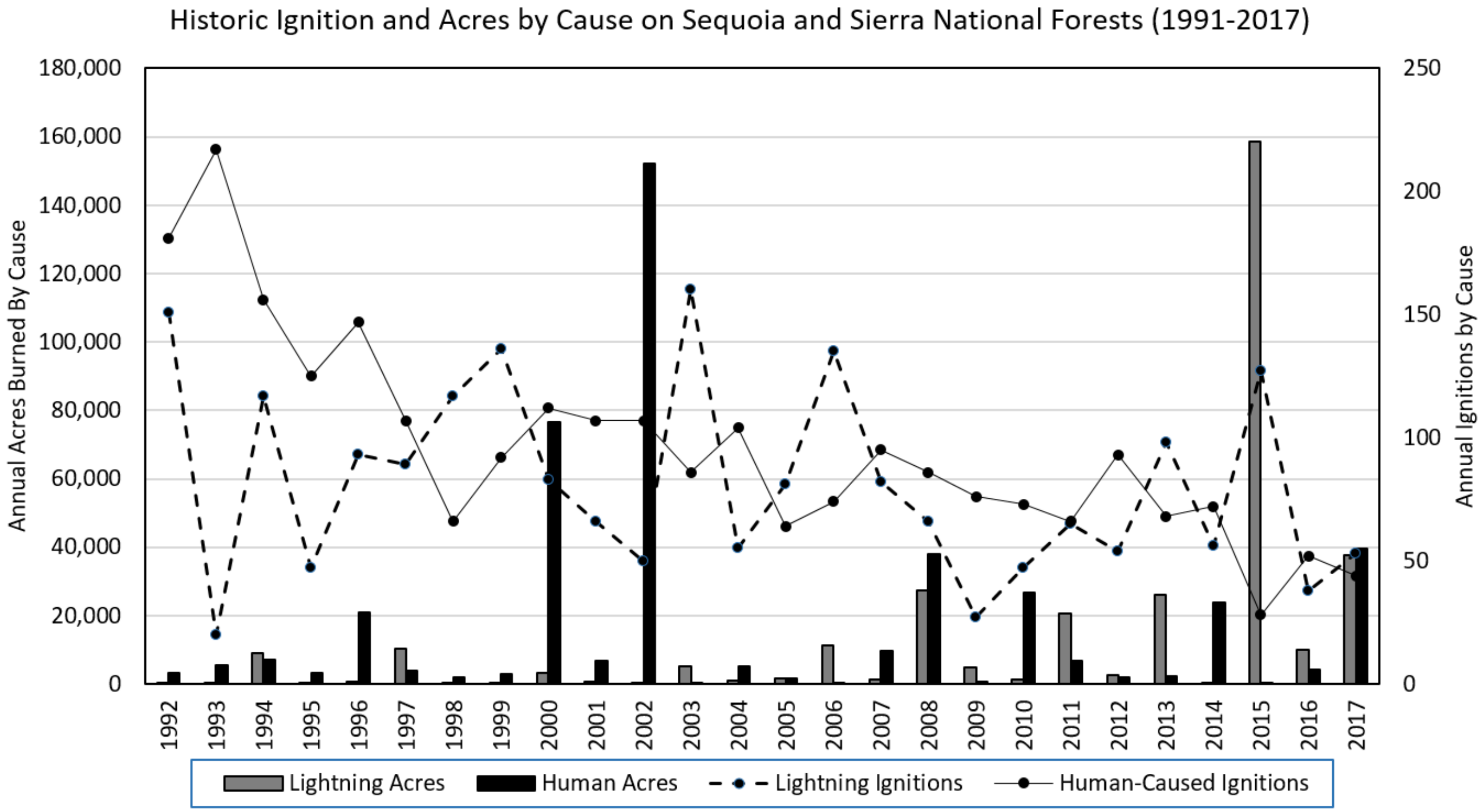

Figure 13. Historic ignitions and acres burned by cause, 1992-2017 Sequoia and Sierra National Forests (1992-2015 data from Short 2017, 2016-2017 data from https://fam.nwcg.gov/fam-web/).

Wildfire Risk Assessment Results

A quantitative wildfire risk assessment was conducted to identify the distribution of modeled risks and potential benefits to highly valued resources and assets. Impacts are measured by the likelihood and intensity of wildfire, and how susceptible the highly valued resources and assets are to those intensities. Also, susceptibility can be positive (benefits value), or negative (damages value). The Fire Simulation System, FSim, was used to model intensity and likelihood, while susceptibility is determined by response functions that measure how the values are affected by various fire intensities. These results are then summarized as expected net value change to the values and assets across the landscape (Figure 14). The expected net value change will be of most wildfire to reduce negative impacts. Conversely, positive expected net value change occurs when the values mostly benefit from fire, leading to more opportunities to manage wildfires to meet resource objectives.

Environmental Consequences of Fire Management

Fire Management Zones

The wildfire risk assessment (Scott et al. 2015) covers a 1,291,906-acre area encompassing the Sequoia and Sierra National Forests. The plan area is characterized by vegetation conditions ranging from valley-bottom grasslands in the Central Valley to alpine forests and rock at the highest elevations, and to arid sagebrush shrub lands on the east side of the Sierra crest.

Alternative A consist of three zones: the wildland-urban intermix defense and threat zones, and the "other" zone which consists of the area outside the urban-wildland intermix. These are derived from the current forest plans. The wildfire risk assessment was the basis for the creation of strategic fire management zones in alternatives B and D and, in part, the zones in alternatives C and E. Public engagement, rather than modeling, influenced the development of the general fire zone (GFZ) in alternatives C and E. The zones identified from the modeling outputs are described below for comparison. The consequences are described separately by alternative in the analysis that follows.

Overview of the Proposed Strategic Fire Management Zones

Fire Management Zones under Alternative A

The zones under alternative A shown in Figure 15 were created for the existing two forest plans during the 2004 Sierra Nevada Forest Plan Amendment (United States Department of Agriculture 2004b) based primarily on buffer distances from the edges of human communities. Lightning-caused wildfires may be managed to meet resource objectives when conditions allow, and it can be done in a safe manner as identified in the current forest plans. Fire management zones in alternative A are static and not expected to change over time.

1. **Wildland-urban Intermix Defense Zone:** This zone identifies areas with a one-quarter-mile buffer from structures. Fire management direction in this zone focuses on hazardous fuel reduction treatment as the highest priority. Fuel reduction treatments (mostly mechanical) in this zone are the most intense to create defensible space to prevent the loss of life and property.
2. **Wildland-urban Intermix Threat Zone:** This zone identifies areas with a buffer of 1.25 miles beyond the one-quarter-mile buffer from the wildland-urban intermix defense zone. Fire management direction in this zone focuses on hazardous fuel reduction treatment as the highest priority. Fuel reduction treatments in this zone are strategically located to interrupt wildfire spread and reduce fire intensity. The needs of wildlife are weighted more heavily in this zone than in the defense zone.

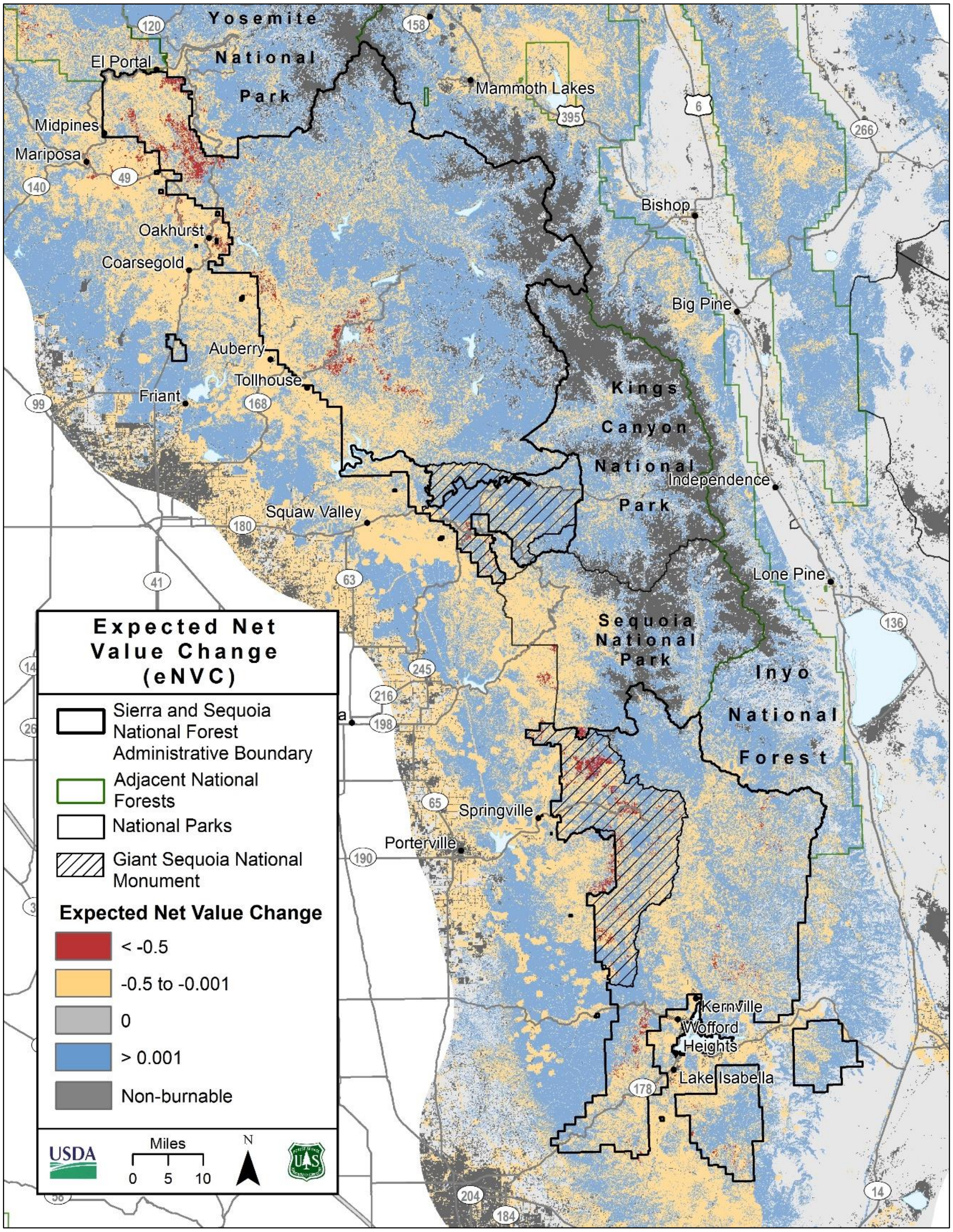

Figure 14. Map of Expected Net Value Change (eNVC).

Expected net value change, or eNVC, is calculated as the product of burn probability and value change (to one or more resources or assets) over a range of wild-fire intensity classes (usually flame length). Expected net value change is a risk-neutral measure of the wildfire risk to resources and assets. It forms the basis for the quantitative wildfire risk assessment process described in this report. If no beneficial effects are under consideration, eNVC can simply be called expected loss. The terms value change, response, and net response are functional synonyms for net value change; all refer to the net effects of positive and negative changes on the value of a resource or asset (RMRS-GTR-315).

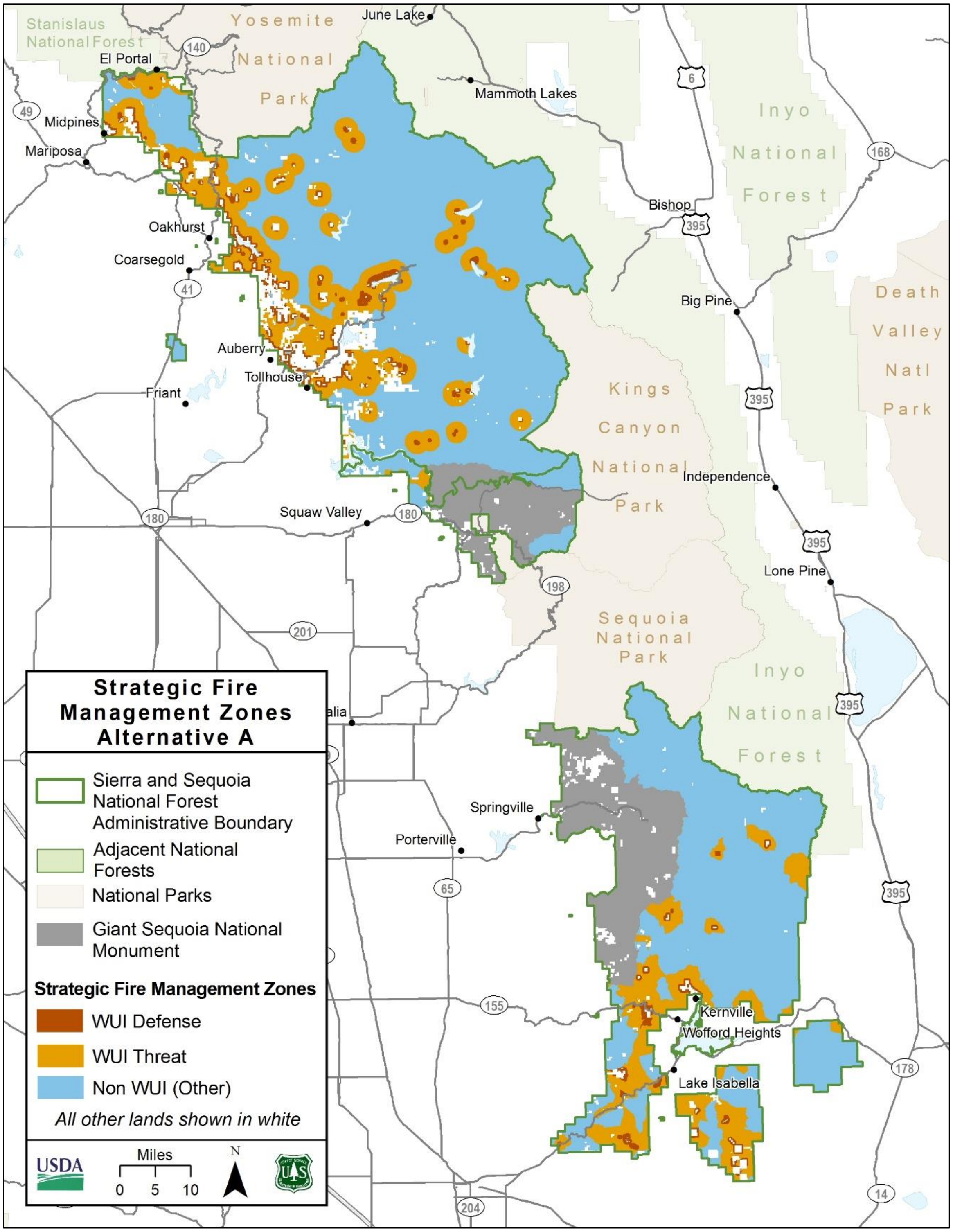

Figure 15. Map showing the location of the fire management zones for alternative A
(WUI = wildland-urban intermix)

3. **Other (Non-WUI):** This zone integrates the remainder of the forest outside the wildland-urban intermix defense and threat zones and encompasses other land allocations. Fuel treatments in the general forest are designed to support treatments in the wildland-urban intermix threat zone, protect sensitive habitats, and reintroduce fire into fire-dependent ecosystems. Habitat requirements dominate this zone. Wilderness is managed to maintain predominantly natural and natural-appearing environments, and mechanical vegetation treatments are not allowed. Prescribed fire can be used to reduce the risk and consequences of wildfire burning in wilderness, or prevent wildfire escaping from wilderness to an acceptable level.

Strategic Fire Management Zones under Alternatives B and D

The zones for alternatives B and D (Figure 16) were created from modeled outputs produced by the wildfire risk assessment (Scott et al. 2015). Strategic fire management zones are dynamic zones, and the current proportion of total area in each zone is shown in Figure 18. Over time, conditions in these zones may change, and these changes may lead to areas that better fit the definition of another zone. For example, if new developments in previously undeveloped areas of the general protection zone were to occur, and there was inherent wildfire risk at that location, the CWPZ may need to be expanded into the general protection zone. Another example is when the restoration zone conditions improve toward the natural range of variation, thereby making the zone change to maintenance zone appropriate.

1. **Community Wildfire Protection Zone (CWPZ):** This zone identifies the areas with the highest risk to communities and community assets. This zone assists with preparedness decisions, communication and outreach to high-risk communities, and prioritization of fuel treatments in and near communities.
2. **General Wildfire Protection Zone (GWPZ):** This zone identifies areas with a moderate to high risk to communities and assets as well as natural resources. This zone assists in prioritizing fuel treatments and fire management activities where targeted ecological restoration and hazardous fuel reduction will be needed to contribute to the protection of communities.
3. **Wildfire Restoration Zone:** This zone identifies the areas with a low to moderate risk, mostly to natural resources and some risk to assets. This zone assists with prioritization of fuel reduction treatments to create more opportunities under a wider range of conditions to manage wildfires to meet resource objectives and achieve forest plan desired conditions.
4. **Wildfire Maintenance Zone (WMZ):** This zone identifies the areas with very low risk, mostly to natural resources and some risk to assets. Wildfires that occur in this zone will likely maintain or help achieve forest plan desired conditions. The management of wildfires to meet resource objective is encouraged when conditions allow and when it can be done in a safe manner.

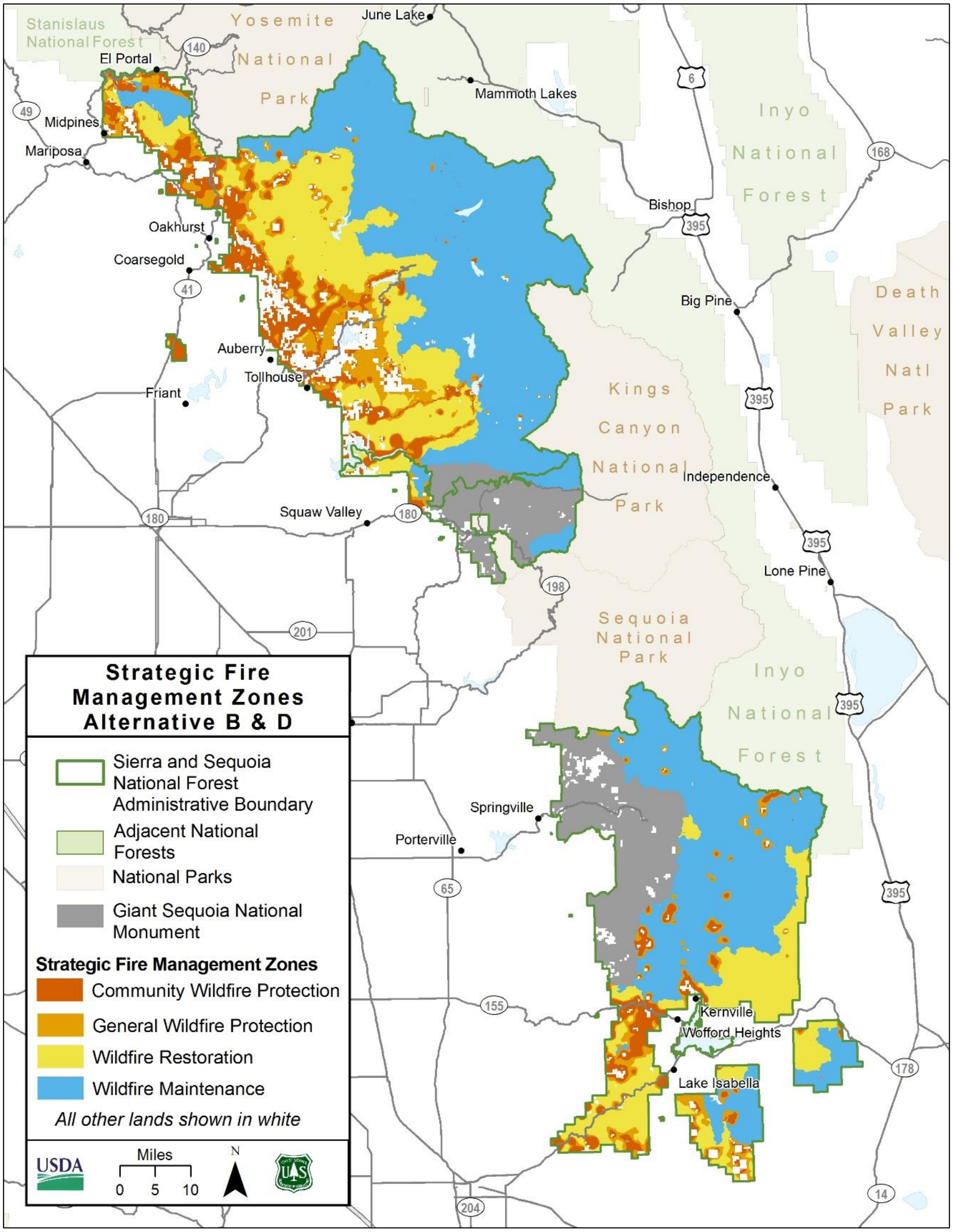

Figure 16. Map showing the location of the strategic fire management zones for Alternatives B and D

Strategic Fire Management Zones under Alternatives C and E

The dynamic zones created for alternatives C and E are management areas based on a combination of existing management areas and modeled outputs from the wildfire risk analysis (Figure 17). Over time, conditions in these zones may change, and these changes may lead to areas that better fit the definition of another zone. For example, if new developments in previously undeveloped areas were to occur, and there was inherent wildfire risk at that location, the wildland-urban intermix defense zone may need to be expanded into the GFZ. Another example is when the GFZ conditions improve toward the natural range of variation, thereby making the zone change to maintenance zone appropriate.

1. **Wildland-urban Intermix Defense Zone:** This zone identifies areas created with a one-quarter-mile buffer from structures. This zone is the same as the wildland-urban intermix defense zone in alternative A.
2. **Wildfire Maintenance Zone:** This zone identifies areas with very low risk, mostly to natural resources and some risk to assets. Wildfires occurring in this zone will likely maintain or help achieve forest plan desired conditions. This zone was created with the same concept as the wildfire maintenance zone in alternatives B and D; however, the proportion of the forest area that it covers is slightly higher due to the way the zones were divided. Management of wildfires to meet resource objectives and applying prescribed fire treatments is encouraged in this zone when conditions allow and when it can be done in a safe manner.
3. **General Fire Zone (GFZ):** This zone identifies the remaining areas within the forest boundary. This is a broad area, including the wildfire restoration zone, general wildfire protection zone, and portions of the CWPZ from alternatives B and D. An increased emphasis on managing wildfire to meet resource objectives and increased use of prescribed fire in fire-adapted ecosystems would occur in this zone.

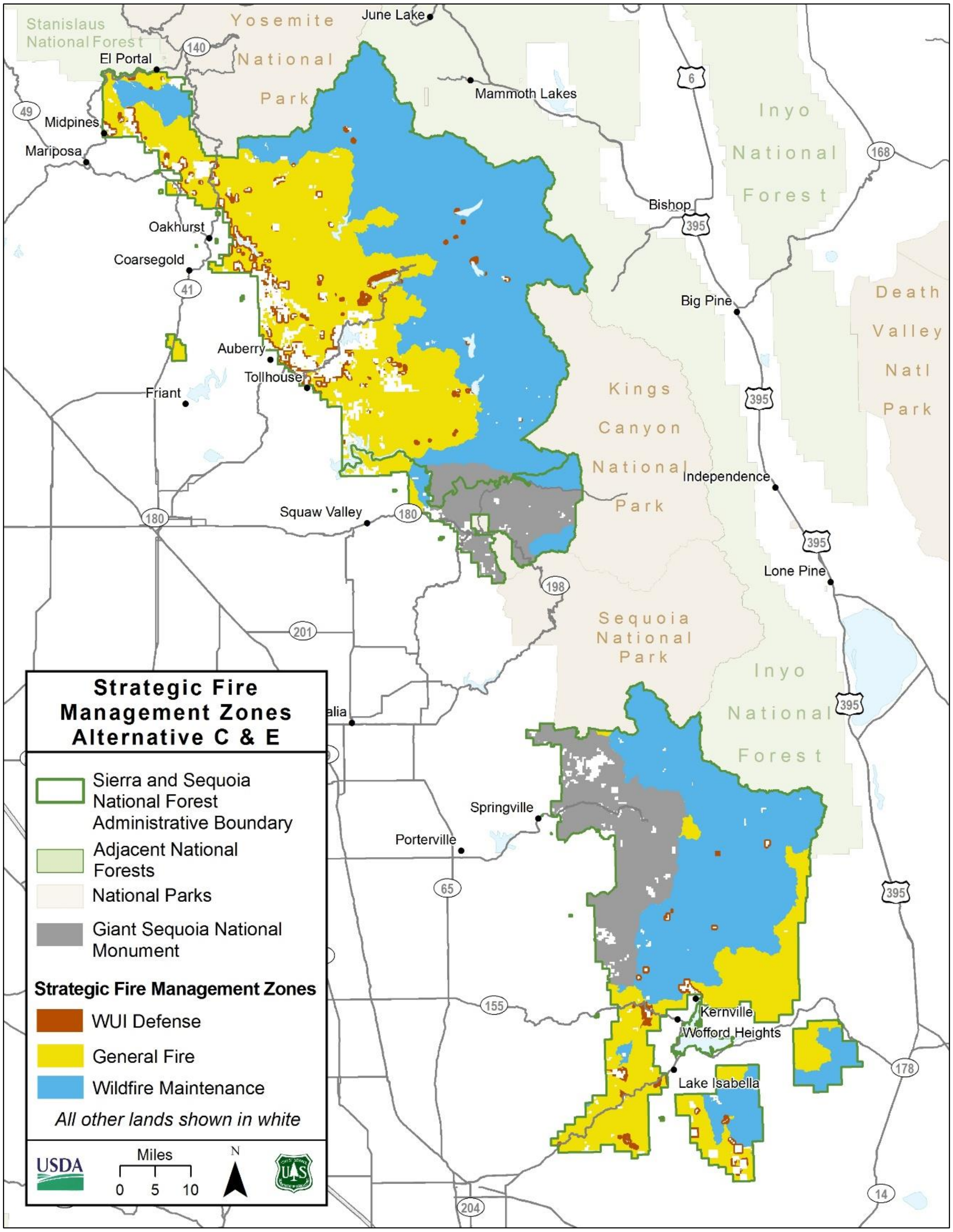

Figure 17. Map showing the location of the strategic fire management zones for Alternatives C and E (WUI = wildland-urban intermix)

Consequences Specific to Alternative A

Under this alternative there are two fire management-oriented zones, wildland-urban intermix defense and threat zones and the remaining area, referred to as "Other" (Figure 15). The proportion of the total area of the combined Sierra and Sequoia National Forests in each zone are 3 percent in the wildland-urban intermix defense zone, 21 percent in the wildland-urban intermix threat zone, and 76 percent in non-wildland-urban intermix, as shown in Figure 18. Quantitative risk assessment processes were not used in development of any zones in this alternative. The wildland-urban intermix zones are used primarily to prioritize fuel treatments on each national forest. Recent mortality in these zones will also help to prioritize actions. Short-term impacts are minimized, and treatment amounts generally correspond to the baseline treatment scenario modeled by (Westerling and Keyser 2016) in "Agents of Change."

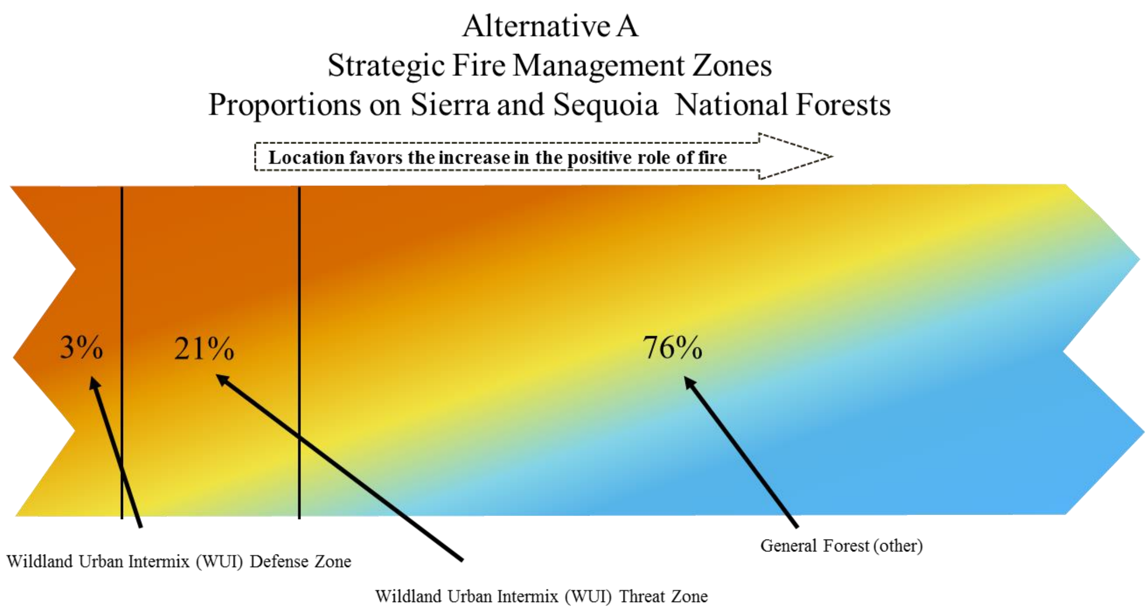

Figure 18. Proportion of the Sierra and Sequoia National Forests in each zone in alternative A. To interpret this figure, 3 percent of the plan area (far left) falls into the defense zone, and 21 percent falls into the threat zone. The red/orange/yellow shading indicates that risks, values, and assets far outweigh benefits in these zones. The increasing amount of blue in the right portion diagram indicates that, given appropriate plan direction, there are more opportunities to achieve benefits in 76 percent of the plan area that makes up the general forest. See figure 12 for detailed interpretation of continuum figures.

The focus of fire management in this alternative is to use mechanical and prescribed fire treatments to slow fire spread and provide firefighters defensible space in the wildland-urban intermix. Protections for habitat are described in standards and guidelines, and generally apply to fuel treatments. The overall strategy outside of the wildland-urban intermix is reliance on strategically placed land area treatments to slow fire spread and aid in the management of fires. For these strategically placed treatments to be effective, the pattern of treatments and percent of area treated on the landscape is important (United States Department of Agriculture 2004b). Due to various treatment constraints, treatment effectiveness is often limited. Other strategically located treatments were not identified in relation to the risks and benefits they would provide to fire decisionmaking and are not a priority for treatment. For instance, treating along key roads and ridges provides fire managers with opportunities to develop operational plans to conduct larger prescribed burns or to manage wildfires to meet resource objectives. Without an emphasis on treating along these strategic locations, there are few opportunities to manage wildfires outside of wilderness and remote areas. The potential benefits from wildfire were not analyzed during previous planning for the existing plans. While multiple management strategies are allowed for lightning-caused ignitions under this alternative, the primary response is to suppress most lightning fires. This practice propagates the current trend away from the natural range of variation related to fire as an ecosystem function.

The amount of prescribed burning and mechanical treatments under alternative A would continue. It is also quite possible, given current requirements, that treatments would decline as many areas that avoid or minimize restrictions have already been treated.

Restore and Maintain Landscapes Through the Use of Wildfire

Managing Uncertainty: In this alternative there is great uncertainty regarding using wildfire to meet resource objectives. This is because it lacks fire management zones informed by upfront identification of potential risks and benefits, as well as plan components that adequately identify resource objectives that can be met with managed wildfire. Further, outside the wildland-urban intermix, there is minimal implementation of strategically located treatments to provide managers with strategic and tactical advantages when a fire does occur. Therefore, in this alternative there would likely be a continued emphasis on suppressing wildfires.

Alternative A was developed with an emphasis on reducing fire threats to communities based on a distance-based concept of risk. Fuel reduction activities are concentrated in the two distance-based wildland-urban intermix zones. The results of the wildfire risk assessment (Scott et al. 2015) validate that the wildland-urban intermix defense and threat zones reasonably capture where potential damages might occur. This is demonstrated by the amount of red and orange areas in Figure 18. However, the two wildland-urban intermix zones do not capture potential damages to infrastructure outside these areas, or to natural resources as shown in the amount of red and orange in the “other” zone. In alternative A, since the “other” zone was not delineated by quantitative assessment, it has a mix of positive and negative effects, leading to high uncertainty for fire management decisions. Ideally, well-partitioned risk-based zones will capture either mostly negative or mostly positive effects. This gives decisionmakers more certainty ahead of the time when prompt wildfire decisions are needed. But Figure 18 shows that the positive versus negative outcomes are not partitioned well in the “other” zone. This means a higher amount of uncertainty for making fire management decisions in areas where wildfires could contribute to restoring and maintaining landscapes.

In alternative A, the uncertainty of where the potential damages and benefits are located makes it more difficult for forest and fire managers to decide on a fire management strategy when a fire occurs. Under this alternative, decisions are typically supported by analysis and information about potential wildfire risks and benefits gathered on-the-fly, after the wildfire starts. This can be challenging when there are multiple fires occurring in the area, across states, or across the nation. In these situations, fire resources are scarce and precautionary decisions to suppress fires are often made by default.

Facilitating Wildland Fire Management: Current direction in alternative A facilitates continued wildfire suppression over other options. Standards and guidelines restrict activities and prescribe canopy cover and tree diameter limits. The most flexibility to design effective fuel reduction treatments occurs in the wildland-urban intermix defense zone. Outside of the defense zone, additional standards and guidelines apply to minimize or mitigate effects on wildlife habitat.

Under the current direction, designing implementable and effective fuel reduction projects that comply with the standards and guidelines has been difficult in some areas. This typically results in small, disconnected treatment units. Often treated areas are left with residual fuels and vegetation that are not very effective at slowing fires, and that make prescribed burning more complex.

Most fuel reduction treatments are designed as mechanical thinning or mechanical manipulation of fuels followed by prescribed burning of treated units or burning of piles of fuels. In many cases, thinning has occurred, but prescribed burning has yet to occur resulting in a backlog of areas that may have undesirable outcomes should they burn in a wildfire rather than a prescribed burn. The opportunity to apply prescribed burning over large landscapes is limited given the pattern of heavy fuels and interspersed areas where fuel reduction treatments have occurred.

The ability to manage wildfires to meet resource objectives is allowed, as long as they have a fire management plan that describes how wildland fires will achieve resource management objectives (United States Department of Agriculture 2004b). Federal wildland fire decision support systems provide this function. Current forest plan direction does not emphasize fuel reduction treatments in key locations that can serve as anchor points, such as along ridges and key roads. Without these features, decisions to suppress fires are much more likely. Due to constraints and requirements for other resources, the current pattern of small and disconnected fuel reduction treatments under alternative A would continue at the same low pace and scale of treatment. This plan direction consists of narrow ranges of vegetation desired conditions that does little to help fire managers understand what outcomes are acceptable or even desirable, and further reduces the potential to restore and maintain landscapes to a level where they are sustainable, resilient, and can recover from disturbance.

Support Fire-Adapted Communities

Managing Uncertainty: Although management activities in this alternative are focused on protecting life and property, since the zones were delineated based on buffers, or by default, management decisions in the non-wildland-urban intermix are less effective. This alternative does not account for the likelihood of fires spreading from adjacent areas into the wildland-urban intermix, substantial uncertainty remains related to this risk to communities.

Facilitating Wildland Fire Management: Fire managers would continue to assist communities to become more fire adapted through continued collaborative efforts such as community wildfire protection plans and fuel reduction treatments. Priority is placed on fuel reduction in the two wildland-urban intermix zones, but little effort has been made outside of this zone, which does little to facilitate fire management outside the wildland-urban intermix that would support fire-adapted communities. Managing wildfires to meet resource objectives is an option, although it is rarely used near fire-adapted communities due to public concerns and the challenge of managing risks.

Improve Safe and Effective Fire Response

Managing Uncertainty: Under alternative A, risks were not spatially identified outside the wildland-urban intermix defense and threat zones. Without assessing risk upfront, planning actions, such as fuel reduction treatments and fire prevention actions, would be less focused or prioritized on high-risk locations. Further, understanding where fire would likely result in positive outcomes reduces uncertainty and aids in safe and effective fire response. Thus, wildfire response would continue to favor the current response of actively suppressing most fires. This would continue to make it difficult for fire managers to make on-the-fly decisions that consider the safety of fire responders and costs of the fire commensurate with values at risk because these risks to values are not evaluated upfront.

Facilitating Wildland Fire Management: The two wildland-urban intermix zones in alternative A do not provide the support for improving wildfire response to large, unwanted wildfires that could threaten communities. The limited fuel reduction treatments are focused on slowing fire spread and reducing fuels in more easily treatable areas near roads and on flatter ground. The original intent to treat in a more geometric pattern so that wildfires would run into these areas like speedbumps has proven difficult to implement. Part of the reason is the prescriptive and restrictive standards and guidelines that limit the type and effectiveness of treatment. Fires that burn on national forest land and spread toward communities would continue to threaten structures and homes. Although management of wildfires to meet resource objectives is allowed, the objectives are not well defined in plan components to facilitate that choice in most situations.

Consequences Specific to Alternative B

Under this alternative there are four risk-based strategic fire management zones that cover the national forest lands. The proportion of the total area of the Sierra and Sequoia National Forests in each zone are 11 percent in the CWPZ, 8 percent in the general wildfire protection zone, 25 percent in the wildfire restoration zone, and 56 percent in the wildfire maintenance zone (Figure 19). Alternative B has no new recommended wilderness in the Sierra National Forest, but the Sequoia National Forest includes about 4,900 acres of recommended wilderness. Since recommended wilderness would be managed the same as designated wilderness, minimum impact suppression tactics (MIST) are required, and mechanized equipment exceptions would only occur with forest supervisor approval. However, because this modest increase in recommended wilderness is appended to an existing wilderness area (Monarch) and is inside the Giant Sequoia National Monument, notable effects on fire management greater than those in alternative A would not be expected.

This alternative includes WHMAs. WHMAs allow more flexibility for treatments than alternative A. These include slightly more waivers for prescribed fire, and more flexibility toward canopy cover and diameter limits on tree removal. Also in alternative B, fuel reduction treatments would be more spatially extensive than alternative A. These treatments are intended to achieve vegetation desired conditions and would be more effective fuels reduction treatments for reducing fire hazard. Additionally, alternative B provides direction to identify, improve, and utilize features that provide strategic and tactical advantages during wildfire incidents. This will lead to increased areas suitable for managing fires to meet resource objectives. This alternative includes community buffers a few hundred feet wide directly next to structures where conditions are prioritized that provide a safe working environment for firefighters and has few restrictions. Where wildlife habitat management areas overlap community buffers in the CWPZ, priorities track with proximity to communities. The closer to communities, hazard reduction is prioritized, while further out, habitat considerations increase.

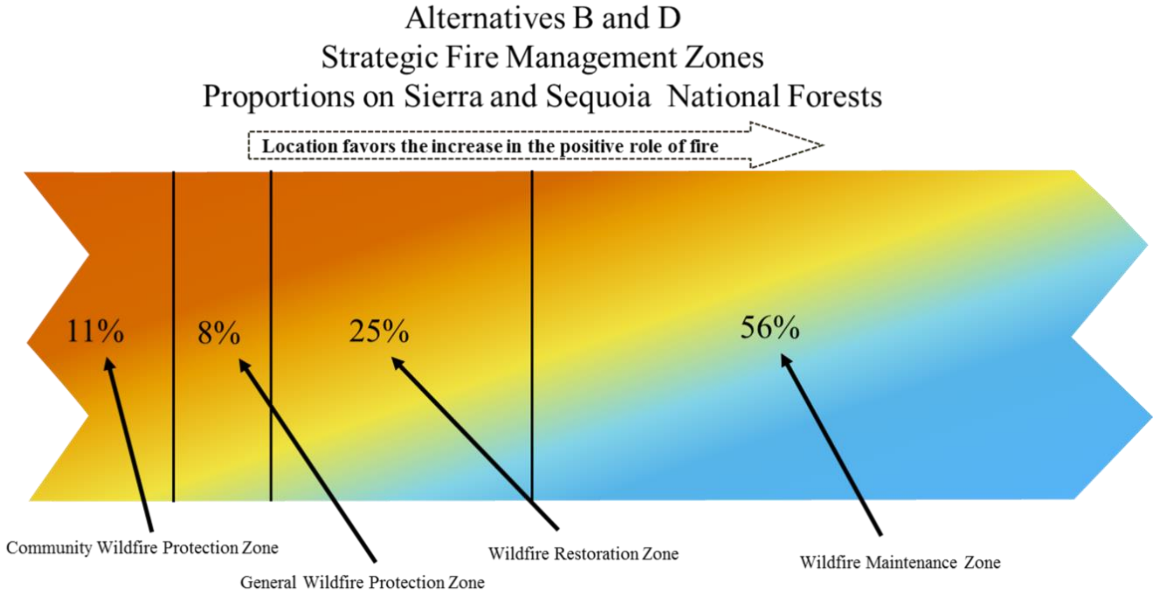

Figure 19. Combined proportions of the Sierra and Sequoia National Forests in each zone in alternatives B and D.

To interpret this figure, 11 percent of the plan area (far left) falls into the community wildfire protection zone and 8 percent falls into the general wildfire protection zone. The red/orange/yellow shading indicates that risks far outweigh benefits in these zones. The increasing amount of green/blue in the right portions of the diagram indicate that there are more opportunities to manage wildfire to meet resource objectives in the 81 percent of the plan area that makes up the wildfire restoration (25%) and wildfire maintenance (56%) zones. See figure 12 for detailed interpretation of continuum figures.

Alternative B also includes more new eligible wild and scenic rivers than alternative A (see "Eligible and Suitable Wild and Scenic Rivers" for details). Site-specific projects and activities on National Forest System lands may be authorized on eligible segments only where the project and activities do not adversely impact the free-flowing character or outstandingly remarkable values and must also be consistent with the interim protection measures outlined in section 84.3 of the handbook (FSH [Forest Service Handbook] 1090.12 - 84.3 – Interim Protection Measures for Eligible or Suitable Rivers). In eligible segments classified as wild, cutting trees and other vegetation for fuels reduction is not permitted. However, prescribed fire and wildfires managed to meet resource objectives may be used to restore or maintain habitat for threatened, endangered, or sensitive species or restore the natural range of variability (FSH 1090.12 - 84.3 – Interim Protection Measures for Eligible or Suitable Rivers). In eligible segments classified as scenic and recreational, a range of vegetation management and timber harvest practices are allowed, if these practices are designed to protect users, or protect, restore, or enhance the river environment, including the long-term scenic character (FSH 1090.12 - 84.3 – Interim Protection Measures for Eligible or Suitable Rivers). The wild segments constrain mechanical fuel treatments in this alternative more than under alternative A. No additional constraints arise from the scenic and recreational segments between this alternative and alternative A.

Managing wildfire to meet resource objectives is highly encouraged in the maintenance and restoration zones and somewhat limited in the protection and general zones. Short- and long-term impacts are considered, and treatment amounts generally correspond to the 30 percent treatment scenario modeled by (Westerling and Keyser 2016), as described in "Agents of Change." The indication is that under the 30 percent treatment scenario, burned area and proportions of high-severity fire would continue to increase for the coming decades.

Restore and Maintain Landscapes Through the Use of Wildfire

Managing Uncertainty: Knowing up front the potential outcomes of a fire before it happens reduces uncertainty for fire management decisionmakers. The strategic fire management zones in this alternative were designed with that in mind. Under alternative B, fire management responses ranging from managing the fire to meet resource objectives to full suppression are available across all zones. When it can be done safely, fire would be allowed to assume its natural role. This is conducive to meeting resource objectives and would provide for ecological restoration and improved resilience in any of the zones. Having the flexibility to manage wildfire along the full range of the continuum can be useful if decisionmakers have the needed information to decide to use that flexibility. The zones categorize the locations of where positive or negative wildfire impacts on highly values resources and assets would be expected. Important strategic locations are identified in relation to potential damages and benefits, most of which are along zone boundaries. The conditions under which a particular fire burns dictate the outcomes of the fire. But the zones define the locations of likely outcomes. For these reasons, alternative B manages uncertainty much better than alternative A. Better understanding and management of uncertainty should result in more wildfire being managed to restore and maintain landscapes. However, it is expected that this would occur the most often in the wildfire restoration and wildfire maintenance zones because these zones identify the areas with the lowest risk and greatest potential benefits to highly valued resources and assets.

Facilitating Wildland Fire Management: Alternative B provides an increased opportunity to manage larger wildfires than alternative A in three important ways. First, the fire management zones were developed to capture the variation in the distribution of potential risks and benefits to values and assets so that fire management decisionmakers come in to an incident with advanced situational awareness. Second, the flexibility to provide safe firefighting environment in the community buffer, the increased flexibility in the WHMAs, as well as the greater extent of treatments that reduce fuel loading in other strategic locations. Third, the plan components are designed to provide fire managers with a range of vegetation desired conditions and objectives that facilitate fire management decisions. These lead to more opportunities for fuel reduction projects and wildfires managed to meet resource objectives. Treatments would be prioritized in strategic locations such as roads, ridgetops, and other natural and human-made features. In particular, this alternative provides plan components that facilitate projects designed to create mosaics of variable silvicultural treatments, restore fuels toward the natural range of variation, and provide greater resilience. These treatments would serve as anchor points for larger prescribed burns, and they create areas of low fuel that can be used to manage future wildfires.

Support Fire-adapted Communities

Managing Uncertainty: Uncertainty is lower than in alternative A because the zones were informed by the quantitative risk assessment. The community and general wildfire protection zones capture a substantial portion of the high fire risk to communities and assets as shown by the large portion of red and orange in Figure 19.

Facilitating Wildland Fire Management: Fire managers would continue to assist communities to become more fire adapted through continued collaborative efforts such as community wildfire protection plans and fuel reduction treatments. More fuel reduction treatments in more locations would occur in alternative B than in alternative A. This facilitates fire management in supporting fire-adapted communities by increasing anchor points and other strategic opportunities.

Although the use of wildfire to meet resource objectives would likely be limited initially in the wildfire protection zones, more fuel reduction treatments would lower wildfire risk over time and increase the potential to reduce fire suppression costs by managing at least portions of wildfires to meet resource objectives.

Improve Safe and Effective Fire Response

Managing Uncertainty: Because risks and benefits are better identified than in alternative A, fire managers would more quickly and accurately gain situational awareness needed for a safe and effective response. The zones reduce uncertainty by categorizing risk and allow for fires to be managed on a continuum between meeting protection objectives and resource objectives in these zones and implementation of a risk-based response. Categorizing the potential benefits along with the residual risks to resources reduces uncertainty in the wildfire restoration and maintenance zone as shown by the gradation of red to blue in those two zones as shown in Figure 19.

Facilitating Wildland Fire Management: In this alternative, more treatments would occur throughout a broader landscape than alternative A, which prioritized wildland urban intermix. This approach will have a greater likelihood of interrupting the spread of wildfire and reducing the intensity of fires as they burn into treated areas. Additionally, treatments would be designed along strategic roads, ridgetops, and other natural and human-made features that would create more opportunities to conduct larger prescribed burns and provide strategic and tactical locations to manage future wildfires. This alternative allows for wildfires to be managed to meet resource objectives in all zones, but strongly encourages it as areas on the landscape (zones) shift toward the wildfire maintenance zones. Lastly, in this alternative, community buffers in close proximity to structures are identified in the CWPZ. Here, fuel conditions that promote safe and effective fire response prevail, and other resource restrictions are minimized.

Consequences Specific to Alternative C

In alternative C, the strategy is to use fire as the primary tool to increase the pace and scale of restoration while minimizing short-term effects on species and habitat caused by mechanical treatments. Mechanical fuel reduction treatments are focused around structures. The wildland-urban intermix defense zone is the same as that in alternative A. Unlike alternative A, alternative C does not include community buffers. The wildfire maintenance zone is the same as that from alternative B and developed through the risk assessment process. The remaining areas are lumped into the GFZ. The primary restoration tool is prescribed fire. Managing wildfire to meet resource objectives is limited in the wildland-urban intermix defense zone, which only accounts for 3 percent of the landscape. In the general fire and wildfire maintenance zones, which comprise the remaining 97 percent of the plan area, managing wildfire to meet resource objectives is highly encouraged (Figure 20). Treatment amounts generally correspond to the 15 percent treatment scenario modeled by (Westerling and Keyser 2016) in “Agents of Change.” In this treatment scenario, substantial increases in wildfire burn area, and in particular, proportion burning at high-severity would continue to increase into the coming decades.

The impacts from wild and scenic river management would be the same as those described under alternative B.

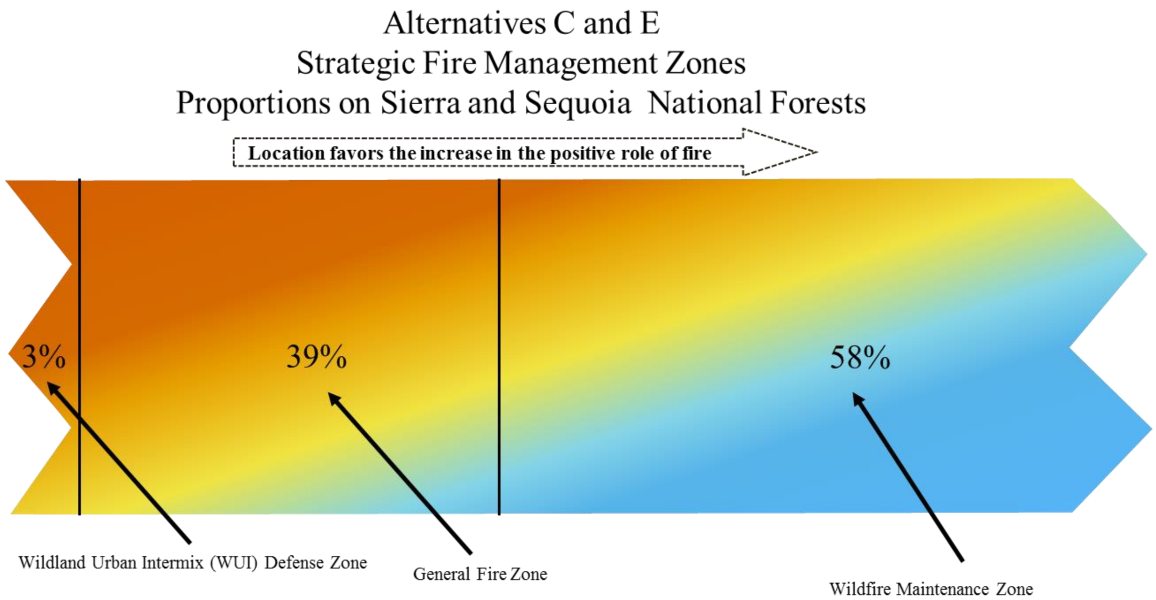

Figure 20. Combined proportion of the Sierra and Sequoia National Forests in each zone in alternatives C and E.

To interpret this figure, three percent of the plan area (far left) falls into the wildland-urban intermix defense zone. The red/orange/yellow shading indicates that risks far outweigh benefits in this zone. Thirty-nine percent of the plan area falls into the general fire zone and here there is a mix of areas where either risks or benefits prevail. The increasing amount of green/blue in the right portions of the diagram indicate that there are more opportunities to manage wildfire to meet resource objectives in the 58 percent of the plan area that makes up the wildfire maintenance. See Figure 12 for detailed interpretation of continuum figures.

Restore and Maintain Landscapes Through the Use of Wildfire

Managing Uncertainty: Under alternative C, fire management responses ranging from managing fires to meeting resource objectives to conducting full suppression, exist across all the zones. The wildfire maintenance zone was created using the risk assessment and generally occurs in the higher elevations and wilderness areas. This leads to lower uncertainty in this zone than alternative A. This zone is most suitable for managing wildfires to meet resource objectives. As with alternative A, the wildland-urban intermix defense zone was defined by proximity to communities. Unlike alternative A, this alternative does not have the wildland-urban intermix threat zone. The GFZ, which is the largest zone in this alternative, is the remaining area between these two zones. There is considerable uncertainty for fire management decisions related to the GFZ, but it is similar to the uncertainty of alternative A's "other" zone, which was also created by default. This zone has a range of expected wildfire effects on highly valued resources and assets. These effects range from likely damage (red/orange/yellow in Figure 20), to some expected benefits (green/blue in Figure 20). This wide range in risk to benefits in the GFZ provides decisionmakers little information to aid in choosing an appropriate management strategy for a wildfire in this zone. Overall, because this alternative includes the wildfire maintenance zone created by the risk assessment, it manages uncertainty related to this indicator better than alternative A.

Facilitating Wildland Fire Management: Mechanical fuel reduction treatments in this alternative would be more restricted than in alternative A but would include strategically placed fuel breaks created by hand thinning of small trees and understory vegetation. Mechanical treatments also would be limited primarily to removing small-diameter material and focused mostly in the defense zone. The limited amount and areas of mechanical pretreatment will do little to facilitate fire management decisions for restoration of fire. Further, this will have financial implications on meeting goals because the timber volume will not offset treatment costs. Thus, prescribed burning would be heavily relied on to meet fuels reduction goals, which, in order to mitigate negative impacts with higher surface fuel loading, may require multiple prescribed burns over time. This ensures prescribed burns will be more complex, compared with burns with mechanical pretreatment in alternative A. Prescribed burns with little or no pretreatment may require additional fire resources, additional planning effort, and have narrower burn windows in order to safely meet burn objectives. Further, extensive areas of mortality will make it very difficult to safely implement prescribed burning as a pretreatment to facilitate eventually managing wildfire for resource objectives. Wildfires managed to meet resource objectives are more strongly encouraged than in alternative A. Any wildfires managed for resource benefits in areas within 15 to 20 years of substantial tree mortality would risk killing regenerating conifers and lead to type conversion to shrub dominant systems (Stephens et al. 2018). Due to the more limited areas of effective fuel reduction treatment in the other zones, managing wildfires for resource objectives would be mostly limited to the wildfire maintenance zone.

Alternative C has more recommended wilderness than all other alternatives. These areas are expected to be managed similar to designated wilderness. MIST are required, and mechanized equipment exceptions are allowed only with Forest Supervisor approval. These MIST operations should not significantly affect operations where the wilderness is in the maintenance zone. There are a few small areas where the recommended wilderness overlap with defense zones (for example, Big Creek area near Huntington Lake in the Sierra National Forest, near Calkin Flats and Fairview in the Sequoia National Forest). If fires occur in those areas, protection objectives will trump wilderness objectives.

Support Fire-adapted Communities

Managing Uncertainty: Uncertainty related to this indicator in alternative C is similar to alternative A but is dependent on location. In the wildland-urban intermix defense zone, the effects are very similar. For example, because the largest zone in this alternative (GFZ) was delineated by default (not based on risk assessment or proximity), uncertainty is higher in this zone than under alternative A. However, because this alternative has the wildfire maintenance zone, which is delineated by quantitative risk assessment, uncertainty in this zone is lower in the more remote areas than under alternative A.

Facilitating Wildland Fire Management: Fire managers would continue to assist communities to become more fire adapted through continued collaborative efforts such as community wildfire protection plans and fuel reduction treatments. Fuel reduction treatments would be similar to alternative A, and primarily occur only in the defense zone. But since treatments would be restricted to removal of smaller diameter trees, these treatments would be less effective than under alternative A. Prescribed fire would be the primary tool, but with less pretreatment, and these operations would be more costly because the complexity of planning and implementation are greater than those in alternative A.

The opportunity to manage wildfires to meet resource objectives exists in all zones in this alternative but is not likely to be used in the wildland-urban intermix defense zone. Even though this alternative emphasizes using fire to meet resource objectives more than alternative A, unless more severe fire effects are acceptable, the likelihood to manage wildfires for resource objectives in the GFZ enough to make much progress toward desired conditions is low.

Improve Safe and Effective Fire Response

Managing Uncertainty: Under alternative C, risk to communities is expressed by the wildland-urban intermix defense zone. Similar to alternative B, the wildfire maintenance zone reduces the uncertainties of where potential resource benefits can be obtained by managing wildfire to meet resource objectives. However, in this alternative the GFZ was delineated without consideration of the spatial distribution of risks and benefits provided by the risk assessment. Figure 20 shows the potential risks and benefits to highly valued resources and assets for the three zones. The large area with red and orange in the GFZ in the figure demonstrates that there are mostly risks to resources and assets. However, there are also some benefits in the GFZ as indicated by blue and green in Figure 20. But since this zone was created by default, the spatial distribution of these risk and benefits is unknown, creating uncertainty. This large uncertainty in the GFZ makes it more difficult to make fire management decisions that consider safety to firefighters and the public in relation to risks to highly valued resources and assets.

Facilitating Wildland Fire Management: This alternative has the fewest areas where fuels are reduced mechanically prior to prescribed burnings. Fuel reduction treatments would be less effective than alternative A, because it would primarily remove small-diameter trees in the wildland-urban intermix defense zone. Due to habitat restrictions, efforts would generally avoid California spotted owl and fisher habitat. This alternative emphasizes using fire for restoration. Some strategic treatments along key roads and ridges may occur, but due to desire to minimize habitat impacts, treatments would be avoided where they are located near habitat. Where the strategic treatments do occur, this may facilitate more large prescribed burning than alternative A. With less pretreating of fuels in general, prescribed burns will be more difficult to implement. When using prescribed fire without pretreatment of fuels, burns must be conducted at the cooler end of prescription, and would likely require multiple burns, to conduct the burn safely and achieve objectives. In areas where prescribed burning has occurred, there would be greater opportunities to manage future wildfires than in alternative A. Where fuels are heavier or fuel reduction treatments are less effective, the primary response to wildfire ignitions would likely continue to favor suppression. Due to less emphasis on pretreatments combined with extensive areas of tree mortality, risks will be greater and opportunities for direct firefighter engagement will be greatly reduced, resulting in larger fires with higher severity effects. The opportunity to manage wildfires to meet resource objectives exists under this alternative in all strategic fire management zones. However, without acceptance of short-term impacts, the ability of this alternatives to provide strategic and tactical opportunities that are critical facilitators of safe and effective fire response will be limited and would likely not provide much advantage over alternative A.

Consequences Specific to Alternative D

Alternative D uses the same strategic fire management zones as described for alternative B (see Figure 19). This alternative also includes focus landscapes and community buffers, but does not have wildlife habitat management areas. Alternative D does not include any new recommended wilderness.

In this alternative, fuel reduction treatments would be concentrated mostly in the focus landscapes in the form of strategic fuel breaks, with more flexibility available to achieve intended outcomes. Further, fewer seasonal restrictions and survey requirements allow completion of treatments in fewer years. Only alternative D proposes treatment amounts consistent with the climate-fire analysis 60 percent treatment scenario (Westerling and Keyser 2016). This study indicated treatment amounts in line with alternative D would be required in order to start seeing reductions in area burned and high-severity proportions with the expected warming over the coming decades (see "Agents of Change" for details). Because some short-term impact tradeoffs for mid- to long-term resilience are accepted, fuel reduction treatments would be more effective in focus landscapes. This will accelerate the ability to achieve desired conditions and resilience, and create more strategic features improved and used to facilitate large prescribed fires and managing wildfires to meet resource objectives. Community buffers immediately surrounding structures and community wildfire protection zones have few restrictions on treatments. Fuel reduction treatments would be applied in all strategic fire management zones. Because there will be more merchantable products from thinning, there would be fewer funding and resource limitations than any other alternative. Managing wildfire to meet resource objectives is highly encouraged in the wildfire maintenance and restoration zones and somewhat limited in the community wildfire protection and general wildfire protection zones.

The impacts from wild and scenic river management would be the same as those described under alternative B.

Restore and Maintain Landscapes Through the Use of Wildfire

Managing Uncertainty: In alternative D, the management uncertainty would be much improved over alternative A. Eventually, due to more areas of treatments, and more effective outcomes in terms of fuel reduction rate of movement toward resilient conditions, uncertainty of alternative D related to this indicator would be lowest of the alternatives.

Facilitating Wildland Fire Management: Strategic treatments along ridgetops, roads, and other natural and human-made features would be greatest in this alternative. Further, greater flexibility to create and improve strategic features facilitates fire management activities in the large-scale focus landscapes. This would provide much greater facilitation of wildland fire management over alternative A. As with alternative B, fire management zones were delineated based on the risk assessment results. The increase in fuel reduction treatments goes further to restoring vegetation, with more strategic areas treated that can be used to control or contain fires. Thus, the potential for wildfires managed to meet resource objectives increases in all zones. Alternative D has best chance to treat a large enough portion of the landscape to increase likelihood of reducing fire behavior in untreated portions of landscape next to treated areas (Finney effect). All of these restoration activities would reduce fuels and potential smoke emissions, compared with large, undesirable wildfires. These factors make this alternative superior to alternative A in its ability to support large landscape prescribed burns, facilitate opportunities to manage wildfires to meet resource objectives, and create conditions most resilient to current and future stressors. Lastly, but perhaps most importantly, alternative D would have the greatest likelihood of restoring desired vegetation conditions and historic fire regimes that lead to expanding the area of the wildfire maintenance zone. This indicates more area meeting the desired condition, essentially the real goal of the strategy.

Support Fire-adapted Communities

Managing Uncertainty: Uncertainty in alternative D is lower over the long term than under all other alternatives. Since this alternative maximizes fuels reduction and restoration efforts, over time, uncertainty would decrease to levels far lower than those in alternative A.

Facilitating Wildland Fire Management: There would be more fuel reduction treatment opportunities in this alternative than in alternative A. Fire managers would continue to assist communities to become more fire adapted through continued collaborative efforts such as community wildfire protection plans and fuel reduction treatments. An increase in the amount of fuel reduction under this alternative includes more mechanical treatment and prescribed burning in the two wildfire protection zones than in the combined zones of alternative A. Fuel reduction and restoration treatments in the wildfire restoration zone would further reduce the risk of large high-intensity wildfires starting further away on the national forests that may threaten communities. This may also improve conditions that lead to increasing the maintenance zone, further facilitating wildfire management to meet resource objectives.

Improve Safe and Effective Fire Response

Managing Uncertainty: The creation of the four strategic fire management zones in alternative D greatly reduce uncertainty for fire management decisions compared with alternative A. Fires would be managed on a continuum between meeting protection objectives and resource objectives in these zones, while using risk-based responses. Fire managers would come into an incident with a higher level of initial situational awareness than in alternative A. This is because the distribution of risks and benefits are partitioned into the risk-based zones and better understood prior to the fire even occurring. This alternative would reduce fuels on more of the landscape, which would reduce risks over time and tend to shift areas toward less risk in future risk assessments.

Facilitating Wildland Fire Management: In this alternative, the system of strategic fuel breaks throughout the focus landscapes would be more widespread, and due to fewer constraints, more effective than in alternative A. The increased amount of fuel reduction includes more mechanical treatment and prescribed burning in the two wildfire protection zones. Fuel reduction in the wildfire restoration zone would further reduce the risk of large high-intensity wildfires starting further away on the national forests that may threaten communities. The greater amount and effectiveness of fuel treatments combined with well-distributed treatments offers more strategic opportunities to facilitate fire management. Further, with implementation of this alternative over time, the improving condition of the landscape would increase the ability to address this indicator.

Use of wildfire to meet resource objectives would likely be limited initially in the wildfire protection zones, more fuel reductions treatment would lower the risk over time and increase the potential to reduce fire suppression costs by managing at least portions of wildfires to meet resource objectives.

Consequences Specific to Alternative E

In relation to wildfire management, alternative E exhibits substantially the same fire management consequences as those of alternative C for the indicators, and in relation to the other alternatives. alternative E differs from alternative C in the amount of recommended wilderness versus back country management area. Recommended wilderness would be managed similar to designated wilderness. There is less recommended wilderness in alternative E than alternative C, and therefore fewer restrictions for fire management decisions requiring special approvals that apply to wilderness. Thus, alternative E would have more fire suppression options available without special permissions than alternative C. Since the majority of designated and recommended wilderness areas as well as backcountry management area are located in the wildfire maintenance zone, wildfire is expected to have mostly beneficial effects. So, the need for mechanized equipment will be lower than in the GFZ and around communities. For these reasons the consequence as measured by the indicators will rate alternative E only very slightly better than alternative C for the facilitation measure of the safe and effective fire management response indicator.

The impacts from wild and scenic river management would be the same as those described under alternative B.

Cumulative Effects

Cumulative effects identified here are expected to occur within the next 15 to 20 years and cover the areas of the southern Sierra Nevada, including the Sierra and Sequoia National Forests, as well as the surrounding National Parks (Yosemite to the north, and Sequoia-Kings Canyon between the two national forests). There are cumulative effects from the management of wildland fire by adjacent landowners. These include the National Park Service, managing Sequoia, Kings Canyon, and Yosemite National Parks, the BLM, and State fire agencies. There are also large areas of private land next to and in the plan area. The National Park Service emphasizes fire restoration and has cooperated with the Forest Service numerous times on management of wildfires to meet resource objectives in the southern Sierra Nevada (Meyer et al. 2015).

The cumulative effect has been that on adjacent National Park Service lands there is a high level of restoration that has been accomplished in the last 15 years, greatly reducing the probability of large, high-intensity fires in this area. The BLM manages fires similarly to the Forest Service although with more of an emphasis on fire suppression. Consequently, there has been little wildfire managed to meet resource objectives on National Forest System lands near BLM lands.

Several foreseeable future actions could influence fire trends in the southern Sierra Nevada including a proposed forestwide prescribed burn project that focuses on restoring historic fire regimes, minimizing the potential for uncharacteristic wildfires (including reducing wildfire risk to public and firefighter safety). This action would increase the ability to facilitate wildland fire management under all alternatives. Yosemite National Park proposed an amendment to its 2004 Fire Management Plan to align it with current Federal wildland fire policy (National Wildfire Coordinating Group 2009). The status is currently in progress, with finalization to be determined. This will potentially expand the area available to manage wildfires as an ecological process in wilderness areas in the park. The associated cumulative effects of increasing the amount of management of wildfires to meet resource objectives would be positive, as ecological conditions would improve. In terms of the indicator and measures, the combined benefits of the park's efforts and increased use of managed wildfire for resource objectives of the action alternatives on the national forests would lead to better ecological outcomes than alternative A. Alternative D would have the greatest results compared with alternative A, followed by alternative B, then alternative C. As more fires are managed for resource benefits, short-term impacts are likely, especially related to smoke.

Analytical Conclusions

Each alternative was evaluated in its ability to address the indicators, as described in the conclusions below. Consideration of current trends and ecological conditions given climate change, fire activity, and recent massive tree mortality weigh significantly in the final evaluations.

All of the action alternatives to some degree used fire management zones informed by a quantitative risk assessment. Alternative A carries forward the fire management zones that were designed without the benefit of a quantitative risk assessment. Another shortcoming of alternative

A is lack of detailed and ecologically based plan components that describe desired outcomes and provide flexibility for fire managers to make risk-based decisions when managing wildfires. For alternative A, these factors greatly limit the restoration and maintenance of landscapes through managing wildfire to meet resource objectives when compared with the action alternatives. Alternative A relies heavily on ignition risk assessments and local knowledge after the fire has started to manage wildfire to meet resource objectives. While initial assessments and local knowledge are very important, having as much information ahead of time as possible greatly enhances situational awareness and makes on-the-spot decisions much more safe and reliable.

Alternative A does have fewer fuel treatment constraints in new eligible wild and scenic river corridors classified as “wild.” However, projects can be authorized in the areas if they are deemed necessary and do not compromise the associated characteristics. Overall advantages of this alternative over the action alternatives related to fire and fuels management in these corridors would be minimal.

The strategic fire management zones developed for alternatives B and D during the wildfire risk assessment process identify areas of risk more accurately than the wildland-urban intermix in alternative A. By using the spatial wildfire risk assessment, alternatives B and D identify areas on the landscape where strategic fuels and vegetation treatment would facilitate safe, efficient, and cost-effective wildfire management. These alternatives also identify where fire may play a beneficial role and can be managed to meet resource objectives.

By using zones based on buffered distances rather than fire modeling, alternatives A, C, and E do not account for the likelihood of fires to spread into the wildland-urban intermix from adjacent areas. Such fires contribute to the risk to communities or infrastructure. Outside of the wildland-urban intermix defense and threat zones in alternative A, there is little specific direction that is encompassed by a risk management-based approach to wildfires. In alternatives C and E, a risk management-based approach is applied in the wildfire maintenance zone. But fuel reduction treatments implemented along strategic fire management features such as along ridgetops, roads, or other natural or human-made features would be fewer and less effective due to more constraints to avoid short-term impacts. These features are prioritized in alternatives B and D, facilitating safe implementation of cost-effective and larger prescribed fires, and provide more opportunities to manage wildfires to meet resource objectives.

Forest and fire managers would continue to work with communities and stakeholders to support fire-adapted communities under all alternatives. For implementing treatments on Federal lands, alternatives A, C, and E have more restrictions on implementing fuels reduction treatments that could adversely impact the effectiveness at supporting fire-adapted communities. Alternative D followed by alternative B would fare far better at addressing this indicator.

In alternatives B, D, and somewhat under alternatives C and E, the risk-based zones provide better information that reduces uncertainties compared with alternative A. The reduced uncertainty allows forest and fire managers to have more latitude to proactively plan and restore the landscape effectively by managing wildfire to meet resource objectives, and using prescribed fire. This is due to the awareness of the potential positive and negative impacts on the values and assets, thereby reducing risk. Alternatives C and E emphasize the use of prescribed fire while limiting mechanical treatment to small-diameter trees primarily in the defense zone. Thus, these alternatives rely heavily on factors outside manager control, producing great uncertainty.

Alternatives B and D explicitly apply risk management across the entire plan area, which provides the most efficient and effective way to prioritize fuel reduction treatments around communities and other values at risk. These alternatives also have the greatest amount of restoration, and provide the greatest flexibility to create effective treatments, which reduces current and future risk and increases resilience. They also effectively prioritize ecological restoration to increase the potential to safely manage wildfires to reduce fuels and benefit resources across the landscape. The greater amount of ecological restoration, and the enhancement of strategic fire management features, would provide the greatest likelihood of implementing large prescribed fires or managing wildfires to meet resource objectives. These increased treatment efforts and increased use of prescribed fire and managed wildfire for resource objectives are crucial components to sustaining forests and building resilience (Stephens et al. 2018). These conditions will provide a safer work environment for firefighters, lower the likelihood for wildfires that escape control, and allow a greater window of opportunity to manage wildfire. Over time, alternative D would meet desired conditions sooner, and over more area, than alternative B.

In order to evaluate and compare effects, damages and benefits to highly valued resources and assets were quantified based on the risk assessment. The locations of the resources and assets, and how wildfire is expected to affect them, were quantified. This information provided estimates of the percentage of net damages and benefits by zone for each alternative. Below are comparisons of the results for locations of impacted assets and resources (Figure 21), and the source zone from which the wildfires originate (Figure 22) for all the alternatives. In Figure 21, the horizontal bar charts on the right show the percentage of the total expected damage and total expected benefits to assets and resources associated with each zone. Note that the total expected damages and benefits are independent. For instance, alternatives B and D have 31 percent damages and 31 percent benefits in the restoration zone. However, this represents 31 percent of the total damages or benefits, and does not translate to the Restoration Zone having the same number of acres of damages and benefits, but rather, the proportion of the total damages or benefits of alternatives B and D. The pie charts on the left represent the combined percentage of the forests that reside in the different strategic fire management zones. Thus, to interpret alternative A, the pie chart on the left shows 3 percent wildland-urban intermix defense zone, 21 percent wildland-urban intermix threat zone, and 76 percent non-wildland-urban intermix. Then on the right, the bar chart shows 12 percent of the wildland-urban intermix defense zone as susceptible to damages, and 5 percent expecting benefits. A fire zone with higher values on the left side of vertical line (damage) leads to more focus on protection objectives. Those with higher values on the right side of the vertical line (benefit) indicate more opportunities to manage wildfires for resource objectives.

Another point from Figure 21 relates to an important feature of the quantitative risk assessment; that the landscape was partitioned into land allocations with similar risk profiles. For example, the community protection zone (Figure 21, alternatives B and D) identified areas with high damage to benefit ratios. Conversely, the wildfire maintenance zone is dominated by high benefit to damage ratios. Having the landscape partitioned this way greatly reduces uncertainty, and assists with wildfire management decisions. The General Fire Protection and Restoration Zones are more mixed, but the former leans toward more protection objectives and the latter toward more opportunities for managing wildfires to meet resource objectives. However, there are large decision-making advantages to having the Community Wildfire Protection and Maintenance Zones occupying two distinct extremes. If you contrast this with a more arbitrarily delineated zones that have a mix of damage and benefits (“other” in alternative A, and the GFZ in alternatives C, and E), when a wildfire occurs, it complicates fire management decisions.

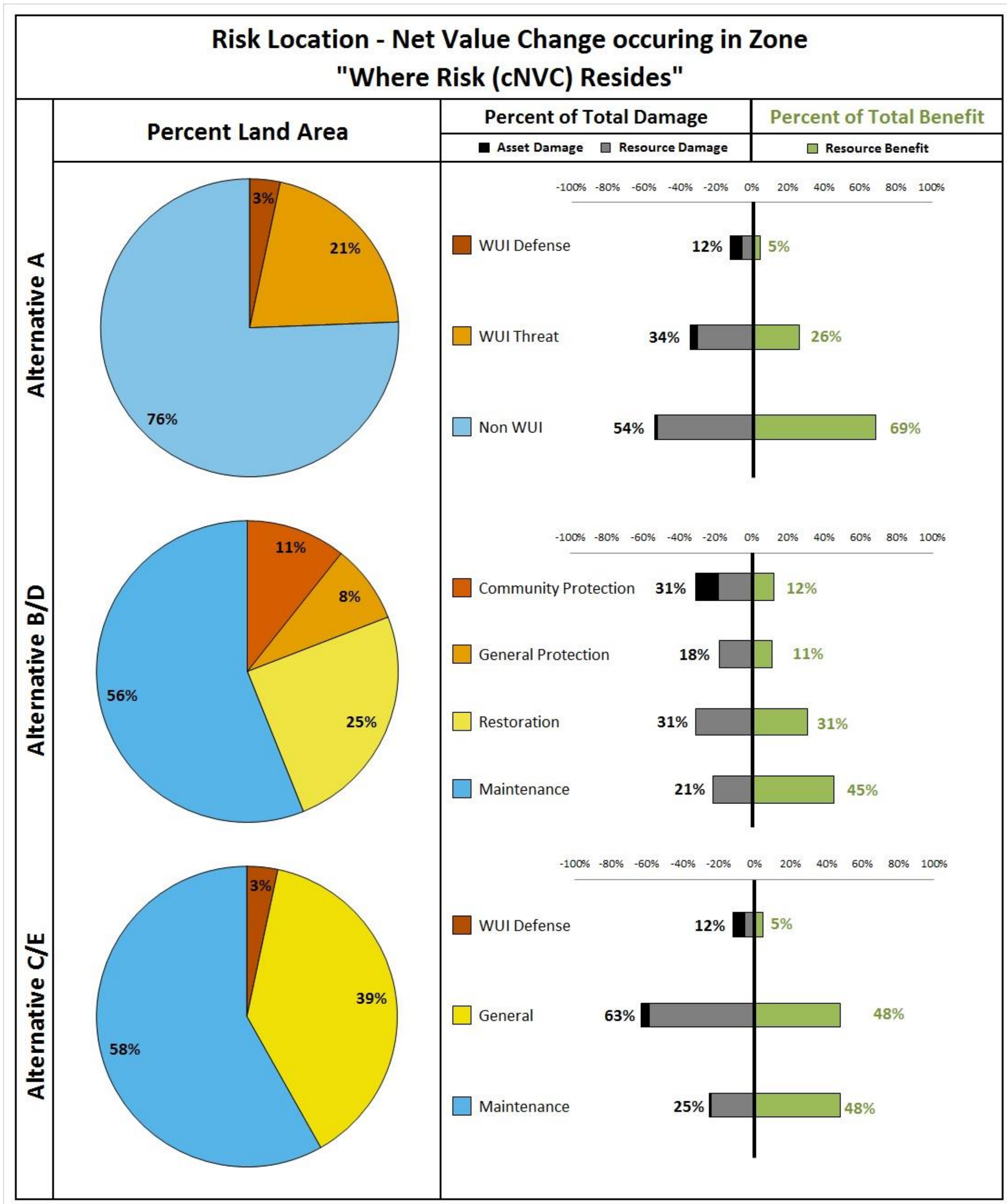

Figure 21. Risk location by alternative or comparison of the magnitude of net value change by strategic fire management zone.

For example, for alternative A, the pie chart on the top left shows the plan area is partitioned as 3% WUI defense zone, 21% WUI threat zone, and 76% Other. Then on the right, the bar chart shows 12% of the WUI Defense Zone is susceptible to negative wildfire impacts. The black portion of that bar indicates damage to assets, with the small gray portion indicating resource damage. On the right side of the vertical line, the green bar indicates 5% of the WUI may expect benefits from wildfires.

WUI = wildland-urban intermix

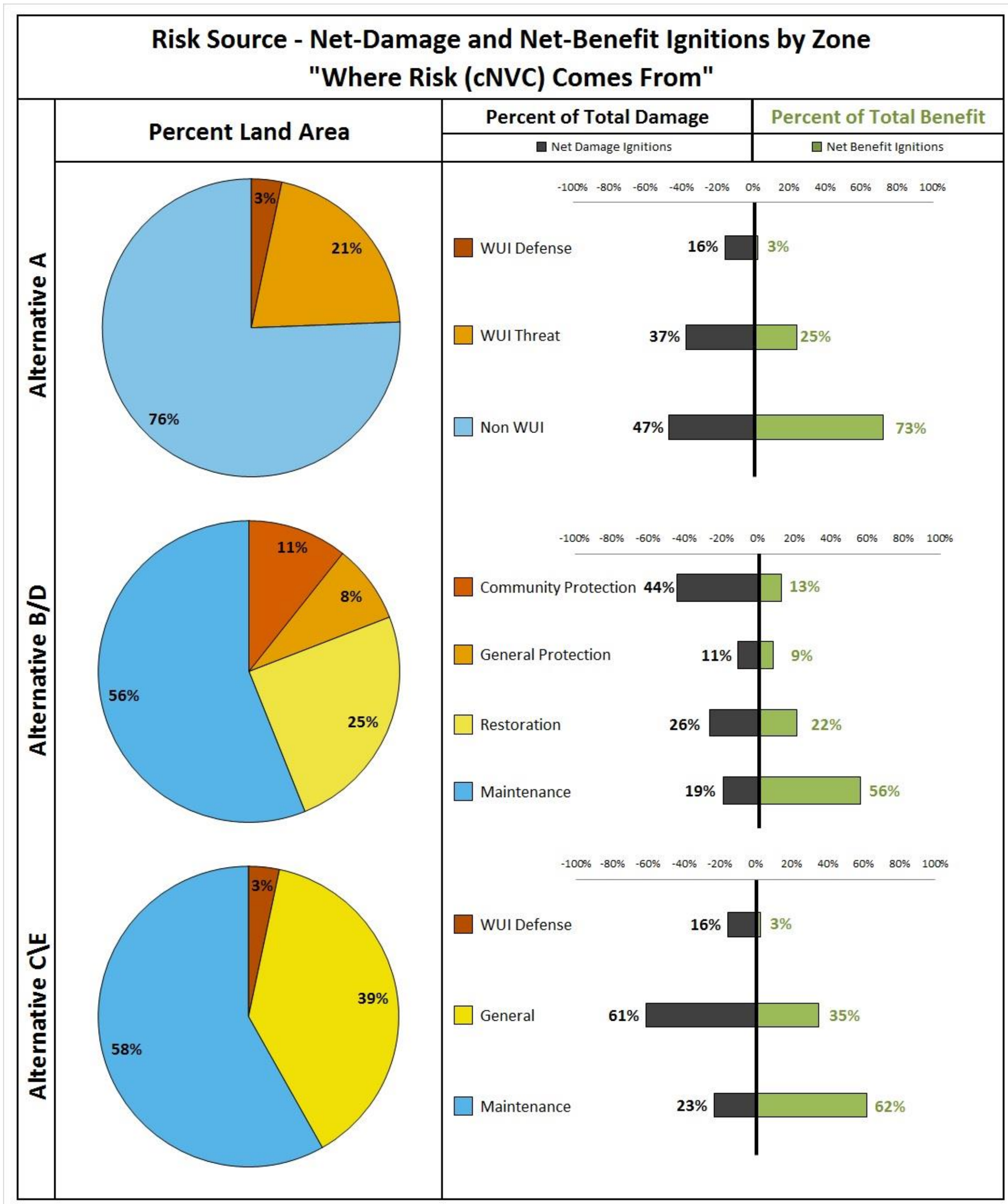

Figure 22. Risk source by alternative or comparison of the magnitude of net value change by strategic fire management zone.

The proportions in the pie charts are the same as Figure 21. To interpret the bar charts on the right, fires that start in the Community Wildfire Protection Zone in alternative B cause much more damage (44%) than benefits (13%). However, fires that start in the Maintenance Zone are much more likely to cause benefits (56%), compared with damage (19%). These represent the zones where the fires start, not the zone in which the effects occur.

WUI = wildland-urban intermix

Figure 22 shows potential damage and benefits to assets and resources based on the fire zone where the modeled wildfire originates (source). Any strategic fire management zone with nearly equal potential for damage and benefits has a high level of uncertainty and adds little information for forest and fire managers in their wildfire management decisions. Conversely, zones that have a large proportion on one side or the other help manage uncertainty and aid in management decisions. A graph that has a larger proportion on the damage side leads to managing for protection objectives, while those that have a larger proportion on the benefit side indicates many likely opportunities to manage wildfires for resource objectives. Since these graphs capture impacts from the source, most zones show both resource and assets affected because wildfires start in those zones and move into adjacent zones where resource and assets exist. However, alternatives B and D are more effective in categorizing risk and can aid in managing uncertainty because the majority of the asset damage is in the protection zones.

Lastly, in order to compare the alternatives, they were ranked by how well the alternatives addressed the indicators (Table 11). Simple numerical ratings were given based on how well they managed uncertainty and facilitated wildfire management. A lower numerical ranking indicates an alternative would be more effective in addressing the indicators and measures.

Table 11. Comparative ranking of alternatives by fire management indicators and measures.

Alternative	Measures	Managing uncertainty	Facilitating fire management	Total
A	Restore and maintain landscapes	4	3	7
A	Fire-adapted communities	3	3	6
A	Wildfire response	3	3	6
B	Restore and maintain landscapes	1	2	3
B	Fire-adapted communities	1	2	3
B	Wildfire response	1	2	3
C	Restore and maintain landscapes	3	4	7
C	Fire-adapted communities	4	4	8
C	Wildfire response	4	4	8
D	Restore and maintain landscapes	1	1	2
D	Fire-adapted communities	1	1	2
D	Wildfire response	1	1	2
E	Restore and maintain landscapes	3	4	7
E	Fire-adapted communities	4	4	8
E	Wildfire response	4	3	7

Lower numbers equate to higher ranking in an alternative's ability to address indicators and measures (1 = low uncertainty/high fire management facilitation, 5 = high uncertainty/low fire management facilitation)

Air Quality

Background

Air quality is important to human health, forest visitor experience, vegetation health, soil quality, water quality, and visibility. Both external and internal sources of air pollution can affect forest air quality. Ozone and nitrogen oxides are examples of common pollutants transported from urban areas and are significant agents of change in the southern Sierra Nevada forests. Management direction in the forest plans can affect air quality in the plan area by allowing prescribed burning or managing wildfires to meet resource objectives and resulting smoke production.

The emphasis in this section is on smoke from prescribed burning and wildfire managed to meet resource objectives. These management actions contribute to air pollution on National Forest System lands but can also influence short- and long-term smoke emissions from unplanned wildfires. The overwhelming source of other air pollutants is from lands next to the national forests, especially in the San Joaquin Valley. For more details on other air pollutants see the Science Synthesis (Bytnerowicz et al. 2014) and the bioregional and forest assessments (United States Department of Agriculture 2013b, d, c).

Air quality is regulated at three levels: Federal, State, and local air pollution control districts. Federal agencies, such as the Forest Service, must meet all regulations put forth at each level. The two national forests fall in three air pollution control districts: San Joaquin Valley Unified, Eastern Kern, and Mariposa County Air Pollution Control Districts (Figure 23).

The Clean Air Act establishes air quality standards. The standards include regulating emissions such as ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. Smoke is one of the sources of particulate matter. Dust is also a type of particulate matter. Although most of these air pollutants originate outside of the national forests, some of them (in particular, ozone) can have a negative impact on forest health. Trees and other plants can become less healthy and even die from high ozone exposure. Management on national forests cannot control ozone levels, but management of forests, in particular reducing forest density, can make forests more resilient to ozone damage (Bytnerowicz et al. 2014). See “Terrestrial Ecosystems” for more information on forest responses to ozone.

Air quality on National Forest System lands is regulated in a few ways. All lands are designated as in “attainment” or “nonattainment” based on whether they meet the standards or not. If there is insufficient data, areas can be designated as “unclassified.” When an area’s air quality exceeds the regulatory guidelines it is designated as “nonattainment.” These statuses are designated at the Federal level by the U.S. Environmental Protection Agency (EPA), and additional requirements are designated at the state level by the California Air Resources Board. The status of each area is reevaluated periodically, and the current status is described under “Affected Environment,” below. The Forest Service is also required by the Regional Haze Rule of 1999 to monitor air quality in class I airsheds (wilderness areas). The goal of this law is to return haze levels to natural background conditions by the year 2064.

Analysis and Methods

This analysis examines the potential air quality impacts from implementation of the proposed forest plan and the alternatives. The proposed action is programmatic covering the broad pattern of potential projects and wildfires that can influence air quality. Project-level emissions analysis will take place prior to implementation.

The assessment of air quality impacts is both quantitative and qualitative. The primary approach compares the tradeoffs between potential smoke emissions from the restoration treatments that reduce the potential wildfire emissions and the wildfire emissions that would occur without the restoration. For more detail on the emissions analysis see the fire-climate supplemental report and the smoke and air quality supplemental report. Forest carbon storage and effects are discussed in the carbon stability supplemental report. This section focuses on regulated air pollutants.

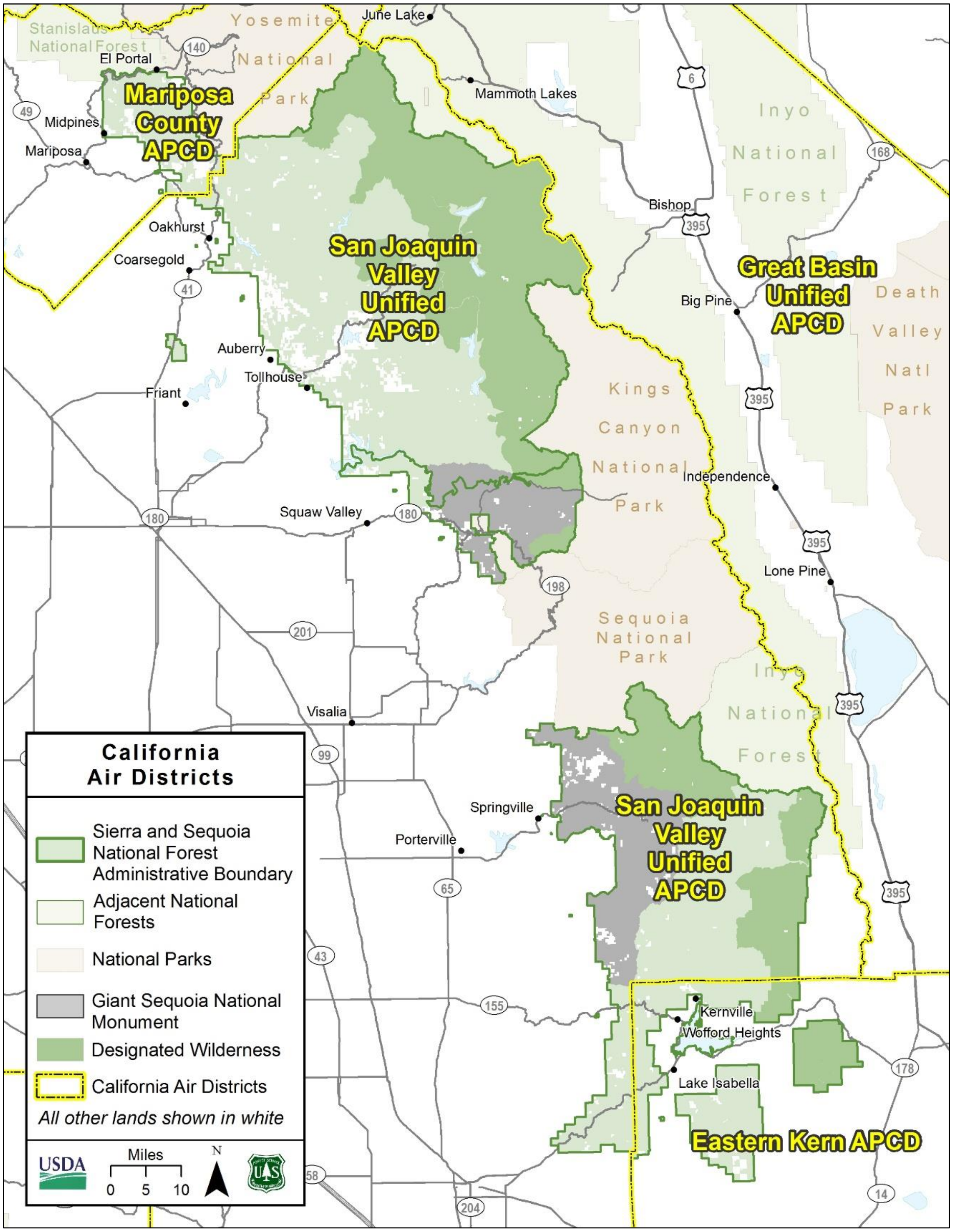

Figure 23. Map of air management districts in California

Assumptions

There are many uncertainties about when or where wildfires occur and what potential other sources of smoke may be and how great the emissions. Several assumptions were made for this analysis, mostly to address these uncertainties.

- It is unknown exactly, when, where, or how much wildfire will occur, but the trend of increasing large wildfires and associated high smoke emissions is expected to continue (Hurteau et al. 2014). In addition, research indicates that the amount of wildfire emissions are widely underestimated (Liu et al. 2017).
- The amount of emissions released by combustion of vegetation will vary depending on the amount of vegetation present and the completeness of combustion. For example, combustion of a stand of Douglas-fir produces more emissions than a sparsely vegetated acre of pinyon-juniper with identical combustion efficiency. Thus, vegetation type is an important factor in quantifying emissions. See the smoke and air quality supplemental report for assumptions of vegetation types under each alternative and corresponding emissions factors.
- Restoration actions that follow the proposed plan and alternatives would result in reduced emissions from wildfires that burn across those areas (Hurteau and North 2009) (Hurteau and North 2010) (Tarnay and Lutz 2011) (Vaillant et al. 2013). Restoration treatments would "offset" future large wildfire emissions. The amount of the reduction depends on the type and intensity of treatments. See below for a summary of the research on the amount of emissions reductions with forest thinning, biomass removal, mastication, and prescribed fire.
- Effects analysis reflects a best assumption on the treatment levels feasibly conducted by the agency under each alternative. Emissions could be higher if more restoration is completed with support and collaboration with partners. While collaboration may increase emissions, all treatment emissions would be less than the emissions from catastrophic wildfires.
- Smoke management would be practiced actively with all prescribed fire and wildfires managed to meet resource objectives. This would include smoke prediction modeling, smoke monitoring, and close coordination with the local air districts.

Mechanical Thinning, Biomass Removal, and Mastication

Mechanical treatments include thinning trees, removing biomass (smaller trees, shrubs, or larger tree branches), and mastication (where small trees and shrubs are shredded or crushed). Thinning can result in substantially lower emissions during large wildfires (Hurteau and North 2009) and local examples indicate by as much as 90 percent or more (Hurteau et al. 2008). During large wildfires woody biomass burns, resulting in a release of carbon and smoke. Thinning will occur in each alternative to varying degrees where practical. Machinery use would generate emissions; however, these would be minimal at the plan area level. Project-level analysis will address emissions from machinery.

Smoke from Prescribed Fires and Wildfires Managed to Meet Resource Objectives

All fires produce smoke emissions. The amount of smoke emitted and the area it impacts varies with the size of the fire, type of fire, vegetation density, and location. Smoke management is a key aspect of prescribed fires and wildfires managed to meet resource objectives. Prescribed fire activities generally occur under favorable atmospheric conditions for smoke dispersion to limit human health impacts. Wildfires managed to meet resource objectives offer long-term benefits by reducing future wildfire emissions. Research indicates that prescribed burning results in an 18 to 25 percent reduction in wildfire emissions, with examples as high as 60 percent (Wiedinmyer and Hurteau 2010). Long-term reductions in emissions from implementation of these activities were modeled by (Hurteau et al. 2014). In addition, smoke emissions from wildfires managed to meet resource objectives can be more than five times lower per burned unit area than emissions resulting from large and catastrophic wildfire events, such as the 2013 Rim Fire (Long et al. 2017b). The degree to which emissions are reduced depends on the amount of restoration that occurs.

Smoke from Wildfires

In general, large wildfires produce 100 to 1,000 tons of fine particles in smoke per day, moderately sized fires produce 10 to 100 tons, and small fires produce less than 10 tons per day (Tarnay and Lutz 2011). Emissions from wildfires are generally much larger than prescribed fire (Vaillant et al. 2013). Larger fires have regional impacts, whereas smaller fires have local impacts. Restoration treatments such as mechanical thinning, prescribed fire, and wildfires managed to meet resource objectives can reduce long-term wildfire emissions. Research indicates that smoke emissions from large fires will double during the next half century due to trends in vegetation conditions, climate, and fire ignitions (Hurteau et al. 2014). Increasing smoke emissions identified by Hurteau et al. (2014) is a baseline in this analysis.

Indicators and Measures

Three indicators describe the indirect and cumulative effects of each alternative to air quality. A short-term (present to fifteen years) or long-term (fifteen years to mid-century) category describes the timeline of effects on each indicator. The selected indicators consist of smoke effects from alternative implementation on air quality, recreation, and visibility. The following section presents each indicator and measure used in further detail.

Smoke Effects on Air Quality

The potential effect of smoke on air quality indicators was measured quantitatively. Emissions produced by alternative A serves as a baseline to compare emissions produced by actions under alternatives B, C, D, and E. The pollutants analyzed are the criteria pollutants of total organic gases (TOG), reactive organic gases (ROG), carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM), particulate matter less than 10 micrometers (PM_{10}), and particulate matter less than 2.5 micrometers ($PM_{2.5}$). Long-term, indirect, and cumulative effects from implementation is analyzed using modeled future emissions from Hurteau et al. 2014. This indicator is comprised of two categories of emissions: wildfires and restoration treatments. Restoration treatments include the following activities: mechanical treatments, prescribed fire, and managing wildfire to meet resource objectives.

Smoke Effects on Recreation

This indicator will be measured qualitatively. Smoke obscures visibility and impacts recreation through visitor avoidance of smoke-impacted areas. Modeling information (Hurteau et al. 2014) is used to analyze long-term, indirect, and cumulative effects from implementation.

Smoke Effects on Visibility in Class I Airsheds (Wilderness)

The Forest Service, along with other agencies, monitors class I wilderness areas through the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. There are three sites in the southern Sierra Nevada in the Kaiser Wilderness, Hoover Wilderness, and Dome Lands Wilderness. This monitoring network measures pollutant concentration as well as visibility, a measurement of how clearly distant objects can be seen. Indirect and cumulative effects are qualitatively assessed. Long-term modeled impacts (Hurteau et al. 2014) were are, compared with current trends.

Affected Environment

The Central Valley of California with the surrounding mountain ranges acts as a basin trapping pollution in the valley. The Sierra and Sequoia National Forests form part of the eastern boundary of the Central Valley bowl and overall have moderate to poor air quality (Bytnerowicz et al. 2014). The Sierra and Sequoia National Forests exceed State and Federal ozone standards, and are therefore in nonattainment status. Ecosystem impacts from air pollution have been identified as a threat to ecological integrity in the analysis area. Examples of impacts include: ozone damage, excessive nutrient nitrogen, and pesticide drift. High concentrations of ozone harm forest health, making trees more susceptible to drought, insects, and pathogens. For more details on other air pollutants see the Science Synthesis (Long et al. 2013) and the bioregional and forest assessments (United States Department of Agriculture 2013b, c, d).

Overall air quality in the region is largely outside of the control of the Forest Service except for smoke management for activities on National Forest System lands. Smoke management opportunities are limited during large wildfires. There has been a trend in increased large wildfires and associated heavy smoke emissions. The level of smoke emissions from large wildfires is expected to double over the next fifty years, given current vegetation conditions and trends in climate and fire ignitions (Hurteau et al. 2014). The current pace and scale of restoration in the last decade has been too limited to reverse current trends of increasing emissions catastrophic fire (see "Fire Management"). Multiple wildfires managed to meet resource objectives have occurred in the eastern portion of the Sequoia National Forest in the Kern River drainage.

Environmental Consequences to Air Quality

Consequences Common to all Alternatives

The alternatives each vary in the amount of treatments analyzed. Current conditions under alternative A are used as a baseline to analyze impacts on the indicators and measures of air quality, recreation, and visibility. In addition, information gathered during the forest plan assessment phase is used in the analysis.

In the fire-climate study conducted for the southern Sierra Nevada, reductions in projected wildfire emissions from different levels of restoration were analyzed (see "Fire Trends" on page 69). Figure 24 shows the reductions in projected wildfire smoke emissions with four different restoration scenarios. This graph was based on a climate projection called the GFDL (Geophysical Fluid Dynamics Laboratory) A2 climate scenario and it assumed that the fires burn with high severity and high emissions. Figure 24 shows that with climate projections, smoke emissions are predicted to double from the model's point of reference level from 1961 to 1990. The first bar represents the current trend and is labeled "Baseline." The second bar represents current management activities projected to the mid-century, resulting in large increases in emissions from wildfires. The remaining bars indicate future wildfire emission reduction

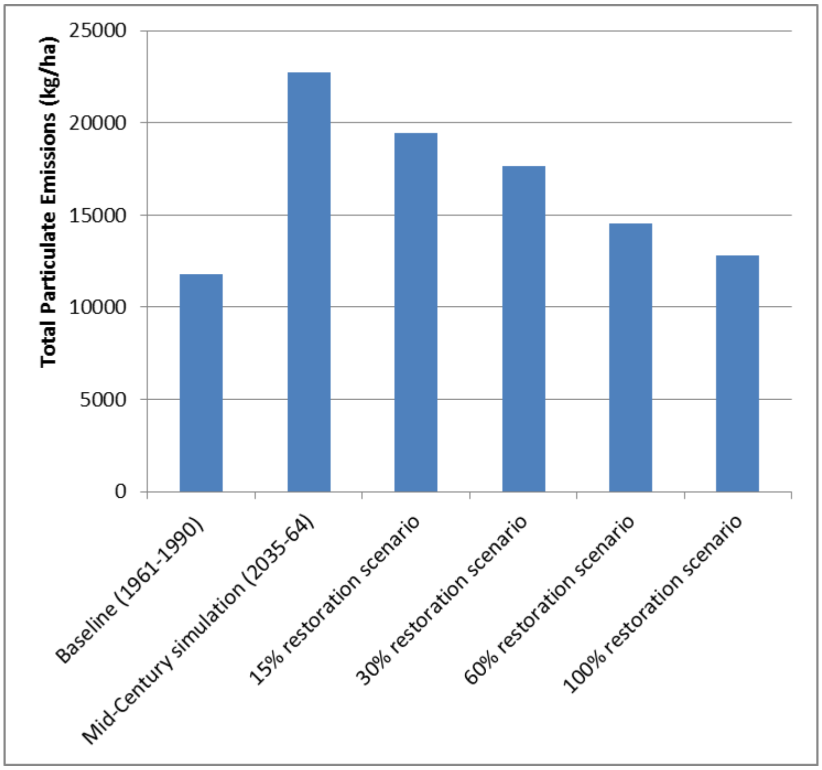

Figure 24. Graph displaying modeling results of particulate matter emissions from wildfires
(Data was modeled by (Hurteau et al. 2014)

comparing total particulate emissions measured in kilograms per hectare (kg/ha) from different treatment levels. The same relationships were applied to the indirect and cumulative effects of each alternative.

In general, alternative A is represented by the historic scenario, with restoration rates remaining the same at 5 to 10 percent of the landscape. Alternative B is represented by the range of conditions between the 15 and 30 percent restoration scenarios. Alternative C is represented by the range of conditions between the historic and 15 percent restoration scenarios. Alternative D is represented by the range of conditions between the 30 and 60 percent scenarios. Alternative E is similar to alternative C with respect to air quality effects.

Based on the fire-climate simulations, wildfire emissions would continue to increase and double from current conditions by mid-century with some limited exceptions (Hurteau et al. 2014). All alternatives would have beneficial reductions in potential wildfire smoke emissions where restoration treatments occur; however, the degree of long-term improvement depends on the level of restoration (Figure 24). Uncertainty of analysis exists when considering when, where, and how much of a large wildfire will overlap with restoration treatments. Potential long-term reduction in emissions from restoration was analyzed. For additional information see “Analysis and Methods.”

Consequences Specific to Alternative A

Under alternative A, there would continue to be limited restoration treatments (such as prescribed burning and mechanical treatments) that would reduce fuels and potentially reduce emissions during large wildfires. This alternative represents current management and resulting emissions. The primary impact from alternative A would be a continuation of current trends in large wildfires that produce large smoke emissions and nearby urban sources. The exception may be in the Kern River drainage in the Sequoia National Forest due to prior management actions that have restored fire to much of that area and where some wildfires are managed to meet resource objectives.

Smoke Effects on Air Quality

Under alternative A, there would be a continuation of current trends in large uncharacteristic wildfires that contribute to reduced sustainability of air quality (as modeled by (Hurteau et al. 2014). Because emissions from wildfires are largely uncontrollable and can be large in scale, they result in large air quality impacts. In addition, wildfires may occur during times of unfavorable atmospheric conditions resulting in a compounded air quality effect. Smoke from wildfires tends to be of higher intensity than prescribed fires and managers have little control to limit emissions. For example, typically high ozone concentrations are present during summer months and air quality effects would be compounded by the smoke from wildfire. Consequences include adverse effects on human health, particularly for residents of communities in that path of smoke events.

Alternative A would not contribute to altering current trends or improve the sustainability of air quality benefits to people. While alternative A is considered “no action,” emissions would be generated by continuing current management and indirectly through wildfires. See Table 12 for an estimate of annual emissions from alternative A. Under this alternative, emissions would be generated by continuing current management activities such as prescribed fire and limited wildfires managed to meet resource objectives. Alternative A shows emissions in tons per year and modeled mid-century emissions with no change in management from today. The annualized increase in emissions is primarily due to increased amounts of wildfire in this alternative at mid-century. This alternative serves as a baseline for comparison of each alternative. Emissions figures represent the most recent reported annual emissions (California Air Resources Board 2013). These two basins cover the vast majority of the emissions in the analysis area. Table 12 shows no data for most of the pollutants at mid-century because the study (Hurteau et al. 2014) only modeled particulate matter and not other pollutants.

There would be a moderate to substantial intensity of the associated short- and long-term effects on air quality across a large geographic area from alternative A, which is dependent on the degree to which increasing wildfire emissions takes place in the future. Air quality would continue to be impacted through increased wildfire emissions in the long term (mid-century). In the short term, treatments would cause a sporadic reduction (as treatments occur) of impacts on air quality from wildfires but would have pulses of impact associated with prescribed burning.

Table 12. Baseline annual emissions in tons per year under alternative A, compared with the modeled mid-century emissions with no change in management

Reference Period	Total Organic Gases	Carbon Monoxide	Nitrogen Oxides	Sulfur Oxides	Particulate Matter	Particulate Matter PM_{10}	Particulate Matter $PM_{2.5}$
San Joaquin Air Basin Baseline annual emission	662,658	290,650	99,390	3,504	191,297	101,506	26,499
Annualized increase in emissions at mid-century	No data	No data	No data	No data	45,283	No data	No data

PM_{10} and $PM_{2.5}$ refer to particulates that are 10 or 2.5 micrometers in size. Those are sizes used in standard measurements of particulate matter for compliance with air quality regulations.

Smoke Effects on Recreation

There would be no change in the current trends of those forest conditions that result in smoke due to wildfire effects, which reduce recreation visitation on the national forests. Such smoke events have potential adverse short- and long-term effects on local communities. There is also additional loss of benefits to the recreation users who must find other settings for their recreation activities. The substitute recreation site may offer less opportunities or lower quality of the experience. In addition, substitute sites may be located farther away than the preferred site, thus increasing costs of recreating.

There is an economic contribution provided by recreation to both local communities through visitation and to recreation users through the recreation experience that contributes to quality of life. Rural communities located along access routes to the national forests have a strong tie to the economic contributions that recreation visitors provide. This includes the spending that supports jobs and also contributions to local tax revenues through the sales tax and lodging tax collected. These local tax revenues support important public services that improve the quality of life in these communities. Alternative A does not contribute to altering current trends or improve the sustainability of these recreation benefits to people. Alternative A could result in increased wildfire and reduced recreation facility availability.

There would be a moderate to substantial intensity of smoke that would affect recreation across a large geographic area from the associated short- and long-term effects of implementing alternative A.

Smoke Effects on Visibility in Class I Airsheds (Wilderness)

In general, data from the three IMPROVE sites show that visibility is currently increasing in the plan area (see "Assessment"). However, modeling indicates that wildfire emissions will significantly increase by mid-century (Hurteau et al. 2014). Increasing emissions is expected to reduce visibility throughout the plan area.

Visibility in class I airsheds is regulated under the Regional Haze Rule and the Forest Service is responsible for meeting goals set-forth by the EPA. Implementation of alternative A would make attaining these goals unlikely as wildfires increase.

Impacts on visibility are expected to be low to moderate in the short term and would increase to high in the long term.

Consequences Specific to Alternative B

Alternative B would result in restoration treatments in up to 30 percent or more of many landscapes in the foothill, montane, and sagebrush/pinyon-juniper areas. In the fire-climate scenario, there would continue to be an increase in large fires and heavy smoke emissions but a little more than half of what could occur without any restoration. There would be more prescribed fire, mechanical thinning, and in some areas wildfires managed to meet resource objectives. All of these restoration activities would reduce potential emissions from large, undesirable wildfires. There would be increased smoke emissions from prescribed fires but levels of smoke would be substantially lower (45 percent less) than during wildfires and result in immediate postfire reductions in potential wildfire smoke emissions (Vaillant et al. 2013).

Smoke Effects on Air Quality

Alternative B would contribute to reducing current trends in large uncharacteristic wildfires that adversely affect the long-term sustainability of air quality. The prescribed burning in this alternative would have a potential short-term adverse effect on air quality, but these activities tend to be conducted under favorable atmospheric conditions and thus these effects can be mitigated to some extent. Wildfires managed to meet resource objectives similarly consider the impacts of smoke as management actions are taken, although there is less control than for prescribed fires. The mechanical thinning proposed in the alternative would reduce the quantity of smoke that would occur during prescribed fire activities and for wildfires managed to meet resource objectives by reducing the amount of fuels available to burn.

Air pollution resulting from agricultural and industrial activities is a concern for the national forests next to California's Central Valley. The Forest Service does not have direct control over this pollution but can contribute to air quality enhancement by limiting the smoke from wildfires that add to this pollution. In the long term, implementation of alternative B would indirectly improve air quality compared with alternative A by reducing the potential for large wildfires, and therefore reducing emissions. Alternative B contributes to altering current trends and improving the sustainability of air quality benefits to people. Under alternative B, emissions would be generated by increasing current prescribed fire and wildfires managed to meet resource objectives. Indirect emissions would occur from wildfires. Emissions estimates were conservatively modeled and report the highest amount of emissions possible. During actual implementation, emissions would be reduced from the reported amounts by pre-thinning vegetation. See Table 13 for a conservative estimate of emissions. Actual emissions and smoke impacts depend on additional factors such as seasonality of implementation, meteorology, and combustion efficiency. In the short term, alternative B would directly increase emissions. By mid-century, alternative B is projected to decrease emissions.

Table 13. Emissions from treatments under alternative B in tons per year, compared with air basin emissions

Pollutant	Carbon Monoxide	Nitrogen Oxides	Sulfur Oxides	Particulate Matter	Particulate Matter 10	Particulate Matter 2.5
Air Basin Baseline	290,650	99,390	3,504	191,297	101,507	26,499
Alternative A	12,079	68	62		1,122	952
Annualized % of increased emissions alternative B	4	0	2	0	1	3

There would be a moderate intensity of the associated short- and long-term effects on air quality across a large geographic area. Air quality would improve through wildfire emissions reduction in the long term (mid-century). In the short term, treatments would cause a sporadic reduction (as treatments occur) of impacts on air quality from wildfires but would have pulses of impact associated with prescribed burning and wildfires managed to meet resource objectives.

Smoke Effects on Recreation

Alternative B would contribute to reducing current trends in those forest conditions that result in smoke due to wildfire effects. Reductions in smoke events have potential beneficial short- and long-term effects on local communities due to reductions in interruptions to visitation. There is a corresponding potential for short-term reductions in air quality due to increases in prescribed burning. However, the net-effect of air quality on recreation visitation is expected to be mitigated to some extent given the level of mechanical thinning occurring before any prescribed burning occurs. In addition, mitigation measures would control when and where prescribed burning can occur to reduce smoke events and most prescribed burning occurs in the late fall through spring, outside of the peak recreation season. There is also additional benefit to the recreation users who are able to enjoy recreation activities in the national forests when wildfires would otherwise prevent visitor use.

As described under alternative A, there is an economic contribution provided by recreation to both local communities through visitation and to recreation users through the recreation experience that contributes to quality of life. Alternative B would contribute to a decrease of current trends of smoke to improve the sustainability of recreation benefits to people.

There would be a moderate to substantial intensity of smoke that would affect recreation across a large geographic area from the associated short- and long-term effects of implementing alternative B.

Smoke Effects on Visibility in Class I Airsheds (Wilderness)

Effects on the visibility in class I airsheds under alternative B represent a trade-off. In the short term, increased emissions would directly reduce visibility in the class I airsheds in the analysis areas. In the long term, treatments under alternative B would reduce emissions and thus indirectly improve visibility in class I airsheds by mid-century. In general, data from three IMPROVE sites show that visibility is currently increasing in the plan area (see “Assessment”). However, modeling indicates that wildfire emissions would significantly increase by mid-century (Hurteau et al. 2014). Increasing emissions is expected to reduce visibility throughout the plan area. Restoration treatments can improve visibility through the reduction of emissions in the long term. Less smoke would be produced in the analysis area under this alternative compared with alternative A due to mechanical thinning in stands outside of wilderness areas, as well as increasing restoration treatments such as wildfires managed to meet resource objectives.

Visibility in class I airsheds is regulated under the Regional Haze Rule and the Forest Service is responsible for meeting goals set-forth by the EPA. Implementation of alternative B would make attaining these goals less likely in the short term due to the increase of emissions from prescribed burning and wildfires managed to meet resource objectives. This effect would decrease after implementation is complete. In the long term, a more resilient landscape would increase the likelihood of attainment in class I airsheds by the mid-century.

In the short term, moderate to substantial intensity impacts resulting in decreases in visibility would occur in class I airsheds when implementation is occurring. In the long term, moderate to substantial intensity impacts resulting in improved visibility in class I airsheds would occur through reduced wildfire emissions.

Consequences Specific to Alternative C

Alternative C increases the amount of treatment compared with alternative A. This would result in short-term smoke emissions but potentially substantial reductions in large wildfire smoke emissions in areas where large prescribed burns occur. The prescribed fires are conducted under controlled conditions for smoke management and dispersal allowing the effects to be mitigated as opposed to wildfires. There is uncertainty about how much of the prescribed fire and wildfires managed to meet resource objectives would be implemented because there are more limitations on mechanical treatments. There would be less treatment of strategic areas along roads and ridgetops so there is less likelihood of treatments reducing current trends in large wildfires emissions that adversely affect the long-term sustainability of air quality.

Smoke Effects on Air Quality

Alternative C would contribute to reducing current trends in large uncharacteristic wildfires that adversely affect the long-term sustainability of air quality to the extent that larger landscape prescribed burning occurs. The prescribed burning would have a potential short-term negative effect on air quality but these activities tend to occur under favorable atmospheric conditions and thus effects can be mitigated to some extent. There is less mechanical thinning proposed than under alternative B and therefore these prescribed fires and wildfires managed to meet resource objectives would have a greater quantity of smoke associated with restoration activities as more fuels are available to burn.

Air pollution resulting from agricultural and industrial activities is a concern for the national forests next to California's Central Valley. The Forest Service does not have direct control over this pollution but can contribute to air quality by controlling the smoke from wildfires that add to this pollution. Alternative C would contribute to altering current trends and improving the sustainability of air quality benefits to people. Emissions would be generated by increasing current prescribed fire and wildfires managed to meet resource objectives. Indirect emissions would occur from wildfires. The emissions estimates were conservatively modeled and no reduction techniques, such as pretreatment thinning of vegetation, were modeled. See Table 14 for an estimate of emissions. Actual emissions and smoke impacts depend on additional factors such as seasonality of implementation, meteorology, and combustion efficiency. In the short term, alternative C would directly increase emissions. By mid-century, alternative C is projected to limit some wildfire emissions.

There would be a moderate intensity of the associated long-term effects on air quality across a large geographic area and a moderate to substantial intensity of associated short-term effects. Air quality would improve through reduced wildfire emissions in the long term (mid-century) where prescribed burning occurs and where wildfires are managed to meet resource objectives. In the short term, treatments would cause a sporadic reduction (as treatments occur) of air quality impacts from wildfires. There would be pulses of impact associated with prescribed burning and wildfires managed to meet resource objectives that would be larger than alternatives B and D due to less fuel reduction with mechanical methods and more fuels to burn.

Table 14. Emissions from treatments under alternative C measured in tons per year and compared with the air basin annualized emissions

Pollutant	Carbon Monoxide	Nitrogen Oxides	Sulfur Oxides	Particulate Matter	Particulate Matter M10	Particulate Matter 2.5
Air Basin Baseline Emissions	290,650	99,390	3,504	191,297	101,507	26,499
Alternative C Emissions	28,154	157	143	n/a	2,615	2,219
Annualized % of increased emissions alternative C	9	0	4	0	3	8

PM_{10} and $PM_{2.5}$ refer to particulates that are 10 microns or 2.5 microns in size. Those are sizes used in standard measurements of particulate matter for compliance with air quality regulations.

Smoke Effects on Recreation

Alternative C contributes to reversing current trends in those forest conditions that result in smoke due to wildfire effects. Reductions in smoke events have potential beneficial short- and long-term effects on local communities due to reductions in interruptions to visitation. There is a corresponding potential for short-term reductions in air quality due to increases in prescribed burning and wildfires managed to meet resource objectives. The net-effect on air quality is more uncertain under alternative C than under alternatives B and D given there is less mechanical thinning occurring before any prescribed burning. There would be mitigation measures used to control when and where prescribed burning can occur in order to reduce smoke exposure, and smoke impacts would be considered when managing wildfires to meet resource objectives. There is also additional benefit to the recreation users who are able to enjoy recreation activities in the national forests when wildfires would otherwise prevent visitor use.

Like alternatives A and B, there is an economic contribution provided by recreation to both local communities through visitation and to recreation users through the recreation experience that contributes to quality of life. Alternative C would also contribute to altering current trends to improve the sustainability of recreation benefits to people.

There would be a moderate to substantial intensity of smoke that would affect recreation across a large geographic area from the associated short- and long-term effects of implementing alternative C.

Smoke Effects on Visibility in Class I Airsheds (Wilderness)

Effects on the visibility in class I airsheds under alternative C represent a trade-off. In the short term, if fully implemented increased emissions from prescribed fire and wildfires managed to meet resource objectives would reduce visibility in the class I airsheds in the analysis areas. In the long term, treatments under alternative C would reduce emissions from wildfires and thus indirectly improve visibility in class I airsheds by mid-century. In general, data from three IMPROVE sites show that visibility is currently increasing in the plan area (see “Assessment”). However, modeling indicates that wildfire emissions would significantly increase by mid-century (Hurteau et al. 2014). Increasing emissions is expected to reduce visibility throughout the plan area. Restoration treatments can improve visibility through the reduction of emissions in the long term. In the short term, treatments from this alternative would result in greater quantities of visibility-reducing smoke in nearby class I airsheds as compared with alternative B because fewer acres would have reduced fuels from mechanical treatment prior to prescribed burning or wildfire managed to meet resource objectives.

Visibility in class I airsheds is regulated under the Regional Haze Rule and the Forest Service is responsible for meeting goals set-forth by the Environmental Protection Agency. Due to the limited potential amount of mechanical fuel reduction treatments, implementation of alternative C would make attaining these goals unlikely.

In the short term, moderate to substantial intensity impacts resulting in decreases in visibility would occur in class I airsheds when implementation is occurring. In the long term, moderate to substantial intensity impacts resulting in improved visibility in class I airsheds is expected.

Consequences Specific to Alternative D

Alternative D would have the greatest amount of restoration activities, including prescribed fire, mechanical thinning, and wildfire managed to meet resource objectives. Thirty to fifty percent of many montane and foothill landscapes would have restoration treatments. Based on the fire-climate scenarios (see "Fire Trends") this would result in a substantial reduction in potential wildfire emissions. At mid-century there would still be an increase in emissions over current levels but far less than the projected doubling of smoke emissions under alternative A.

Smoke Effects on Air Quality

Alternative D contributes to reducing current trends in large uncharacteristic wildfires that adversely affect the long-term sustainability of air quality. The prescribed burning in this alternative would have a potential short-term adverse effect on air quality, but these activities tend to be conducted under favorable atmospheric conditions and thus effects can be mitigated to some extent. The mechanical thinning proposed in the alternative would also help to reduce the quantity of smoke that would occur during these prescribed fire activities and when areas are burned in wildfires managed to meet resource objectives.

Like the other alternatives, air pollution resulting from agricultural and industrial activities is a concern for the national forests next to California's Central Valley. Alternative D contributes to altering current trends and improving the sustainability of air quality benefits to people. Under alternative D emissions would be generated by increasing current prescribed fire and wildfires managed to meet resource objectives. Additional indirect emissions would occur from wildfires. The emissions were conservatively modeled, meaning the figures represent maximum emissions and may be lower when restoration activities are implemented. See Table 15 for an estimate of annual emissions.

Table 15. Emissions under alternative D in tons per year, compared with the baseline air basin emissions

Pollutant	Carbon Monoxide	Nitrogen Oxides	Sulfur Oxides	Particulate Matter	Particulate Matter M10	Particulate Matter 2.5
Air Basin Baseline Emissions	290,650	99,390	3,504	191,297	101,507	26,499
Alternative C Emissions	58,123	325	296	n/a	5,400	4,581
Annualized % of increased emissions alternative C	17	0	8	0	5	15

PM_{10} and $PM_{2.5}$ refer to particulates that are 10 microns or 2.5 microns in size. Those are sizes used in standard measurements of particulate matter for compliance with air quality regulations.

Actual emissions and smoke impacts depend on additional factors such as seasonality of implementation, meteorology, and combustion efficiency. Under this alternative, emissions would be generated through continuation of current management activities. In the short term, alternative D would directly increase emissions. In the long-term, alternative D is projected to decrease emissions.

There would be a moderate to substantial intensity of the associated short- and long-term effects of alternative D to air quality across a large geographic area. Air quality would improve more than any other alternative through reduced wildfire emissions in the long term (mid-century). In the short term, treatments would cause a sporadic reduction (as treatments occur) of air quality impacts from wildfires but would have pulses of impact associated with prescribed burning and increased use of wildfires managed to meet resource objectives.

Smoke Effects on Recreation

Like alternative B, alternative D would contribute to reducing current trends in those forest conditions that result in smoke due to wildfire effects. Reductions in smoke events have potential beneficial short- and long-term effects on local communities due to reductions in interruptions to visitation. There is a corresponding potential for short-term reductions in air quality due to increases in prescribed burning and wildfires managed to meet resource objectives. However, the net-effect of air quality on recreation visitation is expected to be mitigated to some extent given the level of mechanical thinning occurring before any burning occurs as well as the mitigation measures in place to control when and where prescribed burning can occur in order to reduce smoke events. There is also additional benefit to recreation users who are able to enjoy recreation activities on the national forests.

As with the other alternatives, there is an economic contribution provided by recreation to both local communities through visitation and to recreation users through the recreation experience that contributes to quality of life. Alternative D would contribute to altering current trends in air quality to improve the sustainability of recreation benefits to people.

However, there would be a moderate to substantial intensity of the associated short- and long-term effects of alternative D to air quality across a large geographic area.

Smoke Effects on Visibility in Class I Airsheds (Wilderness)

Like the other alternatives, increased emissions from prescribed fire and mechanical treatments under alternative D would directly reduce visibility in the class I airsheds in the analysis areas in the short term. In the long term, treatments under alternative D would reduce wildfire emissions and thus indirectly improve visibility in class I airsheds by mid-century. Restoration treatments can improve visibility through the reduction of emissions in the long-term.

With the increased amounts of restoration and reduction in smoke from future wildfire, implementing alternative D increases the likelihood of attainment in class I airsheds by the mid-century. In the short term, moderate to substantial intensity impacts resulting in decreases in visibility to class I airsheds would occur during implementation of prescribed burning. In the long term, moderate to substantial intensity impacts resulting in improved visibility in class I airsheds is expected.

Consequences Specific to Alternative E

Under alternative E, impacts on air quality are similar to alternative C. Wilderness designations of alternative E may reduce feasibility of restoration using fire (due to exclusion of prescribed fire), resulting in slightly less catastrophic wildfire emissions in the short term with increased emissions in the long term. The timing and intensity of the impacts will depend on the degree of restoration that is implemented.

Smoke Effects on Air Quality

Alternative E smoke effects on air quality are similar to alternative C. Wilderness designations of alternative E may reduce feasibility of restoration using fire (due to constraints on prescribed fire). Thus smoke from prescribed fires would be lessened under this alternative in the short term. In the long term, smoke from catastrophic wildfires will increase (Table 16).

Table 16. Emissions from treatments under alternative E measured in tons per year and, compared with the air basin annualized emissions

Pollutant	Carbon Monoxide	Nitrogen Oxides	Sulfur Oxides	Particulate Matter	Particulate Matter M10	Particulate Matter 2.5
Air Basin Baseline Emissions	290,650	99,390	3,504	191,297	101,507	26,499
Alternative C Emissions	28,154	157	143	n/a	2,615	2,219
Annualized % of increased emissions alternative C	9	0	4	0	3	8

PM_{10} and $PM_{2.5}$ refer to particulates that are 10 microns or 2.5 microns in size. Those are sizes used in standard measurements of particulate matter for compliance with air quality regulations.

Smoke Effects on Recreation

Under alternative E, smoke effects on recreation are similar to alternative C. The air impacts from alternative C will be similar to alternative E since the reduction in wilderness acreage is substituted with primitive and semi-primitive back county uses that are be similar to alternative C. Smoke impacts on recreation between these alternatives will be indiscernible.

Smoke Effects on Visibility in Class I Airsheds (Wilderness)

Under alternative E, smoke effects on visibility are similar to alternative C. The air impacts from alternative C will be similar to alternative E since the reduction in wilderness acreage is substituted with primitive and semi-primitive back county uses that are similar to alternative C. Smoke impacts on Class I airsheds between these alternatives will be indiscernible.

Cumulative Effects

In the short term, increased smoke production from prescribed burning and managing more wildfires to meet resource objectives under alternatives B, C, D, and E would result in a reduction in air quality, recreation opportunities, and visibility. In the long term, alternatives B, C, D, and E would result in a cumulative reduction in air quality impacts from wildfires by mid-century compared with alternative A (Figure 22). The cumulative impacts of these alternatives by mid-century would result in increased air quality, recreation opportunities, and visibility due to a reduction in smoke from wildfires and increased ecosystem resilience. The degree of positive impact depends on the level of restoration selected for implementation. In the short term, alternative A would result in fewer cumulative impacts on air quality, recreation, and visibility than the other alternatives because there would be less prescribed burning and little wildfire managed to meet resource objectives. In the long term, cumulative effects from alternative A would result in an increase of negative impacts by mid-century due to increased wildfire emissions (Hurteau et al. 2014).

The approach to increasing the amount of areas where fire is restored as a process is consistent with approaches of the National Park Service and BLM in wilderness and remote areas. Cumulative effects of smoke from these management actions by the different agencies are managed by ensuring close coordination. Daily cumulative smoke impacts from agricultural and forest burning throughout the state of California are addressed on a daily interagency coordination call. Frequent attendees include representatives from the Sierra, Sequoia, and Inyo National Forests, Sequoia and Kings Canyon National Parks, San Joaquin Valley Unified Air Pollution Control Districts, Great Basin Valleys Air Pollution Control District, and others. This daily call limits the amount of smoke produced in the airsheds of the plan area.

Urban emission sources will continue to intermix with emissions from both catastrophic wildfires and restoration emissions. The degree to which emissions in nearby urban areas increases or decreases through time is unknown. Increased population may result in increased emissions; however, new technologies may reduce emissions. These sources combined affect the air quality of the plan area. The degree to which catastrophic fire emissions contribute to the air quality of the plan area is dependent on the alternative selected.

Analytical Conclusions

Effects on air resource indicators from each alternative are categorized by time frames of short term (present to 15 years) and long term (15 years to mid-century). Effects on air resource indicators are categorized by emissions source-type of either wildfire or restoration treatments (prescribed fire, wildfire managed for resource benefit, and mechanical thinning) as shown in Table 17. No alternative offers both short-term and long-term improvements to air resource indicators. Models indicate wildfire emissions will increase through time and are considerably greater than restoration emissions. Restoration treatments would slow the progress of increasing wildfire emissions. The degree of slowing wildfire emissions growth through time depends on the level of treatments.

Table 17. Summary of air quality indicators and effects by alternative

Smoke effects indicator	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Air quality	Short-term, emissions stay the same; long-term, emissions increase	Short-term, emissions increase; long-term, emissions reduced	Short-term, emissions increase; long-term, emissions reduced	Short-term, emissions increase the most; long-term, emissions reduced the most	Short-term, emissions increase; long-term, emissions reduced
Recreation	Short-term effects stay the same; long-term, more smoke effects	Short-term, more smoke effects; long-term, slightly less smoke effects	Short-term effects stay the same; long-term, more smoke effects	Short-term, more smoke effects; long-term, less smoke effects	Short-term effects stay the same; long-term, more smoke effects
Visibility in class I airsheds	Attainment unlikely	Attainment more likely	Attainment likely	Attainment most likely	Attainment likely

Restoration activities would increase emissions and affect air quality in the short term, but the degree of increase is dependent on the amount of treatment. Alternative D has the highest short-term emissions from treatments followed by alternatives B and then alternatives C and E. In the long term, alternative D would result in the greatest reduction in emissions from wildfires followed by alternatives C and E, alternative B, and lastly, alternative A. Short-term effects on air resource indicators from restoration activities can be moderated through smoke management best practices.

There would be potential adverse short- and long-term effects on the benefits to people that are obtained from the resulting decline in recreation visitation. Prescribed fire and managed wildfire smoke may impact recreation opportunities on the two national forests. In the short term, current trends of increasing impacts on recreation would continue under alternative A from smoke from wildfires that burn during the summer recreation season. There would be less smoke in the short term under alternatives B and D where wildfires burn into areas where treatments occurred, with less benefit under alternatives C and E due to the lower amounts of treatment. In the long term, impacts on recreation are expected to increase with increasing wildfire emissions in alternative A, followed by alternative B and then alternatives C and E. Only alternative D would decrease the long-term smoke from wildfires in the summer recreation season due to the greater amount of fuels reduced.

Increases in emissions and other cumulative effects would make long-term attainment of visibility goals unlikely under alternative A. Restoration treatments under alternatives B and D would result in a direct effect of reduced smoke emissions by mid-century. Reduction in wildfire emissions would make long-term attainment of visibility goals more likely under alternatives B and D than under alternative A (Figure 24). The prescribed burning restoration treatments under alternatives C and E would result in reduced smoke emissions by mid-century and, to the extent that prescribed burning and wildfires managed to meet resource objectives occur, a reduction in wildfire smoke would make long-term attainment of visibility goals more likely than under alternative A but less likely than under alternatives B and D. Short-term impacts would lessen throughout time as fuels are reduced and would increase visibility in the long term.

Revision Topic 2: Ecological Integrity

Background

The topic of ecological integrity is very broad and spans from terrestrial to aquatic ecosystems. It includes the organisms that live in these ecosystems as well as the functions of the ecosystems themselves. To address this revision topic, the analysis is divided into three sections: terrestrial ecosystems; aquatic and riparian ecosystems; and wildlife, aquatic and plant species. This topic also relies heavily on the information provided in "Agents of Change." The major vegetation types are discussed in "Terrestrial Ecosystems," and that discussion is referred to by other sections in this document.

Terrestrial Ecosystems

The terrestrial ecosystems analysis is presented in three subsections: terrestrial vegetation ecology, terrestrial ecosystem process and function, and climate vulnerabilities and adaptations.

Terrestrial Vegetation Ecology

Background

This section summarizes current terrestrial ecosystem conditions of dominant vegetation types in the Sequoia and Sierra National Forests, and the consequences of implementing the draft forest plans or the alternatives. It includes an analysis of the alternatives' effects on vegetation ecology, including composition, structure, and resilience to fire, climate, drought, insects, and pathogens by major ecological and elevational zone and vegetation type. Building on "Agents of Change, Climate, Fire, Insects and Pathogens," there are more specifics about fire regime integrity and effects by vegetation type.

Much of the analysis is based on the premise that the natural range of variation provides important background for evaluating ecological integrity and sustainability (Wiens et al. 2012, Manley et al. 1995). It was used to develop plan direction and select indicators and measures for the analysis. Also important in the analysis of ecological integrity and sustainability of vegetation was consideration of climate and associated fire trends that may be creating a combination of conditions that are outside of what occurred in the natural range of variation (Safford et al. 2012a, Millar and Stephenson 2015).

Natural range of variation is a concept that focuses on the dynamic nature of ecosystems, recognizing they are not static (Landres et al. 1999). This concept is relevant to ecosystem attributes such as vegetation composition, structure, and function that influence ecosystem values and services such as wildlife habitat. Natural range of variation is typically characterized as the ecosystem conditions and processes that have occurred over long time periods that are appropriate for a given management application (Morgan et al. 1994). While natural processes such as fire are part of the ecosystem that contributes to the natural range of variation, it is recognized that human actions following Euro-American settlement have dramatically changed vegetation and fire regimes in the analysis area. Because of these changes, the natural range of variation is typically analyzed for the time period prior to European settlement; generally mid- to late-1800s, depending on vegetation type. A basic premise is that ecosystems currently have greater integrity and are more sustainable if their conditions fall within the natural range of variation (Safford et al. 2012b).

Application of natural range of variation concepts also recognize that native cultures managed and influenced ecosystem conditions and processes (Jackson and Hobbs 2009). For example, in the analysis area, Native American tribes actively used fire to manage resources of tribal importance (such as vegetation and game) (Lake and Long 2014).

Although the concept of natural range of variation and its use in sustainable ecosystem management is well developed from a theoretical standpoint, its application in resource management is not always straightforward. For example, sometimes an important measure of vegetation structure used to characterize wildlife habitat, such as canopy cover, is not directly or easily reconstructed historically. Or, quantitative information on historic conditions, such as tree densities, may only be available for a short period of time just before or at the onset of European settlement. Despite these limitations, it is still considered a useful way to evaluate the very important but complex concept of ecological sustainability. It is also increasingly recognized that human presence and needs may result in desired ecological conditions that are different than the natural range of variation (Higgs et al. 2014). Vegetation desired conditions for the proposed plan take into account not only natural range of variation, but also current societal desires for supporting recovery of endangered species and reducing fire near communities.

During the assessment phase, terrestrial ecosystems were classified into broad ecological zones, based on similarities in dominant vegetation types, climate, and fire patterns at a landscape scale. These broad ecological zones were used to analyze and summarize conditions and impacts of the alternatives to vegetation ecology and terrestrial function in the following subsection. The ecological zones include the westside foothill, montane, upper montane, subalpine and alpine zones, and pinyon-juniper and sagebrush ecological zones in the Sequoia and Sierra National Forests as shown in Figure 25 (see the maps in volume 3 to see ecological zones for each national forest by alternative). The area in acres in each ecological zone by national forest is shown in Table 18.

Table 18. Area in acres by ecological zone across each national forest, rounded to the nearest thousand acres[1]

Ecological Zone	Sequoia National Forest (acres)	Sierra National Forest (acres)
Foothill	123,000	263,000
Montane	374,000	431,000
Upper Montane	204,000	369,000
Subalpine/Alpine	16,000	228,000
Arid Shrublands and Woodlands	94,000	0

1. Acreage estimates do not include the Giant Sequoia National Monument.

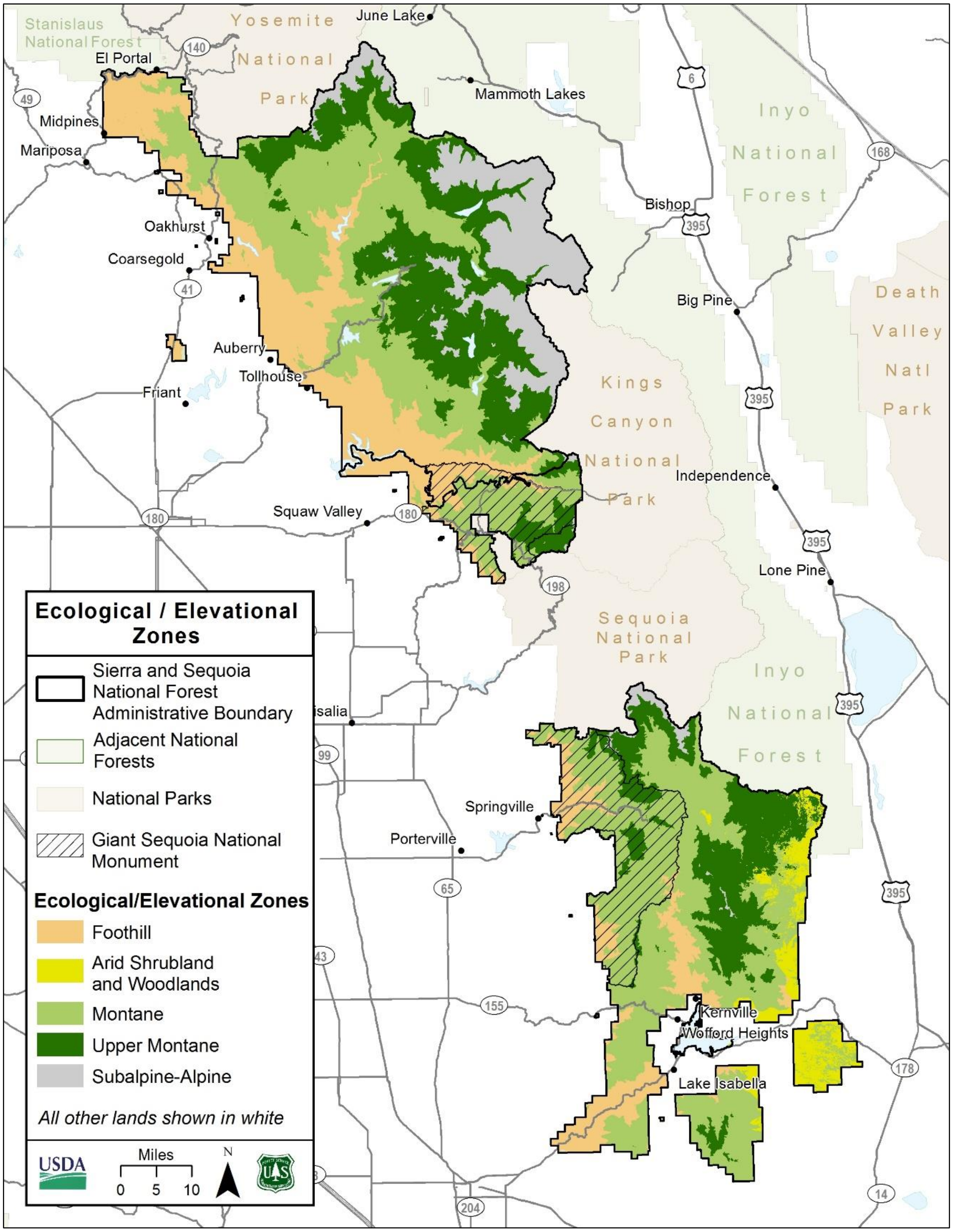

Figure 25. Ecological/elevational zones for the Sequoia and Sierra National Forests

Analysis and Methods

The overarching approach we used in this analysis was to evaluate the similarity of current and estimated future conditions under each alternative to the desired conditions for each vegetation type. We used a combination of qualitative and quantitative analyses. For both types of evaluations, we identified the specific indicators, measures, thresholds for levels of similarity between desired conditions and current or future conditions, and associated assumptions. These are described in more detail in the vegetation ecology and fire ecology supplemental reports.

The desired conditions for vegetation and other terrestrial ecosystems are all directly related to the natural range of variation. For each major vegetation type, we developed desired conditions for vegetation structure, composition, and function that were specific and quantitative where possible. For example, there has been extensive research on how forest density has changed over the last 100 or more years (Stephens et al. 2015, Collins et al. 2011, Collins et al. 2015) and other research on how forests differ between areas in national parks that have had little direct management except fire suppression and where over the past 40 years, fires have been restored (Lydersen and North 2012, Lydersen et al. 2013). This research includes information on dominant species, tree densities of different tree sizes, variation in tree spacing or heterogeneity, and evidence of high fire severity. There are some desired conditions that strive for a balance between habitat needs for at-risk species and the natural range of variation. That includes having more areas of structurally diverse old-forest habitat for California spotted owl (not uniformly high canopy cover across the landscape).

The choice of specific measures used in the desired conditions depends on a combination of what conditions are used to characterize suitable wildlife habitat, what is important for ecological integrity and sustainability, what is most departed from the natural range of variation, and what is most useful to apply to restoration projects. Canopy cover is an example that is important to wildlife habitat, is known to be departed from the natural range of variation and can be used to apply to restoration projects. Tree density is more difficult to relate to habitat and sustainability because it varies so widely from site to site. Basal area is a measure of forest density that incorporates aspects of tree density and tree sizes, and is available from the natural range of variation research and very useful in restoration project design. Because of these considerations, desired conditions were developed for canopy cover at the landscape scale and in patches, and basal area was used to measure forest density.

Indicators and Measures

There are several main aspects to vegetation ecology that were used for this analysis.

Composition. Composition includes the mix of plant species. The analysis looks at predicted changes to overstory and understory composition. For the overstory, we considered the primary tree species, such as black oak mixed with ponderosa pine. For the understory, we considered the mix of native flowering plants, shrubs, and grasses and presence and extent of nonnative, invasive plants.

Structure. Structure includes the type of plants (trees or shrubs), how big individual plants or trees are, how densely they occur, and how they are arranged, such as uniformly or in a clumpy or heterogeneous pattern. Vegetation structure at the landscape scale was characterized by the amount of vegetation in the California Wildlife Habitat Relationships classes (Mayer and Laudenslayer 1988). At the patch scale, we analyzed forest density, represented by canopy cover and basal area. We used heterogeneity (variability in tree spacing, sizes and openings) to analyze within-patch structure.

Vegetation types as described by California Wildlife Habitat Relationships classes are useful in comparing the proportion of the landscape in forested versus non-forested areas, and the amount of open- versus close-canopied, or small- versus large-tree-dominated patches. While they are sometimes equated to seral stages (stages of forest development), there is not necessarily a one-to-one correspondence. For example, very open small-tree-dominated woodland at high elevations may be a very old subalpine forest. The stand size characteristic is based on the average stand diameter. When forests consist of mixtures of tree sizes or diameters, this can make it difficult to distinguish younger from older forests. The California Wildlife Habitat Relationships classification does not reflect aspects of structure that are important to many wildlife species, such as large trees and snags (North 2012). The analysis of old forest characteristics, including the proportion of the landscape in old forest and restoration approaches for large and old trees in old forests are described in greater detail in the old forest supplemental report. Despite the shortcomings of the California Wildlife Habitat Relationships classification, it is what has been applied for multiple decades. It is still used in part to characterize wildlife habitat suitability for some of the species of conservation concern analyzed in this plan, including the California spotted owl and fisher. Because of its continued use in wildlife models, it was analyzed here.

Resilience to Fire, Climate, Drought, Air Pollutants, Insects and Pathogens. Resilience is a measure of the elasticity of an ecosystem; that is, its ability to absorb disturbances or stressors such as severe droughts and insect outbreaks and to maintain or quickly recover its intrinsic ecological characteristics (composition, structure, and function) and ecosystem services (such as provide habitat or soil protection). For this analysis, the ability of terrestrial ecosystems, especially vegetation, to withstand drought, warmer temperatures, high-intensity fires, and insect and pathogen outbreaks was analyzed. In the previous section on climate, the broader capacity of ecosystems to respond to climate change was covered. Resilience to fire was addressed in the context of the natural range of variation of fire regimes.

Two different measures were used to reflect ecological fire resilience. In forested ecosystems, we used the intensity and type of fire, such as surface or crown fire. In non-forest and woodland ecosystems, we used fire return interval departure and presence of nonnative annual grasses to analyze resilience. For both of these measures, the analysis was at a landscape scale, since fires and vegetation responses can vary from site to site. The aggregate of all of those effects and resilience to fire is most important for ecological impacts.

Analysis Methods and Data Sources

We used a combination of scientific summaries, scientific research, and existing and available vegetation information for the analysis. This included Forest Inventory and Analysis plot data and remote sensing, satellite data. Most of the information in "Affected Environment" was based on the bioregional and forest assessments (United States Department of Agriculture 2013b, c, d). This included information from the "Living Assessment" (United States Department of Agriculture 2013j, k), published scientific literature, the "Sierra Nevada Scientific Synthesis" (Long et al. 2014), and the "Natural Range of Variability Assessments" (Estes 2013b, Merriam et al. 2013, Safford 2013, Sawyer 2013, Meyer 2015b, Meyer 2015c, Slaton and Stone 2015a, b, Safford and Stevens 2017). This information was used to evaluate the conditions of the indicators relative to desired conditions and analysis thresholds.

For each indicator and vegetation type or ecological zone, we evaluated potential effects on composition, structure, and resilience at the programmatic level for each alternative. This entails identifying plan direction relevant to the vegetation type for each alternative and making projections about the potential effects of future implementation of that plan direction. The specific timing and location of potential restoration projects is not known but the types of effects associated with implementation can be discussed. The evaluation of potential effects on composition, structure, and resilience associated with plan implementation is based on scientific literature (and professional experience) that has examined the effects of treatments similar to those that would be implemented under alternatives A, B, C, D, and E using fire-climate modeling (see “Fire Trends”) (Westerling et al. 2015), and ecological fire resilience modeling (United States Department of Agriculture 2013a, b, c, d).

Most of the earlier literature on the ecological restoration of Sierra Nevada montane forests has focused on fuels treatments. More recently, there has been an increase in ecological restoration for vegetation composition, structure, and ecological function. Much of the associated research on ecological restoration for mixed conifer and yellow pine (ponderosa and Jeffrey pine) forests has been summarized in two recent technical reports, GTR 220 and 237 (North et al. 2009b, North 2012), and the recent “Science Synthesis for the Sierra Nevada Bioregion” (Long et al. 2014). Red fir restoration is also addressed in the Science Synthesis to some degree and other information sources (Meyer et al. 2017, Meyer 2013a, Meyer et al. 2019). Restoration management strategies and treatments proposed and described in those documents are the basis for management direction contained under alternative B, C, D, and E, as well as alternative A to a lesser extent.

For arid shrublands and woodlands, we examined several recent comprehensive scientific literature reviews and management strategies directed at restoration of greater sage-grouse habitat (Chambers et al. 2007, Wisdom and Chambers 2009, Arkle et al. 2014, Chambers et al. 2013, Chambers et al. 2014). This includes reducing conifer density in sagebrush areas, prevention and restoration of areas with nonnative, invasive annual grasses, and restoration of perennial grasses.

For some vegetation types there are multiple applicable research papers, and for readability only key ones were cited here. Additional scientific research on the effects of different restoration management activities specific to different vegetation types are summarized in the vegetation ecology supplemental report.

The analysis is displayed in two ways. First, there is a narrative for each indicator by major vegetation type that explains the potential consequences of implementing the different type, amount, and location of restoration activities. Second, there is an overall rating of whether the indicator has a low, moderate, or high similarity to desired conditions. This rating is based on the degree of departure (and especially the proportion of the landscape with departure of current or expected future conditions) from the desired conditions and natural range of variation. The criteria and thresholds for the ratings were identified for each major vegetation type and indicator and are displayed in the vegetation ecology supplemental report. The tables for montane ponderosa pine and mixed conifer forests (Table 19) and arid shrublands and woodlands (Table 20) are included below because these are the primary vegetation types that would be managed.

Table 19. The indicators, measures, and criteria for evaluating the current condition and consequences for the montane ecological/elevational zone (ponderosa pine, black oak, moist and dry mixed conifer)

Ecological Zone Vegetation Type	Indicator	Measure	Criteria
Black oak, and Black oak-Ponderosa pine	Composition and structure	Similarity to desired conditions. Black oak cover and density, mature black oak are common with high acorn production	High – black oak is dominant or co-dominant in the overstory and understory over >60% area Moderate – same as above but 40-60% area Low –same as above but for <40% area
Black oak, and Black oak-Ponderosa pine	Composition understory	Understory – native plant composition, abundance and condition (improved with openings and fire restoration)	High – open canopy (similar to desired conditions) dominant, with restoration of fire common: >60% area Moderate – same as above but 30-60% area Low – same as above but <30% area
Ponderosa pine and dry mixed conifer	Overstory composition	Similarity of dominant overstory tree composition to desired conditions (>60% pine in mixed conifer and >90% pine in ponderosa pine, except where black oak is common)	High: meet conditions on most (>60% of area) of the landscape Moderate: meet conditions on some (40-60% of area) of the landscape Low: meet conditions on limited (<40% of the area) of the landscape
Ponderosa pine and dry mixed conifer	Understory composition	Understory – native plant composition, abundance and condition (improved with openings and fire restoration)	High – open canopy (similar to desired conditions) dominant, with restoration of fire common: >60% area Moderate – same as above but 30-60% area Low – same as above but <30% area
Moist mixed conifer	Overstory composition	Similarity of dominant overstory tree composition to desired conditions (is >60% pine on dry sites and 40-60% on moist sites. Black oak common and healthy)	High: meet conditions on most (>60% of area) of the landscape Moderate: meet conditions on some (40-60% of area) of the landscape Low: meet conditions on limited (<40% of the area) of the landscape
Moist mixed conifer	Understory composition	Similarity of understory composition and condition to desired condition (heterogeneity- see below- and amount of low and moderate intensity fire restored)	High: high heterogeneity and extensive (>60% area) low and moderate intensity fire restoration Moderate: moderate heterogeneity and moderate low and some fire restoration (40-60% area) Low: low heterogeneity and limited fire restoration (<40% area)

Table 20. The indicators, measures, and criteria for evaluating the current condition and consequences for arid shrublands and woodlands ecological zone and vegetation types

Ecological Zone Vegetation Type	Indicator	Measure	Criteria
Sagebrush	Composition	Similarity of understory composition and condition to desired condition (areas of native perennial grasses and flowering plants thriving and increasing, native shrubs healthy)	High: meet conditions in a high proportion (>75%) of the area; Moderate: conditions met in some to most (25-75%) of the area; Low: conditions met in limited proportion (<25%) of the area
Pinyon-juniper	Composition	Similarity of species composition to desired condition (limited nonnative invasive grasses or plants, primarily cheatgrass)	High: few to no invasive plants Moderate: limited frequency of occurrence and slow rates of spread Low: moderate to high frequency of occurrence and rates of spread
Pinyon-juniper	Structure	Pinyon pine tree and regeneration densities	High: high proportion (>75%) of the area in desired condition Moderate: some to most (25-75%) of the area in desired condition Low: limited (<25%) area in desired condition
Xeric shrub	Composition	Native species composition; invasive species (occurrence, density and number of species); native soil crusts are intact	High: high proportion (>75%) of the area in desired condition Moderate: some to most (25-75%) of the area in desired condition Low: limited (<25%) area in desired condition

Thresholds for evaluating condition of vegetation indicators were based on scientific literature where available and, where not available, on general ecological theory (that is, percolation theory (Turner 1989), research on landscape vegetation conditions and changes in fire patterns (Parisien et al. 2007, Parisien et al. 2010, Parisien et al. 2012, Westerling et al. 2015), and logical categories. There is limited scientific literature that specifies what proportion of a landscape needs to be in a certain condition to have ecological integrity. Landscape ecology theory provided an overall basis for setting the high and low ecological condition thresholds (Turner 1989). Percolation theory distinguishes changes in landscape processes and functions when less than 40 percent of a landscape is in a different condition. This could include fragmentation of habitat, movement of wildlife, or movement of fire. Research on fire probabilities (extent, large fire size and severity) suggests that landscapes with at least 40 percent in a condition that is more consistent with the natural range of variation have a reduced likelihood of fire probability and large fire size, and areas with more than 60 to 75 percent have a substantially reduced likelihood, compared with untreated or minimally treated landscapes (with less than 5 to 10 percent of the landscape receiving restoration treatment) (Parisien et al. 2007, Parisien et al. 2010, Parisien et al. 2012, Westerling et al. 2015).

The effects of the 2012-2016 drought and associated tree mortality on vegetation structure and composition are considered in this section but primarily addressed in “Changed Forest Conditions associated with Tree Mortality” and “Combined Effects of Climate, Fire, Insects, and Pathogens.”

Assumptions

We made reasonable assumptions that:

- the majority (greater than 60 percent) of a landscape in condition within the natural range of variation or similar to desired conditions would have high ecological integrity and resilience;
- nearly half (30 to 60 percent) of a landscape in condition within the natural range of variation or similar to desired condition would have moderate ecological integrity and resilience; and
- less than that would have low (15 to 30 percent) or very low (0 to 15 percent) ecological integrity and resilience.

The characterization of the NRV of fire severity in Sierra Nevada forest ecosystems (including the characterization of high severity fire proportion and patch size) is based on a large volume of "best available science information" summarized in Safford and Stevens (2017), Meyer (2013a, b), Long et al. (2014), North et al. (2009b, 2012), and other sources cited in "Agents of Change."

These comprehensive best available science information summaries include information sources that meet specific criteria for best available science information as defined by the 2012 Forest Planning Rule as accurate, reliable, and relevant to the issues being considered. In particular, valid best available science information is characterized by the following: (1) quantitative analysis was performed using appropriate statistical or quantitative methods; (2) logical conclusions and reasonable inferences were drawn; (3) science uses well-developed scientific methods that are clearly described; and (4) information is placed in proper context, including spatial and temporal scales (FSH 1909.12 - Land management planning handbook, Chapter 42.12).

Information sources that do not meet these criteria, (for example, (Baker 2014, Odion et al. 2014, Hanson and Odion 2014)) were not included or cited in the evaluation of fire regime NRV in Sierra Nevada forest ecosystems used in the RDEIS and forest plans. Moreover, many recent best available science information publications (Brown et al. 2008, Safford et al. 2008, Collins et al. 2011, Fulé et al. 2014, Collins et al. 2015, Safford et al. 2015, Stephens et al. 2015, Collins et al. 2016, Stevens et al. 2016, Hagmann et al. 2017, Levine et al. 2017, Miller and Safford 2017, O'Connor et al. 2017, Hagmann et al. 2018, Safford and Stevens 2017) clearly demonstrate that the aforementioned publications do not meet the criteria for best available science information because they contain: (1) a series of serious analytical and methodological issues and flaws; (2) unreasonable inferences and inappropriate conclusions drawn; (3) scientific methods and analyses poorly developed and described; (4) science information that is placed in inappropriate ecological context; and (5) other related issues (technical references inappropriately cited and placed out of context).

Moreover, several of these contested publications and related articles focused on fire effects on forest wildlife habitat (for example (Hanson et al. 2018)) contain elements of 'agenda-driven science' that are considered outside scientific norms and acceptance, including: (a) undeclared conflicts of interest; (b) inappropriate use of data and scientific literature; (c) drawing unsupported conclusions; (d) inappropriate use of social media and reliance on 'quasi-scientific' outlets (such as blogs on non-scientific websites); or (e) inappropriate professional behavior (such as pressuring other scientists to retract published papers, conducting biased reviews of articles, and obtaining other scientists' data through unprofessional means without seeking collaboration)

(Peery et al. 2019). For these reasons, these information sources were not considered valid best available science information for the evaluation of fire regime integrity or resilience in Sierra Nevada ecosystems.

Affected Environment

Current conditions are first summarized overall and then later described by ecological/elevation zone and vegetation type. The distribution and area in major vegetation types by national forest are shown in Figure 26 and Figure 27 and Table 21. Note that the vegetation maps for the Sequoia and Sierra National Forests use the existing vegetation data mapped by the Forest Service Remote Sensing Laboratory. For the Sequoia and Sierra National Forests, the area of wetland and riparian vegetation types are not included because they are not mapped comprehensively in this data set, only the larger, most visible areas. See the aquatic and riparian ecosystem section for more detail on the meadow, wetland, and riparian vegetation types. For both national forests, the information has not been updated for recent fires (since 2016), including but not limited to the Cedar (2016), Pier (2017), Railroad (2017), Lions (2018), and Ferguson (2018) fires. In addition, vegetation on the ground would show more detail and smaller patches of varying vegetation types than represented in these figures.

Table 21. Acres of main vegetation types, Sequoia and Sierra National Forests[1]

Vegetation Types	Sequoia National Forest (Acres) [2]	Sierra National Forest (Acres) [2]
Grassland	82,000	56,000
Hardwood	120,000	220,000
Chaparral	228,000	143,000
Ponderosa Pine	7,000	37,000
Dry Mixed Conifer	51,000	112,000
Moist Mixed Conifer	59,000	106,000
Jeffrey Pine	51,000	30,000
Red Fir	66,000	132,000
Lodgepole Pine	11,000	35,000
Subalpine Conifer	4,000	181,000
Alpine	1,000	44,000
Pinyon-Juniper	51,000	0
Sagebrush	25,000	0
Xeric Shrub	2,700	0
Giant Sequoia Groves[3]	—	2,000
Aspen	18	500

1. Vegetation types based on the California Wildlife Habitat Relationships classification.

2. Rounded to the nearest thousand acres, except for vegetation types totaling less than a thousand acres on both the Sequoia and Sierra National Forests.

3. Does not include giant sequoia groves in the Giant Sequoia National Monument.

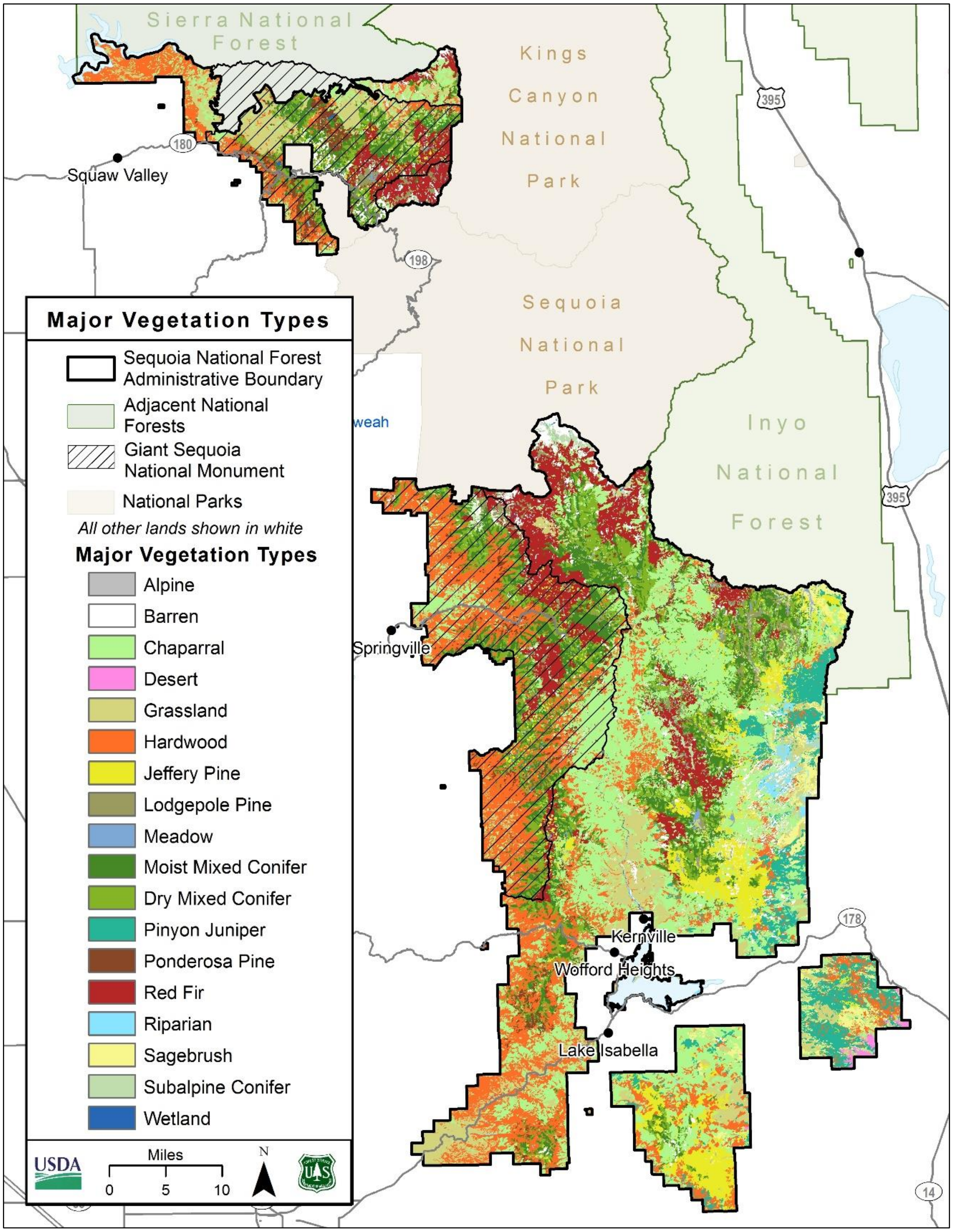

Figure 26. Major terrestrial vegetation types based on the California Wildlife Habitat Relationships classification, Sequoia National Forest.

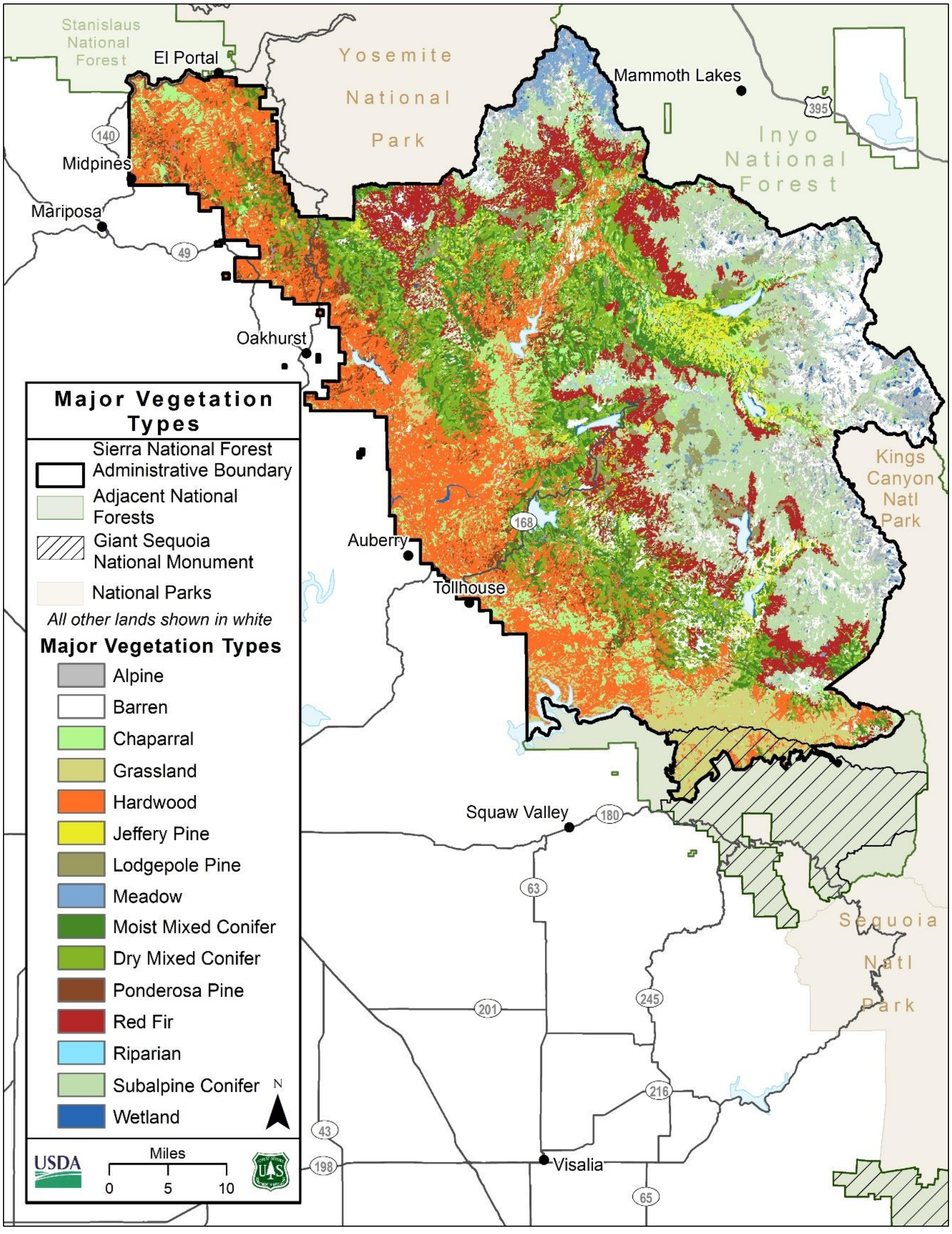

Figure 27. Major terrestrial vegetation types based on the California Wildlife Habitat Relationships classification, Sierra National Forest.

Hardwood types are important for wildlife species and some of the species of conservation concern. These were broken out by dominance of the primary species such as black oak, live oak, or blue oak. Table 22 below shows the area of vegetation dominated by different hardwood species. These types occur mostly in the foothill zone but also in the montane zones. The quaking aspen type is likely underestimated for the Sierra and Sequoia National Forests in this map data.

Table 22. Area in acres in different hardwood vegetation types by national forest, rounded to the nearest thousand acres for widespread vegetation types

Regional Dominance Type[1]	Sequoia National Forest[2]	Sierra National Forest[2]
Interior Live Oak	16,000	38,000
Interior Mixed Hardwood	5,000	6,000
Black Oak	9,000	11,000
Canyon Live Oak	30,000	55,000
Blue Oak	12,000	21,000
Valley Oak	10	35
California Buckeye	800	230

1. Defined by California Wildlife Habitat Relationships classification. Aspen acreage provided in prior table.

2. Rounded to the nearest thousand acres, except for vegetation types totaling less than a thousand acres on both the Sequoia and Sierra National Forests.

Summary of Similarity of Current Conditions to Desired Conditions

Based on the assessments for individual major vegetation types, the current conditions show a high similarity with desired conditions for only a few types, particularly the alpine and subalpine types. For the majority of vegetation types, especially those in the montane ecological zone, the vegetation characteristics exhibit a low to moderate similarity with the desired conditions. A summary of the similarity between current conditions and desired conditions are shown in Table 23 for all ecological zones and common vegetation types.

Table 23. Similarity between current conditions to desired conditions by ecological zone and vegetation type

Ecological Zone	Vegetation Type	Vegetation Composition Overstory	Vegetation Composition Understory	Vegetation Structure Density	Vegetation Structure Heterogeneity	Drought, Climate, Pollution Resilience	Fire Resilience
Foothill	Chaparral	High	Moderate	Not applicable	Not applicable	Moderate	Moderate
Foothill	Oak woodland	High	Low	Moderate	Moderate	Low-moderate	Moderate
Montane	Black oak	High	Moderate	Moderate	Moderate	Moderate	Moderate
Montane	Ponderosa pine	Low	Low	Low	Low	Low	Very low
Montane	Dry mixed conifer	Low	Low-moderate	Low	Low	Low	Very low
Montane	Moist mixed conifer	Moderate	Low	Low	Low	Low	Very low
Upper montane	Red fir	High	Moderate	Low	Low-moderate	Low	Moderate

Ecological Zone	Vegetation Type	Vegetation Composition Overstory	Vegetation Composition Understory	Vegetation Structure Density	Vegetation Structure Heterogeneity	Drought, Climate, Pollution Resilience	Fire Resilience
Upper montane	Lodgepole pine-moist	High	Moderate	Moderate	Moderate	Moderate	Moderate
Upper montane	Lodgepole pine-dry	High	Moderate	Moderate	Moderate	Moderate	Moderate
Upper montane	Jeffrey pine	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Upper montane	Chaparral	Moderate	Moderate	Not applicable	Not applicable	Moderate	Moderate
Subalpine	Subalpine	High	High	High	High	Low	Moderate-high
Alpine	Alpine	High	High	High	High	Low	Moderate-high
Arid shrublands and woodlands	Sagebrush	Not applicable	Low	Moderate	Low	Moderate	Moderate
Arid shrublands and woodlands	Pinyon-juniper	High	Moderate	Moderate	Low-moderate	Moderate	Low-moderate

Vegetation in the Kern River drainage is covered separately in Table 24, because the current condition of vegetation types in this drainage differs substantially from the rest of the Sequoia and Sierra National Forests. This is because of the extensive restoration of wildfire managed to meet resource objectives in this more remote area over the last 15 years (Fites-Kaufman et al. 2005, Ewell et al. 2012, Meyer 2015a). This area also has a substantially different current condition and similarity to desired conditions. It spans westside to eastside vegetation but is mostly similar to the westside conditions. It is described at the end of the montane or upper montane zone sections.

Table 24. Similarity between current conditions and desired conditions by vegetation type and ecological zone in the Kern River drainage

Vegetation Type	Vegetation Composition Overstory	Vegetation Composition Understory	Vegetation Structure Density	Vegetation Structure Heterogeneity	Drought, Climate Resilience	Fire Resilience
Montane	Moderate to high	Moderate to high	Moderate to high	Moderate to high	Moderate to high	Moderate to high
Upper Montane	High	High	Moderate to high	Moderate to high	Moderate to high	Moderate to high
Subalpine/Alpine	High	Moderate to high	Moderate to high	Moderate to high	Moderate	Moderate to high

Vegetation Types

Foothill Zone: Blue Oak Woodlands, Chaparral/Live Oak

The foothill ecological zone occurs at the lowest elevations on the western slopes of the Sierra Nevada, bordered by the San Joaquin Valley on the lower edges. A mosaic of chaparral, blue oak savannahs, live oak woodlands and forests, narrow riparian stringers along rivers and streams, seeps, and scattered gray pine occur at the lower elevations. At the higher reaches of the foothill zone, patches of ponderosa pine and black oak occur and gradually transition into ponderosa pine forests in the montane zone above.

Blue Oak Woodland

Overall, the vegetation and fire patterns in the blue oak woodlands are somewhat outside of the natural range of variation, and resilience is low to moderate (Merriam et al. 2013, Sawyer 2013). Understory vegetation is dominated by nonnative grasses and annuals that arrived with early European settlement. There are low levels of oak seedlings, saplings, and small trees necessary to perpetuate the oak woodlands. The frequency and intensity of fires are outside their natural range of variation, and changed fire regimes may cause a permanent change (type change) in vegetation type from oak woodlands to grasslands (Rodriquez-Buritica and Suding 2013). The low levels of seedlings, saplings, and small trees make this vegetation type vulnerable to climate change and drought, which is expected to be severe in these low elevation areas. The blue oak woodlands in the foothill zone is among the most altered and fragmented vegetation type from urbanization and agriculture and lies mostly below the western boundaries of national forests (Franklin and Fites-Kaufman 1996, United States Department of Agriculture 2001c). Because of the combination of these factors, the small amount of this vegetation type under public land management is disproportionately important for ecological integrity. Blue oak woodlands in the western Sierra Nevada display considerable fragmentation, increasing vulnerability to climate change because there is limited area for blue oak to migrate. During the 2012-2016 drought in California, blue oak woodlands in the Sequoia and Sierra National Forests exhibited relatively lower levels of mortality, with some areas experiencing moderate levels of mortality at lower elevations, especially in portions of the lower Kings River Drainage. Recent wildfires in this zone, including the 2016 Sacata Fire, have amplified levels of tree mortality in blue oak woodlands during the drought.

Overall, the blue oak woodlands are moderately similar to desired conditions. Although it is desirable to increase the proportion of native understory plants and the amount of area dominated by them, restoration of this vegetation type to native herbaceous plant dominance is considered highly challenging. This is due to the persistence of nonnative plant cover and dominance in California's grasslands and oak woodlands, even following multiple restoration treatments (Parsons and Stohlgren 1989). There is less blue oak regeneration and recruitment than desired under current conditions in many blue oak woodlands (Merriam et al. 2013).

Chaparral/Live Oak

Evergreen shrubs and live oaks (especially interior live oak at lower elevations and canyon live oak at relatively higher elevations) dominate the steep, lower slopes on the westside foothills of the western Sierra Nevada in the Sierra and Sequoia National Forests, and Piute Mountains of the Sequoia National Forest. Evergreen chamise, California lilac, manzanita, and interior live oak dominate the vegetation, but there are numerous other less common species, including the uncommon yellow-flowering flannelbush and knobcone pine. Most of the trees and shrubs are highly adapted to fire. Most shrubs and oaks sprout after top-kill in fires. Other shrubs and many annual flowering plants have seeds that are stimulated to sprout after heat or smoke, creating carpets of flowers. Knobcone pines have cones that open when exposed to high heat.

Overall, chaparral is similar to desired conditions but is at the high end of the natural range in some aspects, with some areas never having burned in over a century (Estes 2013a, Keeley and Davis 2007). Where fire has been frequent and near developed areas, nonnative grasses have invaded small areas, hindering native plant regrowth. Several recent fires have burned large areas in chaparral in the analysis area and vicinity. The 2013 Aspen Fire and 2014 French Fire burned large areas of chaparral in the San Joaquin River drainage, and the 2015 Rough Fire has burned extensive areas of chaparral in the Kings River Canyon. More recently, the 2018 Ferguson Fire burned substantial portions of chaparral in the south fork of the Merced River drainage on the northwestern portion of the Sierra National Forest. These fires burned under hot and dry conditions, following drought. The chaparral burned at very high and high intensity, with little variation in severity. This is within the natural range of variation for fire in chaparral (Knapp et al. 2005, Estes 2013a), although some areas of too frequent fire (such as the Kings River Canyon or around Lake Isabella) may be at risk of invasive plant spread due to the relatively high frequency of previous wildfires over the past several decades. Impacts of the 2012-2016 drought on vegetation in this zone have mostly been observed in taller tree species, such as foothill pine.

Black Oak/Ponderosa Pine

Patches of black oak, sometimes with scattered or clumped ponderosa pine, canyon live oak, or other tree species (for example, foothill pine), occur at the upper elevations of the foothill zone. These patches transition broadly into mixed conifer that occurs at higher elevations. The mixed black oak-ponderosa pine vegetation type is covered in the next section.

Montane Zone: Ponderosa Pine/Black Oak-Pine, Mixed-conifer Forests

The montane zone has large areas of forests dominated by varied mixtures of ponderosa pine or Jeffrey pine, sugar pine, incense cedar, white fir, and at higher elevations some red fir (Safford 2013, Fites-Kaufman et al. 2007). These are the most productive areas, where a combination of climate and soils provide ideal growing conditions. On the Kern Plateau, Jeffrey pine replaces ponderosa pine and conditions are drier. The southern reaches of the Sequoia National Forest are also drier, with white fir replacing red fir at higher elevations and Jeffrey pine replacing ponderosa pine. Historically, these productive forests had the most frequent fire, averaging 5 to 20 years (Safford et al. 2013, van Wagtendonk and Fites-Kaufman 2006). Frequent fires swept through the understory, keeping understory tree densities and surface fuels low. There was thought to be a high level of structural variation, with varied tree sizes, densities, spacing, and arrangements, collectively called “heterogeneity” (North et al. 2009a).

Current vegetation composition, structure, and resilience are highly dissimilar to desired conditions, except in the Kern Plateau and Kern River drainage. Conditions have changed considerably since before European settlement (van Wagtendonk and Fites-Kaufman 2006, Fites-Kaufman et al. 2007, Van de Water and Safford 2011, Collins et al. 2011, Lydersen and North 2012, Safford and Van de Water 2014, Collins et al. 2015, Stephens et al. 2015) and are largely outside the natural range of variation in most of the montane zone (Safford 2013, Merriam et al. 2013).

Composition of the overstory and understory has changed substantially. Pines and oaks have decreased substantially and shade-tolerant species, such as cedar and fir, have increased (North et al. 2009a). Large black oaks are being shaded out by conifers in many areas, causing unhealthy crowns, reduced acorn production, and reduced oak regeneration and recruitment (Merriam et al. 2013). Increases in tree density, and decreases in frequent low- and moderate-intensity fires have impacted understory shrubs, grasses, and flowering plants (van Wagtendonk and Fites-Kaufman 2006, Fites-Kaufman et al. 2007, Wayman and North 2007, Webster and Halpern 2010). These plants have evolved with fire and some of them have adaptations, such as the ability to sprout from bulbs or roots, or fire-stimulated seed germination that enables them to thrive with fire. Other plants, such as ponderosa pine, need bare soil to germinate and survive. As a result, in the absence of frequent fire, the understory flora of shrubs, flowering plants, and grasses is less diverse and in poor condition.

Forest structure has changed in several ways. Forest density is higher, canopy cover of trees is more uniformly higher, small and medium tree density is higher, and large tree density is lower (Collins et al. 2011, Collins et al. 2015, Stephens et al. 2015). In-stand variation in tree size and density has decreased substantially (Lydersen et al. 2013). Large tree densities and distribution across the landscape are substantially lower in most places than historically (United States Department of Agriculture 2001b, Franklin and Fites-Kaufman 1996, Fites-Kaufman et al. 2007, Stephens et al. 2015). Until recently, the low levels of large trees were due to past harvest from the European settlement period to the 1980s (Mckelvey and Johnston 1992).

More recently, water stress, climate change, and air pollutants have weakened large trees such as ponderosa pines (Panek et al. 2013, Bytnerowicz et al. 2014). Outside of fires, large tree mortality has doubled in the last two to three decades across the western United States (Van Mantgem et al. 2009). This pattern is associated with increases in temperature and changes in precipitation. There are also high levels of air pollutants, primarily ozone and possibly nitrogen that are impacting forest health and contributing to increased tree mortality to an unknown degree (United States Department of Agriculture 2013d). Ozone weakens trees, especially yellow pines (ponderosa pine, Jeffrey pine), and makes them more susceptible to drought and insects (see “Air Quality”). These stresses are compounded by the competition for water from the dense, younger trees that surround many old trees (McDowell et al. 2008, Franklin and Johnson 2012).

Resilience of montane forests to high-intensity fire, drought, insects, pathogens, climate change, and air pollution is very low in most areas (Safford et al. 2013, North 2012, Collins and Skinner 2014). Dense vegetation contributes to higher-intensity fire and increased tree mortality from fires. Dense forests are more vulnerable to stress brought on by drought, insects, pathogens, and air pollution. As a case in point, many dense lower-elevation ponderosa pine and mixed conifer forests have experienced severe and extensive levels of tree during and following the 2012-2016 drought. In the southern Sierra Nevada, some forested landscapes have experienced more than 50 percent mortality of medium- to large-size ponderosa pine, sugar pine, and other tree species (see “Changed Forest Conditions associated with Tree Mortality” in the previous section and Figure 7, Figure 28). There may also be a contribution from ozone weakening the trees in addition to insects, drought, and warming climate. This not only reflects decreased resilience but is also resulting in decreased forest diversity, degraded habitat conditions for old-forest associated wildlife species, and reduced landscape variation.

Figure 28. Recently dead sugar pines in mixed conifer forest in the Sequoia National Forest.

Fires in yellow pine and mixed conifer forests are less frequent, but evidence is strong that they are on average larger and more severe in large uniform areas than before European settlement (Collins and Skinner 2014, Safford et al. 2013). Changes in fire have contributed to shrinking chaparral patches scattered in forests (Estes 2013a) and black oak patches and trees (Merriam et al. 2013). Most of the montane area is likely to burn as crown fires during peak fire weather conditions. The mix of fire types (crown and surface fires) and resulting severity (high to moderate or low) is difficult to predict precisely. There are many conditions that influence the type and effects of fires, including the time of day, condition of the vegetation, and dryness of the vegetation and fuels. Overall, the more continuously dense and dry vegetation is, the more likely large areas of crown fire will occur. Recent trends in fires have been increased proportions of crown fire and high severity effects on forests, especially montane yellow pine and mixed conifer forests (Miller and Safford 2012, Steel et al. 2015). This is especially evident during and following the 2012-2016 drought, where increased crown or surface fuel loading has elevated the potential of uncharacteristically large and severe wildfires (see “Combined Effects of Climate, Fire, Insects, and Pathogens”).

Moist Mixed Conifer, compared with Dry Mixed Conifer Forests

Historically and currently, there are differences in the composition and structure of forests in drier sites, compared with moister parts of the landscape (Lydersen and North 2012). South and west-facing slopes are drier and more dominated by pines, whereas forests on north- and east-facing slopes, with less sun, have a greater fir component (Fites-Kaufman et al. 2007). The slope location also affects the moisture level for plants (Lydersen and North 2012). Drainages and lower slopes are moister. Ridges and upper slopes are drier. Differences in forests and vegetation were more prevalent prior to fire suppression and historic logging. Now forests are more uniformly dense and have a higher proportion of shade-tolerant firs (especially white fir) and incense cedar. Historically, both the moist and dry mixed conifer had higher levels of heterogeneity under a frequent fire regime (Lydersen et al. 2013). It is unknown if there were differences in heterogeneity between dry and moist mixed conifer forests. Reconstructions of historic forest patterns suggest that moist mixed conifer forests contained a higher proportion of denser forest patches than dry mixed conifer. The desired conditions for moist versus dry mixed conifer reflect these differences.

Both moist and dry mixed conifer forests are dissimilar to desired conditions. However, current dry mixed conifer forests are often more dissimilar to desired conditions than moist mixed conifer forests. Mixed conifer forests (both types) have higher tree densities (especially shade-tolerant species in the smaller size classes) and canopy cover, greater surface fuels, including coarse woody debris, greater snag densities, more homogenous stand structure (including the loss of canopy gaps), lower average tree diameter, and less understory plant diversity and cover (Safford and Stevens 2017). However, the dry mixed conifer forests have increased the most in tree density and canopy cover and had the greatest shift in composition from fire- and drought-tolerant pines (such as ponderosa pine and Jeffrey pine) to less fire and drought tolerant white fir and incense cedar (Lydersen and North 2012). Moist mixed conifer forests are slightly to moderately less departed from the natural range of variation and desired conditions, compared with dry mixed conifer forests. However, both mixed conifer types exhibit low resilience to stressors (drought, climate change, insects and pathogens, and uncharacteristic wildfire) as a consequence of fire suppression, past logging impacts, and other legacy effects (for example, widespread intensive grazing in the 19th century) that have led to a high departure from the natural range of variation. Both dry and moist mixed conifer are highly likely to experience high levels of crown fire during hot and dry fire weather conditions. Moreover, these mixed conifer types experienced moderately high levels of tree mortality during and following the 2012-2016 drought, particularly in denser stands experiencing greater levels of moisture stress (for example, lower elevations on south-facing slopes).

Upper Montane Zone

The primary vegetation types in this zone include red fir forest, Jeffrey pine forest, lodgepole pine forest, and montane chaparral (Potter 1998). These vegetation types and others (such as wet meadows and riparian areas) occur in a patchy mosaic across the upper montane landscape, depending on changes in elevation, topography, soils, climate, and prior disturbance history (like fire and insects). Fire is an important ecological process in the upper montane zone, influencing successional pathways and forest structural patterns, such as canopy patch-gap dynamics (van Wagtendonk and Fites-Kaufman 2006). However, decades of fire exclusion, timber harvest, and patterns of increasing high-severity fire in many upper montane forests have resulted in decreased heterogeneity and increased vegetation uniformity across the landscape (Meyer et al. 2014a, Kane et al. 2014). Increased high-severity fire has also resulted in greater degrees of forest fragmentation and reduced forest connectivity in upper montane forests (Kane et al. 2014). These patterns of increasing fragmentation resulting from stand-replacing fire are often linked to warming climate and, in fire-excluded forests characterized with a frequent fire regime (such as Jeffrey pine forests), increased fuel loading (Miller and Safford 2012, Safford 2013).

During and following the 2012-2016 drought, tree mortality in the upper montane zone of the southern Sierra Nevada has been most pronounced in red fir forests. Red fir stands occurring in drier portions of this zone (lower elevations, south-facing slopes outside drainages) with a history of fire exclusion have been most heavily impacted by the effects of exceptional drought and climate change, with many stands exhibiting moderate levels of tree mortality (Meyer 2017, Meyer et al. 2019). Jeffrey pine and lodgepole pine forests have been relatively less impacted by the recent exceptional drought, except in areas of increased Jeffrey pine and mountain pine beetle activity, respectively. There is little information on the effects of the recent drought on montane chaparral, but anecdotal observations suggest that these impacts are minimal. For more information on the effects of the 2012-2016 drought on upper montane forests, see "Changed Forest Conditions associated with Tree Mortality."

Red Fir Forests

Red fir forests are common in westside, upper montane landscapes of the southern Sierra Nevada. This forest type is dominated by red fir and typically occurs on deeper, more productive soils on most slope positions except ridgetops. Mixed red fir stands may also contain white fir at lower elevations and lodgepole pine, Jeffrey pine, western white pine, or mountain hemlock at higher elevations (Potter 1998). The understory may include several species of shrubs or herbaceous plants, including pinemat manzanita, greenleaf manzanita, huckleberry oak, chinquapin, snowberry, Utah serviceberry, mountain whitethorn, pine-woods lousewort, and Brewer's golden aster.

Tree species composition is generally similar to the desired conditions, but understory species cover and diversity in fire-excluded stands is at the lower end of the desired conditions and the natural range of variation (Meyer et al. 2014a, Meyer et al. 2019).

Current stand structure conditions in red fir forests are dissimilar to desired conditions. There has been a considerable shift in the tree size class distribution to smaller diameters. Forest structure at the stand and landscape scales is more uniform and less heterogeneous. There has been a decrease in the density of large-diameter red fir trees in many areas (Meyer et al. 2014a). Younger and intermediate-sized trees are denser than the desired condition, and there is a deficit of open-canopy mature and old forests in most of the plan area.

Resilience of red fir forests to drought, insects, pathogens, climate change, and high-intensity fire is moderate but declining. Recent tree mortality rates associated with insects, pathogens, and moisture stress in red fir forests is increasing at a rate that is exceeding the desired conditions and natural range of variation. Climate vulnerability of red fir forests is relatively high, compared with other vegetation types. Because red fir is associated with colder winters and snow, it is particularly vulnerable to climate change and drought, as observed during and following the 2012-2016 drought in California. Resilience to high-intensity fire is moderate. Higher stand density, more uniform forest structure, and increased surface fuel loading associated with fire exclusion and drought-related tree mortality have resulted in increased high severity areas. Although some areas of high severity are within the natural range of variation (van Wagtendonk and Fites-Kaufman 2006), larger patches of high severity are becoming more common with drought and climate change as observed in some upper montane forest landscapes burned in the 2013 Rim Fire and 2015 Rough Fire.

Jeffrey Pine Forests

Jeffrey pine forests typically occupy more xeric, or very dry, locations in the upper montane zone of the southern Sierra Nevada. This forest type generally occurs on shallow, less productive soils on middle to upper slope positions. Jeffrey pine forests are dominated by Jeffrey pine but may be mixed with shade-tolerant white fir at lower elevations and red fir at higher elevations (Potter 1998).

There is a moderate difference between current species composition and the desired conditions. Because Jeffrey pine occurs on very dry sites, most often on shallow, rocky soils, vegetation is slow to change. Because of fire suppression, there has been an increase in shade-intolerant white fir and red fir trees.

Current stand structure conditions in Jeffrey pine forests are also different from desired conditions; however, there has been less change than with the red fir, lodgepole pine, or mixed conifer forests due to slower ingrowth of other species. There has been a shift in the tree size class distribution to smaller diameters, which has resulted in more uniform and less heterogeneous forest structure at stand and landscape scales. Overall canopy cover has increased, there are fewer canopy gaps or openings, and there has been a decrease in the density of large-diameter Jeffrey pine trees (Safford 2013). There is a deficit of open-canopy mature forests throughout the plan area,, compared with the desired conditions. Surface fuels and small trees that serve as ladder fuels are greater than the desired condition.

Resilience is moderate in Jeffrey pine forests. Climate vulnerability of Jeffrey pine forests is relatively low, compared with other forest types in the upper montane and subalpine zones (Schwartz et al. 2013a) and Jeffrey pine may exhibit greater resilience to projected increases in temperature and fire frequency in the Sierra Nevada (Monleon and Lintz 2015, Stephens et al. 2010). This is because Jeffrey pine is a very drought- and fire-tolerant species, compared with other upper montane conifers such as red fir. Notably, Jeffrey pine has experienced relatively lower levels of tree mortality during and following the 2012-2016 drought (see Changed Forest Conditions associated with Tree Mortality). Where forest density has increased more, these stands have moderate resilience. These areas are more likely to experience stress from drought, insects, pathogens, or fire-related mortality. Fire resilience is moderate to high. Fire is moderated in areas where Jeffrey pine is low density and has not increased, especially on very rocky sites.

Montane Chaparral

Montane chaparral occurs in various sized patches in the upper montane zone, varying from one to hundreds of acres. It occurs on two types of areas. First it occupies the rockiest and driest locations in the southern Sierra Nevada. Chaparral patches are often interspersed with Jeffrey pine forests. It may also occur on previously forested sites that burned at high severity once or several times. Montane chaparral is mostly a temporary vegetation type, or early seral stage of forest, and is invaded and replaced by forest over time in the absence of recurrent fire. In the upper montane zone, forests are slow to recolonize chaparral, so it can persist for tens or hundreds of years on potentially forested areas (Estes 2013a).

The diversity and composition of current montane chaparral is similar to the desired conditions. However, the density of advanced tree regeneration in some areas of montane chaparral may exceed the natural range of variation where fire has been excluded for more than a century. Fire favors chaparral shrub species, most of which sprout following a fire that kills most of the shrub above ground, or have seeds that are stimulated to germinate from heat. Most small conifers are killed during fires in chaparral because these fires burn at moderate to high intensity.

Current structural conditions in montane chaparral are similar to the desired conditions. Climate vulnerability of montane chaparral is relatively low, compared with other vegetation types in the upper montane and subalpine zones because the shrub species are very drought and temperature tolerant. During the 2012-2016 drought, montane chaparral experienced minimal mortality in the southern Sierra Nevada. However, in some locations of the plan area, montane chaparral is currently threatened by the combination of invasive plant species (such as invasive annual grasses) in areas repeatedly burned by fire. Alternatively, in some limited areas, the long-term lack of fire results in vegetation succession or shift to forests, mostly fir dominated. As the trees grow larger, they shade out the shrubs. Historically, fire returned on average every 30 to 50 years, which killed the young, growing conifers in many areas. Other areas would change to forests, and some forest patches would burn at high severity and change to chaparral. Recent fires have restored the pattern to some degree. More recent fires may have resulted in larger patches of montane chaparral because of recent trends of increasing wildfire size and extent across the southern Sierra Nevada.

Subalpine and Alpine Zone

The subalpine and alpine zone of the southern Sierra Nevada is characterized by mostly steep slopes, poorly developed granitic-based soils, and a very high percentage of precipitation that falls as snow (van Wagtendonk and Fites-Kaufman 2006). The primary vegetation types in this zone include subalpine and alpine forest (Potter 1998). Warming climate trends in the plan area are likely to lead to increased fragmentation and reduced connectivity of subalpine and alpine vegetation, especially in the latter half of the 21st century (Lenihan et al. 2008, Schwartz et al. 2013a). These broad-scale changes have important implications for a wide array of species dependent on subalpine and alpine environments, especially southern Sierra Nevada endemics such as foxtail pine (subspecies *austrina*), alpine chipmunk, granite draba, Sierra Nevada leptosiphon, and sweet-smelling monardella (Meyer et al. 2014a, Rundel 2011).

Subalpine Woodlands and Forests

Subalpine vegetation occurs near the highest elevations of the plan area. Subalpine tree-dominated areas form woodlands when trees are sparse or low density. Most subalpine tree-dominated areas are woodlands. In other areas, trees are moderate to high density, more often in smaller patches. These areas comprise subalpine forests. The subalpine vegetation type typically occurs on shallow, less productive soils on most slope positions, including ridgetops and steep slopes.

Current overstory and understory species composition is similar to the desired conditions. Current subalpine woodland and forest structure is also mostly similar to desired conditions, although there is a recent increase in the density of small-diameter subalpine trees and a decrease in the density of large-diameter trees. This has been attributed to climatic warming trends, which has increased favorable growing conditions in this harsh environment (Meyer 2015c, Safford et al. 2012a).

Resilience of subalpine woodlands and forests was high until recently but is undergoing rapid changes due to climate warming. Climate vulnerability of subalpine forests is among the highest of all vegetation types in the plan area (Meyer et al. 2014a, Safford et al. 2012a). Tree mortality rates associated with moisture stress and insects in subalpine forests dominated by high-elevation white pines is increasing at a rate that may soon exceed the desired conditions and natural range of variation. For example, during the earlier 2007-2009 and later 2012-2016 droughts, some high-elevation white pines, such as limber pine and whitebark pine, have experienced high levels of mortality in specific areas of the southern Sierra Nevada (Meyer et al. 2016, Millar et al. 2012). Resilience to fire is generally high in subalpine forests and woodlands (Meyer et al. 2014a).

Alpine Vegetation

Alpine vegetation occurs at the highest elevations of the plan area (greater than 10,000 feet elevation). This vegetation type typically occurs on very shallow, low productivity soils on most slope positions, including ridgetops and steep slopes. Alpine vegetation in the plan area is dominated by perennial herbaceous plants (like Mason’s sky pilot) or dwarf shrubs (such as white heather) but may also contain small, isolated subalpine tree islands and krummholz (stunted) whitebark pine stands. Shallow bedrock may dominate much of the cover in many alpine landscapes of the plan area.

Current species composition and structure of alpine vegetation is very similar to the desired conditions. Resilience is low to moderate. The vegetation in the alpine areas establishes and grows very slowly. Climate vulnerability of alpine vegetation is among the highest of all vegetation types in the plan area (Lenihan et al. 2008, Safford et al. 2012a), and some alpine plant and animal species have recently shifted their geographic ranges to higher elevations in the plan area (Moritz and Stephens 2008, Kopp and Cleland 2014). With no other area to go to at higher elevations for cooler temperatures, these plants may decline in numbers or locations. Despite high climate vulnerability, effects of the 2012-2016 drought appears to have been minimal in alpine ecosystems; however, the absence of recent information from the southern Sierra Nevada makes this conclusion uncertain.

Kern River Drainage

The Kern River drainage includes the Kern Plateau, located east of the Kern River, which dominates the center of the Sequoia National Forest and a small area in the southwest portion of the Inyo National Forest. The canyon where the Kern River drains is also included in the Kern River drainage, especially in the north and middle sections of the watershed. Much of this area is remote and steep and as a result there have been multiple wildfires that have been managed to meet resource objectives in this area over the past 15 years (Meyer 2015a). Most of the area is in the montane zone, followed by the upper montane zone. There are smaller subalpine and foothill areas that are included. Some of the fires in the area have been very large, and mostly high intensity and severity, including the 2002 McNally Fire. This was in the western portion and partly outside of the Kern River drainage. Most of the 2002 McNally Fire was not beneficial because it had very large patches of high-severity fire, but the majority of the fires have been beneficial and have resulted in substantial movement toward desired conditions (Fites-Kaufman et al. 2005), (Ewell et al. 2012, Meyer et al. 2015).

On the Kern Plateau, extensive fires have occurred over the last 15 years in a range of weather conditions. Because the area is very dry, increases in forest density have been less dramatic than in other mixed conifer areas. There has been less ingrowth of white fir. Because of these more moderate changes in forest density and composition, the effects of the fires in the last 15 years have been less severe in many areas. For many of these fires, there has been a greater proportion of moderate- and low-intensity fire and resulting low- and mixed-severity effects. As a result, large areas have had reductions in forest density toward the desired conditions. There has been an increase in heterogeneity at the landscape, patch, and within-patch scales in forests and chaparral.

These fires have restored understory plant composition and condition, since the majority of the species are adapted to and many benefit from fire. This includes the riparian areas. Examples include lupines, aspen, grasses, and other sprouting plants. Overall, the montane and upper montane forests and chaparral in much of the Kern Plateau have a moderate to high similarity to desired conditions. The area has a moderate to high resilience to drought, insects, pathogens, climate change, and high-intensity fire. This is apparent in lower levels of tree mortality and increasingly restricted sizes of large fires. This has happened multiple times, mostly recently on the 2015 Rough and Cabin Fires in the Sequoia National Forest (Reiner et al. 2016). Levels of tree mortality following the 2012-2016 drought are generally lower on the Kern Plateau, compared with similar parts of the Sequoia and Sierra National Forests (see Figure 8 and Figure 9), likely owing to the relatively higher levels of fire restoration and generally higher elevations of this area.

Arid Shrublands and Woodlands Zone

Arid shrublands and woodlands dominate the lower elevations in the southeastern portions of the Sequoia National Forest. The primary vegetation types include pinyon-juniper and sagebrush. These vegetation types in the Sequoia National Forest occur in an area of convergence between two biogeographic provinces: the Sierra Nevada and Mojave Desert, and as a result have high plant diversity and some unusual plant combinations. Changes in climate and the fire and grazing regimes in the late 19th and 20th centuries have been particularly important factors influencing the composition, structure, and distribution of the different vegetation types in the plan area (Slaton and Stone 2015a, b). These changes include some limited expansion of trees into open shrublands and changes in vegetation successional patterns associated with modern livestock grazing and fire exclusion, although these patterns depend on several additional factors (such as vegetation type or climate). Invasive plants like cheatgrass and red brome have also significantly expanded their range in many arid shrublands and woodlands in recent years in the bioregion (Slaton and Stone 2015a, b). In some cases this has led to type conversion from native shrub or woodland vegetation to nonnative grasslands. This rate of invasion is expected to continue or increase in the future, although projected changes in climate will alter the geographic distribution of these invasions in the later 21st century (Bradley 2009, Finch 2012).

Sagebrush

This vegetation type occurs in small portions of the eastern Sequoia National Forest. The distribution of different sagebrush species are strongly correlated to temperature and precipitation regimes. Dominant species include sagebrush and bitterbrush (Slaton and Stone 2015b).

The condition of sagebrush areas depends on the location and environment. The current composition and structure of sagebrush on some more productive substrates are different from the desired conditions for this vegetation type. The composition and structure on less productive, harsher (colder, drier, shallow and rocky) soils is mostly similar to desired conditions.

Projected changes in climate suggest that the geographic distribution of sagebrush will largely shift northward and to higher elevations due to increased summer moisture stress (Finch 2012).

Overall, resilience of sagebrush is low to moderate depending on the type of sagebrush, amount of nonnative annual grasses and proximity to risk factors for fire and nonnative grass invasion. Nonnative invasive plant species are increasing in number and extent in sagebrush. Most notably the invasive annual grasses of cheatgrass and red brome have increased.

In the arid shrubland vegetation types of the Sequoia National Forest, there are sagebrush and pinyon-juniper areas that have decreased fire resilience because of nonnative annual grasses (such as cheatgrass and red brome) that make them susceptible to more frequent fires that disrupt native vegetation composition and structure (Chambers et al. 2014). For example, postfire vegetation recovery in sagebrush ecosystems invaded by cheatgrass can result in the conversion of sagebrush vegetation to nonnative annual grassland, especially in the presence of other stressors, such as inappropriate livestock grazing and climate change (Chambers et al. 2007, Chambers et al. 2014).

Pinyon-juniper

Pinyon-juniper is present in the Southeastern Sequoia National Forest, especially in the Scodie Mountains, eastern Piute Mountains, and portions of the eastern Kern Plateau. Pinyon-juniper is dominated by singleleaf pinyon and Sierra juniper, although many stands in the plan area are dominated exclusively by singleleaf pinyon (Slaton and Stone 2013). Pinyon-juniper types may also be mixed with or located in close proximity to sagebrush and other arid-adapted vegetation types.

The condition of structure in pinyon-juniper, compared with desired conditions varies with location and environment. Where pinyon-juniper grows on harsher sites (steep rocky slopes and ridges or sites with shallow and rocky soils), structure is generally similar to desired conditions (Slaton and Stone 2015a). On more productive sites, structure of pinyon-juniper is moderately dissimilar to desired conditions, including higher tree densities and fuel loading.

Resilience also varies with location and environment. On the harsher sites, the vegetation is generally resilient because the structure has remained more open and there is low understory vegetation cover. On more productive sites, resilience is low to moderate. Higher tree density, accumulated fuels around the base of the trees, and higher and more decadent shrub, grass, and herb cover result in higher-intensity fire and less resilience to drought, insects, and pathogens. During and following the 2012-2016 drought, there have been elevated levels of tree mortality in pinyon-juniper woodlands, especially for pinyon pine stands in the Piute and Scodie Mountains of the Sequoia National Forest (see “Changed Forest Conditions associated with Tree Mortality”). Pinyon-juniper ecosystems invaded by cheatgrass have reduced ecological integrity and are prone to type conversion to nonnative grasslands, particularly in areas of inappropriate livestock grazing, uncharacteristic wildfires (fires burning too frequently), and other stressors (for example, high vulnerability to climate change) (Miller et al. 2014a, Miller et al. 2014b).

Environmental Consequences to Vegetation Composition, Structure, and Resilience

This analysis focuses on vegetation types most departed from the natural range of variation and vegetation desired conditions in the draft forest plans. These vegetation types are also the focus of restoration actions (mechanical and prescribed fire treatments and managing wildfire to meet resource objectives) and where the greatest potential consequences will occur. This includes ponderosa pine, mixed conifer, Jeffrey pine, and mixed pine-black oak vegetation types. There will also be some increased emphasis on restoration actions in upper montane red fir and lodgepole pine forests in some alternatives. There will be some focused management of chaparral in westside foothills, particularly near developed areas. There will be limited management of other vegetation types, including blue oak woodlands, subalpine forests and woodlands, alpine vegetation, and arid shrublands and woodlands (pinyon-juniper, sagebrush, xeric shrub). In these vegetation types, management will primarily focus on the use of prescribed fire or wildfires managed for resource objectives.

Consequences Common to all Alternatives

For purposes of this analysis, it is assumed that when vegetation treatments move vegetation toward the vegetation desired conditions, the vegetation moves toward the natural range of variation and has associated benefits of moving toward ecological integrity and sustainability. The landscape amount and intensity of the treatments affect how much the vegetation moves toward desired conditions. Low-intensity treatments, where little area is treated or slight changes are made, would have a slight improvement in vegetation conditions (Schmidt et al. 2006), (Stephens et al. 2015). When more area is treated, particularly at the landscape scale, there is a greater positive impact on ecological integrity and sustainability. For example, as described in “Fire Trends,” the effect of restoring between 40 and 60 percent of the landscape was sufficient to result in reduced trends in large fires and associated large, high-severity patches that are considered outside the natural range of variation (van Wagtendonk and Fites-Kaufman 2006, Collins and Skinner 2014, Stephens et al. 2015).

The primary types of vegetation treatments will be used to variable degrees in all alternatives. Treatments would include mechanical thinning (various prescriptions, understory, varied diameter), salvage, mastication, prescribed fire (small and landscape, by itself or with mechanical treatment), and wildfire managed for resource objectives. The environmental consequences depend on the extent and intensity of the treatment and the vegetation type it is applied in. Below is a brief description of the array of restoration treatments that will be used and a summary of the overall consequences for the major vegetation types they will be applied to. This includes the most recent and relevant best available scientific information. A more detailed discussion of the best available science is found in the vegetation ecology supplemental report.

Mechanical Treatments: Montane Zone

Mechanical restoration treatments can be highly effective at restoring forest structural features (canopy cover, tree density, heterogeneity) and overstory tree species composition in lower and upper montane forests (Larson et al. 2012, North 2012, 2014, North et al. 2007, North et al. 2009a). However, the type and intensity of treatment can result in varying levels of change in forest structure. Additionally, mechanical treatments may be effective at achieving some restoration objectives (for example, restoration of tree species composition), but these treatments are often less effective than fire treatments (prescribed fire or wildfires managed for resource objectives) for the restoration of structural heterogeneity and key ecological processes (for example, nutrient cycling, plant-pollinator interactions, soil respiration).

In long-term monitoring plots on Forest Service study sites in California, both overstory and pole-sized tree densities were effectively reduced following mechanical treatment but fuels levels increased 8 years following treatment due to vegetation regrowth and dead fuel accumulation (Vaillant et al. 2015). Similarly, fuel treatment research plots also resulted in decreases in tree density (Stephens and Moghaddas 2005). There are two types of thinning that would occur in all alternatives (but especially alternatives B, C, D, and E). One is thinning from below where smaller diameter trees are removed. The second is variable diameter thinning where smaller-diameter understory trees and some larger-diameter midstory or overstory trees are removed. There is no specific research to compare the effects of these two approaches on moving vegetation toward the desired conditions. However, in many stands that have densities exceeding the desired conditions, thinning from below will remove fewer trees and have a limited effect of moving stands toward desired conditions for canopy cover, basal area, or heterogeneity. This is especially likely where there are large numbers of mid-sized trees dominating a stand, such as following railroad logging.

There is limited information on the efficacy of mechanical treatments in montane forest stands with high levels of tree mortality resulting from the 2012-2016 drought in California. However, recent monitoring of restoration projects in the southern Sierra Nevada suggest that strategic mechanical thinning can be an effective tool in restoring desired forest stand conditions or facilitating desirable successional trajectories in tree mortality landscapes (Young et al. 2019). Coupled with prescribed burning, mechanical thinning can help increase stand resilience to future insect outbreaks and droughts and reduce forest fuels to more desirable levels (Stephens et al. 2018). This includes the use of mechanical thinning treatments to facilitate ecological transitions in montane forests (for example, shift in dominance from ponderosa pine or white fir to hardwoods with a pine component) to increase stand resilience to insects, drought, uncharacteristic wildfires, and climate change (Millar and Stephenson 2015).

Prescribed Fire and Wildfire Managed for Resource Objectives: Montane Zone

Prescribed fire can restore understory species composition (Wayman and North 2007), (Webster and Halpern 2010), and reduce tree density (Stephens and Moghaddas 2005), (Vaillant et al. 2015). The amount of reduction in overstory tree density depends on the intensity and size of the fire. Low-intensity fires have little to no effect on overstory tree density and composition, but moderate-intensity fire has been found to reduce forest density by up to 70 percent and basal area by 20 percent (Schmidt et al. 2006). There is little research on the effects of prescribed fire on heterogeneity, but the prevailing view is that prescribed fire can increase heterogeneity if it is incorporated into the burn prescription (Collins and Skinner 2014), especially if it is moderate intensity (Schmidt et al. 2006). Larger landscape prescribed fire or wildfire managed for resource objectives are likely to restore heterogeneity at multiple spatial scales (Kane et al. 2013, Collins et al. 2011, Kane et al. 2014, Meyer 2015a). This may be due in part to more varying fire intensity with larger burn areas, across a wider range of conditions (burning day and night, on different days). Wilderness areas are especially conducive toward the management of wildfires for resource objectives, which supports ecological benefits in wilderness areas of the southern Sierra Nevada (Meyer 2015a) and elsewhere in the western United States (Miller and Aplet 2016). Additionally, wilderness areas with restored natural fire regimes can provide important reference sites that inform wildland fire science and the natural range of variation in montane forest ecosystems (Miller and Aplet 2016). Prescribed fire treatments can also increase the resilience of montane forest stands to moisture stress as observed during the 2012-2016 drought (van Mantgem et al. 2016).

Mechanical and Prescribed Fire Treatments: Montane Zone

Many studies show that the combination of mechanical thinning and prescribed or wildfire managed to meet resource objectives are the most effective in reducing vegetation density, restoring understory and overstory composition, and increasing heterogeneity (North et al. 2007, Collins et al. 2007, Collins and Skinner 2014). This is especially the case for understory composition. Many plants in the analysis area in areas that had frequent fire historically are fire adapted (Fites-Kaufman et al. 2006, van Wagtendonk and Fites-Kaufman 2006).

The longevity of restoration treatments depends largely on the growth rates of the plants that have been affected by the treatments. For understory trees and shrubs, reduced density only lasts 8 to 15 years because they grow back rapidly (Stephens et al. 2012, Chiono et al. 2012, Vaillant et al. 2015). On the other hand, fire-induced reductions in tree density took up to 8 years to be realized in one prescribed fire study in the analysis area (Van Mantgem et al. 2011).

Mechanical and Prescribed Fire Treatments: Montane and Upper Montane Zone

Most of the literature on the ecological restoration of upper montane forests is partially covered and summarized in the technical reports also devoted to lower montane forests (North et al. 2009a, North 2012, Long et al. 2014, Safford 2013). This overlap is especially evident for Jeffrey pine forests of the Sierra Nevada. Consequently, information pertaining to the restoration of Jeffrey pine and some other upper montane forests are presented in the montane zone sections above.

The best information pertaining to the effectiveness of mechanical treatments at restoring structural heterogeneity in mixed conifer stands comes from research conducted at the Teakettle Experimental Forest and Stanislaus-Tuolumne Experimental Forest. Understory and variable-density thinning in mixed conifer stands at these experimental forests resulted in reduced stem density and a residual spatial tree pattern that was closest to historic conditions (reduced tree clustering at smaller spatial scales), although surface fuel loading was not reduced relative to stands not thinned (North et al. 2007, Knapp et al. 2017). Consequently, understory thinning (and especially variable-density thinning) increased structural heterogeneity at smaller spatial scales. At the Teakettle and Stanislaus-Tuolumne Experimental Forests, prescribed burning decreased stand densities, reduced surface fuel loading, and increased stand heterogeneity but had marginal effects on canopy cover. In contrast, mixed conifer stands at Teakettle treated with a combination of mechanical thinning followed by prescribed burning had substantially lower densities and canopy cover (closer to the historic conditions or natural range of variation), reduced fuel loading, and greater stand heterogeneity than untreated stands or those treated with prescribed burning alone (North et al. 2007, Knapp et al. 2017). Consequently, posttreatment stand structure in the combined understory-thinning and burn treatment was closer to the historic conditions and resulted in generally greater stand structural heterogeneity than found in stands treated with a single restoration treatment (mechanical thinning or prescribed burning alone). The combination of mechanical and prescribed fire treatments was most effective at restoring stand structure, but only in cases where the mechanical treatments retained the largest-diameter trees in the stand and where thinning prescriptions emphasized variable-density thinning to enhance structural heterogeneity (North et al. 2007, North et al. 2009a, Knapp et al. 2017).

In red fir forests, low-severity fire is especially conducive to increasing forest structural heterogeneity at multiple spatial scales (Kane et al. 2013). In addition, surface fuel loading tended to be two times higher in unburned than twice-burned red fir stands of Yosemite National Park, with high variation in fuel loading among burned and unburned sites. Both prescribed fire and wildlife managed for resource objectives (especially low to moderate severity fire) are highly effective at restoring stand structure (for example, tree densities, basal area, canopy cover, heterogeneity) and understory diversity in red fir forests (Meyer et al. 2015, Meyer et al. 2019).

Mechanical and Prescribed Fire Treatments: Arid Shrublands and Woodlands

There are limited treatments that will occur in arid shrublands and woodlands in the Sequoia National Forest. The primary purpose of these treatments is to reduce fire hazard around communities and developed areas using mechanical mowing, crushing, or mastication treatments. Restoration treatments in sagebrush and pinyon-juniper vegetation may also focus on enhancing structural heterogeneity, age and size diversity, and understory diversity by reducing the density of large and dense vegetation patches.

Woody vegetation reduction by any means, either prescribed fire or mechanical treatments, can result in higher herbaceous cover (McIver et al. 2014). Where woody vegetation cover is removed and tree cover is reduced in dominance, there can be benefits to understory plant species richness and diversity (Roundy et al. 2014). Prescribed fire can be effective at removing woody vegetation but may result in a greater risk of invasion by nonnative annual plants (Chambers et al. 2014, Miller et al. 2014b, Pyke et al. 2014). Mechanical treatments can more directly target individual trees that are desired to be removed but also can lead to increased nonnative plant invasion, especially in areas of inappropriate livestock grazing or off-highway vehicle (OHV) use (Chambers et al. 2014, Miller et al. 2014b, Pyke et al. 2014). However, the use of targeted nonnative plant treatments (for example, control or eradication of invasive annual grasses such as cheatgrass) or seeding with native perennial bunchgrasses and forbs in combination with mechanical thinning and prescribed fire treatments may reduce the long-term abundance or occurrence of some nonnative plants, especially in cooler and moister sites (Chambers et al. 2014, Miller et al. 2014a, Pyke et al. 2014).

Treatment of shrub vegetation with mowing and prescribed fire have varying effects on the understory but different effects in the shrub layer. Some researchers found increases in native herbaceous and perennial grass species with prescribed fire or mowing (Bourne and Bunting 2011), (Chambers et al. 2014, Miller et al. 2014b, McIver et al. 2014), whereas others found decreases (Pyke et al. 2014). Shrub cover responses varied with decreases reported after prescribed fire (Roundy et al. 2014) or mowing (Bourne and Bunting 2011). In some cases, shrub cover decreased for the first year (Bourne and Bunting 2011) but then cover and seedling density rebounded or increased by year three. One study (Miller et al. 2014b) summarized the shrub changes in terms of greater sage-grouse habitat and reported an increase of three times in shrub cover for prescribed fire and two times pretreatment levels for mechanical treatments.

Mechanical treatments in arid shrublands and woodlands may include some limited cutting and falling of encroaching conifers, followed by the piling or scattering of slash or removal of slash offsite. Mastication treatments can be applied to mow and mulch shrubs and small trees. Slash may be chipped to alter and redistribute surface fuels. Conifer removal and mastication treatments are generally effective at restoring ecosystem structure and are considered low- to moderate-intensity methods with less impact on biological soil crusts and less invasive species spread than high-intensity mechanical methods (chaining, bulldozing, plowing) (Chambers et al. 2014, Miller et al. 2014b). Mechanical treatments of encroached conifers in sagebrush ecosystems generally result in increased native herbaceous plant cover and diversity (including native forbs and perennial grasses), increased native shrub abundance, reduced canopy and ladder fuel loading, and increased fine surface fuel loading (Roundy et al. 2014). Mechanical treatments are most effective in promoting native herbaceous plant and sagebrush cover and inhibiting cheatgrass cover with the application of posttreatment management approaches, such as delayed grazing coupled with posttreatment monitoring (Chambers et al. 2014, Miller et al. 2014b). Cheatgrass abundance may actually increase following mechanical treatments in the absence of these posttreatment measures (Chambers et al. 2007, Miller et al. 2014a).

Prescribed fire may be applied in pinyon-juniper and sagebrush ecosystems to restore ecosystem structure and composition (Chambers et al. 2014, Miller et al. 2014b, Miller et al. 2014a). Applied alone or in combination with mechanical treatments, prescribed fire can be effective at reducing the densities of encroaching conifers, increasing sagebrush seedling density, increasing native forb and grass cover, reducing ladder and surface fuel loading, and decreasing overall biomass (Miller et al. 2012, Rau et al. 2010). Prescribed fire is particularly effective at restoring ecosystem composition and mitigating cheatgrass invisibility in sagebrush ecosystems with relatively high ecological integrity (in the early to mid-phase of pinyon or juniper expansion) (Chambers et al. 2014). In contrast, the application of prescribed fire can exacerbate cheatgrass invasion in sagebrush ecosystems lacking sufficient pre-fire cover or seed banks of residual native grasses and forbs (as in the late phase of pinyon or juniper invasion) (Jones et al. 2015, Miller et al. 2014a). Additionally, prescribed fire (especially at higher burn intensities) can reduce the abundance of biological soil crusts (Miller et al. 2014a), which reduces the resistance of sagebrush ecosystems to cheatgrass invasion (Chambers et al. 2007). However, proper pre-fire fuel mitigation such as mechanical treatments and postfire management (like grazing management) may help reduce some of the impacts of prescribed fire on biological soil crusts (Miller et al. 2014b).

Invasive Plant Treatments All Areas

All alternatives include similar measures to mitigate the invasion and spread of nonnative species such as risk assessment and rapid identification and control where possible.

Ecological Fire Resilience

Ecological fire resilience is most important at the landscape scale. Individual small patches of high fire severity are within the natural range of variation (van Wagtendonk and Fites-Kaufman 2006). The consequences of large areas of high severity and proportions exceeding the natural range of variation are important. To analyze these consequences, ecological fire resilience was analyzed using "benchmark" or generalized landscape restoration levels of 15, 30, 60, and 100 percent of the landscape (see "Fire Trends," scenario modeling discussion). The specific locations of restoration treatments are not identified in the draft programmatic plans or alternatives. These results were used to make inferences on the consequences of the different levels and spatial patterns of restoration among the alternatives. See the discussion in "Fire Trends" for more detail on the effects of landscape changes in vegetation and effects on fire and potential for large, high-intensity fires.

The changes in ecological fire resilience for the scenarios are shown in Figure 29. For the primary forest types where restoration would occur (ponderosa pine, mixed conifer, black oak-ponderosa pine, red fir, Jeffrey pine), high resilience is where less than 25 percent of the area would burn as crown fire. Low resilience is where more than 75 percent of these areas would burn as crown fire. While the scenarios were not developed specifically for the alternatives, alternative A would be most similar to the current condition or 15 percent restoration scenario, alternative B would be most similar to the 15 percent or 30 percent scenarios, alternatives C and E would be most similar to the 15 percent scenario, and alternative D would be most similar to the 30 percent to 60 percent scenarios.

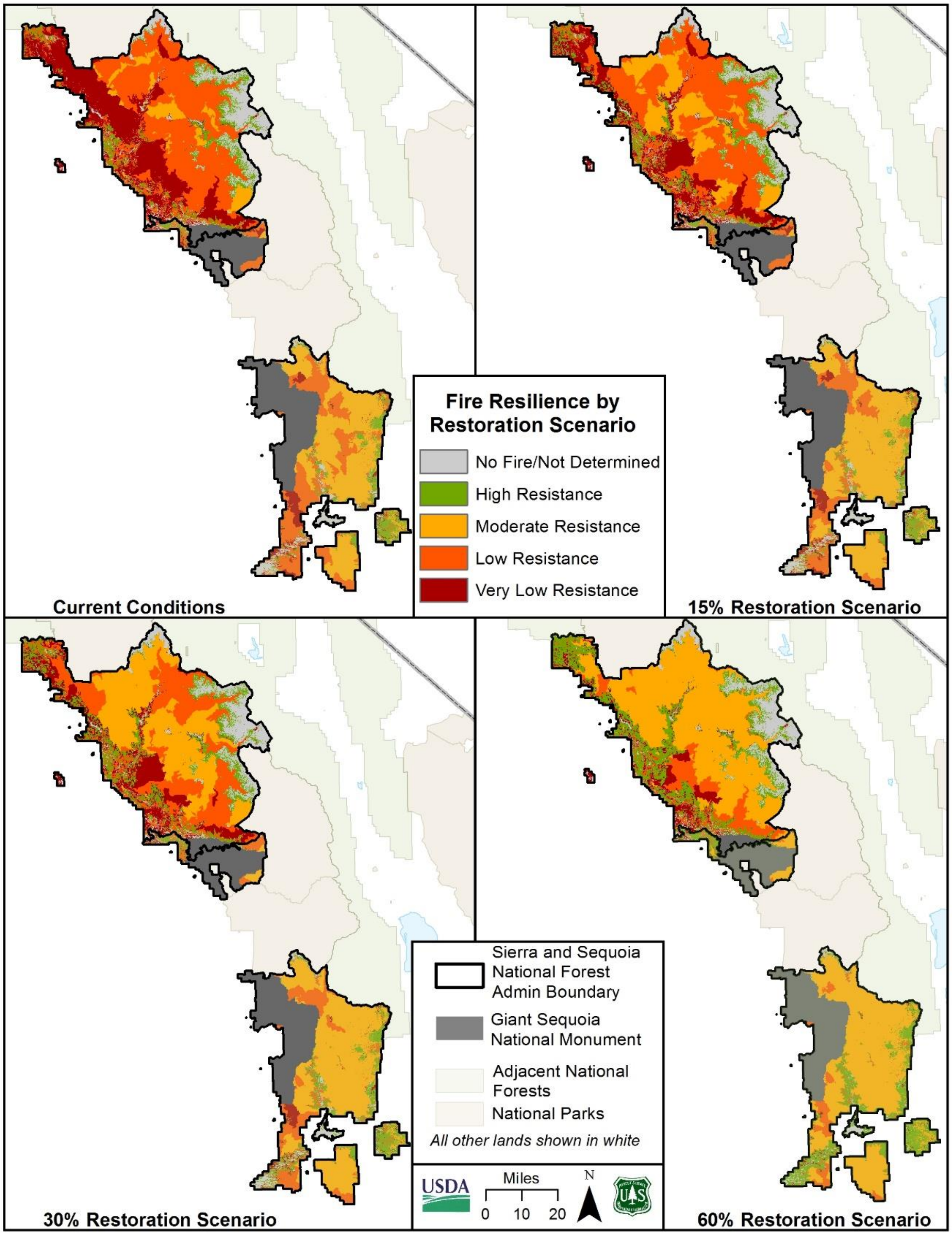

Figure 29. Landscape ecological fire resilience by restoration scenarios

Consequences Common to Alternatives B, C, D, and E

Alternatives B, C, D, and E share most of the same vegetation desired condition and other plan components (Table 25). The differences are in some of the overlapping desired conditions for some wide-ranging wildlife species, namely the California spotted owl and fisher. Below is a discussion of the general nature and environmental consequences of the large number of shared vegetation desired conditions.

Table 25. Draft forest plan desired conditions for vegetation across all vegetation types

Vegetation Desired Conditions[1]	Draft Forest Plan Section[1]
Mosaic providing ecosystem integrity and diversity. Provides habitat for native and desirable nonnative plant and animal species.	TERR-FW-DC SPEC-FW-DC
Resilience to climate change, drought, insects, and pathogens	TERR-FW-DC
Conditions contribute to recovery and persistence of threatened and endangered species and species of conservation concern	TERR-FW-DC SPEC-FW-DC
Provides landscape connectivity for wide-ranging habitat generalist (deer) and habitat specialist (old forest) species	TERR-FW-DC
Carbon-carrying capacity is stable or improving	TERR-FW-DC
Fire occurs in ecologically appropriate regime and enhances ecosystem heterogeneity, habitat, and species diversity. Vegetation conditions help reduce the threat of undesirable wildfires to local communities, ecosystems, and scenic character.	TERR-FW-DC
Landscape sustainability provides a variety of benefits to people	TERR-FW-DC
Vegetation supports continued use by tribes	TERR-FW-DC

[1] Specific sections where desired conditions are referenced in the Land Management Plan for the Sequoia and Sierra National Forests

The vegetation desired conditions for these alternatives are specific to each major vegetation type and include desired ranges and often median levels of seral stages and canopy cover, basal area, snags, and large tree densities (Table 26). These are based on a combination of best available scientific information that reflects the natural range of variation (Safford et al. 2013, Meyer et al. 2014b) and habitat requirements for wide-ranging federally listed species or species of conservation concern (for example, California spotted owl, fisher; see vegetation desired condition supplemental report). There are more general desired conditions that are important, but there is no specific best scientific information to base them on. This includes forest heterogeneity (North et al. 2009a, North 2012).

Table 26. Organization of draft forest plan desired conditions by ecological zone and major vegetation types

Ecological Zone	Vegetation Types	Draft Forest Plan Section[1]
Foothill	Blue oak woodlands; Live oak/chaparral	TERR-BLU-DC; TERR-CHAP-DC
Montane	Ponderosa pine, Black oak, Dry mixed conifer, Moist mixed conifer	TERR-MONT-DC; TERR-BLCK-DC; TERR-POND-DC; TERR-DMC-DC; TERR-MMC-DC

Ecological Zone	Vegetation Types	Draft Forest Plan Section[1]
Upper Montane	Red fir, Jeffrey pine, Moist lodgepole pine, Dry lodgepole pine; Montane chaparral	TERR-UPPR-DC; TERR-RFIR-DC; TERR-JEFF-DC; TERR-LDGP-DC; TERR-MCHP-DC
Subalpine/Alpine	Subalpine conifer, Alpine dwarf shrub	TERR-ALPN-DC
Arid Shrublands and Woodlands	Sagebrush, Pinyon-juniper, Xeric shrub	TERR-SAGE-DC; TERR-PINY-DC; TERR-XER-DC

[1] Specific sections where desired conditions are referenced in the Land Management Plan for the Sequoia and Sierra National Forests

Comparison of Composition and Structure by Alternative

Table 27 through Table 32 show how similar vegetation composition and structure would be to desired conditions by ecological zone and vegetation type for each alternative. Table 27 shows foothill vegetation, Table 28 and Table 29 show montane vegetation, Table 30 shows upper montane vegetation, Table 31 shows subalpine and alpine vegetation, Table 32 shows arid shrubland and woodland vegetation (sagebrush, pinyon-juniper, and xeric shrub), and Table 33 shows the Kern River drainage (Jeffrey pine, mixed conifer, upper montane, and subalpine forests and woodlands). This area represents an ecological transition between westside and eastside vegetation. A discussion of the consequences by alternative follows.

Table 27. Similarity to vegetation composition and structure desired conditions for foothill vegetation by alternative

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Composition	Low to moderate	Moderate	Low to moderate	Same as B
Composition (Invasive plants)	Low	Low-moderate (restoration areas)	Low	Same as B, or slightly lower
Structure	Low to moderate	Moderate (restoration areas)	Low to moderate	Slightly greater than B

Table 28. Similarity to vegetation composition and structure desired conditions for montane vegetation by alternative

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Composition	Low (limited restoration)	Low-moderate; moderate in increased areas of restoration and managed fire	Low (moderate in some areas of fire restoration)	Moderate (increased restoration)
Composition (Invasive plants)	Moderate	Moderate, slightly greater than A	Moderate	Slightly more than B
Structure	Low (limited restoration)	Low to moderate; increased areas of restoration and managed fire	Low (moderate in some areas of fire restoration)	Moderate (increased restoration)

Table 29. Similarity to vegetation composition and structure desired conditions for montane vegetation by alternative and location relative to the Community Wildfire Protection zone (presented for alternative B), Wildlife Habitat Management Area (alternative B only) and focus landscapes (alternative D only)

Characteristic	Alternative B		Alternative D	
	Inside Wildlife Habitat Management Area[1]	Inside Community Wildfire Protection Zone	Outside focus landscapes	Inside focus landscapes
Composition	Low to moderate	Moderate (high in community buffers)	Moderate	High
Composition (Invasive Plants)	Moderate	Moderate	Moderate	Moderate
Structure	Low to moderate	Moderate (high in community buffers)	Moderate	High

[1] Areas inside the Wildlife Habitat Management Area that overlap with the Community Wildfire Protection Zone are slightly more similar to desired conditions than in the Wildlife Habitat Management Area only (no overlap).

Table 30. Similarity to vegetation composition and structure to desired conditions for upper montane vegetation by alternative

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Composition	Low-moderate (Jeffrey pine) to Moderate (Red fir and lodgepole pine)	Moderate increase (especially in areas of increased managed fire)	Low-moderate (moderate in areas of increased managed fire)	More than B, moderate to high in focus landscapes
Composition (Invasive plants)	Moderate	Slight increase from A (restoration areas)	Moderate	Slightly more than B (restoration areas)
Structure	Low (limited restoration)	Low-moderate (moderate in restoration areas, mainly increased managed fire)	Increase over A but less than B (increased managed fire)	More than B (more restoration), moderate to high in focus landscapes

Table 31. Similarity to vegetation composition and structure to desired conditions for subalpine and alpine vegetation by alternative

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Composition	Moderate (subalpine) high (alpine)	High (subalpine and alpine)	Same as B	Same as B
Composition (Invasive plants)	High	Same as A	Same as A	Same as A
Structure	Moderate (subalpine) high (alpine)	High (subalpine and alpine)	Same as B	Same as B

Table 32. Similarity to vegetation composition and structure to desired conditions for arid shrublands and woodlands by alternative

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Composition	Low (very limited restoration)	Low but slightly greater than A (limited restoration)	Same as B	Same as B
Composition (Invasive plants)	Low to moderate	Slight increase from A (restoration areas)	Same as B	Same as B
Structure	Low (very limited restoration)	Low but slightly greater than A (limited restoration)	Similar to B but slightly less	Same as B

Table 33. Similarity to vegetation composition and structure desired conditions for the Kern River drainage by alternative

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Composition	Low (limited restoration)	Low to moderate (restoration areas)	Same as B	More than B (more restoration)
Composition (Invasive plants)	Low to moderate (low in low elevations)	Slight increase from A (restoration areas)	Slight increase in similarity to desired conditions from A (restoration areas)	Less similarity to desired conditions as, compared with B (and similar to A)
Structure	Low (limited restoration)	Low-moderate (restoration areas)	Less than B	More than B (more restoration)

Consequences Specific to Alternative A

Although the current plans aspire to treat 20 to 30 percent of the forest to reduce fuels, this has not been achieved. It is estimated that 5 to 10 percent of forests in the montane and upper montane zones have been treated since 2001. Most of the treatment would occur in the wildland-urban intermix and in the montane zone.

Foothill Zone

There is limited treatment under alternative A in the foothills. Most would occur in the wildland-urban intermix defense and threat zones, near communities and key infrastructure (like communication towers). These treatments would be oriented toward fire protection and would move chaparral toward fire desired conditions. Blue oak woodlands would continue to be managed primarily for grazing. There may be occasional restoration projects in coordination with local tribes in areas of tribal importance. These would be limited in scale and number.

Composition. There would continue to be some areas that are similar to desired conditions that have been treated previously (primarily areas treated for fuel hazard reduction in wildland-urban intermix defense and threat zones). Ground-disturbing treatments in this zone could increase the amount and extent of annual invasive grasses (such as red brome and cheatgrass) and other invasive plants. There is plan direction to minimize the spread of invasive plants but it is difficult to keep out of restored areas because it is so prevalent in the foothill zone.

Structure. Treatment of chaparral in the wildland-urban intermix defense and threat zones would result in more uniformly younger seral stages. Outside of the wildland-urban intermix defense and threat zones, much of the chaparral is mature to old but not outside the natural range of variation. Increases in large, high-intensity fire may lead to large uniformly younger and fewer areas that are mature to old. The 2015 Rough Fire in the Kings River Canyon and 2018 Ferguson Fire in the Merced River drainage burned at high intensity in chaparral. While fires of these intensities are natural in chaparral because of the elevated fuel conditions, prior arrival of invasive plant species, recent vegetation mortality due to the 2012-2016 drought, and steep canyon topography, the size of the fire may have been larger and the fire effects more negative (such as more homogenous fire severity patterns) than would have occurred historically.

Blue oak woodlands would continue to remain in the same condition they are now but may worsen because of the stress of a warmer climate coupled with other interacting stressors (Rodriquez-Buritica and Suding 2013). This includes further reductions in regeneration and increases in overstory mortality rates. Little to no restoration occurs in blue oak woodlands, and this trend would be expected to continue.

Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. Resilience to drought, air pollutants, climate change, insects, pathogens, and uncharacteristic wildfires is declining and will continue to worsen in the near future (Sydoriak et al. 2013). The low levels of restoration treatments in the foothills would not substantially increase resilience in this vegetation zone.

Montane Zone

Overall treatment rates are limited under alternative A. Generally, less than 5 to 10 percent of the foothill, montane, and upper montane landscapes have been restored over the last 10 years. On most of the forest landscape, there is limited flexibility to restore composition and structure because: (1) management direction for the California spotted owl emphasizes maintaining current conditions (including structural homogeneity) rather than restoring desired conditions (such as restoring forest structural heterogeneity and long-term resilience); and (2) management direction is focused on a narrow range of values (reinforcing structural homogeneity) rather than the natural range of variation. Forest management is usually limited to low intensity treatments due to canopy cover restrictions. As a result, composition, structure, and resilience in most montane, upper montane, and foothill forests and woodlands would remain dissimilar to vegetation desired conditions.

Composition. There would continue to be a high proportion of shade-tolerant and fire-intolerant trees in the overstory and understory. In ponderosa pine, dry mixed conifer, and Jeffrey pine stands, there would be limited opportunities to restore dominance or codominance of ponderosa or Jeffrey pine due to diameter limits that restrict removal of competing shade-tolerant species such as white fir and incense cedar that have grown quickly during a century of fire suppression. This is particularly a challenge in the nearly 100,000 acres (especially in the Sierra National Forest or portions of the Sequoia National Forest) that were harvested in the early 1900s by railroad logging. In many of these stands, the largest trees are now mostly 30 to 36 inches in diameter but are developing a structure and composition that are moving away from the desired condition. Similarly, there would be limited opportunity to restore black oak overstory and understory primarily due to diameter limits and canopy cover requirements. There would be little opportunity to provide sufficient light for ponderosa or Jeffrey pine regeneration due to the direction to retain canopy cover and diameter limits that make it difficult to create sunny openings of sufficient size where pine seedlings and saplings can grow. Limited amounts of prescribed fire would result in little restoration of understory plants that are adapted to fire.

Structure. There could be restoration to increase heterogeneity, but restrictions on changing canopy cover in California spotted owl and fisher habitat and lack of sufficient management direction focused on the natural range of variation would limit how much change would occur. While treatments primarily reduce understory trees, there would continue to be a high dissimilarity to vegetation desired conditions in most of the landscape, including in areas of high tree mortality following the 2012-2016 drought.

Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. The low proportion of the landscape that would be restored and the low intensity of treatments make it highly likely most of the area would continue to have a low resilience to drought, climate change, insects, pathogens, and uncharacteristically large and severe wildfires.

Upper Montane Zone

There would continue to be limited mechanical treatment and prescribed fire restoration in upper montane forests under alternative A. There would be some wildfire managed to meet resource objectives, especially in the Kern River drainage and some wilderness areas. These managed fires would generally move upper montane forests toward vegetation desired conditions. Composition, structure, and resilience of montane chaparral and upper montane Jeffrey pine would benefit from fire.

Composition. Restoration treatments would move understory tree composition toward desired conditions in Jeffrey pine forests. Shade- and fire-intolerant white fir would be removed up to the diameter limit. Mechanical treatments and fire would have a similar beneficial effect. There would be little change in composition of red fir forests and lodgepole pine forests because they tend to be the dominant species, with or without restoration. Understory composition would continue to improve with restoration, especially where it includes fire (Wayman and North 2007). Where wildfire is managed to meet resource objectives, it would improve montane chaparral composition. Many of these species in montane chaparral are adapted to fire.

Structure. Restoration treatments would move some areas slightly toward desired conditions and others substantially. Mechanical treatments would move areas slightly toward desired conditions because of restrictions on changes in canopy cover and diameter limit for California spotted owl. There would be limited ability to reduce forest density and most importantly in the upper montane forests, increase heterogeneity. Where large areas have wildfire managed to meet resource objectives, there would be increased heterogeneity and a decreased vegetation density. Chaparral would have more of a mosaic of age structure. Jeffrey pine and red fir forests would have increased heterogeneity, reduced and patchier surface fuels, and increased resilience.

Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. Restoration treatments would continue to be at a very low level, except for more remote areas (like the Kern River drainage and wilderness areas) that have had and will likely continue to have wildfire managed to meet resource objectives. The more remote areas have a moderate level of resilience, and the Kern River drainage would likely increase to a high level of resilience over the period of the plan. The other areas would likely remain at a low level of resilience.

Montane and Upper Montane Zone (Kern Plateau)

There would continue to be limited mechanical treatment and prescribed fire restoration in montane forests of the Kern Plateau under alternative A. There would be some wildfire managed to meet resource objectives, especially in the Kern Plateau and some adjacent wilderness areas. These managed fires would generally move montane and upper montane forests toward vegetation desired conditions with respect to vegetation composition, structure, and resilience.

Composition. Restoration treatments would move understory tree composition toward desired conditions in Jeffrey pine and mixed conifer forests. Shade- and fire-intolerant white fir would be reduced in dominance closer to the natural range of variation. Mechanical treatments and fire would have a similar beneficial effect. There would be little change in composition of red fir forests and lodgepole pine forests because they tend to be the dominant species, with or without restoration. Understory composition would continue to improve with restoration, especially where it includes fire (Wayman and North 2007). Where wildfire is managed to meet resource objectives, it would improve montane chaparral composition. Many of these species in montane chaparral are adapted to fire.

Structure. Mechanical and prescribed fire restoration treatments would move some areas slightly toward desired conditions and others substantially, including reduced forest density and increased structural heterogeneity. Larger areas managed with wildfire to meet resource objectives would increase forest heterogeneity, decrease vegetation density, and favor a greater representation of larger diameter trees. In these areas, montane chaparral would have a more diverse mosaic of age structure and seral stages. Montane and upper montane forests would have increased heterogeneity, decreased tree density, patchier and reduced surface fuels, and greater size class diversity.

Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. The application of wildfire managed to meet resource objectives would promote a high level of resilience to stressors in the Kern Plateau over the period of the plan. Resilience would increase in these landscapes as a consequence of the restoration of natural fire regimes (a key ecological process), reduced tree densities, and vegetation biomass to a level commensurate with the natural range of variation, increased vegetation structural heterogeneity, and greater vegetation diversity.

Subalpine and Alpine Zone

There is little direct management of subalpine and alpine vegetation under alternative A. Most of this vegetation is in wilderness areas, where natural processes are the dominant management approach. Exceptions are in limited locations where recreation use is concentrated.

Composition. Alternative A would continue to minimize the spread of invasive plants in subalpine and alpine environments where restoration treatment activities are supported (like ski areas).

Structure and Resilience. Subalpine and alpine vegetation are among the most vulnerable to climate change (Meyer et al. 2014b, Sydoriak et al. 2013). Management in the remote areas, mostly wilderness where these vegetation types occur, would continue to be very limited. With changing climate, in the absence of restoration, mortality of some subalpine trees (like whitebark pine) would continue to increase.

Arid Shrublands and Woodlands

Restoration of arid shrublands and woodlands would be limited under all alternatives. However, the least amount of restoration sagebrush, pinyon-juniper, and xeric shrub vegetation would occur under alternative A. Restoration of composition and structure would be limited to small areas and a very small proportion of the extent that this vegetation type occurs in the Sequoia National Forest.

Composition. There would be limited areas that will move vegetation toward desired conditions. Although alternative A would continue to reduce the spread of invasive plants in some areas, there would be slightly fewer opportunities to remove invasive plants in arid shrublands and woodlands due to lower rates of treatment.

Structure. There would continue to be many areas that are dissimilar to desired conditions for a mosaic of ages of sagebrush and pinyon-juniper. There would continue to be large areas where many of the shrubs and trees are more susceptible to stressors.

Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. There would continue to be a low resilience to large, high-intensity fire and climate change. Low structural diversity and limited reduction of invasive plants would make it likely that resilience will decline further. There would continue to be a high dissimilarity to desired conditions.

Consequences Specific to Alternative B

In this alternative, plan direction for vegetation management would change desired conditions, objectives, standards and guidelines, management approaches, and goals that would affect vegetation composition, structure, and resilience. The degree of change varies by vegetation type and location. The most overarching changes are described here, and the rest are described in specific vegetation types and locations as relevant.

All Areas

Throughout all of the analysis area, there are two fire-related management areas that have different vegetation-related plan direction and each would have different impacts. They are the strategic fire management zones and the community buffers.

Community buffers are linear areas surrounding communities. The widths are based on expected fire behavior. The desired conditions for vegetation may be different in the CWPZ, with lower canopy cover, snag densities, log densities, and surface fuels. Otherwise, management direction for fire-oriented treatments is consistent with desired conditions for terrestrial vegetation.

There are several differences in plan components that would affect the mix and intensity of vegetation treatments and thus vegetation consequences. The direction on large-diameter trees differs as shown in Table 34.

Table 34. Application of large tree plan components under alternative B

Plan Direction	All Wildfire Zones
30-inch diameter limit with exceptions (TERR-FW-STD)	Applies
Desired densities of large trees by forest type (TERR-OLD-DC)	Applies

There are diameter limits with exceptions for some large trees (30 to 40 inches in diameter) that can be removed mechanically. This may result in slightly more thinning of larger trees in some areas (such as homogenous stands dominated by white fir that historically contained a greater proportion of pine), although the amount depends on site-specific conditions. This may have consequences for old forests and is discussed in the following subsection on "Terrestrial Ecosystem Processes and Function." There would also be more use of wildfire managed to meet resource objectives, primarily outside of the wildfire protection zones. This would result in more restoration of terrestrial vegetation using this type of treatment. This would most likely occur in upper montane and subalpine vegetation types but also some montane vegetation types. There is no anticipated effect of additional recommended wilderness on vegetation composition, structure, and resilience under alternative B, because this additional wilderness is located in the Giant Sequoia National Monument (near the existing Monarch Wilderness) where current forest management activities are very limited due to minimal road access and accessibility. Also, mechanical treatment options are fairly restrictive under the Giant Sequoia National Monument Plan.

Foothill Zone

There would be some increase in restoration in the foothill zone under alternative B compared with alternative A, because management direction in the former includes desired conditions and goals to reduce fire risk to communities and related management approaches.

The fire protection zones are larger than the current wildland-urban intermix threat zones and may result in increased treatments. This includes but is not limited to treatments in community buffers, ecological restoration along ridges and roads that would be used for evacuation routes, and as anchors for fire operations during large prescribed fires or wildfires. Other areas may be restored in areas of tribal importance where multiple sites are planned for restoration, especially oak woodlands that are traditional gathering sites (Lake and Long 2014).

There may be restoration near developed recreation sites, a number of which are in foothills areas, and there are objectives to restore some of these areas. There is additional management direction specific to blue oak woodlands and chaparral that is more specific than management direction in the current forest plans (alternative A). Other management direction limiting livestock browsing of oak and removal of large live oaks and snags remains the same. There are new guidelines that direct management toward heterogeneous mosaics of chaparral and avoid type conversion to annual grasslands.

There are specific objectives to restore vegetation composition by reducing nonnative plant invasions on several hundred acres of the Sierra and Sequoia National Forests. Most of this area will be in the foothill zone where nonnative invasive plants are most prevalent.

Composition. There would be a slight increase in the amount of foothill vegetation that is similar to desired conditions under alternative B. This increase would occur in community buffers, along ridges and roads in the fire protection zones, and in areas of tribal or cultural importance that contribute to the restoration of desirable native species. These targeted areas of restoration would also reduce nonnative plants. There is plan direction to incorporate best practices to reduce the further spread of nonnative plants in all projects.

These improvements may be offset to an unknown degree by nonnative invasive plant expansions in restoration areas, despite best management practices, since climate change and uncharacteristic wildfires enhance invasive species spread. Direction to retain mature blue oak remains, but there is increased emphasis on maintenance and restoration of blue oak regeneration (seedlings) and recruitment (saplings and small trees). Current livestock grazing management through allotment management plans would continue to improve conditions in blue oak woodlands. There is also specific management direction to increase and emphasize ecological restoration for vegetation types or in areas of tribal interest, including specific restoration objectives on both the Sequoia and Sierra National Forests. Some of this would be focused in blue oak woodlands and some in chaparral. This restoration would likely involve improvements in hardwood stands, reducing fire threats to sites of tribal cultural value, and improving the quality and quantity of important gathering sites. Treatments that involve reductions in nonnative annual grasses and other plants and restoration of native understory plants would also benefit tribal resources and gathering.

Structure. There would be a slight improvement in vegetation structure in the foothill zone due to ecological restoration, mostly in blue oak woodlands. In the community buffers and fire protection zones there may be changes in chaparral that are toward the lower end of the natural range of variation by shifting older vegetation successional stages toward more early-stage (younger growth) patches because of the emphasis on community and infrastructure fire protection. These changes would be limited to a small proportion of these areas, and mainly occur along ridges and roads or directly surrounding communities at high fire risk. Most of the chaparral would remain in an older condition outside of recent fire areas. There might be some prescribed fires that restore a mosaic of ages in steeper, more inaccessible areas where high-intensity fire would threaten communities.

Ecological Resilience to Drought, Air Pollutants, Climate Change, Insects, and Pathogens. There would be a slight increase in ecological resilience overall and a moderate increase at sites where restoration occurs. Restoration of blue oak woodlands is very difficult (Rodriquez-Buritica and Suding 2013), particularly restoration of the native understory plant community that is more resilient and, as a result, the increase in resilience would be slight.

Montane Zone

Compared with alternative A, alternative B would increase the amount of vegetation restoration in the montane zone through several objectives (Table 35).

Table 35. Vegetation restoration objectives within 15 years following plan approval that include most or all of the montane zone, Sequoia and Sierra National Forests, alternative B

TERR-FW-OBJ	Sequoia National Forest[1]	Sierra National Forest[1]
1. Restore forest structure and composition in the montane, upper montane, and portions of the foothill landscape, using primarily mechanical treatment	7,500 to 12,000 acres	30,000 to 60,000 acres
2. Restore low and moderate severity fire mosaics	32,000 acres	50,000 acres
3. Restore areas of tribal importance	3 areas	5 areas

[1] Terrestrial ecosystems forestwide objectives are based on a minimum value to be achieved within 15 years following plan approval.

The area with restoration treatments (mechanical and prescribed fire) could more than double from current levels (alternative A) in the Sequoia and Sierra National Forests. Wildfires managed for resource objectives would contribute an additional 40,000 and 46,000 acres in the Sequoia and

Sierra National Forests, respectively, under alternative B. Between 25 and 35 percent of the montane landscape is expected to be restored under this alternative, except for the Kern River drainage, where up to 50 to 80 percent of the landscape could be restored. The Kern River drainage already has more than 40 percent of the area restored and would increase by at least 10 to 20 percent. Although wildfires managed to meet resource objectives have occurred extensively in the Kern River drainage, the new plan direction that provides for managing wildfires to meet resource objectives would make this more likely to continue to occur or increase.

Most of the restoration would occur in forest ecosystems of the montane zone that are departed from desired conditions (or outside the natural range of variation). Restoration in these areas would move at least 30 percent of these landscapes toward desired conditions, including in some portions of the wildlife habitat management area (especially where it overlaps with the CWPZ and community buffers). Although much of the restoration would be focused on the dry sites that have the greatest departure from desired conditions, some would also occur in moist patches and riparian areas to provide more effective change in future landscape fire behavior or to facilitate larger prescribed burns. There would be some restoration of California spotted owl protected activity centers that occur primarily on dry sites, allowing mechanical treatment in up to one-third of a protected activity center per decade.

The effectiveness of restoration treatments in the montane zone would be enhanced by the strategic prioritization of restoration treatments under alternative B. This includes an emphasis on treating vegetation and fuels along ridges and roads to: (1) reduce the intensity and spread rate of uncharacteristic wildfires; and (2) facilitate landscape-scale prescribed fire and wildfires managed for resource objectives. This approach is supported by the risk-based wildfire management zones under alternative B. Landscape-scale restoration treatments would also be based on additional topographic features, such as south-facing slopes and upper topographic positions that can increase forest heterogeneity, vegetation diversity, and ecological integrity (North et al. 2009b, North 2012). Additionally, vegetation plan components under alternative B would provide better direction for the management of montane vegetation compared with alternative A. Lastly, a plan monitoring program would assist in evaluating vegetation trends to more effectively enhance restoration treatment effectiveness over time.

There are large areas in the Sierra and Sequoia National Forests that were railroad logged in the late 1800s and particularly the early 1900s (Laudenslayer and Darr 1990). These areas are now dominated by uniform stands of mostly medium- and large-diameter younger trees (less than 110 years old) trees. Outside of the fire protection zones, the large tree diameter limit may result in very little movement toward desired conditions for structure in the railroad logged areas, because many of the trees are at or slightly above 30 inches in diameter. This condition is estimated to extend across 95,000 acres for the northern portion of the Sierra National Forest alone.

Outside of community buffers, the emphasis would be on retaining California spotted owl and fisher habitat in protected activity centers and denning habitat in the short term. Canopy cover retention would be emphasized in these areas toward the upper end of the desired conditions, such as greater than 60 percent cover in half of each fisher hexagon grid area and across all individual owl protected activity centers. At least one-third and up to one-half of these sites fall on dry patches with a desired canopy cover level of 40 percent. Restoration treatments would be less intense, with fewer small- and medium-sized trees removed (Roberts 2015); (Fry et al. 2015) and less opportunity to create heterogeneity. There would be less ability to create small openings or variable spacing of overstory, mid-sized trees to increase heterogeneity because of canopy retention requirements, and limits on removing larger trees outside of the two wildfire protection zones.

Where areas are outside of the fire restoration and maintenance zones, the direction for large trees changes, but the canopy cover retention direction for fisher and owl habitat remains the same. Here, there is no limit on the diameter of large trees that can be removed and instead desired conditions for large tree densities apply. In most of the montane likely treatment areas, the greatest limitations on implementation to reach vegetation and old forest desired conditions is the plan direction limiting removal of canopy cover and treatment amount in spotted owl and fisher habitat. In these areas, there would be a limited movement toward vegetation and old forest desired conditions because relatively few trees could be removed. This would result in less total area treated, since it would cost more per acre to treat and no timber or biomass receipts would be available to treat nearby areas in the landscape.

There is a moderate level of uncertainty about how seasonal restrictions would impact the ability to meet the restoration objectives (see Table 35) under alternative B because of the limited operating periods for the California spotted owl and for fisher. There is a high concentration of California spotted owl protected activity centers in much of the montane landscape. With drought and increasingly more severe fire conditions during the summer, mechanical operations in the forests are often restricted on high fire danger days. This limits the number of days for mechanical restoration and can create a backlog of work that result in economic hardships on contractors and can make restoration projects less economically feasible. Similar limitations to prescribed fire are discussed below.

The amount of prescribed fire and wildfire managed to meet resource objectives could increase under alternative B, although there are some uncertainties about the amount of increase in the montane zone due to air quality, wildlife habitat, human and firefighter safety, and other concerns and considerations (such as the availability of fire management resources and budgets). The amount under alternative B could double that under alternative A. The increase would be due to the greater amount of mechanical restoration that would facilitate more prescribed burning both in and outside of mechanically treated areas. Larger prescribed fires would be more feasible because the prioritized restoration along ridges and roads would provide “anchors” for burn operations. There would likely be more prescribed fire in treated areas to connect these areas into larger landscape burns. Wildfires managed to meet resource objectives would still be limited in most montane areas due to concerns that wildfires could become uncontrollable in the dense forests if they burn into these areas (except for in the Kern River drainage).

Under alternative B, there is a moderate level of uncertainty in how much prescribed fire could occur in montane areas. There is uncertainty that there would be sufficient time periods or “windows” to conduct prescribed burning because of recent drought, longer fire seasons, limited operating periods for California spotted owl, mitigations for other wildlife, and air quality regulations. There is a backlog of areas previously mechanically treated that have not had follow-up prescribed burning or are in need of maintenance prescribed burning. Alternative B emphasizes designing larger landscape prescribed burns where feasible to incorporate these backlogged areas. The fire management strategy emphasizes restoration along ridges and roads to increase capacity to conduct large prescribed burns.

Restoring prescribed fire in mechanically treated areas is needed to best achieve some of the vegetation desired conditions because mechanical treatments cannot fully mimic the ecological function of fire, including beneficial effects on fire-adapted plants (see next section, “Terrestrial

Ecosystem Processes and Function"). Prescribed fire can reduce and maintain desired conditions by reducing understory vegetation density (like tree seedlings and saplings), producing more variable understory vegetation cover, and reducing surface fuels and creating patchy distributions of fuels that would result in improved fire resilience. If the backlog of prescribed burning continues, there would be less positive response of fire-adapted understory plants.

Composition. Restoration treatments would move vegetation toward desired conditions substantially in treated areas. Treatments would increase the dominance and codominance of ponderosa pine, Jeffrey pine, sugar pine, and black oak (where it occurs), especially on dry sites in the two wildfire protection zones. Desired conditions and management direction to increase open mature forest patches, tree density (cover and basal area), and increase forest heterogeneity would favor the shade-intolerant pine and oaks. The health and resilience of large pines and black oaks would be improved by reducing stand density around them, although clumps and groups of large and old trees would be retained. This would increase the likelihood that the current pine and black oak trees survive stresses from drought, air pollutants, and climate change (temperature increases). Restoration of heterogeneity through mechanical thinning, and especially prescribed fire, would move the composition, condition, and diversity of native understory plants toward desired conditions. Shrubs, flowering plants, and grasses that are adapted to fire would have more vigorous and dense foliage, increased flowering and fruiting, and increased density in a patchy pattern (Fites-Kaufman et al. 2006, Wayman and North 2007, Webster and Halpern 2010).

There would be less restoration toward desired conditions for composition in areas outside of the community buffers and wildfire protection zones. In the wildlife habitat management areas, canopy cover desired conditions and retention guidelines in California spotted owl and fisher habitat would result in more limited changes in overstory canopy cover. This is especially true in the areas next to patches of high tree mortality from the 2012-2016 drought, because these areas may be required to provide sufficient patches of higher canopy cover and forest biomass to support spotted owl and fisher habitat.

Structure. Under alternative B, it is expected that over the life of the plans between 25 and 35 percent of the montane landscape would move toward desired conditions, particularly in landscapes where wildfires are managed for resource objectives such as the Kern River drainage. Tree density would be lower and heterogeneity considerably higher in treated patches and across large areas of the landscape. Landscape forest structure would be most changed in areas treated with large prescribed fires and other restoration actions. This would move some of the landscape toward desired conditions, including heterogeneity at the landscape, patch, and within-patch scales.

Ecological Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. In montane forests, alternative B would promote the resilience to fire, climate change, drought, air pollutants, insects, and pathogens in treated patches, especially in community buffers outside the wildlife habitat management areas where restrictions on the amount and intensity of restoration in California spotted owl and fisher habitat are reduced. The elevated restoration treatment rates would build greater adaptive capacity in montane landscapes. Decreased tree density and increased heterogeneity at the landscape and site scales would improve resilience to the multiple stressors (North 2012). Restoration of more vegetation species resilient to drought, climate, and fire (especially ponderosa pine, Jeffrey pine, and black oak-pine) would improve overall forest resilience. Increased fire resilience will be most effective in the Kern River drainage where managed fires have been prevalent (Meyer 2015a), because a sufficient proportion of the landscape would be restored to result in reduced risk of uncharacteristic wildfires at the landscape scale (the scale of fires; see "Fire Trends").

Figure 30 shows potential changes in ecological fire resilience based on restoration of representative landscapes and treatments in the CWPZs in approximately 15 years following plan approval. This example shows changes from mechanical thinning only and does not incorporate additional large prescribed fires or wildfires managed to meet resource objectives that could occur, especially at higher elevations. Ecological fire resilience is the same as defined in the forest assessments. In general, it is based on the proportion of crown fire that would occur in a landscape area under 97th percentile weather conditions. High resilience is defined as less than 25 percent of the area would burn as crown fire; moderate resilience is defined as 25 to 50 percent; low resilience as 50 to 75 percent; and very low resilience as greater than 75 percent crown fire.

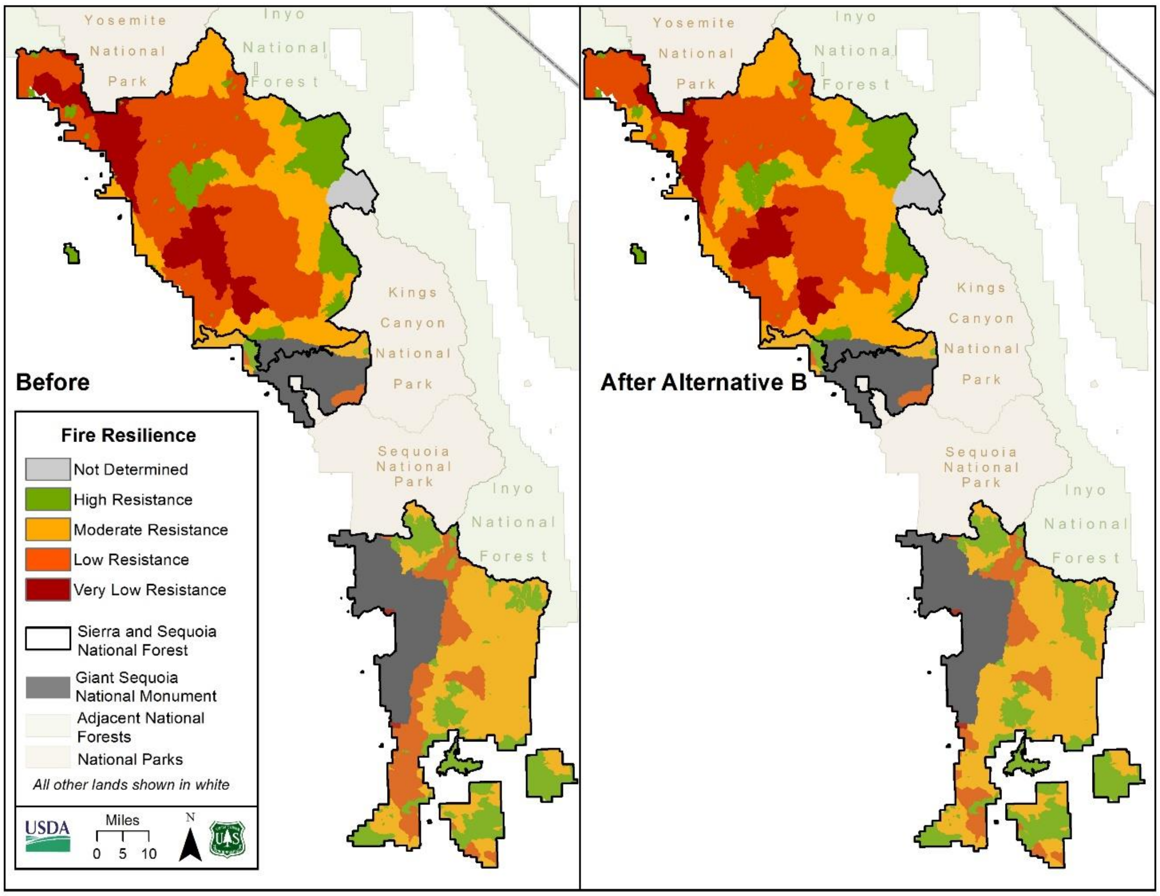

Figure 30. Illustration of potential changes in ecological fire resilience under alternative B
Note: This does not include improvements in resilience from wildfire managed for resource objectives. There would be further improvements from these managed fires, primarily in the Kern River drainage.

In Figure 30, representative landscapes show how treatments might result in an improvement from low or very low resilience to moderate fire resilience. This means that in the 25 to 35 percent of the montane and upper montane zones that are restored, overall fire intensity would change to lower amounts of crown fire during the hot and dry parts of a typical fire season. Crown fire would decrease from covering more than 50 to 75 percent of the area to between 25 and 50 percent of the area, resulting in reduced fire impacts on montane and upper montane landscapes. This is a substantial movement toward desired conditions.

There is uncertainty in how much resilience would change in the portions of the forest landscape that experienced high levels of tree mortality during and following the 2012-2016 drought (such as in the lower montane zone). In these heavily impacted stands, increased surface fuel loads (especially coarse woody debris) and snag densities have resulted in conditions that may reduce their resilience to future uncharacteristic wildfires, especially in stands that were untreated prior to the recent drought (Stephens et al. 2018).

Upper Montane Zone

There would be an increased amount of some kinds of restoration in upper montane forests under alternative B compared with alternative A. Restoration using mechanical treatment would be similar to alternative A and limited, except around communities at high fire risk. There may be other areas that are restored outside of community buffers that are in priority areas for the forest where treatments occur in the upper montane zone, such as near developed recreation sites. Most of the increase in restoration would be from wildfire managed to meet resource objectives. Much of the upper montane landscape is in the wildfire maintenance zone, where there is the greatest opportunity for wildfire managed to meet resource objectives. There would be improvements in the composition, structure, and resilience of terrestrial vegetation under alternative B because of the greater emphasis on more detailed, ecologically based desired conditions (see Table 35 at beginning of alternative B consequences section, above). Similar treatments and management direction (including within community buffers) would occur in the lower-elevation upper montane forests as in the montane forests (see above). This is where red fir and Jeffrey pine are codominant with white fir.

Composition. Alternative B would result in limited changes in tree composition in red fir and lodgepole pine forests because these forests tend to be single-species dominated and are not highly departed from desired conditions (Meyer 2015b). Restoration would promote or sustain the dominance of Jeffrey pine forests through ecological restoration treatments toward desired conditions. Most of the treatments would be focused at lower elevations and not in Jeffrey pine forests, but some would occur. In these areas, younger white fir and red fir would be reduced through restoration treatments. This is particularly true in the Kern River drainage where large areas have already been restored with fire managed to meet resource objectives and more is expected to occur in these remote areas. In areas with restoration treatments there would be some enhancement of the cover and composition of native understory vegetation.

Structure. Alternative B would improve structural conditions in upper montane forest patches through ecological restoration treatments (especially the restoration of fire) that are based on principles described in science-based publications (North et al. 2009a, North et al. 2012b, North 2012). Alternative B would also promote greater structural heterogeneity at a landscape scale through the broader application of wildfire managed to meet resource objectives in some upper montane landscapes, especially in the wildfire maintenance zone.

Ecological Resilience to Drought, Climate Change, Insects, and Pathogens, and Fire. In upper montane forests, alternative B would promote resilience because restoration would decrease forest density, reduce excessive fuel loads, and increase structural heterogeneity and vegetation diversity. In restored areas, this would increase resilience to drought and build greater adaptive capacity to climate change. There may be increased fire resilience where large landscape areas are restored. This would depend on the amount of wildfire restored to meet resource objectives because most of the restoration in upper montane vegetation would occur in these fires.

Subalpine and Alpine Zone

There would be slight increases in the amount of restoration in subalpine and alpine vegetation compared with alternative A. This would be from increased opportunities for wildfire managed to meet resource objectives and potentially from restoration of whitebark pine to reduce damage from mountain pine beetle and white pine blister rust. In general, most subalpine and alpine vegetation occurs in wilderness areas where natural processes are the primary emphasis of maintenance and restoration. Little restoration would occur, and where it does it would primarily be limited to small areas in need of rehabilitation in locations where recreation use is concentrated or in locations where invasive species are present.

Composition and Structure. Alternative B would improve composition in subalpine and alpine areas through targeted restoration in highly impacted areas and wildfire managed to meet resource objectives. There might be some limited restoration treatments involving control or eradication of nonnative invasive species that would benefit native vegetation, but most of this would occur in foothill or montane areas where they are more impacted. Although fire is historically infrequent and patchy in subalpine and alpine areas, it is an important natural process. More opportunities to manage wildfire to meet resource objectives would restore the effects of this natural process on subalpine and alpine composition and structure.

Ecological Resilience to Drought, Air Pollutants, Climate Change, Insects, and Pathogens. In most subalpine forests, alternative B would promote increased resilience to fire, climate change, drought, insects, and diseases because of higher restoration treatment rates (specifically the restoration of fire). Wildfire would increase resilience primarily through the reduction of stand densities, increased heterogeneity, and promotion of seral class diversity and tree regeneration. In addition, whitebark pine forests located in recreation areas (like ski areas) would be more ecologically resilient under alternative B. Alternative B would likely have greater treatment rates in recreation areas based on a regional whitebark pine restoration strategy. Despite differences among alternatives, many whitebark pine and other subalpine forests would be heavily impacted by insects and diseases associated with increased moisture stress and warming climate conditions under all alternatives (Meyer et al. 2014b, Schwartz et al. 2013a).

Arid Shrublands and Woodlands

Alternative B would have slightly increased vegetation restoration over current levels in sagebrush, pinyon-juniper, and xeric shrub vegetation types compared with alternative A. There would be more mechanical thinning of vegetation located around communities and developed areas to reduce hazardous fuels. There would be some increases in prescribed fire, but it would be limited to smaller areas and carefully applied to avoid invasion and expansion of nonnative annual grasses (like cheatgrass and red brome). There would also be some restoration of pinyon-juniper to meet desired conditions in areas of tribal importance and in community buffers.

Composition. Alternative B restoration would include actions to control or eradicate invasive plant species in arid landscapes. There would be restoration of some areas to reduce and eradicate nonnative annual grasses and measures to minimize the spread of nonnative invasive plants. This would move composition more toward desired conditions. However, invasive plant control and eradication efforts are unlikely to keep up with the proposed increase in treatment rates, even though partnership efforts and additional funding would increase the overall pace of these efforts. Alternative B would result in slightly greater restoration treatment rates than alternative A. In limited areas where prescribed fire is applied, it would facilitate positive changes in species composition closer to the natural range of variation. This is because fire would be sparingly applied in areas with little to no existing cheatgrass, and fire prescriptions would be designed to benefit native perennial grasses and other native species. Fire would be applied in a mosaic pattern that would be beneficial to fire-tolerant species and have limited impacts on fire-intolerant species (Brooks and Minnich 2006).

Structure. Alternative B would slightly improve structure in restoration areas. Thinning of pinyon-juniper trees around communities and developments would increase structural heterogeneity and increase size class variation. In restoration areas, vegetation would move toward desired conditions.

Ecological Resilience to Fire, Drought, Climate Change, Insects, and Pathogens. Alternative B would improve resilience of arid shrublands and woodlands to uncharacteristic wildfire, drought, insects, and pathogens to some degree, because of the slight increase in restoration treatment rates compared with alternative A. Thinning and control of nonnative invasive grasses would be the primary changes that would increase resilience. There would continue to be elevated levels of insect-related tree mortality in large areas because trees would remain at higher densities in untreated areas. This would especially be the situation on lower elevation sites and more productive sites that have higher tree densities due to the fire suppression effect.

Consequences Specific to Alternative C

There is a moderate to high uncertainty that increased prescribed and wildfire managed to meet resource objectives would occur under alternative C (see “Environmental Consequences to Fire Trends”). One reason is that there would be less mechanical treatment and less opportunity to restore vegetation along ridges and roads that would be used to “anchor” prescribed fire and wildfire managed to meet resource objectives. This is especially a limitation in the foothill and montane zones, especially where there are few natural features (like rock outcrops) that could be used to burn from or contain fires. Another uncertainty comes from less effective reduction of vegetation density, particularly in ponderosa pine and mixed conifer forests that experienced high levels of tree mortality from the 2012-2016 drought. This makes prescribing or managing wildfires more difficult because fuel conditions are greater and the risks of managing fires safely and in adequate management control become higher than alternative A.

There is also slightly more uncertainty in treatment rates under alternative C compared with alternative A, due to the greater amount of recommended wilderness under alternative C that would provide lower flexibility in wildfire management options over a greater proportion of the landscape. This is particularly the case for recommended wilderness areas in close proximity to communities (such as the Devil Gulch and Ferguson Ridge recommended wilderness areas in the Sierra National Forest under alternative C) that would provide greater uncertainty in restoration treatment rates involving prescribed fire and wildfire managed for resource objectives. This could result in slightly fewer areas where vegetation composition, structure, and resilience is aligned with vegetation desired conditions under alternative C compared with alternative A.

Foothills Zone

There would be a slight increase in composition, structure, and ecological resilience in foothill vegetation under alternative C compared with alternative A. The rate of restoration would be limited and similar to alternative A, but with better and more specific management direction for blue oak woodlands and chaparral under alternative C, similar to alternative B. Similarly, there would be specific management direction under alternative C to increase and enhance collaboration with tribes on ecological restoration compared with alternative A. This would move vegetation more toward desired conditions under alternative C.

Montane Zone

Alternative C would provide some restoration in montane forests, with restoration treatment rates greater than alternative A. This assumes that the rate of prescribed burning compensates for the reduction in mechanical thinning (this is uncertain as noted above). Most of the mechanical thinning would occur in the wildland-urban intermix defense zone, which is managed similar to alternative A, but with additional direction to retain habitat for fisher and additional restrictions on treatment in designated habitats for the California spotted owl. There would be some restoration along ridges and roads but it would be of lower intensity because of limitations on treatment in California spotted owl and fisher habitat. There would be some reduction in forest density and little to moderate increase in heterogeneity in areas treated mechanically. This is because of management direction for protection of fisher and owl habitat that limits canopy reductions at the landscape scale and limits the size of trees removed. Much of the montane zone is considered suitable habitat for fisher or California spotted owl. There is an increased emphasis on prescribed fire, but there is uncertainty as to how much prescribed fire or wildfire managed to meet resource objectives would occur in areas with high fuel levels and conditions that favor high-intensity fire (such as densified forests or areas of high tree mortality). There is additional direction for management of fisher habitat during wildfires that may increase the beneficial effects of wildfires. There is a slightly lower likelihood of very large, high-severity fires under alternative C compared with alternative A, according to the fire-climate scenario predictions (see “Fire Trends”).

Composition. Under alternative C, vegetation composition in the montane zone will more closely resemble desired conditions under alternative C compared with alternative A. Most areas would continue to have a high dissimilarity with desired conditions. There is a potential for more prescribed fire that would improve the condition of understory plants that benefit from fire, but there is uncertainty (moderate to high) whether this would occur. There would continue to be large areas with higher canopy cover at levels outside the natural range of variation and would result in large areas where shade-intolerant pines and hardwoods are in poor condition. There would be slightly more restoration of overstory composition toward desired conditions compared with alternative A. Less mechanical restoration and limitations on restoration in California spotted owl and fisher habitat would result in less reduction in tree density that shades out a large portion of the understory plants. Where prescribed fire is used in place of mechanical thinning, it could result in less reduction of high-density understory seedlings and saplings, especially of shade- and fire-intolerant species, such as incense cedar and white fir, because the fires may have to be designed to burn with lower intensity to balance damaging larger trees that are desired to be protected. By burning at lower intensity, it may require several reburn entries over time to achieve the same desired change in composition as achieved under alternative B.

Structure. The effects of alternative C on structure would be greater than alternative A but less than alternative B, because of restrictions on canopy cover reductions in fisher and California spotted owl habitat. There would continue to be large areas that are highly dissimilar to desired conditions. There is the potential for restoration of forest structure toward desired conditions with fire but there is a high uncertainty that prescribed fire and wildfires managed to meet resource objectives would occur to a great extent.

Ecological Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. The effects of alternative C on ecological resilience would be greater than alternative A but less than alternative B. Resilience would continue to be low across most of the landscape, because vegetation density would remain high and heterogeneity low. Denser vegetation is more susceptible to additional stressors, because plants compete more for water, nutrients, and light. Wildfire managed for resource objectives could restore resilience, but there is a moderate to high uncertainty that it would occur.

Upper Montane Zone

Alternative C provides moderate support to maintain or restore upper montane vegetation toward desired conditions. Mechanical treatments are limited in most areas but large areas of upper montane Jeffrey pine, red fir, and montane chaparral in the Kern River drainage would continue to be maintained and restored toward desired conditions, with wildfire managed to meet resource objectives as described under alternative B.

Composition. The effects of alternative C on composition would be slightly greater than alternative A but less than alternative B, because there would be limited restoration in upper montane vegetation under alternative C using mechanical treatment. Compared with alternative B, alternative C would provide slightly greater benefit to native understory plant cover and composition and result in similar potential to remove or control invasive plants due to the limited treatment rates under both alternatives.

Structure. Alternative C would result in slightly greater restoration of structural conditions in the upper montane zone compared with alternative A, due to the somewhat greater restoration treatment rates (primarily from wildfires managed for resource objectives) under alternative C.

Ecological Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. Alternative C results in slightly higher resilience to stressors compared with alternative A, due to the slightly greater treatment rates under alternative B. In the short term, there may be similar levels of wildfire to meet resource objectives in upper montane vegetation under alternative C compared with alternative A. This would provide increased resilience to fire, drought, climate change, and possibly insects and pathogens because fire would increase heterogeneity and decrease density and surface and ladder fuels in some areas. However, there is a moderate level of uncertainty about how much wildfire managed to meet resource objectives would occur over the long term under alternative C, because of less ecological restoration of ridges and roads that could be used to “anchor” fire actions when decisions are made on how to best manage a wildfire.

Subalpine and Alpine Zone

Alternative C would have similar effects in subalpine and alpine vegetation as alternative B, because management direction in higher elevation and wilderness areas are similar. Although there is more wilderness under alternative C, the additional wilderness is primarily in lower elevations and not in the subalpine and alpine zone.

Arid Shrublands and Woodlands Zone

Overall, there is similar vegetation restoration under alternative C compared with alternative A in arid shrublands and woodlands. Limited areas of sagebrush, pinyon-juniper, and xeric shrub that experience restoration and nonnative species control treatments would be more aligned with desired conditions. However, many untreated areas would become less resilient to the effects of uncharacteristic wildfire, spread of nonnative invasive plants, recreation use, and warming climate.

Consequences Specific to Alternative D

The greatest amount of restoration would occur under alternative D. It could more than quadruple the amount under alternative A. The increased restoration would include mechanical treatment, prescribed fire, and wildfire managed to meet resource objectives. The combined area of restoration based on these three treatments is about 3.5 and 5.7 times greater than alternative A in the Sequoia and Sierra National Forests, respectively. Some areas may include overlapping treatments, meaning some of the areas may be treated with both mechanical treatment and prescribed fire or mechanical treatment and managed wildfire.

Most of the increased restoration would occur in the montane zone (particularly ponderosa pine and mixed conifer forests) and portions of the upper montane zone (Jeffrey pine, red fir, and lodgepole pine forests). Overall, alternative D emphasizes more rapidly restoring vegetation resilience, recognizing there may be short-term consequences. There are fewer wildlife-related restrictions on vegetation restoration under alternative D, especially more flexibility in limited operating periods and an increase in the amount of habitat that can be restored in the short term to achieve greater long-term benefits. The fewest restrictions occur in strategically located “focus landscapes” that would likely have the greatest restoration treatment rates.

Focus Landscapes

Focus landscapes are areas that have different suites of standards and guidelines in them that are proposed under alternative D. Focus landscapes are large areas where ecological restoration would be emphasized. Plan direction (by management approach) prioritizes these areas for restoration:

> Emphasize vegetation treatments in focus landscapes (40,000 to 100,000 acres in size) to move terrestrial ecosystems toward desired conditions and increase resilience of old forest habitat, while limiting impacts on California spotted owl, fisher, and Sierra marten.

Focus landscapes represent an approach that would more effectively move vegetation conditions toward desired conditions. This will be accomplished by increased restoration treatment rates and additional flexibility in meeting both resource protection values and increasing vegetation resilience to high-severity fire and other stressors. In these areas, different management direction for old forest species applies, specifically for the California spotted owl and fisher. They are designed to improve landscape resilience because small, isolated, and independent treatment areas would not adequately restore ecosystem functions across landscapes, including natural fire regimes. They may overlap with the fire protection zones but may also occur outside of them. The plans do not specify the particular locations.

Figure 31 and Figure 32 show examples of possible focus landscapes in the Sierra and Sequoia National Forests, respectively. The focus landscapes are outlined in black and numbered from north to south (for example, focus landscape no. 1 is in the northern half of the Sierra National Forest). In these focus landscape examples, at least 40 percent of the area would be treated.

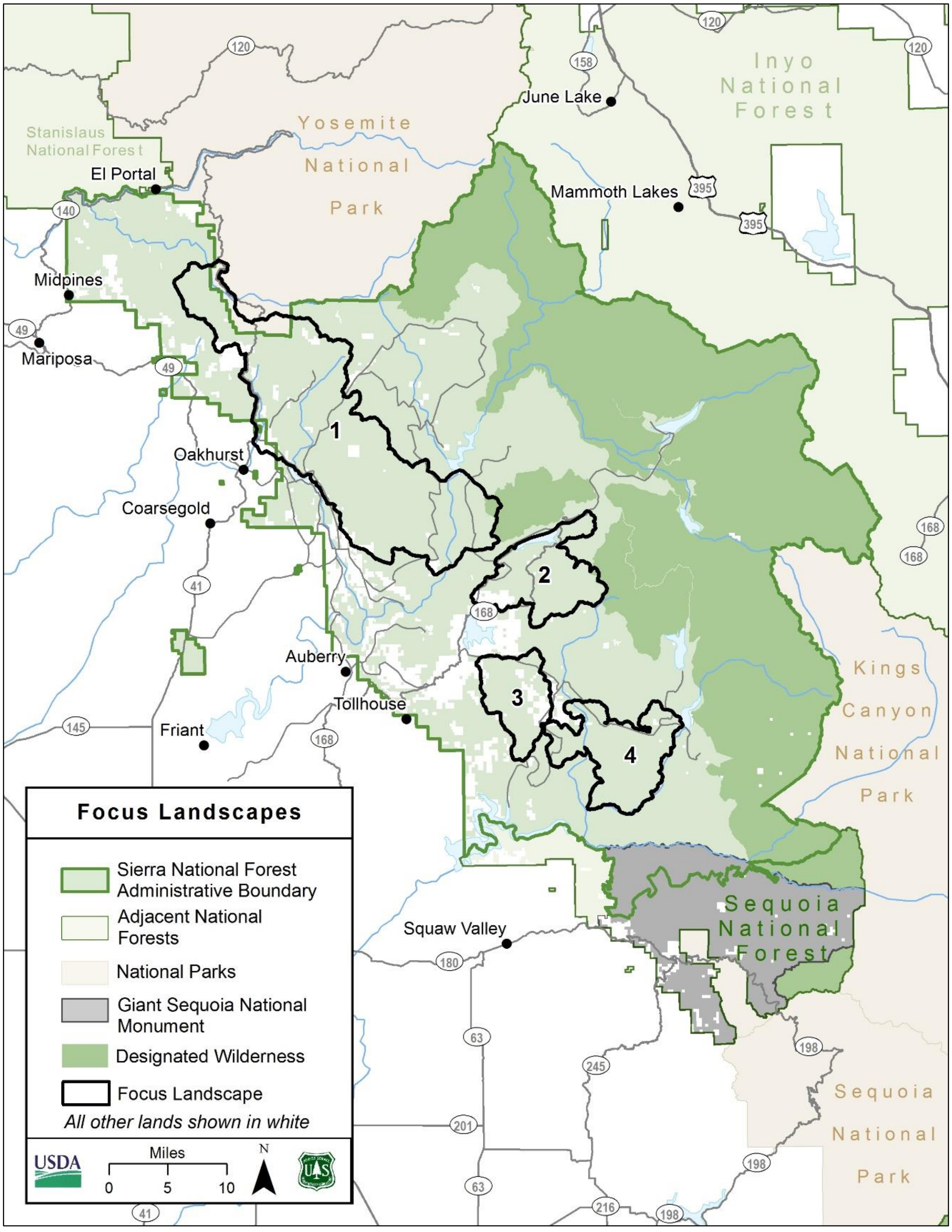

Figure 31. Example illustrating four focus landscapes (outlined in black) in the Sierra National Forest

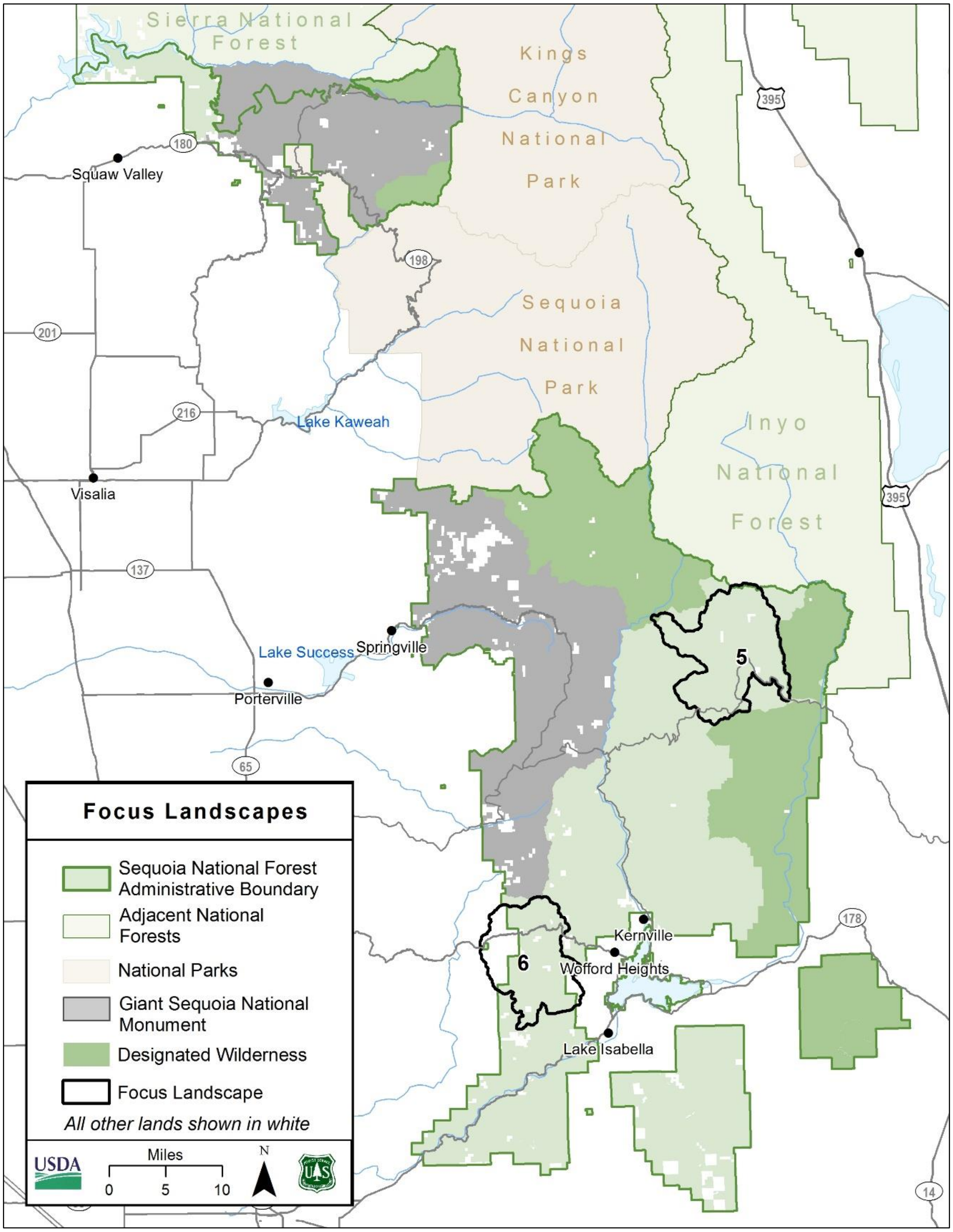

Figure 32. Example illustrating two focus landscapes (outlined in black) in the Sequoia National Forest

Focus landscape areas were defined using on fire potential operational delineations (PODs) that: (1) were near the CWPZ; (2) contained mature forest or fisher linkage areas (similar to the wildlife habitat management area under alternative B); (3) overlapped with areas of moderate to high fire risk (this excludes the wildfire maintenance zone); and (4) were primarily located on national forest system lands. Based on these criteria, there could be four possible focus landscapes in the Sierra National Forest and two in the Sequoia National Forest (there is no set number of focus landscapes or total area contained in focus landscapes). There are a smaller number in the Sequoia National Forest, because over one-third of the suitable area is in wilderness or other remote areas where managed wildfire has been the primary management tool in the last 15 years. Most of these focus landscapes fall within the montane zone, but some portions of these landscapes overlap the upper montane and foothill zones.

It is assumed that at least half of the restoration treatment acres would occur in the focus landscapes. At least one-third of these areas would overlap with the fire protection zones and achieve dual benefits of restoring habitat and old forest that is highly departed from desired conditions and at risk, and reduce fire risk to communities.

> To protect old forest components from uncharacteristic fire, prioritize restoration in key old forest areas. Methods of protecting existing old forest components on the landscape may include thinning or selective harvest, prescribed fire, and wildfires managed to meet resource objectives.
>
> Prioritize ecological restoration in landscapes around key linkage areas and areas with suitable habitat at highest fire risk.
>
> Develop landscape-scale projects to increase the pace and scale of ecological restoration, ecosystem resilience, and fire resilience and to protect the carbon carrying capacity of the forest.

In focus landscapes, restoration treatments would occur in a strategic fashion across the forest landscape. First, treatments would be dependent on topography and vegetation types, with an emphasis on greater reduction in stand densities and fuels on south-facing slopes, upper slope positions, and ridgetops (this pattern would also occur outside focus landscapes under alternative D; Figure 33). Relatively higher stand densities and biomass would occur on north-facing slopes, lower slope positions, and canyon bottoms. Second, treatments would be arranged along major roads and ridges that would increase the ability to conduct large- landscape prescribed fires or to manage wildfires (see fuelbreak treatments below). Most of these treatments would also occur on drier sites that are generally at the lower end of the natural range of variation for vegetation density and biomass. The third treatment arrangement would occur in less accessible landscapes (for example, lower road density, steeper slopes), where large, landscape-scale prescribed fires and wildfires managed for resource objectives would be the primary means of restoring vegetation and reducing potential fire severity. These would occur across all vegetation types but most commonly in the upper montane zones (both inside and outside focus landscapes).

Treatments in focus landscapes would include a combination of: (1) variable density thinning; (2) fuelbreak treatments along strategic ridgetops, considering the fire PODs; (3) fuels reduction near communities and other high-valued resources and assets; and (4) other vegetation management treatments, including, but not limited, to watershed restoration. Focus landscapes requires sufficient pace and scale of vegetation management treatments to restore forest structure and composition, improve stand resilience, and promote desirable outcomes for future wildfires on the landscape. Larger-diameter trees removed in fuelbreaks, stand density reduction treatments, and small gap creation would provide funds in support of stewardship projects that would help accomplish large-scale restoration treatments.

Variable density thinning and burning would restore heterogeneity, decrease overall forest density, decrease surface fuel continuity, and increase understory cover, density, and vigor, particularly of sun-loving plants. The approach would be as described in GTR-220 and GTR-237 (North et al. 2009a, North 2012), emphasizing restoration of heterogeneity. There would be variable spacing in thinning and burning. Some areas would be thinned more and some areas less or not at all. There would be thinning across a range of diameters, between small- to medium-diameter trees. Some small openings would be created to facilitate the regeneration of pines, while clumps of trees would be retained in some areas to provide wildlife habitat structures. There would be retention and creation of heterogeneity in the understory as well, as described in the desired conditions. Some patches of high surface fuel would occur, and other areas would have little to none.

Fuelbreak treatments would provide options to contain uncharacteristic wildfires and to support landscape-scale prescribed burning. Fuelbreaks would complement variable density thinning and other treatments on slopes, by focusing on drier portions of the landscape, such as upper topographic positions and south-facing slopes (Figure 33). The structural features of fuelbreaks (total width, canopy openness) would depend on the fire risk and expected fire behavior based on vegetation, topography, and fuels. Fuelbreak edges would often be “feathered” and nonlinear to promote gradual transitions in forest vegetation cover without abrupt linear edges. Some discrete and small patches of canopy cover would be retained as “habitat islands” to promote habitat connectivity for forest-dependent species such as fisher. Fuelbreaks would aid in tactical fire management decisions for wildfires and can serve as anchor points to conduct landscape-scale prescribed burning. The level of fuelbreak maintenance needed would decrease over time as fire is restored to the landscape.

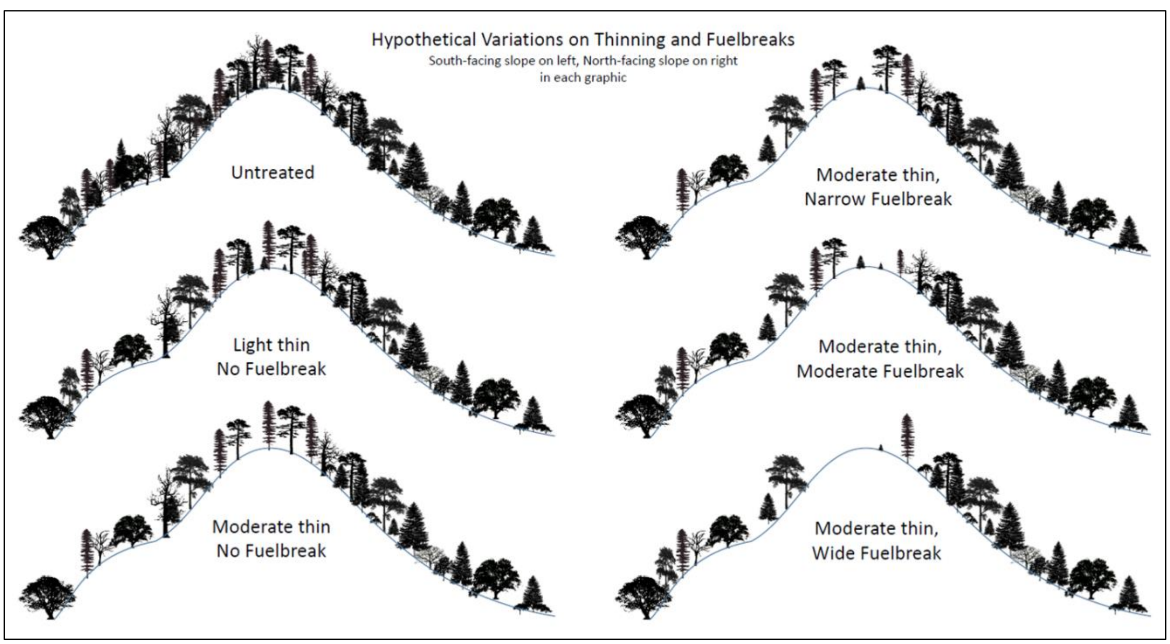

Figure 33. Examples of forest thinning and fuelbreaks in a focus landscape (shown in profile)

In focus landscapes, there would be greater flexibility in limited operating periods in montane and upper montane forests. This comes from an earlier end date to California spotted owl limited operating periods, a smaller avoidance area for California spotted owls, and a doubling of the area where the fisher limited operating periods are waived. In the focus landscapes, there are fewer limitations on restoration in California spotted owl habitat. More protected activity centers can be treated with mechanical thinning or prescribed burning, potentially doubling these treatment rates in focus landscapes. The amount of fisher hexagon grid areas that can be mechanically restored in a five-year period increases from 30 percent outside focus landscapes to 50 percent inside focus landscapes. A larger proportion of the area in focus landscapes would have vegetation conditions that are similar to desired conditions. The total amount of focus landscape could reach 40 to 50 percent or more of the entire montane landscape area. This reaches a level of restoration across the landscape that achieves widespread landscape resilience and ecological integrity. Nevertheless, up to half of the fisher hexagon grid areas, and at least two-thirds of the protected activity centers, would retain more canopy cover than is characteristic of the natural range of variation, especially in drier sites.

The plan direction for these species in the focus landscapes is less restrictive, with an emphasis on restoration of habitat conditions closer to the natural range of variation and vegetation desired conditions. Vegetation structure and composition would be restored but in some constraints in California spotted owl protected activity centers and suitable fisher hexagon grid areas. There are a different suite of standards and guidelines that apply to fisher and owl habitat in focus landscapes (and community buffers). Mechanical treatment would be allowed in protected activity centers, and the diameter limit for conifer removal is increased from 24 inches (12 inches for hardwoods) outside focus landscapes to 30 inches (16 inches for hardwoods) inside focus landscapes. For fisher, limitations on mechanical treatments are increased from up to 30 percent of hexagon grid areas over 5 years outside focus landscapes to up to 50 percent of hexagon grid areas in focus landscapes or in community buffers. These changes would increase opportunities to treat vegetation in more areas and with greater intensity making it more likely that vegetation will move toward desired conditions in the focus landscapes under alternative D compared with alternative A.

It is more likely that the mechanical treatment in focus landscapes of alternative D would result in more reduction in forest density and restoration of pine- and oak-dominated composition on ponderosa pine and dry mixed conifer sites than alternative A. There is also a waiver of limited operating periods for prescribed fire in fisher denning habitat in focus landscapes, based on project-specific evaluation, that would increase the likelihood of prescribed fire. The increased opportunity for mechanical treatment and prescribed fire in focus landscapes would increase the amount of contiguous landscape areas that meet vegetation desired conditions that are resilient to fire. The concentration of treatments in contiguous landscape areas (such as in focus landscapes) would provide greater reductions in potential high fire severity than when the treatments are spread out (such as under alternative A; see “Fire Trends”).

Restoration under alternative D would include the same management direction as alternative B to limit the introduction and spread of nonnative invasive plants. Any associated improvements to native plant composition may be offset to an unknown degree by nonnative invasive plant expansions in restoration areas, despite best management practices, since climate change can favor the growth and spread of invasive species.

Under alternative D, restoration treatments would primarily occur in three general locations. First, treatments would be prioritized in community buffers and along ridges and roads in the community and general fire protection zones. Second, treatments would be prioritized in the focus landscapes (which can include community buffers, along ridges and roads, and other strategic locations). Third, there would be a focus on restoration of montane and some upper montane forests that are substantially departed from their desired conditions, with a particular emphasis on ponderosa pine, mixed conifer, and Jeffrey pine forests.

The following sections describe the environmental consequences of alternative D on vegetation composition, structure, and ecological resilience to stressors by ecological zone.

Foothills Zone

There are similar trends toward desired conditions for vegetation in the foothills under alternative D as under alternative B, but there is a substantially greater area that would benefit.

Composition. There would be an increase in the area that is similar to desired conditions under alternative D due to an emphasis on restoration in the two wildfire protection zones, where most of the foothill vegetation occurs, and work with tribes on cultural and ecological restoration. These improvements may be offset to an unknown degree by nonnative invasive plant expansions in restoration areas, despite best management practices, since climate change can favor the growth and spread of invasive species.

Structure. There would be a moderate improvement in vegetation structure in the foothill zone due to ecological restoration. There may be changes in chaparral that move toward the lower end of the natural range of variation by treating more late seral patches and moving them to early seral patches because of the emphasis on community and infrastructure fire protection.

Ecological Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. There would a moderate increase in ecological resilience overall and a moderate increase at sites where restoration occurs. Increased mechanical restoration and more flexible management of wildlife habitat, including more flexible limited operating periods would provide more opportunities for large prescribed fires. Much of the foothill landscape includes steep, inaccessible areas that are not forested, where large prescribed burns are the primary restoration option. This type of restoration would move chaparral/live oak vegetation toward more of a fine-scale mosaic of different age and size structure. This would increase resilience to fire and reduce the likelihood of development of large high-intensity fires that create uniformly young chaparral over large areas and threaten communities and adjacent forests. Restoration of blue oak woodlands is very difficult, particularly restoration of the native understory plant community that is more resilient.

Montane Zone

Alternative D would have the greatest amount of vegetation restoration in the montane zone. Between 40 to 60 percent of the montane landscape in many places is expected to be restored over the life of the plan. Alternative D would have the greatest amount of restoration with much of the restoration in focus landscapes. Restoration in these areas would move at least 40 percent of these landscapes toward desired conditions that are based largely on the natural range of variation. Restoration would include both dry and moist mixed conifer, and nearby riparian areas where needed. There would be restoration of California spotted owl protected activity centers that occur primarily on dry sites. The concentration of restoration in landscape areas would result in a higher likelihood that these areas would burn at lower intensities during wildfires and retain mature forest. In the focus landscapes, projects would be larger, more effectively thinning vegetation and restoring more fire to the landscape to move toward desired conditions. Mechanical thinning would remove some larger trees and more mid-sized and small trees, which would increase the economy of scale and enable more area in the landscape to be treated, especially with a variety of stewardship opportunities.

The amount of prescribed fire and wildfire managed to meet resource objectives would be greatest under alternative D. The amount would be nearly five times greater than under alternative A. The increase would be due to the greater amount of mechanical restoration and emphasis on increasing the use of fire as a restoration tool and to restore it as an ecosystem process to these frequent fire adapted and fire deficit ecosystems. The mechanical restoration would focus first on strategically placed areas on ridges and along major roads, in addition to patches in the focus landscapes. The purpose of these strategic areas is to improve the ability to safely and effectively conduct large prescribed fires, suppress fires, and to manage wildfires in a manner that results in lower intensity and a mosaic of severity that enhances protection of communities and restores ecosystems. There would also be more prescribed fire in and between areas restored mechanically. Larger prescribed fires would be more feasible because vegetation would be less dense, making desired fire effects and fire control more achievable. There would be a lower likelihood of sustained crown fire. There is a moderate level of uncertainty that the planned amount of prescribed fire would not occur because of air quality constraints.

The effectiveness of restoration treatments in the montane zone would be enhanced by the strategic prioritization of restoration treatments under alternative D. This includes an emphasis on treating vegetation and fuels along ridges, roads, and topographic features that historically supported lower vegetation biomass (such as south-facing slopes and upper topographic positions) that can increase forest heterogeneity, vegetation diversity, and ecological integrity (North et al. 2009b, North 2012). Moreover, vegetation plan components under alternative D would provide better direction for the management of montane vegetation compared with alternative A.

Composition. Compared with alternative A, restoration treatments under alternative D would substantially increase the dominance and codominance of ponderosa and Jeffrey pine, sugar pine, and black oak (where it occurs), especially on dry sites and in focus landscapes. Desired conditions and direction to achieve them include decreased tree density (cover and basal area) and increased heterogeneity. These will favor the shade-intolerant pine and oaks. The health and resilience of large pines and black oaks will be improved by reducing stand density around them, although clumps and groups of large and old trees would be retained. This would increase the likelihood that the current pine and black oak trees survive stresses from drought, air pollutants, and temperature increases related to climate change.

Restoration of heterogeneity through mechanical thinning, and especially prescribed fire and fire managed to meet resource objectives, would improve the composition, condition, and diversity of native understory plants. Shrubs and herbaceous plants that are adapted to fire would have more vigorous and dense foliage, increased flowering and fruiting, and increased density in a patchy pattern.

Structure. Under alternative D, it is expected that between 40 and 60 percent of the montane landscape would move toward desired conditions, particularly in focus landscapes. Tree density would be lower and heterogeneity considerably higher across large areas of the landscape under alternative D compared with alternative A. The landscapes would be most changed in the protection zones, but also in the restoration zones accessible by road and equipment and feasible for large landscape prescribed fire. This would move substantial portions of the landscape toward desired conditions.

Ecological Resilience to Fire, Drought, Air Pollutants, Climate Change, Insects, and Pathogens. In montane forests, alternative D promotes the greatest resilience to uncharacteristic wildfire, climate change, drought, air pollutants, insects, and pathogens because the elevated restoration treatment rates under this alternative (especially in focus landscapes) builds greater adaptive capacity in montane landscapes than other alternatives. Decreased tree density and increased heterogeneity at the landscape and site scales would improve resilience to these multiple stressors. Higher levels of prescribed fire associated with increased mechanical treatments and large prescribed fires in other areas would decrease surface fuels and increase resilience to large, high-intensity fire more than alternative A.

Figure 34 shows potential changes in ecological fire resilience based on restoration of representative focus landscapes and treatments in the CWPZs. This does not incorporate additional large prescribed fires or wildfires managed to meet resource objectives that could occur, especially at higher elevations.

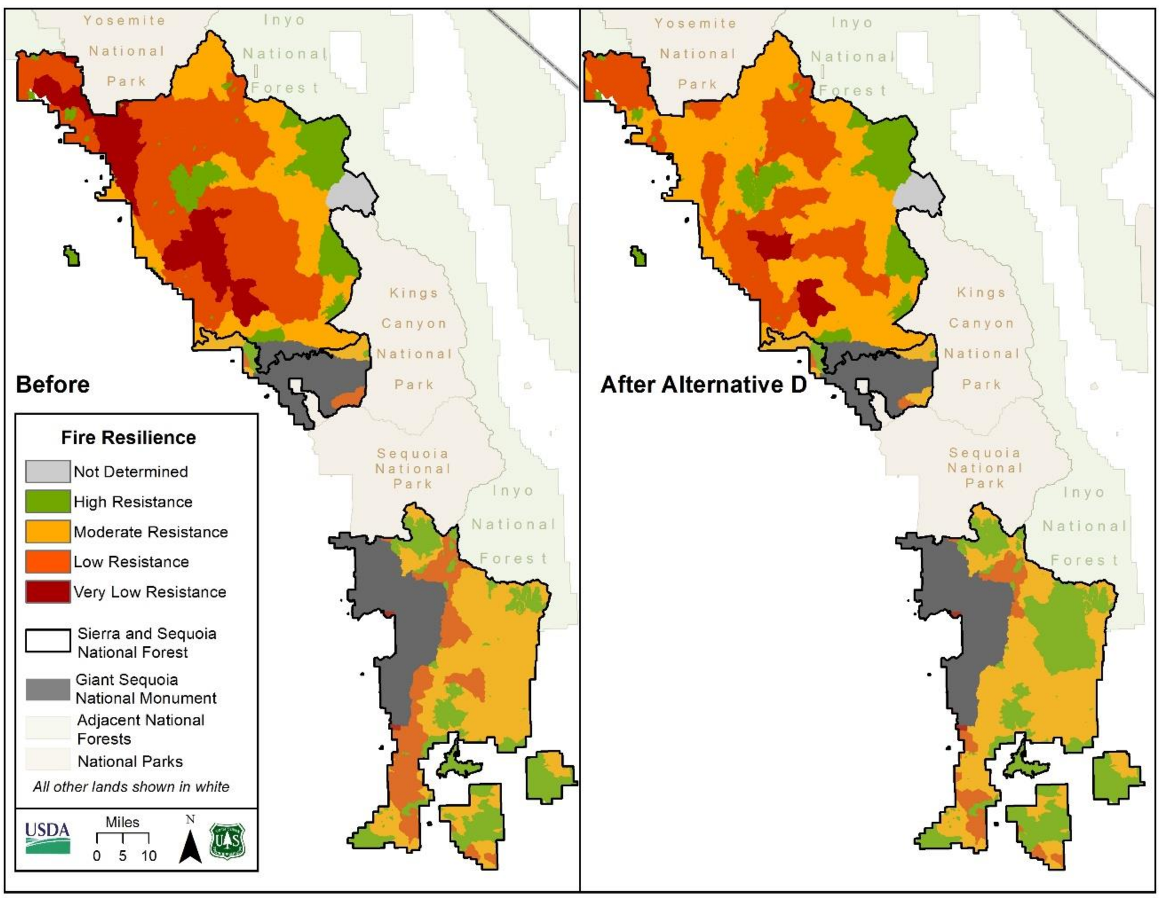

Figure 34. Potential changes in ecological fire resilience, alternative D

Note: This does not include improvements in resilience from wildfire managed for resource objectives. There would be further improvements from these managed fires, primarily in the Kern River drainage.

Upper Montane Zone

Ecological fire resilience is the same as defined in the forest assessments. In general, it is based on the proportion of crown fire that would occur in a landscape area under 97th percentile weather conditions. High resilience is where less than 25 percent of the area would burn as crown fire; moderate resilience as 25 to 50 percent; low resilience as 50 to 75 percent; and very low resilience as greater than 75 percent crown fire.

Alternative D would result in greater restoration of desired vegetation composition and structure in upper montane landscapes than under alternative A. Most of the restoration would be through wildfire managed to meet resource objectives. There would also be increased amounts of mechanical and prescribed fire restoration in upper montane forests that are highly departed from desired conditions and have low resilience to insects and pathogens. Overall, ecological resilience would increase and move toward desired conditions to a greater degree under alternative D compared with alternative A.

Subalpine and Alpine Zone

In the subalpine and alpine zone, alternative D would result in greater restoration of desired conditions for vegetation structure and composition than alternative A. Wildfire managed to meet resource objectives would increase the resilience of subalpine and alpine vegetation to fire, drought, climate change, and insects and diseases. In subalpine forests, this would primarily occur through the reduction of stand densities and promotion of diversity of species, structures, seral stages, and tree regeneration. Whitebark pine forests in recreation areas (like ski areas) would potentially be more resilient to insects and diseases under alternative D compared with alternative A. Alternative D would have greater treatment rates in recreation areas based on a regional whitebark pine restoration strategy.

Despite differences among alternatives, many whitebark pine and other subalpine forests would be heavily impacted by insects and diseases associated with increased moisture stress and warming climate conditions under all alternatives.

Arid Shrublands and Woodlands Zone

Overall, there is slightly greater vegetation restoration under alternative D compared with alternative A in arid shrublands and woodlands. Limited areas of sagebrush, pinyon-juniper, and xeric shrub that experience restoration and nonnative species control treatments will be slightly more aligned with desired conditions under alternative A. However, many untreated areas would become less resilient to the effects of uncharacteristic wildfire, spread of nonnative invasive plants, recreation use, and warming climate.

Consequences Specific to Alternative E

Overall, the consequences of alternative E would be similar to alternative C. In both alternatives, there is a moderate to high uncertainty in the use of wildland fire due to lower levels of mechanical pretreatment that would be required to reduce hazardous fuels prior to burning. Reduction in areas of high fuel loads would be required to provide adequate safeguards to ensure effective management control of wildland fire.

In the foothills, montane, and upper montane zones, there is slightly less uncertainty in treatment rates under alternative E compared with alternative C, because the lower amount of recommended wilderness under alternative E would provide greater flexibility in wildfire management options over a greater proportion of the landscape (especially in the Sierra National Forest, where there is about half as much designated wilderness under alternative E compared with alternative C). This is particularly the case for recommended wilderness areas in close proximity to communities (such as near the communities of Bass Lake in the Sierra National Forest or Lake Isabella in the Sequoia National Forest under alternative C). This would provide slightly greater uncertainty in restoration treatment rates involving prescribed fire and wildfire managed for resource objectives under alternative C compared with alternative E. In the subalpine and alpine zone and arid shrublands and woodlands zone, treatment rates under alternatives C and E would be similar, because the amount of recommended wilderness in these two zones does not substantially differ between these alternatives. Management direction for backcountry management areas under alternative E would provide similar forest management options to restore vegetation in montane, upper montane, and some foothill landscapes compared with alternative C.

Cumulative Effects

There are several past, present, and reasonably foreseeable future actions of adjacent landowners that can cumulatively influence vegetation composition, structure, and resilience to stressors in the Sequoia and Sierra National Forests over the next 10 to 15 years. These actions are summarized under "Environmental Consequences to Fire Trends" and "Environmental Consequences to Insects and Pathogens" cumulative effects.

Alternatives B, C, D, and E would emphasize an all-lands-management and shared-stewardship approach that would increase the capability of the Sequoia and Sierra National Forests to work cooperatively in restoring vegetation composition and structure (including reductions in nonnative invasive plant occurrence) and increasing the resilience of terrestrial ecosystems to drought, climate change, insects, pathogens, air pollutants, and uncharacteristic wildfires. Alternatives B, C, D, and E include many plan components to build effective partnerships, including the following potential management approaches and potential actions:

> Work with adjacent land management agencies to identify methods to reduce costs and increase effectiveness in restoring fire to the landscape.
>
> Consider partnerships with Federal and state agencies and other partners to identify priority areas for restoration, including areas of high tree mortality or next to communities threatened by uncharacteristic wildfires.
>
> Continue commitment to participating in collaborative planning processes to ensure that restoration strategies are science-based and reflect diverse interests (Sierra National Forest).

Additional partnerships and funding could increase restoration treatment rates in the Sequoia and Sierra National Forests to a greater degree than that anticipated under alternatives B, C, D, and E. Although alternative A would encourage partnership efforts for wildland fire management in the southern Sierra Nevada, these efforts would be more narrow in scope due to limited plan direction in current forest plans for the Sequoia and Sierra National Forests (Meyer et al. 2015). The cumulative effect under alternative A would be more limited application of fire restoration in the Sequoia and Sierra National Forests, which would result in greater departure of vegetation composition and structure from desired conditions and lower resilience of terrestrial ecosystems to stressors compared with all action alternatives.

Analytical Conclusions

All Ecological Zones

Alternative D, followed by alternative B, would move the most area toward and closest to the desired conditions for vegetation ecology in all ecological zones. That is because these alternatives emphasize the following:

- Greater restoration treatment rates
- More flexibility in the application of restoration treatments
- Strategic prioritization of restoration treatments on the landscape
- Increased restoration treatment effectiveness

First, greater restoration treatment rates under alternatives D and B would result in a greater application of fire and mechanical treatments that restore vegetation structure, composition, and function, including ecological resilience.

Second, alternatives D and B would include more flexible standards and guidelines for mechanical thinning and prescribed burning. They also would emphasize the natural range of variation in desired conditions that would enhance structural heterogeneity and habitat diversity to the greatest degree among alternatives.

Third, alternatives D and B would provide strategic prioritization of restoration treatment areas across the landscape. This would increase large-scale vegetation and habitat resilience, while protecting important resources and assets on each national forest.

Examples of strategic prioritization are an emphasis on the treatment of wildfire protection zones, ridgetops, and natural fuelbreaks to support risk-based, strategic wildfire management, such as the following:

- Facilitate positive fire effects
- Minimize negative impacts on vegetation structure and composition
- Where existing vegetation conditions are highly departed from desired conditions, promote resilience to stressors

Fourth, increased restoration treatment effectiveness under alternatives D and B (and alternative C to a large extent) would be based on the following key elements, including:

- Ecological principles from GTR-220 and 237 that are relevant to montane and some upper montane forest vegetation (North et al. 2009a, North 2012)
- Vegetation plan components that provide management direction for specific vegetation types, for example, moist versus dry mixed conifer, red fir, sagebrush
- Improved management direction for postfire landscapes
- Wildfire management zones to facilitate low to moderate fire regimes across the forest landscape
- Forest plan monitoring programs to evaluate plan effectiveness at restoring vegetation desired conditions and to facilitate adaptive management on a programmatic level

Foothills Zone

The most restoration in the foothills zone would occur under alternative D, followed by alternative B. There would be more opportunities for restoring oak woodlands, mixed chaparral, and pine-oak forests, including working with tribes. This would benefit vegetation composition, especially black oaks and understory plants. There would be increased restoration of native plants and eradication of nonnative, invasive plants to some extent, especially noxious weeds and new plant invasive species. However, it is difficult to completely eradicate established invasive plants, such as nonnative annual grasses, across large areas, and no alternative is expected to achieve this.

Alternatives C and E would have similar levels of restoration as alternative A (low in the foothill zone). This would be due to limiting the use of fire restoration in a zone that is frequently in proximity to communities. This is especially the case in situations without mechanical pretreatment. Overall, alternative D would result in the most area moved toward desired conditions in the foothill zone, followed by alternative B.

Montane Zone

Alternative D, followed by alternative B, would move the most area toward and closest to the desired conditions for vegetation ecology, for reasons described in "All Ecological Zones," above. The higher rates of treatment, more flexibility, strategic prioritization, increased effectiveness, and emphasis on treating across larger areas would be more likely to result in entire landscapes that are restored within the next 10 to 15 years. This increases the likelihood that large landscape areas are not only restored but that they can withstand fires of all intensities and still maintain much of their forest structure and composition. There would be moderate or mixed severity and limited large patches of high-severity fires. While small distributed pockets of high-severity fire can create heterogeneity and early successional stages (see "Complex Early Seral Forests" in the following section), very large fires are outside of the desired condition and the natural range of variation.

The beneficial effects of alternative D are substantially greater than under alternative B. Under alternative D, slightly more than half of the landscape is likely to be restored fully to desired conditions. This would result in a high level of resilience across large landscape areas, which would improve the resilience of adjacent areas. Under alternative B, there are some areas that would have landscape treatments, but the treatment on only some of these landscapes would be intense enough to move substantially toward desired conditions.

In forest stands of high tree mortality following the 2012–2016 drought, restoration treatments would move stand conditions toward desired conditions and would increase ecological resilience of developing stands. However, in the most heavily impacted stands, such as those with greater than 75 percent basal area loss, it would take several decades to achieve forest desired conditions, such as the reestablishment of medium to large diameter trees typical of mature forest stands. Heavily impacted stands may represent up to a half of focus landscape areas.

Alternatives A, C, and E are likely to result in lower levels of restoration treatments, with alternative A having the lowest rates of restoration in the montane zone. Vegetation is likely to remain highly dissimilar to desired condition for structure, composition, and resilience across most of the landscape. Under alternatives C and E, the emphasis on prescribed fire and wildfire to meet resource management objectives may increase in areas restored by fire. But these may be more limited than intended, because low levels of accompanying mechanical treatment in strategic locations would limit opportunities to conduct large prescribed burns or wildfires managed for resource objectives. Consequently, while restoration treatment rates under alternatives C and E are likely to be higher than under alternative A, there is also greater uncertainty in the fire restoration treatment rates that are emphasized under alternatives C and E.

Upper Montane Zone

Alternative D, followed by alternative B, would move the greatest amount of upper montane vegetation toward the desired conditions, for the reasons described in "All Ecological Zones," above. The higher treatment rates, more flexibility, strategic prioritization, increased effectiveness, and emphasis on a landscape-scale approach would more likely result in landscape-scale restoration within the next 10 to 15 years, especially for forest ecosystems. These greater restoration treatment rates in upper montane landscapes increase the capacity of ecosystems to resist undesirable fire effects, such as large, high-severity patches that exceed the desired conditions. They also help these landscapes recover from insect and pathogens and maintain much of their desired structure and composition, despite climate change.

Alternative A, followed by alternatives C and E, would likely result in lower restoration treatment rates than alternatives D and B. Consequently, under alternative A, vegetation would likely remain dissimilar to the desired condition in structure, composition, and resilience across many upper montane landscapes.

Alternatives D, B, C, and E would likely increase the use of fire for restoration in many upper montane landscapes, especially in areas more conducive to wildfires managed to meet resource objectives. However, fewer of these opportunities may be available under alternatives C and E, because they provide fewer strategically placed mechanical treatments that support more opportunities to use prescribed fire and wildfire to meet resource objectives. These strategically placed mechanical treatments would often be critical to ensure that highly valued resources and assets are sufficiently protected from undesirable fire effects following planned and unplanned ignitions.

The trend for increasing large, high-intensity fire is highly likely to continue under all alternatives, as described for montane forests above. Due to the increased level of restoration, there would be a substantially lower probability under alternative D and a somewhat lower probability under alternative B of high-intensity fires, based on the fire-climate restoration scenarios (Westerling et al. 2015).

Subalpine and Alpine Zone

Alternatives B, C, D, and E would move the greatest amount of subalpine and alpine vegetation toward the desired conditions. The higher restoration treatment rates under these alternatives build greater adaptive capacity in many subalpine landscapes than under alternative A. Alternative A would likely support the slowest rate of return to desired conditions and would promote the least long-term resilience to stressors. This is a consequence of the lower treatment rates under alternative A, especially the use of wildfires managed to meet resource objectives.

Alternative A is also the only alternative that does not involve the creation of an interagency whitebark pine conservation and restoration strategy. Under alternatives B, C, D, and E, this strategy would enhance the success of whitebark pine and other subalpine forest restoration in the southern Sierra Nevada. This would be particularly evident in recreation areas where increased treatment rates would build greater adaptive capacity.

Under all alternatives, alpine vegetation would have low resilience to climate change. That is because these high-elevation vegetation types have high exposure to the effects of climate change and low adaptive capacity to changing climate under all climate scenarios (Safford et al. 2012a, Lenihan et al. 2003, Lenihan et al. 2008). Active management is also similarly limited in alpine environments under all alternatives, which further limits the adaptive capacity of alpine ecosystems under any one alternative. Consequently, there are no differences among alternatives with respect to the maintenance of desired conditions in alpine ecosystems.

Arid Shrublands and Woodlands Zone

Similar to sagebrush vegetation, alternative D, followed by alternative B, would move the most sagebrush, pinyon-juniper, and xeric shrub vegetation toward desired conditions, but only slightly greater than under alternatives C and E. Slightly increased treatment rates would restore less dense and more heterogeneous structure and would reduce nonnative invasive plants. These changes would slightly increase the resilience of arid shrublands and woodlands to drought, insects and pathogens, climate change, and fire. Alternative A would have the least restoration of all alternatives. However, under all alternatives, vegetation conditions for arid shrublands and woodlands would remain largely dissimilar to vegetation desired conditions. This would be due to low rates of treatment.

Terrestrial Ecosystem Processes and Functions

Background

Functions of terrestrial ecosystems can refer to many things. Here the primary functions considered include how vegetation and terrestrial ecosystems provide for carbon cycling and regulation; fire regimes as an ecological process; terrestrial biodiversity that includes old forest and complex early seral forest habitats and habitat for pollinators and tree cavity excavators, such as woodpeckers; and connectivity for species across landscapes.

This section also contains an integrated analysis of varied aspects of biodiversity and ecological sustainability from other sections and multiple supplemental reports. This includes an integrated analysis of ecosystem condition in relation to tribal uses, fire regime and fire effects information, and important seral stages. Tribes have lived with and relied on terrestrial, aquatic, and riparian ecosystems in the analysis area for thousands of years. This section is an analysis of the condition of plants, animals, and overall terrestrial ecosystems in relation to tribal uses. Overall sustainability will draw on broad measures of ecological integrity identified in the National Ecological Sustainability Frameworks (United States Department of Agriculture 2004a, 2011b). Ecological integrity pertains to vegetation condition, air pollutant exposure, insect and pathogen levels, and fire regimes. All of these aspects of terrestrial ecosystem function are described below.

In addition to the broad ecosystem approach of vegetation analysis that emphasizes dominant vegetation types, we also recognize that some plant communities or habitats are less common and provide important ecological conditions for at-risk species. Some unique vegetation types, such as giant sequoia groves and aspen stands, are important for biodiversity or at-risk species habitat. This is because they are limited to small areas with unique vegetation structure, composition, or function. In other cases, special habitats are important because they are limited to small areas with uncommon rock or soil types, called edaphic habitats, or they provide essential microclimate conditions surrounding habitats for at-risk species with a restricted distribution. Other special habitats are the cliffs and caves that are essential for at-risk species. The analysis of unique vegetation types is covered in this section, but special habitats are discussed in “Wildlife, Fish, and Plants,” especially under “At-risk Plant Species.”

Analysis Methods, Data Sources, and Assumptions

The overall approach in this analysis was to evaluate the similarity of current and estimated future conditions to the desired conditions, where possible. The desired conditions for most of these indicators are broadly defined. This is because there is less specific best available scientific information and other sources on which to base the desired conditions, or there is more uncertainty as to what desired conditions should be. Therefore, the evaluation is mostly qualitative for relative differences in trends toward the desired conditions.

In some cases there was quantitative information available to make the evaluation, such as aspects of old forest and complex early seral forests. For both types of evaluations, we identified the specific indicators, measures, thresholds for levels of similarity between desired conditions and current or future conditions, and associated assumptions.

Indicators and Measures

Fire Regimes and Fire as an Ecological Process

Fire is a "keystone" ecosystem process in most of the analysis area (McKelvey 1996, van Wagtendonk and Fites-Kaufman 2006, Brooks and Minnich 2006, Wills 2006). This means that it has important and often dominant influences on ecosystem composition, structure, and function. Fire shaped most of the ecosystems; deserts and alpine ecosystems are two exceptions.

Fire Regimes

Fire regime is the pattern of frequency, intensity, severity, seasonal timing, and spatial pattern of fires (Sugihara et al. 2006). Three measures of fire regimes were used here: (1) the frequency of fire, (2) the fire regime condition class, and (3) a qualitative analysis of fire regime integrity. Fire regime integrity refers to the similarity of all aspects of fire regimes, compared with historical patterns before Euro-American settlement. Additional analysis and discussion of fire regimes by individual major vegetation types is addressed in "Terrestrial Vegetation Ecology." This includes fire severity and spatial patterns.

Fire Effects

Ecological fire effects refer to how vegetation is affected by fire, for example, whether vegetation is invigorated and sprouts or if it is killed. Many plants in the analysis area are adapted to fire and can respond positively to it, depending on the intensity, duration, and extent of the fire (Fites-Kaufman et al. 2006). Here a broad analysis was conducted. Specific effects on different vegetation types are described in "Terrestrial Vegetation Ecology" and "Aquatic and Riparian Ecosystems."

Carbon Stocks, Sequestration, and Stability

The primary criteria that we used to analyze carbon stocks, sequestration, and stability were a forest's resilience to fire, climate, and insects and pathogens. In dry forest systems, there can be dramatic changes in carbon stocks and sequestration capacity with one large, high-intensity fire (North 2014). Carbon stability was a focus of analysis; this is because managing for long-term carbon stability, within a carbon carrying capacity, is a forestwide desired condition. Carbon stocks and sequestration both depend on the carbon carrying capacity, and, consequently, are highly related to the carbon stability of an ecosystem. In our analysis of arid shrublands and woodlands, we emphasized soil carbon.

Connectivity

The ability for species to move throughout a landscape is important for ecological integrity (Rudnick et al. 2012). Species that are wide ranging are able to maintain genetic diversity and sustainability in the face of changes to their population or environment (Gilbert-Norton et al. 2010). Connected landscapes allow other species to migrate in the face of climate change or other pressures (Heller and Zavaleta 2009).

Despite its ecological importance, in practice, connectivity is a very difficult concept to apply. This is because it depends on the species and its associated life history and dispersal characteristics (Cushman et al. 2012). Connectivity for wide-ranging habitat specialists, such as fishers, are different than for generalists, such as bears, or short-dispersal specialists, such as plants growing on certain soil types. For this analysis, the emphasis was on broad patterns of vegetation structure or landscape arrangement of vegetation and some aspects of connectivity function. Functional aspects included existing and predicted habitat fragmentation for vegetation types and important seral stages, such as like old forest. It also included landscape patterns of broad management intensities, including less managed areas, such as wilderness, varying road densities (Cushman and Landguth 2012), and different large fire probabilities.

We analyzed terrestrial ecosystem connectivity at multiple spatial scales. These are all related but focus on different aspects of terrestrial ecosystem connectivity. Most of our analysis was qualitative; we based it on key sources of connectivity presented in the assessments, such as the State of California Essential Habitat Connectivity Project, fisher conservation strategy, and Sierra Nevada Ecosystem Project Areas of Late Successional Emphasis. We also used maps of broad management regimes, such as wilderness, by alternative. Connectivity of old forest and complex early seral habitats are described in more depth in the Terrestrial Connectivity Supplemental Report and Complex Early Seral Forest Supplemental Report.

We based thresholds on general connectivity theory, especially for wide-ranging wildlife. There are many different ways to measure connectivity, but for a general view, percolation theory is useful. Percolation theory suggests that when most of a landscape has conditions suitable for movement, then movement is more likely to occur (Turner 1989, Metzger and Décamps 1997, Kindlmann and Burel 2008). It matters less how habitat is arranged when there is more of it. The thresholds vary by species habitat requirements and mobility.

For this analysis, we assumed that landscapes with greater than 60 percent habitat suitable for movement provided high connectivity. Some research suggests that the threshold is greater than 40 percent. For this analysis we assumed that 40 to 60 percent provided moderate levels of habitat connectivity. In addition to the amount and distribution of habitat, areas that block or constrict movement, such as large reservoirs or major highways, can influence connectivity. Since this is a general landscape view of connectivity, we assumed that relative differences in the number of major barriers provided relative differences in the ability of wide-ranging species to move through the landscape.

Shown below are the criteria and thresholds for environmental analysis of landscape connectivity across vegetation types and in ecological zones in foothill, montane, and upper montane ecological zones.

Indicator

Connectivity for wide-ranging forest species, such as bears, deer, and fishers (see also “Old Forest and Complex Early Seral Forest,” below)

Criteria

- Major barriers and connecting habitat with hiding cover (overhead shrub or tree cover)
- Location of and amount of barrier, such as large reservoirs, developed areas, major roads, and high road density

Thresholds and Evaluation Approach

- High—No major barriers preventing dispersal of sensitive species; greater than 60 percent of the landscape with hiding cover
- Medium—Pinch points or barriers exist in limited places; 30–60 percent of the landscape with hiding cover
- Low—Multiple pinch points or barriers; less than 30 percent of the landscape with hiding cover

Terrestrial Biodiversity

The analysis of important aspects of terrestrial biodiversity adds to the course filter vegetation analysis above. Examples are old forest and complex early seral forest (important seral stages), unique vegetation types, such as giant sequoia groves and aspen stands, and keystone groups, such as pollinators and cavity excavators that play a unique and crucial role in the way an ecosystem functions,. These are important aspects of biodiversity and support the fine-filter analysis of biodiversity by individual species in the sections for at-risk terrestrial wildlife and plant species. The analysis evaluates the extent to which plan components that provide ecosystem diversity will also provide the ecological conditions necessary to support species of conservation concern.

Old Forest and Complex Early Seral Forest

There are two specific seral stages that provide important habitat for terrestrial biodiversity in Sierra Nevada montane forests: old forest (Table 36) and complex early seral forests (Table 37). We analyzed complex early seral by examining the following:

- Anticipated temporal trends
- Proportional abundance, relative to the natural range of variation
- Spatial patterns, such as patch size and evenness in distribution

We analyzed old forests by comparing conditions and trends with similarity to desired conditions for large tree densities and landscape proportions of old forest (Table 36). These desired conditions recognize a “gradient” approach to defining old forest (Franklin and Fites-Kaufman 1996, Spies 2004). That means that there are different degrees of what is considered old growth. Areas that have high densities of large trees relative to the natural range of variation (the median and high range of desired conditions) are at one end of the old forest spectrum; areas with low densities of large trees (the low range) are at the other end of the spectrum.

Because of the long history of selectively removing large, old trees in the analysis area (Mckelvey and Johnston 1992), areas that have low densities are more common (Franklin and Fites-Kaufman 1996). Even single large, old trees can be ecologically important; given this history and current patterns, old forest is still focused on large, old trees in an area. The analysis reflects this gradient approach and wide range in current conditions in large tree densities.

Table 36. Indicators, criteria, and thresholds used to analyze environmental consequences for the old forest special forest habitat

Characteristic	Criteria	Thresholds for Qualitative Evaluation of Trends
Large trees	Densities compared to desired conditions	Relative trends (increase, decrease, stay the same)
Amount of old forest	Proportion of landscape with large trees (size varies by species; see desired conditions in Volume II, Appendix A)	high = more than 60% of landscape moderate = 40–60% of landscape low = less than 40% of landscape
Large snags (larger than 20 inches diameter at breast height; montane and upper montane forests only)	Density (per 10 acres) and variability (range in densities), compared with desired condition	high = 20–40 per 10 acres moderate = 5–20 per 10 acres; low = less than 5 per 10 acres

Table 37. Indicators, criteria, and thresholds used to analyze environmental consequences for complex early seral forest habitat

Characteristic	Criteria	Qualitative Evaluation of Consequences
Amount of landscape	Proportion of area (across forest) that occurs in complex early seral in the landscape	Relative evaluation of the trends in amount
Spatial pattern	Evenness in distribution across landscape, and grain (size of patches), relative to natural range of variation	Relative evaluation of pattern, compared with desired conditions

Unique Vegetation Types

Some vegetation types are notable for their unique ecological characteristics, distinctive functional attributes, and relative rarity. Two unique vegetation types are giant sequoia groves (Sierra National Forest, excluding groves in the Giant Sequoia National Monument) and aspen stands (Sequoia and Sierra National Forests). Each of these forest types is defined by the presence of an individual tree species that is highly valued for its size and old-forest structure (giant sequoia), wildlife habitat value (both species), biodiversity (aspen communities), or other characteristics, such as aesthetic value. Giant sequoia and aspen are also notable as disturbance-dependent species, which require some type of frequent disturbance regime, especially fire, for successful regeneration, recruitment, and growth (Estes 2013a, York et al. 2013, Kuhn et al. 2011). These species are also associated with moister environments and may require shallow subsurface water for long-term persistence.

Giant sequoia groves and aspen stands are relatively rare in the southern Sierra Nevada, together occupying only about 0.1 percent of the land area on the Sierra and Sequoia National Forests.

We analyzed unique vegetation types using ecological condition indicators and relative trend criteria (Table 38).

Table 38. Indicators, criteria, and thresholds used to analyze environmental consequences for unique vegetation types

Unique Vegetation Type	Indicator	Criteria
Giant sequoia groves	Ecological condition of large and old sequoias and sequoia regeneration	Relative evaluation of trends
Aspen stands	Ecological condition of mature aspen trees and aspen regeneration	Relative evaluation of trends

Keystone Groups (Pollinators and Cavity Excavators)

Some plants, animals, insects, and fungi stand out in their role in ecosystem function. Pollinators are one such group. They include mostly insects, including butterflies and bees, but also other animals, such as hummingbirds. Without these pollinators, many flowering plants would fail to persist or would be rare on the landscape. This would then have repercussions on other insects and animals that use these plants for food and shelter.

Another standout group is woodpeckers and other primary cavity excavators, such as nuthatches and sapsuckers. This is because they make cavities that are used by many other birds and mammals. (For this analysis, we selected these two keystone groups as important, but this is not meant to imply that there might not be others.) These are two groups that might be impacted by treatments. The analysis of consequences to pollinators and cavity excavators was qualitative. We synthesized our findings on climate, fire, insects, pathogens, vegetation, less common habitats, and at-risk species.

For pollinators, we used three recent management strategies to identify measures and practices to analyze. These all incorporate summaries of research key elements of pollinator habitat and management approaches: the “Pollinator Research Action Plan” by the USDA and EPA (United States Department of Agriculture 2015c), “Region 5 Draft Pollinator Best Management Practices” (Van Zuuk 2014), and “Pollinator Friendly Best Management Practices for Federal Lands” (United States Department of Agriculture 2015b).

The key element of pollinator habitat is the abundance, condition, and spacing of flowering plants in the landscape. Openings in forests and sunny areas are identified as important, and dense forests are a concern. Also important are nearby water sources and nesting habitat that is widely varied and can include holes in the ground, logs, snags, and hollow or pithy shrub stems. Continuously burned areas can be detrimental, but fire can also improve understory plant flowering. Any activity or management action that removes or reduces flowering can have such impacts as intensive grazing, recreation use, mowing, or herbicides.

To evaluate environmental consequences, we used changes to forest heterogeneity that create openings and restoration of low and moderate-intensity fire, as described below.

Indicator

Understory plant composition, condition, and distribution

Criteria used to evaluate environmental consequences

- Amount of sunny openings or overstory heterogeneity in forests
- Amount and type of fire, relative to the natural fire regime (enhances native flowering plants)

Thresholds

- High—Dominant vegetation is greater than 60 percent within the desired conditions for structure and fire regimes; fire is restored to many areas in historically frequent fire ecosystems; nonnative plants are limited in extent.
- Moderate—Dominant vegetation is 30 to 60 percent within the desired conditions for structure and fire regimes; fire is restored to some areas in historically frequent fire ecosystems; nonnative plants are present in some areas.
- Low—Dominant vegetation is less than 30 percent outside of the desired conditions for structure and fire regimes; fire is restored to limited areas in historically frequent fire ecosystems; nonnative plants are present in numerous areas and are dominant in some larger areas.

For primary cavity excavators, mostly woodpeckers, snags are a primary habitat. Many species of woodpeckers use a variety of snag sizes in a variety of forest conditions: small to large snags in young to old forests, used by white headed and pileated woodpeckers (Bull and Holthausen 1993, Morrison et al. 1987, Raphael and White 1984), or unburned to burned forests, used by black-backed woodpeckers (Saracco et al. 2011, Fogg et al. 2014, Siegel et al. 2014). To evaluate environmental consequences, we used the amount and distribution of snags in varied forest conditions, as described below.

Indicator

Amount and distribution of snags in both burned and unburned forests; diversity of snag habitats

Criteria

Density and variation in size and decay class of snags, compared with desired conditions; spatial pattern (evenness across larger areas but clumpy patterns at smaller scales); presence in multiple forest conditions and settings (young forests, old forests, burned forests, and unburned forests)

Thresholds

- High—Snag densities and distribution are within the desired conditions across most the landscape; these occur in a variety of forest ages and burned and unburned conditions.
- Moderate—Snag densities and distribution are somewhat within the desired conditions across the landscape; these occur in a variety of forest ages and burned and unburned conditions but may be missing in some areas.
- Low—Snag densities and distribution are within the desired conditions across limited areas of the landscape; these occur in some forest age classes and burned and unburned conditions but are missing across significant areas.

Tribal Uses and Biocultural Diversity

Native Americans have lived throughout the analysis area for thousands of years (Lake and Long 2014). The people of various tribes have historically and are currently tied to different ecosystems across the area that provide for basic life needs of food, shelter, and culture. Plants, animals, springs, and seeps across all elevational zones and vegetation types are often important to tribes. There are strong ties between tribes and all components of ecosystems. The condition of biodiversity thus can impact cultural diversity or the ability of tribes to maintain their culture. The condition and distribution of these culturally important aspects of ecosystems is the focus of this section.

We conducted a qualitative analysis for tribal uses and biocultural diversity. This included a synthesis of the findings in the vegetation ecology, fire ecology, and vegetation resilience supplemental reports and discussions in numerous tribal forums over the last several years.

Terrestrial Ecosystem Sustainability

The Forest Service used the National Forest Sustainability Framework (United States Department of Agriculture 2004a, 2011b) to evaluate terrestrial ecosystem sustainability, considering aspects of biodiversity and ecosystem processes (Table 39). This includes ecosystem resilience, connectivity, vegetation condition, insect and pathogen processes, fire regimes, species diversity, and at-risk species. This section draws on findings in the sections discussing agents of change, terrestrial vegetation ecology, fire ecology, and at-risk species.

Table 39. Characteristics from the National Forest Sustainability Framework used in the analysis

Characteristic	Analysis
Area affected by insects and pathogens beyond natural range	Summary from the “Insects and Pathogens” section in “Agents of Change”
Area affected by air pollutants that may cause negative effects	Summary from “Air Quality”
Area affected by invasive species	Summary from “Terrestrial Vegetation Ecology”
Area with fire condition class outside of natural range	Summary from “Fire Regimes and Fire as an Ecological Process”
Area with vegetation condition outside of natural range	Summary from “Terrestrial Vegetation Ecology”

Affected Environment

Table 40 is a summary of the current conditions of carbon, connectivity, old forest, complex early seral habitat, limited habitat types, and tribal uses. The conditions are described in broad terms, in relation to the desired conditions by ecological and elevation zone or dominant vegetation types (see “Terrestrial Vegetation Ecology” for descriptions).

Table 40. Summary of the similarity of current conditions to desired conditions for major indicators of terrestrial function, by ecological/elevational zone

Ecological Zone	Fire Regimes and Fire as an Ecological Process	Carbon Stability	Landscape Connectivity	Old Forest Condition and Amount	Complex Early Seral Forest	Tribal Uses, Biocultural Diversity (Conditions)
Foothill	Moderate	Low	Low	Low	NA	Low
Montane	Low	Low	Moderate	Low	Moderate	Low
Upper montane	Low to moderate	Low to moderate	High	Moderate	Moderate to high	Moderate
Subalpine and alpine	High	Moderate	High	N/A	N/A	Moderate
Arid shrublands and woodlands	Moderate	Moderate	Low To moderate	N/A	N/A	Low to moderate

N/A = not applicable

Fire Regimes and Fire as an Ecological Process

Fire Return Interval Departure

Before 1850, the area that burned in the analysis area and California overall was estimated to be vastly greater than current patterns (Stephens et al. 2007). These changes have not been uniform. The frequency of fire has decreased the most in the montane and parts of the upper montane zones, including ponderosa pine, Jeffrey pine, and mixed conifer. These areas used to burn on average every 10 to 15 years (Van de Water and Safford 2011). Higher elevation red fir forests have changed less, missing only one burn cycle on average (Safford and Van de Water 2014). Subalpine and alpine areas have changed little if at all.

Although lightning strikes often hit the crest where they occur, the sparse vegetation carries little fire. In sagebrush and pinyon-juniper, the level of fire regime interval departure is low but variable (Safford and Van de Water 2014). Where there have been invasions of nonnative, annual cheatgrass, fire is becoming more frequent than it was historically (Chambers et al. 2014). Other areas have had some declines in fire frequency, such as sagebrush ecosystems, in the absence of cheatgrass invasion.

The fire return interval departure index is one way of showing the changes in fire frequency (Van de Water and Safford 2011). The maps below show fire return interval departure for the Sequoia (Figure 35) and Sierra (Figure 36) National Forests. These maps are based on Van de Water and Safford (Van de Water and Safford 2011).

The departure is based on the difference between the current fire frequency (average years between fires) and historical fire frequency. High departure can represent a lack of fire (shown in red, minus 66 percent) or too frequent fire (shown in dark blue, plus 66 percent). A moderate departure can represent a lack of fire (orange, minus 33 percent) or too frequent return of fire (light blue, plus 33 percent). A low departure, shown in green and yellow, represents less than a 33 percent change in fire frequency. Recent fires are shown as transparent shaded areas. The fire return interval departure (FRID) values are based on the most recent FRID data, which includes fires of greater than 10 acres that burned between 1908 and 2017 (greater than 50 acres for fires between 1908 and 1950).

Vegetation types where fires burned most frequently in the past, such as yellow pine (ponderosa pine and Jeffrey pine) or mixed-conifer (dry and moist mixed conifer), have missed the most historical fire return intervals and have undergone the sharpest decline in ecological condition. Yellow pine and mixed conifer have generally experienced a two-thirds decrease in mean percent fire return interval departure, which is categorized as high departure. This pattern of high fire return interval departure in yellow pine and dry mixed conifer forests of the plan area is similar to other regions of the Sierra Nevada and California (Safford and Van de Water 2014). As an exception, portions of the Kern Plateau on the Sequoia National Forest are characterized by relatively low levels of departure; that is, fire return intervals are closer to the natural range of variation. This is because there have been extensive areas of wildfires managed to meet resource objectives in this area (Meyer 2015a).

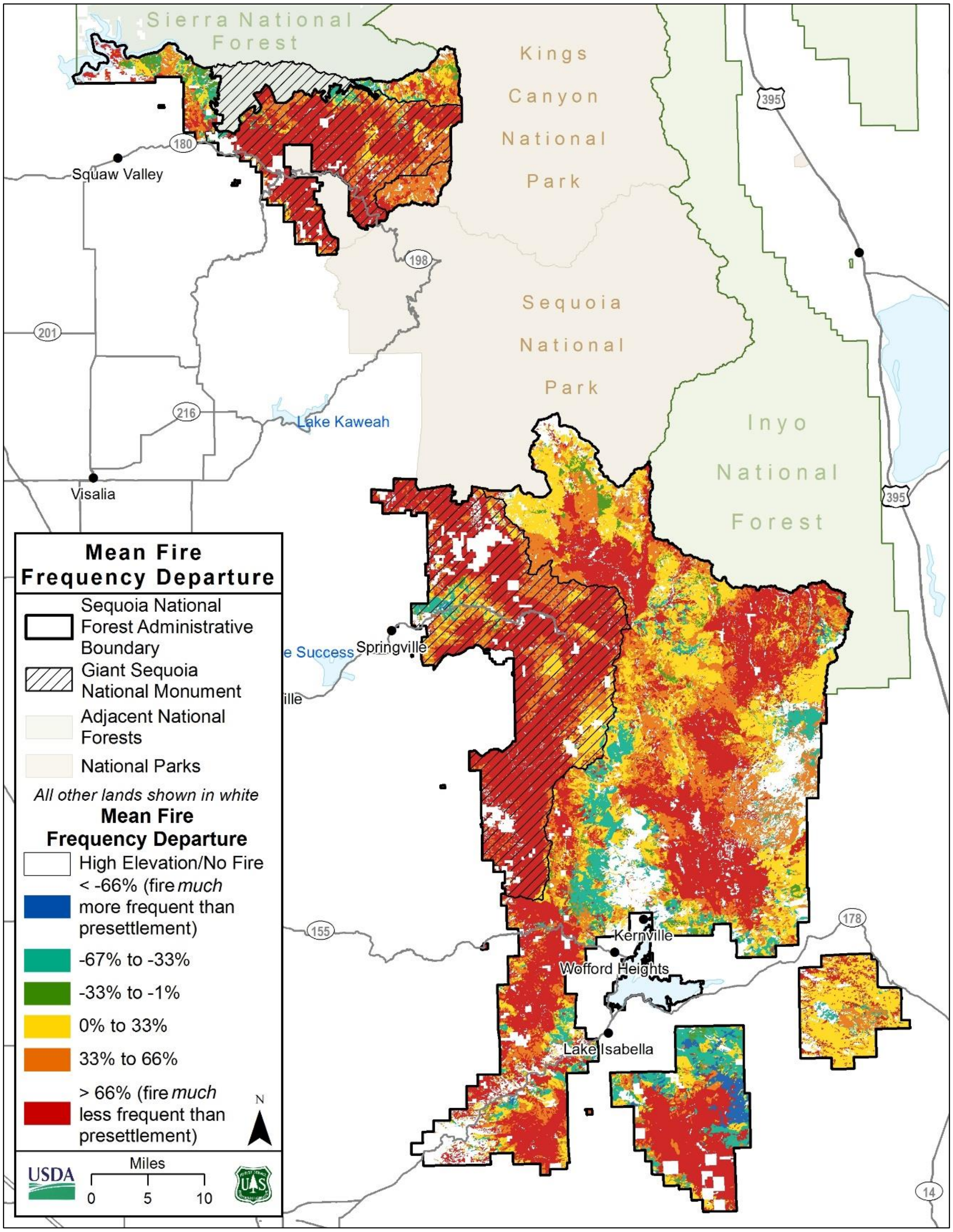

Figure 35. Map of fire return interval departure, Sequoia National Forest

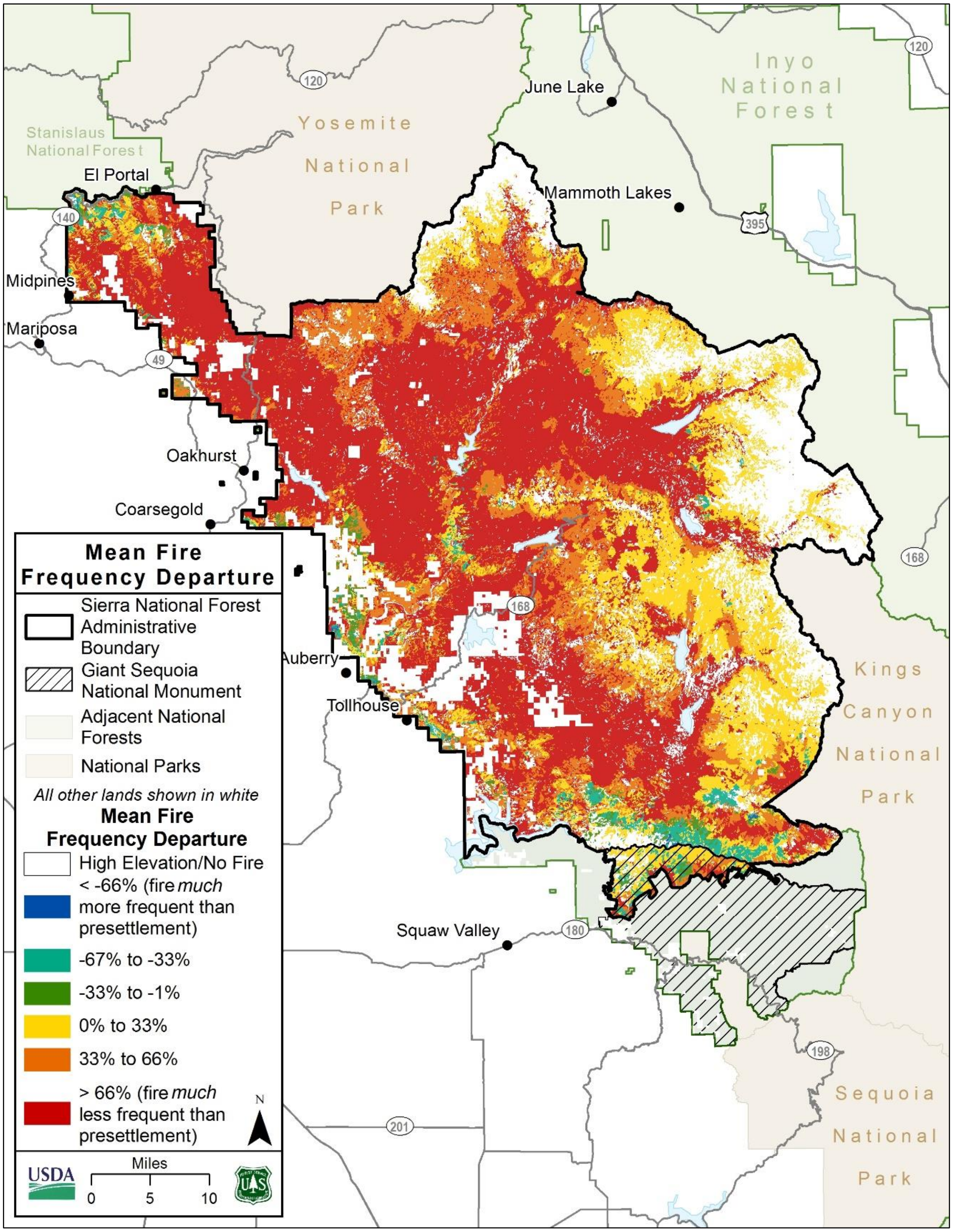

Figure 36. Map of fire return interval departure, Sierra National Forest

Subalpine forests, where fires were historically less frequent due to the patchier and sparse vegetation and shorter fire season, have undergone fewer changes. Upper montane red fir and lodgepole pine forests have had some departure in fire frequency. This is because fires in these forest types were historically less frequent. Currently the departure is low in higher elevations of red fir and subalpine forests, but projected increases in fire frequency with climate change may increase this departure over time.

The departure in arid shrublands and woodlands is varied from low to moderate. Where cheatgrass or red brome has invaded, fires are more frequent than historically resulting in moderate to high fire return interval departure (blue or aqua-green colors in Figure 35).

Fire Regime Integrity

In addition to the occurrence and frequency of fire, the type, such as surface, passive crown, and active crown fire, and severity of fire are important aspects of fire regimes. Many factors influence how severe a fire affects vegetation: the density, size, species, and condition of vegetation, as well as the intensity (heat level), speed (spread rate), and duration (length of time heat is emitted) of a fire. In much of the analysis area, decreased fire frequency as a result of aggressive fire suppression, in combination with past forest management, has led to denser, more uniform vegetation. This densification, especially in forests that historically burned frequently, such as forests of yellow pine or mixed conifer, promotes more severe fire effects. Examples of this are higher proportions and patch sizes of high-severity fire under contemporary conditions than under the natural range of variation (Safford and Stevens 2017).

Table 41 shows the current condition of fire regime integrity for the ecological zones and vegetation types. Dense, uniform, vegetation conditions are especially the case in montane ponderosa pine, Jeffrey pine, and mixed conifer forests (Steel et al. 2015). In upper montane red fir and lodgepole pine forests, there has been less of a notable change. In arid shrublands and woodlands, there has been a moderate but variable change in fire regime integrity, with more frequent and larger fires than the natural range of variation resulting from the invasion of cheatgrass and red brome.

Table 41. Summary of current condition of fire regime integrity by ecological zone and vegetation type in the Sequoia and Sierra National Forests

Ecological Zone	Vegetation Type	Current Condition Fire Regime Integrity
Foothill	Chaparral, oak woodland	Moderate
Montane	Ponderosa pine-black oak, dry mixed conifer, moist mixed conifer	Low
Upper montane	Red fir	Moderate
Upper montane	Jeffrey pine	Low
Montane and upper montane	Kern Plateau forests	Moderate
Subalpine and alpine	Subalpine and alpine	High
Arid shrublands and woodlands	Sagebrush and pinyon-juniper	Moderate, but variable

Carbon Stocks, Sequestration, and Stability

The foothill and montane zones have low carbon stability because vegetation is dense and fuel loads are high. This leads to an elevated risk of high-intensity fire and other stressors (see

"Agents of Change" and "Fire Management"). Subalpine, alpine, and arid shrubland and woodland zones have moderate carbon stability. They have less aboveground, standing carbon and have a moderate to low risk of high-intensity fire. Upper montane forests (especially red fir forests) have low to moderate carbon stability. At the lower elevations in this zone, forest density and fire risk conditions are similar to those of montane forests and carbon stability is low. Climate exposure is also higher at lower elevations of red fir forests. At higher elevations, near subalpine areas and on rockier sites in the upper montane zone, the carbon stability is moderate because fire risk and climate exposure are moderate.

Most of the landscape area in arid shrublands and woodlands on the Sequoia National Forest is dominated by non-forest vegetation, primarily sagebrush and pinyon-juniper woodlands. In these areas, soil and belowground carbon are important (the stability of this carbon is described in the Assessment reports (United States Department of Agriculture 2013b, c). Restoration of degraded arid shrublands and woodlands can also enhance carbon stocks and sequestration, including areas invaded by invasive grasses (Finch 2012). These restoration approaches may increase belowground carbon storage, especially in deep-rooted shrub and perennial grass species, and increase the resilience of arid ecosystems to future stressors. This increase in resilience supports a greater long-term carbon carrying capacity and provides for improved carbon stability in arid landscapes.

Landscape Connectivity

Landscape connectivity is moderate to high in all areas, except the foothill zone, where it is low. This is because it is fragmented by nearby and intermixed developed and urbanized areas.

Terrestrial Biodiversity

Old Forests

Background

Old forests in the analysis area are legacy forest ecosystems in the montane and upper montane zones. Old forests are late successional stands characterized by the following: the presence of large trees (greater than 30 inches diameter), very large trees (greater than 40 inches diameter), and old trees (exceeding 150 years in age) and other unique structural features, such as large snags, large logs, and canopy variation, that contribute to high structural complexity and heterogeneity (Franklin and Fites-Kaufman 1996, North et al. 2004).

Old forests include a mixture of individual trees, tree clusters, and canopy openings, with and without shrub or tree regeneration patches, that vary over space and time. They often contain variable densities of large snags and logs in various stages of decay, with some stands having very low densities of these structures. Historical stand inventories also indicate that many current old forest stands have experienced increases in snag and log densities. This is a result of increasing tree densities associated with fire exclusion and early logging impacts (Safford and Stevens 2017) and increased tree mortality rates, especially in larger diameter trees (Ritchie et al. 2008, Allen et al. 2015).

Following the 2012–2016 drought, in many mature and old forest stands in the southern Sierra Nevada, widespread tree mortality has dramatically increased the density of large snags and logs, from the mortality of large live trees, to levels far exceeding the natural range of variation (see "Changed Forest Conditions Associated with Tree Mortality") (Young et al. 2019).

The current ecological condition and amount of old forest is low to moderate in the Sequoia and Sierra National Forests. These areas were most impacted by selective logging of large and old trees during Euro-American settlement and more recent forestry practices up until the early 1990s (see "Forest Products and Management" and vegetation ecology supplemental report). Large trees have been killed by uncharacteristically large and severe wildfires, such as the 2002 McNally Fire in the Sequoia National Forest, insects, pathogens, air pollution, and climate change (Van Mantgem et al. 2009). During and following the 2012–2016 drought in California, many trees died in mature and old forests in the Sierra and Sequoia National Forests. This was due to the combination of exceptional drought, increasing temperatures associated with climate change, and bark beetle outbreaks (see "Insects and Pathogens" and "Combined Effects of Climate, Fire, Insects, and Pathogens").

Old Forest Management and Diameter Limits

Forest management in mature and old forests can often involve mechanical thinning that may be constrained by diameter limits ("diameter caps"). Such limits prohibit the cutting of large trees above a defined diameter threshold. Although the literature on diameter limits is limited, the available studies suggest that there are clear tradeoffs in achieving multiple forest restoration objectives (Abella et al. 2006, Meador et al. 2015). Mechanical thinning treatments using higher diameter caps—from no limits to greater than 30 inches in diameter—may result in the following (Meador et al. 2015, Abella et al. 2006):

- Greater reductions in the risk of uncharacteristically severe wildfires
- Increases in understory cover and water yield and water availability to large and old trees
- Higher habitat diversity and heterogeneity
- Increased understory diversity
- Enhanced nutrient cycling
- Greater changes in overstory species composition, which favors fire-tolerant species

In comparison, lower diameter limits, such as those greater than 12 to 24 inches diameter, may lead to higher biomass availability and basal area, increased habitat availability for certain forest avian species, and greater scenic quality (Meador et al. 2015, Kalies and Rosenstock 2013).

Under either a high or low diameter cap scenario, mechanical thinning treatments may have little effect on total live tree densities, canopy cover, surface fuel loads, and large snag densities (Egan et al. 2015, Meador et al. 2015). Such treatments represent a less flexible approach to forest management (Abella et al. 2006).

There may be additional tradeoffs when considering operational constraints, socioeconomic considerations, such as stewardship funding opportunities, and climate change mitigation concerns, such as carbon sequestration and stocks (Long et al. 2014, Ababneh 2008, Abella et al. 2006). Given these tradeoffs, the scientific validity of using one diameter limit versus another is often clouded in uncertainty. They are highly contingent on the objectives for each specific forest restoration project (Meador et al. 2015) and the pretreatment stand conditions (Egan et al. 2015).

An ideal approach toward Sierra Nevada forest restoration would be to create mechanical thinning prescriptions that vary by species, that are flexible with respect to tree diameter (rather than maintaining a rigid diameter limit across species), that integrate fire restoration, and that consider the entire array of restoration objectives on a site-specific basis (North et al. 2007). Site conditions and stand management history are also important considerations (Egan et al. 2015). This approach would help balance potentially competing ecological restoration objectives, such as the need to restore forest structure and composition, while retaining important habitat suitability for old forest-dependent species (Meador et al. 2015, Kalies and Rosenstock 2013).

There are three general, diameter cap approaches to managing old forests that have short- and long-term implications for large tree densities: strict diameter limits, diameter limits with exceptions, and no diameter limit, with a focus on desired conditions. Management approaches with strict diameter limits of 24 to 30 inches, with very limited exceptions for operability during mechanical treatment, will retain a greater number of trees in this diameter class in the short term. However, this approach will come at the cost of diminished management flexibility necessary to achieve desired conditions in old forests, with several short- and long-term, negative consequences.

First, the vulnerability of large and old trees to such stressors as drought, insects, pathogens, air pollution, and climate change will increase. This will be due to competition from large but younger shade-tolerant trees and increased susceptibility to bark beetle attack or pathogens. Similarly, large and old trees will be more vulnerable to uncharacteristically severe wildfires when close to large but younger shade-tolerant trees with lower crowns that create fuel ladders and increase the risk of localized crown torching (North et al. 2009a). This increased vulnerability will lead to increased mortality rates of large and old trees in old forests (Van Mantgem et al. 2009, Lutz et al. 2009).

Second, the inability to remove trees in the 24- to 36-inch diameter class will limit the effectiveness of mechanical thinning, to increase structural heterogeneity in forest stands and enhance the growth and survivorship rates of other mature trees in this diameter class. Such trees will grow to become large and old trees. This is the case in many mature and old forest stands of the Sierra and Sequoia National Forests that contain an elevated density of white fir and incense cedar trees that exceed the natural range of variation (North et al. 2007, Stephens et al. 2015, Dolanc et al. 2014).

Third, a strict diameter limit would constrain the effectiveness of mechanical thinning treatments to restore stand composition. One example is favoring fire-resilient pines and hardwoods in fire-excluded mixed conifer stands by selecting shade-intolerant white fir and incense cedar for removal (North et al. 2007).

As a consequence of these constraints, forest stands treated with a strict diameter limit will be more structurally homogenous, less resilient to stressors, and less aligned with desired conditions and the natural range of variation with respect to forest structure and composition.

A diameter limit with exceptions that accounts for specific site conditions, stand management history, and restoration objectives (Egan et al. 2015, Abella et al. 2006) provides a more balanced and flexible approach than a strict diameter limit. In the short term, this approach will retain a slightly lower number of trees in the 24 to 36 diameter class, compared with a strict diameter limit. However, it will add considerably more mechanical treatment flexibility.

There are several exceptions that can promote old forest desired conditions, while retaining a desirable number of young and large trees in the stand. One exception is when removing trees to restore aspen stands, oak groves, meadows, or other areas of cultural or tribal importance (Abella et al. 2006, Berrill et al. 2017, Long et al. 2017a). Another exception is in overly dense stands to favor retention or promote the growth of even larger or older shade-intolerant trees (York et al. 2015, North et al. 2007, Ritchie et al. 2008). A third exception is in dense, homogenous, and single-aged stands, such as unthinned fir-dominated stands resulting from historical railroad logging followed by fire suppression. This exception would be to achieve forest structure and composition restoration objectives, including increased survival of large trees (Collins et al. 2014).

For all of these exceptions, trees exceeding 40 inches in diameter would not be removed, except for public and firefighter safety, thereby ensuring the retention of very large and old trees in mature and old forests. An example of this is a higher, strict diameter limit. Following this diameter-limits-with-exceptions approach, there would be a decreased risk of tree mortality from stressors in all treated stands. However, this approach may not apply to some old forest areas, such as in California spotted owl protected activity centers (outside community buffers), where strict diameter limits apply. Lack of diameter limit flexibility in these areas would perpetuate increased risk of large and old trees to uncharacteristic wildfires, insects, pathogens, or excessive moisture stress associated with climate change and drought.

An approach without a diameter limit but focused on old forest desired conditions, such as desirable large tree densities or a desirable proportion of the landscape with old forests, also has inherent tradeoffs. On the one hand, this approach would remove some young and large trees and, under rare circumstances, it would remove a few old and large trees when current large tree densities exceed the desired conditions.

Large, shade-intolerant but unhealthy diseased trees may be removed, or the recruitment and growth of desirable shade-intolerant trees, such as aspen, black oaks, or ponderosa or Jeffrey pine, may be favored. This would result in the short-term reduction of large tree densities in mature and old forests, especially in the 30- to 40-inch-diameter class.

On the other hand, this approach would facilitate the greatest flexibility in mechanical thinning, with several benefits to old forest stands. First, it would be the most effective at enhancing the health and integrity of large and old trees in old forests. This is because reduced tree densities around these trees would elicit the greatest reduction in competition, susceptibility to insect attack and pathogen occurrence, and moisture stress associated with climate change and drought. Second, it would also increase structural heterogeneity, facilitate restoration in tree species composition, and reduce the risk of uncharacteristically severe wildfires (in this final case, by reducing the density of larger ladder fuels close to large and old trees).

Nevertheless, there is some uncertainty with this approach, because there is a lack of specific direction regarding spatial context on the removal of large tree densities to achieve old forest desired conditions. For example, many large and old trees are typically distributed in a highly uneven spatial pattern that varies from stand to landscape scales. A stand-level evaluation where large trees appear to be in surplus to the desired conditions would facilitate their removal under a flexible approach, without a diameter limit. However, this could be misleading because those evaluating and thinning the stand may not consider whether large trees are in surplus or deficit at the landscape scale. Consequently, the removal of the large trees in the stand where the densities exceed the stand-level desired conditions could reduce densities at the landscape scale. In such a scenario, there would be negative consequences at the larger spatial context, such as reduced habitat availability or connectivity for old forest associated species.

Complex Early Seral Forests

Complex early seral forests apply to actively managed forests in the montane and upper montane zones, including ponderosa pine, mixed conifer, Jeffery pine, lodgepole pine, and red fir forest ecosystems. However, mixed conifer, ponderosa pine, and Jeffrey pine are generally the forest types that experience most postfire management and associated research studies in the plan area and bioregion (Knapp and Ritchie 2016, Long et al. 2014).

Early successional forests following such stand-replacing events as high-severity fire, in the natural range of variation represent an important ecological stage that supports diverse ecological processes, ecological communities, and vegetation structures (Swanson et al. 2010). The concept of complex early seral forests is based on ecological function and not just the age of the vegetation. This habitat type is created by stand-replacing disturbances, such as fires, insect outbreaks, and wind throw. These disturbances create clumps, patches, or larger areas of early successional (young) forest, where overstory trees are temporarily absent or rare. Consequently, this forest successional stage represents a transitory period immediately following a stand replacement and before the ensuing period of forest development and canopy reestablishment.

Complex early seral forest is a type of early successional forest that contains structural, compositional, or functional elements of ecological complexity or integrity. This complexity and integrity in early seral forests often comes from the presence of elements created by the disturbance, such as snags, logs, isolated live trees or tree clumps, young shrubs, herbaceous plants, regenerating trees, and sprouting hardwoods.

Spatial heterogeneity (variation) in vegetation composition and structure during recovery after a disturbance is another important element of complexity in early seral forest (Swanson et al. 2010). Legacy structures following a disturbance such as fire—for example, large snags and logs, resprouting plants, and understory plant diversity—can provide habitat for early-successional-associated wildlife. Increased light availability, reduced litter cover, and increased soil moisture and bare mineral soil following stand-replacing disturbances can provide suitable environmental conditions to support early-seral associated plant species (Wayman and North 2007).

Complex early seral forests, such as those derived from high-severity fire, provide a number of potential benefits, when these stand-replacing patches fall within the natural range of variation. This includes habitat for early successional plant and animal species (Betts et al. 2010, Swanson et al. 2010, Fontaine and Kennedy 2012, Tingley et al. 2014), increased plant-pollinator interactions (Ponisio et al. 2016), and structural heterogeneity (Kane et al. 2013).

In burned forest landscapes, a mosaic of low, moderate, and high severity patches, interspersed with unburned refugia consistent with NRV, are characterized by high diversity of fire effects across the landscape. This is based on fire frequency, severity, and extent and increases the diversity of plants and animals (Ponisio et al. 2016, Tingley et al. 2016). Patches of early successional forests in this mosaic may increase forest landscapes resilience by promoting tree regeneration and colonizing species, such as early successional mycorrhizae, nitrogen-fixing plant species, and keystone species associated with early successional habitats, such as pollinators and cavity excavators (Swanson et al. 2010, White et al. 2016, Saracco et al. 2011, Siegel et al. 2015). Early successional patches may also increase tree regeneration and recruitment for disturbance-dependent species, such as aspen or giant sequoia (Krasnow and Stephens 2015, Meyer and Safford 2011, Piirto and Rogers 2002).

Postfire management may reduce or increase structural complexity in early seral vegetation, depending on a variety of factors: the specific management activity, forest type, ecosystem characteristics (e.g., fuels, habitat features, and plant diversity and composition), disturbance history, and extent and severity of fire (Long et al. 2014). Salvage and reforestation removes such structural elements as snags and logs or creates conditions that may not provide the same level of complexity or habitat quality for associated species (Swanson et al. 2010, Noss et al. 2006).

Some habitat elements, such as pine snags,, often have limited longevity regardless of the level of management after a fire, such as salvage logging (Ritchie et al. 2013). In addition, the effects of postfire management, such as salvage and reforestation, on early seral forest depends on the intensity and type of activities, such as snag and surface fuel retention levels (Ritchie et al. 2013). The effects of postfire salvage and other management treatments on understory diversity, tree regeneration, and plant community composition are variable; most studies indicate little to no differences in understory diversity and composition between treated and untreated stands (Knapp and Ritchie 2016, McGinnis et al. 2010) or increases in understory diversity following shrub removal associated with reforestation (Bohlman et al. 2016).

The effects of postfire salvage on woody fuels is also variable, with some studies indicating no differences between salvaged and unsalvaged areas (McGinnis et al. 2010) and other studies documenting a reduction in woody surface fuels several decades postfire (Peterson et al. 2015). Postfire management activities, such as salvage logging, combined with planting, can significantly increase postfire tree regeneration in moderate- to large-sized high-severity patches. Such patches lack natural regeneration, which can enhance long-term structural complexity and forest integrity (Collins and Roller 2013, Welch et al. 2016).

Postfire reforestation that incorporates the principles of spatial heterogeneity and fire and climate adaptation can be particularly effective at creating resilient forest stands in the future (North et al. 2019). Deforested areas lacking postfire management may convert to a shrub-dominated ecosystem after another fire. This would be due to elevated fuel levels associated with dense snags and shrubs (Coppoletta et al. 2016, Harris and Taylor 2017) and the interactive effects of climate change and fire (Tepley et al. 2017). Similarly, selective postfire management actions that target high valued areas of high fuel loading following a high-severity fire may effectively mitigate the impacts of future uncharacteristic fires and enhance the resilience to future wildfires (Coppoletta et al. 2016).

There is clear evidence of more high-severity fire conditions now, compared with historical conditions, specifically in yellow pine forests, including Jeffrey pine forests (Mallek et al. 2013), (Safford and Stevens 2017). This is partially a consequence of increased fuel loading associated with long-term fire exclusion in these forests (Steel et al. 2015). Even more evident is the lack of low- to moderate-severity fire in nearly all forest ecosystems of the Sierra Nevada, compared with the pre-Euro-American settlement period (Mallek et al. 2013).

The amount and proportion of early seral forest in the Sierra and Sequoia National Forests are often much higher than what occurred historically. This is because there is a surplus of high-severity fire in yellow pine forests in the Sierra Nevada (Mallek et al. 2013). There is no historical (NRV) proportion of complex early seral forest, because this habitat type is largely derived from unnaturally dense forest stands that lack a historical analog.

The surplus of high-severity fire has resulted in a suitable level (similar to reference condition) or excessive amount (exceeding reference condition) of early seral forests in several montane and upper montane forests in the southern Sierra Nevada (see Southern Sierra Nevada Wildfire Risk Assessment: Vegetation Condition Assessment Report). It also resulted in a relatively low 4 to 10 percent, between 1984 and 2014, of postfire salvage and reforestation treatments in Sierra and Sequoia National Forest burned areas (see Complex Early Seral Forest Supplemental Report). Moreover, while there are larger patches of high-severity fire in current yellow pine and mixed conifer forests than under the natural range of variation (Safford and Stevens 2017), high-severity fire patch size remains relatively unchanged in most upper elevation forests, with some exceptions (Meyer 2015b, Meyer 2015c).

Where fire regimes have been partially or wholly restored with prescribed fire or where wildfires were managed to meet resource objectives, it tends to result in more desirable fire effects, dominated by patches of low- to moderate-severity fire; the exception is patches previously burned at high severity.

While there is some uncertainty as to exactly how much high-severity fire occurred historically in montane forests, most evidence indicates this to be a smaller proportion of the burned area in these forest types (Safford and Stevens 2017). Moreover, it is also likely that high-severity fire patch sizes have increased considerably in these forests over the past few decades (Miller and Safford 2012, Westerling and Keyser 2016). Historically, these high-severity patches were smaller, generally less than 1 to 10 acres and rarely exceeding 200 to 250 acres. Moreover, they were not interconnected, resulting from mortality of individual, clumped, or small groups of trees (Safford and Stevens 2017). However, in recent years, mixed conifer and yellow pine forest types have burned severely and extensively, resulting in substantially larger and more interconnected patches of complex early seral forest (Safford and Stevens 2017). This is increasing the total stand-replacing area at high risk of tree regeneration failure in California's coniferous forests. It has important implications for the long-term resilience and sustainability of forest ecosystems in the region (Stevens et al. 2017).

Most Sierra Nevada forest ecosystems are fire excluded and are characterized by excessive tree densities and fuels, especially in low- to moderate-elevation forests (Safford and Stevens 2017, Meyer 2015b). When these forests are severely burned or impacted by drought and bark beetle outbreaks, such as during the 2012–2016 drought, they frequently contain densities of snags that greatly exceed the natural range of variation (Young et al. 2019, Meyer 2017, Coppoletta et al. 2016). This can create post-disturbance vegetation conditions with excessive snag and coarse woody debris biomass, particularly over mid- to large-spatial scales (hundreds to thousands of acres).

Consequently, many complex early seral forests that were derived from overly dense forest stands with high fuel loads are considered to be outside the natural range of variation and in conflict with other vegetation desired conditions, such as snag densities and surface fuel loads in forest ecosystems. This is especially the case in larger, more interconnected patches of complex early seral forest. Such forests were derived from high-severity patches exceeding the natural range of variation and desired conditions for high-severity patch size. These large patches frequently contain high densities of snags, logs, and shrubs, and lack sufficient tree regeneration to facilitate forest succession and recovery. This would result in low ecological integrity and resilience (Collins and Roller 2013, Welch et al. 2016, Shive et al. 2018) and increased probability of frequent high-severity fire (Coppoletta et al. 2016).

In the long term, insufficient forest recovery in large stand-replacing patches would convert to shrub-dominated or nonnative grass-dominated vegetation. This would no longer be considered a forest successional stage, including early seral or complex early seral “forest.” Consequently, these areas no longer could reforest and create potential new complex early seral habitat or other forest successional stages, such as late-successional forests.

By contrast, a complex early seral forest is consistent with vegetation desired conditions and provides ecological benefits (described above) under the following circumstances:

- It occurs in smaller patches of generally less than 10 acres that are isolated and not interconnected within forest landscapes
- It is characterized by snag and log densities and surface fuel loads within the natural range of variation
- It contains sufficient tree regeneration for forest recovery and succession
- It provides suitable habitat for forest-dependent species, such as California spotted owl and fisher

Under these specific conditions, complex early seral habitat may require minimal management intervention, such as salvage or reforestation. This is because current conditions would be closely aligned with vegetation desired conditions.

Unique Vegetation Types. There are two giant sequoia groves to the north and outside of Giant Sequoia National Monument in the Sierra National Forest: Nelder and McKinley Groves. These isolated groves are managed specifically for giant sequoia. These groves are currently impacted by fire exclusion, insects, pathogens, climate change, and other stressors (United States Department of Agriculture 2013j).

Increasing tree densities and fuel loading and the removal of fire as a key ecological process have contributed to the degradation of giant sequoia health and sustainability. They have resulted in inadequate sequoia regeneration and increased risk of uncharacteristic wildfire. This was observed, following the 2017 Railroad Fire, which burned severely in the Nelder Grove on the Sierra National Forest; it destroyed dozens of large and old giant sequoias.

The McKinley Grove is highly departed from its historical fire return interval, due to the long-term absence of fire from this grove. Although grove boundaries have remained stable for the last several hundred years, climate change threatens the long-term persistence of small and isolated giant sequoia groves, such as the Nelder and McKinley Groves. Climate projections indicate that giant sequoia trees, especially the largest specimens, will be highly vulnerable to climate change in the 21st century (Sydoriak et al. 2013, Stephenson et al. 2018).

Aspen stands support a high level of plant biodiversity, with many wildlife species using them during some stage of their life cycles (Kuhn et al. 2011). Most aspens on the west side occur in smaller, isolated patches in wet areas, around meadows or streams, or where subsurface water is shallow. The life cycle of aspens is closely tied to fire and other natural disturbances. Poor aspen regeneration due to conifer ingrowth, disease, lack of characteristic fire, and cattle and wildlife browsing are the primary recorded factors. The ingrowth of conifers is due mostly to fire suppression, since fire favors sprouting aspens and kills young conifers (Estes 2013b). Climate change may also be a factor, as noted in the Rocky Mountains, and climate models indicate moderate climate vulnerability in the Sierra Nevada in the 21st century (Estes 2013b).

The condition of these unique vegetation types is generally low across all ecological zones and vegetation types. However, the ecological condition is moderate at some limited sequoia groves or aspen sites that have recently experienced restoration treatments or that have been exposed to wildfire within the natural range of variation. An example is select portions of the Nelder Grove burned in the 2017 Railroad Fire.

Restoration treatments (both fire restoration and mechanical removal of conifers) have been shown to be highly effective at increasing the regeneration of aspen and giant sequoia (Meyer and Safford 2011, Berrill et al. 2017, Krasnow et al. 2012) and increasing tree growth rates and vigor, especially when diameter limits do not constrain the removal of shade-tolerant trees (Berrill et al. 2016, York et al. 2015).

Keystone Species Groups

The current condition of pollinators and cavity excavators, such as woodpeckers, is uncertain, and there is little direct information available. For pollinators, forests with dense vegetation conditions lacking characteristic fire have lower levels of flowering understory plants, especially those dependent on higher light environments (Webster and Halpern 2010, Wayman and North 2007). These conditions are common for most of the montane forest areas (see "Terrestrial Vegetation Ecology"). Restoration treatments, especially prescribed fire, increase the diversity of native pollinators, such as butterflies (Huntzinger 2003). Canopy arthropods, such as insects and spiders, also benefit from ecological restoration treatments, if the treatments also enhance tree, shrub, and herbaceous plant diversity in forest stands (Rambo et al. 2014). Invasive, nonnative plants can reduce pollinator habitat, especially if the nonnative plants are wind-pollinated grasses, such as cheatgrass. Large areas in the foothill zone and arid shrublands and woodlands have had cheatgrass and other nonnative annual grass invasions. Pollinator habitat is greatly reduced in these areas.

Habitat for cavity excavators (especially snags) is highly varied. In conifer forests, the average number of snags in an area is in the lower end of the desired conditions; but snags are highly variable spatially and often are within or above the natural range of variation (Safford et al. 2013, Meyer et al. 2014a). This high spatial variability means that there are many areas that have no snags and other areas that have more than the average number. Overall, large snag levels, especially very large snags, greater than 30 inches in diameter, may be limited in the forest landscape, especially in plantations, the wildland-urban intermix, and areas impacted by windstorms. There are fewer snags in oak woodlands than conifer-dominated areas. However, in oak woodlands, dead branches on live trees often provide suitable habitat for cavity excavators.

Tribal Uses and Biocultural Diversity

As mentioned previously, the people of various tribes in the area have always been tied to different ecosystems across the bio-region for food, shelter, and culture (See "Tribal Relations and Uses"). This includes gathering and tending trees, such as black oaks and pinyon pines, for primary food, plants for basketry and shelter, and fish and game for food (Anderson and Moratto 1996, Anderson 2006). These ecosystems also provide for culturally important activities, such as cross-Sierra travel and trade trips and sacred ceremonies.

There was and, to a lesser degree, currently is an interaction between Native American land uses and management and ecosystem condition and function. Native Americans often used fire or other means to improve forests and meadows. They supply materials for baskets to store or carry food and improve habitat conditions for game species, such as deer. Fire was also used in riparian areas, where there is a high proportion of plants that are important for basketweaving.

On the west side, such plants as willow, dogwood, and big-leaf maple resprout following burning (Fites-Kaufman et al. 2006). The stems grow straighter, with fewer insect nests, when they have been burned or cut (Anderson 2006). Although fire naturally occurred in riparian areas at different intervals throughout the bio-region, it is well documented that Native Americans supplemented lightning-caused fires with targeted burning (van Wagtendonk and Fites-Kaufman 2006). Some other species that require regular burning to maintain their viability and quality as weaving materials are beargrass, deer grass, redbud, *Ceanothus* species, giant chain fern, and white root.

In arid shrublands and woodlands, seed, root, and bulb gathering occurred, and in some cases, irrigation was used to encourage desirable species (Slaton and Stone 2015a, b). Activity in sagebrush was concentrated near meadows. Fires were set in the spring and fall. The Paiute, Shoshone, and Washoe used pinyon pine extensively and still collect products from the trees, including pine nuts, pitch, and wood. Native Americans pruned the trees, raked away the litter, weeded around them, and burned to increase productivity and protect them from wildfire. Elder interviews attest to the fact that fire was used to foster growth of particular food groups, such as wild onions, elderberries, and caterpillars. Fire was used to eliminate excess fuels that threatened favorite pinyon pine stands.

The condition of plants, animals, and insects that tribes use, as well as the ecosystems they occur in, is low for low- and mid-elevation areas—foothill, montane, and arid shrublands and woodlands zones—and moderate for higher elevation areas—upper montane, subalpine, and alpine zones. This is related to the condition of vegetation and fire regimes relative to the natural range of variation. Dense vegetation and limited low- and moderate-intensity fire are primary factors.

Current vegetation conditions are denser and less diverse in the understory, and many important plants are in poor condition, such as black oak, shrubs used for basketry, and other plants used for traditional foods or medicines. Traditional travel routes are covered in dense vegetation, impeding travel, particularly for elders and young tribal members. Management for biodiversity, particularly through the use of beneficial fire, would help to maintain viable populations of the diverse plants and animals that are necessary for Native American traditionalists to continue their cultural practices.

Integrated Terrestrial Ecosystem Sustainability

The integrated terrestrial sustainability condition varies by the ecological and elevational zone. For details by each zone and major vegetation type, see “Fire Trends,” “Terrestrial Vegetation Ecology,” and “Insects and Pathogens.” These sections are a synthesis of the overall findings.

In most lower and mid-elevation areas, indicators of terrestrial ecosystem sustainability point to a low and moderate condition, as shown in Table 42 (United States Department of Agriculture 2004a, 2011a). The greatest contributors are vegetation and fire conditions that are outside of the natural range. In sagebrush and pinyon-juniper woodlands, invasive plants are widespread, although they are still scattered in many locations. The ecosystems are still functioning but may be at a tipping point for large change, such as a higher susceptibility to widespread drought and insect- and pathogen-related plant and tree mortality and a susceptibility to widespread changes in connectivity, forest cover, and mature forest area from increasingly large, high-intensity fires.

Table 42. Overall ecosystem sustainability conditions by characteristic from National Forest Sustainability Report* by major ecological and elevational zone

Characteristic	Foothill	Montane	Upper Montane	Subalpine/ Alpine	Arid shrublands and woodlands
Area affected by insects and pathogens beyond natural range (and susceptibility to insect attack)	Low (high susceptibility)	Moderate (high susceptibility)	Moderate, (moderate susceptibility)	Low (low to moderate susceptibility)	Low (moderate susceptibility)
Area affected by air pollutants that may cause negative effects	High	High	Moderate	Moderate to low	Low, but some transport of ozone
Area affected by invasive species	High	Moderate	Moderate	Low	Moderate, extensive areas of nonnative grasses
Area with fire condition class outside of natural range	Moderate	High	Moderate	Low	moderate
Area with vegetation condition outside of natural range	Moderate	High	Moderate	Low	moderate

*(United States Department of Agriculture 2004a, 2011a)

Environmental Consequences for Terrestrial Ecosystem Processes and Functions

Consequences Common to All Alternatives

Fire Regimes and Fire as an Ecological Process

Fire regimes would continue to depart from the natural range of variation for much of the mid- and lower elevation areas in the analysis area, except where moderate to high levels of restoration occur across broader areas. Because fire operates at large scales, areas greater than 10,000 acres, with at least 40 to 60 percent restoration, are necessary to effect changes in large fire patterns (the amount of high-intensity or crown fire; see “Fire Trends”). The alternatives vary in the amount of the landscape where various types of restoration would be used, such as mechanical treatments, prescribed fire, or wildfire managed to meet resource objectives. The alternatives also vary in the intensity of the treatments or degree of change in vegetation that affects fire type. Finally, the alternatives vary in the amount of fire that would be applied or managed on the landscape at the desired condition. Such intensities would have beneficial effects on the vegetation and would reduce fire regime interval departure.

In this section, the broader characterizations of the alternatives are described by the vegetation type where the actions would most likely be used. Most of the mechanical and prescribed fire restoration treatments would occur in the montane yellow pine and mixed conifer forest types. Wildfire managed to meet resource objectives would occur primarily in the montane and upper montane forests, particularly in the Kern River drainage and wilderness areas. Large areas of mixed conifer forests and montane chaparral would experience wildfires managed to meet resource objectives. The greater amounts of mechanical treatments under alternatives B and D in strategic locations would increase the likelihood of larger prescribed fires and managed fires to meet resource objectives in montane areas. These characterizations by vegetation type are used to analyze the expected consequences of the alternatives below.

Table 43 summarizes the expected consequences of the alternatives by major vegetation type.

Table 43. Fire regime integrity for vegetation types by alternative

Vegetation Type	Alternative A	Alternative B	Alternatives C and E	Alternative D
Chaparral	Low to moderate	Moderate	Low to moderate	Moderate
Oak woodland	Moderate	Moderate	Moderate	Moderate
Ponderosa pine-black oak	Low	Moderate	Low to moderate	Moderate
Dry mixed conifer	Low	Moderate	Low to moderate	Moderate
Moist mixed conifer	Low	Moderate	Low to moderate	Moderate
Red fir	Moderate	Moderate to high	Moderate	Moderate to high
Jeffrey pine	Very low to low	Moderate	Low	Moderate
Kern Plateau forests	Moderate	Moderate to high	Moderate	Moderate to high
Subalpine and alpine	High	High	High	High
Sagebrush	Moderate	Moderate to high	Moderate to high	Moderate to high
Pinyon-juniper	Moderate	Moderate to high	Moderate to high	Moderate to high

Among all the alternatives, there is little difference in consequences for the subalpine and alpine areas. Limited vegetation and harsh growing conditions result in slow changes in vegetation there. Most of these areas are in wilderness or inaccessible locations.

Upper Montane Zone

Under all alternatives, red fir and lodgepole pine forests have at least moderate integrity, owing to the relatively longer fire return intervals in these forest types; the median fire return interval is approximately 30 to 50 years. However, most red fir and lodgepole pine forests have missed one or two fire return intervals, resulting in a variety of ecological impacts associated with fire exclusion, such as increased fuel loading and tree densities (Meyer et al. 2019). Red fir is among the most vulnerable to climate change (North 2014, Meyer et al. 2014a). This is because red fir is experiencing the greatest relative change in type of precipitation and temperatures. Fires may become more frequent in these areas and disrupt the current moderate levels of fire regime integrity and resilience.

Jeffrey pine forests in the Sierra Nevada are moderately to highly departed from their historical fire regimes, because of decades of fire exclusion in these frequent fire-regime forests. Under all alternatives, fire regimes in Jeffrey pine forests would be relatively intact on the Kern Plateau and neighboring upper montane landscapes, such as the Golden Trout Wilderness. This is because of the many wildfires that are managed to meet resource objectives in this portion of the Sequoia National Forest.

Subalpine and Alpine Zone

Alpine vegetation and many subalpine forests at higher elevations would have high fire regime integrity under all alternatives. This is because of the very long historical fire return intervals in these vegetation types, which often exceed 150 to 200 years. This is greater than the current fire exclusion period of the 20th and early 21st centuries. As a result, they are within the natural range of variation, with respect to fuel loading and fire regimes. All alternatives support at least moderately high resilience to fire.

Arid Shrubland and Woodland Zone

Although highly variable, the historic fire return intervals were relatively long in sagebrush (40 to 450 years) and pinyon-juniper woodlands (90 to 150 years). Under all alternatives, arid shrublands and woodlands would have at least moderate fire regime integrity, owing to the relatively long fire return intervals in these arid vegetation types. However, increasing and excessive wildfires in these vegetation types that exceed the natural range of variation (that is, too frequent fire compared to the historic fire regime) would result in reduced fire regime integrity. This is often associated with vegetation type conversion favoring nonnative annual grasses, such as cheatgrass and red brome.

Ecological restoration treatments in some arid shrublands and woodlands, such as sagebrush invaded by pinyon pine, could increase the resilience of these ecosystems to wildfires. These treatments also could reduce the probability of excessively frequent fire that exceeds the natural range of variation. However, all alternatives would support at least moderate fire regime integrity in many arid shrublands and woodlands. This is because of the long historical fire return intervals in these vegetation types, which may exceed 100 years. This is greater than the current fire exclusion period of the 20th and early 21st centuries.

Carbon Stocks, Sequestration, and Stability

Under all alternatives, there would be several conditions and trends that greatly influence current carbon stocks, sequestration, and especially stability. First, dense forests would continue to occur across much of the area, because there are no alternatives that restore more than 50 percent of most landscapes. This means that carbon storage and sequestration will continue in those areas. There may be increases in carbon sequestration in thinned forests, since individual trees would be less stressed and may have faster growth. At the same time, under all alternatives, there would continue to be large, high-intensity fires, especially in dense forests lacking restoration. When these fires occur, large amounts of carbon stored in forests and soil litter would be converted into carbon dioxide in the air. Climate change will also limit carbon sequestration and carbon stocks following these fires, through increased evaporative demand, which limits tree growth rates and regeneration.

Tribal Uses and Biocultural Diversity

Tribes would continue to use forest lands, vegetation, insects, and animal materials under all alternatives, similar to what occurs now. More information on how these are determined and negotiated is covered in “Tribal Relations and Uses” later in this document. The condition of ecosystems, plants, insects, and animals used by tribes varies by alternative. In addition, all but alternative A contain specific direction that would improve the condition and use by tribal members. The rate and type of ecological restoration that would result in improvements varies by alternative.

Consequences Specific to Alternative A

Fire Regimes and Fire as an Ecological Process

Foothills Zone

Fire regime integrity would continue to be low under alternative A in most areas. There would continue to be some restoration treatments in areas around communities, but the width of wildland-urban intermix defense zone and the wildland-urban intermix threat zone is limited. The restoration may also increase the amount of nonnative, annual grasses that can decrease resilience. Native plants can become crowded out and fires can burn more frequently than the natural fire regime. In some areas, invasive nonnative plants would be removed and the areas would be restored, but it would be limited.

Montane Zone

Fire regime integrity would continue to be low in montane forests under alternative A. For this analysis, the Forest Service assumes that the extent of any type of treatment would be low under alternative A. It also assumes that most of the restoration treatments that would influence fire type, fire severity, and effects would result in limited to moderate changes in vegetation structure and composition. Most of the treatments would occur in montane mixed conifer and ponderosa pine vegetation. Fire regime integrity would continue to be low across most areas, with high proportions of crown fire and fire severity expected during peak fire season fires. The trend of increased fire severity would continue or worsen, due to increased burned areas and fire size (see “Climate Change” and “Fire Trends”).

The Forest Service expects there to be some restoration of wildfires, primarily to meet resource objectives. However, little to none of this would occur in montane forests, except for in the Kern Plateau on the Sequoia National Forest. Large areas in the Kern Plateau have already had managed fire (greater than 30 percent), and this would continue under alternative A. Fire regime integrity would continue as moderate or would shift to high in some parts of this area.

Restoration of native understory flora would be limited because prescribed fires would be limited. Some plant and bird species adapted to early successional stages would benefit from large, higher severity fires, but many other species would not benefit from these unique conditions. Overall, alternative A would result in a deficit of low- and moderate-severity fire and a surplus of high-severity fire that has departed from the natural fire regime. There would be negative impacts on montane ecosystems and most of their component species.

Upper Montane Zone

As described above in “Consequences Common to All Alternatives,” upper montane forests would continue to have moderate fire regime integrity. There would be limited restoration treatments in this area. There would continue to be some ecologically beneficial fires in areas where low and mixed severity fires occur. It is uncertain how many such fires would happen. The greatest likelihood is in the Kern River drainage, where remote areas have had extensive areas of wildfires managed to meet resource objectives.

Subalpine and Alpine Zone

Alternative A would support continued moderate to high fire regime integrity in subalpine forests, as described under all alternatives. There would be limited restoration treatments in these areas.

Similar to upper montane forests, there would continue to be some ecologically beneficial fires, especially in wilderness and in the Kern River drainage.

Arid Shrublands and Woodlands Zone

The least amount of restoration treatment would occur under alternative A in arid shrubs and woodlands. There would be less restoration of sagebrush areas with conifer invasion and in pinyon-juniper woodlands. There would be less restoration of fire as an ecosystem process using prescribed fire. Invasive plant treatments would continue to minimize introductions of invasive species, when possible, but invasive species would continue to expand and potentially alter fire regimes.

Carbon Stocks, Sequestration, and Stability

Low levels of vegetation restoration would continue under alternative A, while the likelihood of large, high-intensity fires would increase (see "Fire Trends") (Westerling et al. 2015). This would increase emissions of carbon to the atmosphere and decrease carbon stocks and sequestration. Most of the carbon stocks and fires both occur in the montane and upper montane zones. Therefore, an individual, very large fire can have large impacts on carbon stocks and emissions. There would be a negative impact under alternative A on carbon stability, carbon stocks, and sequestration rates.

Landscape Connectivity

Alternative A would result in few direct effects on landscape connectivity, because treatment levels would be low. The primary consequence would be the indirect effect of treatments in reducing the likelihood of large high-intensity fires that can disrupt habitat connectivity for many species, except those in early seral habitat. The extent of restoration treatments is less than 10 to 15 percent of the low and mid-elevation landscape area; thus, the likelihood of large, high-intensity fires would increase under alternative A (see "Fire Trends") (Westerling et al. 2015). This would cause fragmentation of forested areas and areas of older and mid-aged chaparral.

Important Seral Stages

Old Forest

The treatments under alternative A would have little to no impact on large trees and the proportion of area in old forests. There are limits restricting the harvest of any trees greater than 30 inches in diameter under almost all conditions. The treatment area is limited under alternative A and there are also limitations on the forest canopy cover changes that can occur in montane forests or other areas where California spotted owl, northern goshawk, fisher, or Sierra marten occur. This would result in a continuation of large areas of high forest density that are susceptible to high-intensity fires (see "Fire Trends" and the fire ecology supplemental report). There is an increased likelihood of large, high-intensity fires under current treatment levels (see "Fire Trends") (Westerling et al. 2015). Therefore, this analysis assumes there would be an increased likelihood of large, high-intensity fires in areas with old forests.

It is unknown what proportion of areas burned in future fires would be high severity and result in large tree mortality. Recent fires have ranged widely in large tree mortality levels and extent. Given the limited levels of current old forest and the several hundred years it takes to redevelop, the impact of single, large, high-intensity fires may have negative impacts on old forests. The likelihood of "mega fires" is thought to be increasing, because of climate warming, longer fire seasons, and drier fuel conditions (Millar and Stephenson 2015). A mega fire is one greater than 50,000 acres, such as the King Fire, which burned extensive areas in old forest in Rubicon River

Canyon at extremely high intensity. When or where these types of fires may occur is unknown, but the likelihood exists in the analysis area and the likelihood is increasing.

Complex Early Seral Forest

The impacts of alternative A on complex early seral forest are related to the consequences described above for old forest, as well as likely salvage, reforestation, and other postfire restoration treatments. The amount and distribution of complex early seral habitat would likely increase under alternative A. This is because the amount of high-intensity fire is likely to increase and anticipated rates of postfire salvage on the Sierra and Sequoia National Forests will continue to affect only 12 percent or less of forests and woodlands on these national forests. The spatial pattern of the complex early seral forest would likely continue to be mostly in large patches from large high-intensity fires. The exception would be in the Kern River drainage, where extensive fire restoration in the last decade has resulted in a wide variety of small and medium, high-severity, fire patches (Meyer 2015a). Fires are starting to burn into previously burned areas, limiting the potential in this area, especially on the Kern Plateau to develop large high-severity fire patches (Vaillant 2009, Ewell et al. 2012).

There is no specific management direction under alternative A directed at desired conditions, guidelines, or standards for complex early seral forest. There is direction to leave at least 10 percent of burned areas unsalvaged. However, the amount of salvaged or reforested burned areas in the Sierra and Sequoia National Forests is limited. This is due to constraints in local timber processing infrastructure, limited market demand for aged timber (over 1 year post-tree mortality), inaccessibility, and other reasons, such as workforce capacity.

In the past three decades, approximately 4 and 10 percent of burned areas have been salvaged or reforested on the Sequoia and Sierra National Forests, respectively (see Complex Early Seral Forest Supplemental Report). Based on these values, approximately 2 and 3 percent of montane and upper montane forests have been salvaged or reforested per decade on the Sierra and Sequoia National Forests, respectively. Therefore, most of the burned areas in these national forests are not treated and are left to provide these habitats. In addition, early seral forest is in or slightly exceeding the NRV for most montane or upper montane forest vegetation types in the Sierra and Sequoia National Forests (see Vegetation Condition Assessment Supplemental Report).

Future projected increases in wildfire severity and frequency, lower rates of forest restoration treatments, and the low levels of postfire management in the Sierra and Sequoia National Forests under alternative A would likely increase the complex early seral forest that exceeds the NRV. This would be especially evident in forest landscapes exposed to repeated uncharacteristic wildfires or those heavily impacted by the 2012–2016 drought. This resulted in substantial tree mortality across the montane and upper montane zones of the southern Sierra Nevada (particularly ponderosa pine and dry mixed conifer forests).

There is uncertainty about how much of the burned areas would be restored in ways that would decrease the ecological character of complex, early seral, forest habitat. However, at the project level after recent fires, there has been a wide range in the amounts proposed to be left unsalvaged or without reforestation. In the analysis area, between 76 and 90 percent of the burned areas have been left unsalvaged for a variety of reasons. Some examples are purposefully retaining areas to provide for complex early seral forests and excluding areas that are too steep or inaccessible. A third example is excluding areas that would have little commercial value by the time projects are implemented, such as after the 2013 Aspen Fire and 2014 French Fire in the Sierra National

Forest. Only 9 to 20 percent of burned areas have been reforested or are planned for reforestation; therefore, while there is a high uncertainty on the precise amount of complex early seral forest that would retain its ecological character after stand-replacing wildfires, currently most burned and other disturbed areas are not treated and are left to provide these habitats.

Unique Vegetation Types

There is limited specific management direction for giant sequoia groves (Sierra National Forest only) and aspen stands (both Sierra and Sequoia National Forests) in the current forest plans.[11] There is some limited direction for managing giant sequoia groves and aspen stands. However, restoration and management approaches designed to reduce stressors, increase ecological resilience, and minimize impacts of activities are generally lacking under the current plans; these activities include restoration and recreation. Recent restoration activities in these vegetation types have been limited in the Sequoia and Sierra National Forests, partially owing to the lack of sufficient and current management direction. In giant sequoia groves and aspen stands, this would increase the risk of these vegetation types to uncharacteristic wildlife, insects, pathogens, and climate change impacts. Examples of this are increased rates of mature tree mortality and depressed sequoia and aspen regeneration. Consequently, alternative A would diminish the ecological condition of sequoia groves and aspen stands.

Keystone Species Groups

Pollinators—Pollinators are positively impacted by restoration treatments that result in sunny openings, and they improve conditions on the forest floor. This is because many flowering plants benefit from fire, although in large fires where nonnative, invasive plants expand, they have an opposing impact. Under alternative A, treatments that benefit pollinators would be very limited. There would be limited amounts of treatments that generally retain moderate and high canopy cover and limited amounts of prescribed fire. Overall, alternative A would continue to maintain dense forest conditions, with limited fire restoration, that retains poor flowering plant conditions that pollinators depend on.

Primary Cavity Excavators—There would be increases in primary cavity excavator habitat. This is because limited restoration would perpetuate dense forest conditions, which would continue to have trees dying and increasing snag levels. However, there is the potential for them to be harvested outside of wildland-urban intermix areas for fuel or hazard.

Tribal Uses and Biocultural Diversity

Of all the alternatives, alternative A would have the least change in conditions of ecosystems, plants, insects, and animals of interest tribes. Conditions would continue to be poor in most areas, and restoration would be an improvement in only limited areas. There would be limited projects that would address specific tribal concerns and incorporate some traditional ecological practices.

Integrated Terrestrial Ecosystem Sustainability

With limited restoration levels, vegetation would continue to remain dense overall and outside the natural range of variation in most low and mid-elevation areas (see “Terrestrial Vegetation Ecology”). There would continue to be a high susceptibility to insects, pathogens, and air pollution stress, on the west side especially.

[11] The Giant Sequoia National Monument Plan provides management direction for sequoia groves in the Sequoia National Forest.

Consequences Specific to Alternative B

Fire Regimes and Fire as an Ecosystem Process

Foothill Zone

There would be an increase in fire regime integrity under alternative B. This is because restoration treatments would reduce the effects of wildfires and would restore fire as an ecosystem process in some areas. There would be an increase in restoration toward desired condition for vegetation and restoration of fire under alternative B, as compared with alternative A. In the CWPZ, treatments would emphasize restoration along ridges and roads and may result in some restoration of chaparral vegetation. However, it would be less than under alternative A. Desired conditions and guidelines for chaparral areas are based on the natural range of variation for chaparral fire regimes and associated vegetation. However, along roads, ridges, and especially in community buffers, there would be a greater emphasis on larger areas of younger chaparral.

Desired conditions for blue oak woodlands are periodic fire to maintain lower dead grass and litter levels and low-severity fire effects. The restoration treatments would be oriented more toward the ecological desired conditions for chaparral and blue oak woodland associated with areas of tribal interest restoration. Many foothill areas have vegetation and plants of importance to tribes. Much of this restoration would include prescribed fire and native plant restoration. This would include reducing nonnative annual grasses, which would increase fire regime integrity and resilience. In blue oak woodlands, it is nearly impossible to replace all nonnative annual grasses, but even a modest shift in some locations toward native perennial grasses would be an improvement in restoring favorable fire effects. These treatments would have beneficial fire effects on plants and animals and would improve fire regime integrity.

Montane Zone

Similar to the foothill zone, there would be an increase in fire regime integrity under alternative B, compared with alternative A. However, the increase would be greater. This is because more treatments would be focused in the ponderosa pine and mixed conifer forests of the montane zone. This would emphasize restoration objectives of montane and other ecosystems that historically had frequent fire and also would emphasize management approaches that prioritize restoration in these areas.

There would be a moderate movement toward the desired fire regime under alternative B, primarily in the Kern River drainage.

Restoration of up to 40 percent of the montane zone to a lower forest density and fuel condition would increase the likelihood that fires would be less severe (see “Terrestrial Vegetation Ecology”). There would be fewer large areas of high-intensity fire than under alternative A; instead, fires would be of more mixed severity (see “Fire Trends”).

There is a moderate level of uncertainty that these beneficial effects would occur. This is because of air quality limitations and spring burning restrictions to protect the California spotted owl. Prescribed burning would have considerable beneficial effects on the plants and animals that benefit from fire. This would be the case especially when there is restoration of sunny openings and heterogeneity coinciding with the burned areas. Many plants that are adapted to fire are also adapted to sunlight. Under alternative B, similar to the consequences described above for the foothill zone, there would be additional beneficial fire effects on plants and animals through increased emphasis on projects related to tribal interests.

Upper Montane Zone

The greater use of wildfire to meet resource objectives under alternative B would substantially increase the integrity of fire regimes in red fir and lodgepole pine forests, compared with alternative A. Upper montane red fir, Jeffrey pine, lodgepole pine, and chaparral are departed from historical fire return intervals, but only moderately, compared with the high departure in montane forests. Recent wildfires and wildfires managed to meet resource objectives have resulted in fire severity levels in upper montane areas that are mostly mixed and have increased fire regime integrity. There have been some larger patches of high-severity fire, but overall there have been low and moderate severity fires. These have decreased vegetation density and increased heterogeneity and have decreased surface fuels. This trend of increased fire regime integrity is expected to continue in upper montane forests under alternative B.

Subalpine and Alpine Zone

The greater use of wildfire to meet resource objectives under alternative B would increase the integrity of fire regimes in some subalpine forests, compared with alternative A. This is especially true in subalpine landscapes with relatively short fire return intervals, such as forests with spatially contiguous fuel loading, south-facing aspects at lower elevations.

Arid Shrublands and Woodlands Zone

Alternative B would have slightly increased levels of restoration in sagebrush and pinyon-juniper areas, compared with alternative A. The restoration would focus primarily on the reduction of hazardous fuels around communities and infrastructure, but treatments would also reduce vegetation densities and fuel loading and would increase some arid shrublands’ and woodlands’ resilience to stressors.

Carbon Stocks, Sequestration, and Stability

Under alternative B, there would be restoration treatments across substantial parts of the Sequoia and Sierra National Forests, about 30 percent of the plan area. These treatments would move vegetation toward the desired conditions, increasing heterogeneity and reducing forest density and fuel loads, when compared with alternative A. This would increase resilience to uncharacteristic wildfires, insects, pathogens, climate change, and other stressors. It also would result in greater long-term carbon stability and stocks. There would be some short-term decreases in forest carbon stocks where trees are removed by mechanical thinning (through conversion to wood products) or fire restoration efforts (through combustion). Short-term increases in carbon emissions would also increase where there are prescribed fires or wildfires managed to meet resource objectives. However, these short-term carbon emissions would be offset by long-term reductions in potential uncharacteristic wildfire emissions (see “Environmental Consequences to Air Quality”). Moreover, carbon sequestration would increase in thinned areas that contribute to increased growth rates and survivorship in montane and upper montane forests. Carbon sequestration would also increase in areas burned by stand-replacing fires where reforestation activities occur. Overall carbon stocks would be about 30 to 40 percent higher under alternative B, compared with A, due to lower rates of carbon emissions (see “Carbon supplemental report”).

Landscape Connectivity

The impacts of alternative B on connectivity would be similar to those under alternative A, but with a lower likelihood of fragmentation of forested areas from large, high-intensity fires. There is management direction specifically directed at connectivity for wide-ranging species and climate-related migrations. This includes management approaches to prioritize ecological restoration in areas providing connectivity in areas where it is limited for forest species. This would provide connectivity for other species needing overhead cover, for example, as follows for the California spotted owl:

> Prioritize ecological restoration of protected activity centers, and areas within them, that have departed furthest from vegetation desired conditions. Also consider prioritizing protected activity centers with the highest wildfire risk in the CWPZ, such as on upper slopes, ridgetops, or in canyons with large areas of chaparral below

There would be lower likelihood of uncharacteristically large and severe wildfires because of the increased area with restoration, especially at the low and mid-elevation areas (see "Fire Trends"). The likelihood of uncharacteristic wildfires would still increase because of climate warming, and these fires could result in forested area fragmentation. These fires could also increase connectivity of early seral forest or complex early seral habitat (see the following pages). However, these habitats tend to be more dynamic in space and time, thereby limiting the need for connectedness of this seral stage or habitat.

There would be an increased emphasis under alternative B on restoration treatments in key forested linkage areas for fisher. This would decrease the likelihood of fragmentation of key north-south forest connecting areas, when compared with alternative A. There would be an increase in connectivity of open forest habitat when compared with alternative A. This is because the restoration treatments would be directed toward desired conditions for forest heterogeneity and reduced overall forest density.

Important Seral Stages

Old Forest

Alternative B would increase restoration and resilience of old forest, especially in ponderosa pine, mixed conifer, Jeffrey pine, and black oak-pine forests. The approach to restoration in old forest would vary widely, depending on location, as shown in Table 44. The differences in approaches would affect potential large tree losses from wildfire, drought, insects, pathogens, safety issues, and excesses in densities over desired conditions.

Across all areas, management approaches to perpetuate, increase, and restore old forests would be applied, as follows:

- To support old forest components
- To encourage the development of old forest conditions in areas where old forest is lacking
- To protect existing old forest components from stressors by prioritizing restoration in key old forest areas

Across all areas, there would be a 30-inch conifer diameter limit, with exceptions, and the same direction for desired densities of large and old trees. The diameter exceptions are primarily limited to the removal of trees between 30 and 40 inches for specific restoration objectives. An example is for the removal of shade-tolerant conifers to promote the health and resilience of aspens, oaks, or even larger conifers. Only in unique and rare circumstances would conifers greater than or equal to 40 inches in diameter be removed for public or firefighter safety, similar to alternative A. There would be some reductions of large trees associated with restoration treatments in areas where large tree densities are relatively high. One example is in overly dense stands with large tree densities at the upper end or exceeding the natural range of variation.

Table 44. Plan direction and effects on large tree densities by management area or zone under alternative B

Plan Component or Effect[1]	Inside Wildlife Habitat Management Area			Outside Wildlife Habitat Management Area	
	Community Buffers	Community Wildfire Protection Zone	Outside Community Buffers and Protection Zone[2]	Community Buffers	Community Wildfire Protection Zone
Large tree direction and consequences	Manage for desired densities of large and old trees	Same	Same	Same	Same
Conifer diameter limit outside	30 inches with exceptions	Same	Same	Same	Same
Diameter limit inside PACs	Does not apply	24 inches	24 inch limit	Does not apply	24 inch limit
Hardwood diameter limit	None	12 inches (8 inches for blue oak)	12 inches (8 inches for blue oak)	None	None
Old forest, large tree direction	Retain largest and oldest trees	Retain largest and oldest trees	Retain largest and oldest trees	Enhance stand resilience and heterogeneity once desired densities are achieved	Retain largest and oldest trees
Wildlife-related canopy cover direction	Manage primarily for desired conditions	Limit reduction of canopy cover below 30 percent	Limit reduction of canopy cover below 30 percent	Manage primarily for desired conditions	Manage primarily for desired conditions, with some limitations in protected activity centers
Retention of large tree clumps in PACs	Manage primarily for desired conditions, including retention of large tree clumps	Retain large tree clumps and focus on removal of trees less than 55 feet tall	Retain large tree clumps and focus on removal of trees less than 55 feet tall	Manage primarily for desired conditions, including retention of large tree clumps	Manage primarily for desired conditions, including retention of large tree clumps
Resilience to stressors	Moderate	Moderate (some low)	Low to moderate	Moderate to high	Moderate to high

[1]All rows in this column represent plan components, with the exception of the last row, resilience to stressors, which represents the effect of the combined plan components on the resilience of large trees to stressors.

[2]Most of the wildlife habitat management area is outside the community buffers and community wildfire protection zone.

Within the community buffers, there would be no additional diameter limits specific to protected activity centers or hardwoods. Across all areas, there would be old forest and wildlife-related desired conditions and guidelines to retain and restore large and old trees that are important for nesting and denning. Wildlife habitat management areas would have additional protection for large trees, including wildlife habitat canopy cover and large tree clump retention guidelines.

The primary purpose for removing large trees (30 to 40 inches in diameter) within the community buffers and CWPZ would be as follows:

- To move stands toward desired conditions for heterogeneity
- To restore species composition
- To improve forest resilience by reducing tree density
- To reduce, in some cases, canopy fuels next to structures (community buffers only)

Very old and large trees (greater than or equal to 40 inches diameter at breast height) would not be removed, except in rare instances where human safety is imminently threatened. The consequences of wildlife habitat management direction on canopy cover and forest density on large tree densities would also vary by location. In areas with little to no restoration activities around large trees, these structures would continue to be vulnerable to mortality from drought, insects, pathogens, and high-intensity wildfire. This would occur outside of restored areas that are dissimilar to terrestrial vegetation desired conditions, such as tree densities and surface fuel loading exceeds NRV.

There may be some decrease in large tree densities as trees die where they are overcrowded. Some large trees may die during prescribed fires or wildfires managed to meet resource objectives, even though there is management direction to limit this mortality with best practices. Additionally, large tree mortality is likely in future droughts, which can increase large tree mortality following burning.

Increased likelihood of reductions in large tree densities from drought, insects, pathogens, and fire would mostly occur outside of the community buffers, especially where California spotted owl and fisher habitat management direction, such as in wildlife habitat management areas, limit opportunities to reduce forest densities (see “Montane Forests”).

In areas subjected to restoration treatments, especially within the community buffers, there would also be reduced vulnerability to tree mortality from drought, insects, pathogens, and wildfire. This would be the result of stand conditions being more aligned with the natural range of variation. The CWPZ would also have reduced tree vulnerability to stressors. This is because this zone has plan direction that aligns stand conditions closer with the natural range of variation, although to a lesser extent than community buffers would.

The consequences of wildfires managed to meet resource objectives on old forests are difficult to predict and analyze and, therefore, they contain some degree of uncertainty. In the Kern River drainage, there would continue to be positive impacts on old forests from these types of fires, based on studies in this area and others in the Sierra Nevada (Meyer 2015a, Meyer 2017, Meyer et al. 2019). Fires in the last 15 years in this area have killed some large and old trees but have substantially reduced the likelihood and extent of large, high-intensity fires; these have the greatest negative impact on old forests.

Overall, alternative B would have greater positive effects on large trees and old forests than alternative A. This would be due to increased forest restoration treatment rates and more specific plan direction for old forests. However, these positive effects under alternative B could be partially outweighed by continued increases in large, high-intensity fires in areas experiencing lower rates of restoration treatment, such as outside the Kern River drainage.

Complex Early Seral Forests

There is specific management direction for complex early seral forests under alternative B, such as desired conditions, standards, and guidelines. This includes retaining at least 10 percent of large contiguous blocks (1,000 acres or more) of areas burned at high severity with high snag densities for complex early seral habitat that is unsalvaged. The management approach is to promote native vegetation, such as conifers, hardwoods, and shrubs, in complex early-seral habitat that supports long-term ecosystem integrity considering climate change, drought, insects, disease, and fire.

Alternative B would result in some changes in the spatial pattern and amount of complex early seral forest. There would be some shift toward a fine-grained, mosaic of complex, early seral forest, especially in upper montane areas that have had wildfires in the last 15 years. Restoration aimed at increased forest heterogeneity would increase the likelihood of increased heterogeneity during fires of all kinds. Prescribed fires and wildfires managed to meet resource objectives and desired conditions for fire severity and vegetation mosaics would increase areas with very small (less than 1 acre), small (1 to 10 acres), and some medium to large (10 to 200 acre) patches of high-severity fires. This would contribute to complex early seral habitat.

Wildfires managed for resource objectives typically have high spatial complexity (Vaillant 2009, Meyer 2015a). The guideline to retain at least 10 percent of unsalvaged areas burned at moderate and high severity would provide for complex early seral habitats. In the past 5 years, dead trees has typically been salvaged on less than one-third of the burned area and is avoided in California spotted owl protected activity centers that are mostly unburned.

Artificial reforestation would occur in some areas (about 2 to 3 percent of burned areas per decade on the Sierra and Sequoia National Forests). However it is often limited in scope and area to locations where salvage occurs first. This is done to make it safe and readily accessible for workers and to prepare mineral soil seedbeds for planting trees.

There would be increased consideration of natural regeneration. This would be the case in some areas burned in extensive large patches of high-severity fire, where there are insufficient living seed trees to ensure enough seedlings will regenerate a forest (Welch et al. 2016). These changes, compared with current management, would increase the proportion of large fires contributing to complex early seral forest habitat. These high-intensity fires would provide large areas of complex early seral forest. In addition, early seral forest is currently within or slightly exceeding the NRV for most montane and upper montane forest vegetation types on the Sierra and Sequoia National Forests (see the Vegetation Condition Assessment Supplemental Report). Projected future increases in uncharacteristic wildfires will increase the proportions of complex early seral forest in the southern Sierra Nevada; nevertheless, increased restoration treatment rates in this zone under alternative B would likely mitigate this trend of increasing wildfire severity. This would bring the proportion of early seral forest closer to the NRV, despite future increases in wildfire severity and frequency.

This increase in early seral forest would lead to proportional large increases in complex early seral forest. This is because about 85 to 95 percent of montane and upper montane forests in the Sierra and Sequoia National Forests are not affected by salvage harvest or reforestation over a 30-year period.

There would be a continued increase in the likelihood of large, high-intensity wildfires because most of the landscape outside the Kern River drainage would have limited restoration. These high-intensity fires would provide moderately large areas of complex, early seral forest under alternative B.

Unique Vegetation Types

Under alternative B, there is specific direction aimed at managing and restoring giant sequoia groves and aspen stands. This direction would enhance the health and survivorship or mature sequoias and aspen trees and would increase regeneration and recruitment for these species. Restoration treatments would increase the resilience of sequoias and aspens to stressors, such as uncharacteristically severe wildfire, insects, pathogens, or climate change.

Alternative B provides greater flexibility in the removal of competing conifers in aspen stands and giant sequoia groves than alternative A. This would increase the survivorship, regeneration, and recruitment of aspens and giant sequoias to a greater degree under alternative B. Also, there would be a beneficial impact on giant sequoia groves and aspen stands in the plan area.

The total delineated management area of giant sequoia groves in the Sierra National Forest would be 95 acres greater than under alternative A. However, this marginal increase in the grove management area would provide only minimal greater additional benefits to giant sequoia groves, compared with alterative A.

Keystone Species Groups

Pollinators—Under alternative B, there would be increased levels of restoration toward vegetation desired conditions, including increased heterogeneity, which would benefit pollinator plants. There would be an emphasis on restoration toward desired conditions of vegetation that are based primarily on the natural range of variation. Restoration of native plants would support restoration of dependent pollinators. This would provide more openings and sunlight to the forest floor, which would improve pollinator habitat. There would be more prescribed fire and wildfire managed to meet resource objectivism, which would improve conditions for fire-associated flowering plants (see “Fire Management”).

In arid shrublands and woodlands, restoration under alternative B would also improve pollinator habitat. Increased levels of restoration in sagebrush and pinyon-juniper are expected to generally favor annual flowering plants over perennials. This could benefit some pollinators during spring blooms. However, it would provide less benefit to pollinators that depend on greater canopy cover or on late-seral, summer perennials, such as species of penstemon or mule ears. Benefits to pollinators would depend highly on effective control of invasive species. Invasive, nonnative annual grasses and other nonnative plants displace native plants and their associated pollinators. Restoration treatments in these vegetation types would be especially effective at enhancing pollinator habitat when treatments also minimize invasive plant spread.

Cavity Excavators—There may be an increase in the amount of snags because snag retention levels are higher than currently (alternative A) in most areas except in the community buffers in the community fire protection zone. There would be an increase in the diversity of plant communities or habitats that snags occur in. This is because of the increased vegetation restoration into more heterogeneous conditions and retention of large trees with deformities and cavities for wildlife habitat. This would increase the diversity of cavity excavator habitat.

There also would be an increase in the amount of open and moderately open forests in the yellow pine and mixed conifer forests. There would be an increase in the amount of snags in small patches of burned forest, because of the increase in prescribed fire and wildfire managed to meet resource objectives. This would increase habitat for cavity excavators and other species that rely on intermixed or adjacent burned and green habitat. There would be increased snag retention levels and direction for complex early seral habitat. This would provide more snag habitat in forests burned at high severity, including in owl nest habitat or in large areas where bark beetles have killed stands of trees (see “Complex Early Seral Forests”).

Tribal Uses and Biocultural Diversity

Under alternative B there is specific direction to improve conditions for plants and vegetation of tribal interest and to restore areas of tribal importance. There also would be a moderate level of restoration of ecosystem, plant, insect, and animal conditions (see “Terrestrial Vegetation Ecology”). Areas restored with mechanical thinning and prescribed fire together would improve conditions for plants and animals of tribal interest (Lake and Long 2014). This includes overcrowded black oaks and shaded understory shrubs and plants currently growing in dense conifer forests (Merriam et al. 2013, Safford 2013).

Areas with prescribed fire and fire managed to meet resource objectives would improve conditions for all understory plants, including those used for food, basketry, and medicine (Anderson and Moratto 1996, Anderson 2006). Large landscape areas treated would improve conditions for bear, deer, and other important wide-ranging species.

Alternative B would have an increase in fire managed to meet resource objectives, particularly at middle and higher elevations, which would benefit large ecosystem areas. The ecological restoration projects specifically planned and coordinated with tribes would incorporate traditional ecological knowledge and other essential information.

Integrated Terrestrial Ecosystem Sustainability

Alternative B would increase integrated sustainability. The greater amount of the landscape area that would be restored under this alternative would increase the resilience of terrestrial ecosystems to uncharacteristic fire, insects, diseases, air pollution, or climate change. Sustainability would be most improved in terrestrial ecosystems targeted by restoration efforts, including lower and upper montane forests.

Consequences Specific to Alternative C

Fire Regimes and Fire as an Ecosystem Process

Overall, there is an emphasis on fire as a restoration tool under alternative C that would increase the use of fire as an ecosystem process, compared with alternative A. However, there is a higher level of uncertainty about how much prescribed fire would occur. This is because there would be fewer associated mechanical treatments along ridges and roads that would prepare areas for large prescribed fires. Similarly, although there is the intent to manage more wildfires to meet resource objectives, there may be fewer opportunities. This is because there would be fewer areas treated mechanically, and with prescribed fire, that could assist with better management of those fires.

Foothills Zone

Lower levels of restoration treatments are proposed under alternative C, greater than under alternative A. Under alternative C, there is more emphasis on prescribed fire and restoration of native plants in areas with nonnative plant invasions than under alternative A. However, there is uncertainty in prescribed fire rates, due to the proximity to communities and lack of pre-burning mechanical treatment, which would increase fire risk. There is a similar emphasis on cooperation with tribes and restoration of areas of tribal interest as under alternative B. Overall, there would be limited opportunities to increase fire regime integrity and beneficial fire effects under alternative C.

Montane Zone

Overall, levels of fire restoration proposed under alternative C are greater than under alternative A in montane forests. There are higher levels of wildfires used primarily to meet resource objectives. However, these would occur mostly in upper montane and subalpine areas, with greater uncertainty in the montane zone (see "Environmental Consequences to Fire Trends"). Overall, there would be a low to moderate increase in fire regime integrity that is slightly greater than under alternative A. The higher levels of prescribed fire and emphasis on cooperation with tribes and restoration of tribal interest areas would increase the beneficial fire effects on some plants and animals in treated areas.

Upper Montane Zone

Overall, there would be greater proposed treatment under alternative C in upper montane forests, compared with alternative A. However, there is direction that supports the use of wildfire to meet resource objectives. This would occur most often in upper montane and some subalpine areas. As a result, there would be an increase in fire regime integrity and beneficial fire effects under alternative C.

Subalpine and Alpine Zone

The consequences on subalpine and alpine vegetation under alternative C would be the same as those described under alternative A.

Arid Shrublands and Woodlands Zone

In sagebrush, pinyon-juniper, and xeric shrub there would be slightly greater fire regime integrity and beneficial fire effects from restoration proposed under alternative C, compared with alternative A.

Carbon Stocks, Sequestration, and Stability

Carbon stocks, sequestration, and stability under alternative C would be greater than under alternative A. This is because restoration treatment rates under alternative C would be higher. However, there is a higher level of uncertainty of these treatment rates under alternative C due to its greater reliance on prescribed fire and wildfire managed to meet resource objectives, with much lower rates of mechanical thinning. This would make it more difficult and challenging to achieve higher fire restoration rates without sufficient reduction of fuels and forest densities before burning. Therefore, there is a high level of uncertainty on the impacts of alternative C on carbon stocks, sequestration, and stability.

If more beneficial prescribed and managed fires occur, then there would be short-term increases in carbon emissions but a long-term increase in carbon stocks and stability. Areas treated with prescribed fire or managed wildfires would have lower surface fuels, lower vegetation densities, and higher fire resilience, making the likelihood of uncharacteristically large and severe wildfires and insect outbreaks lower. However, assuming fire restoration rates can be achieved in the next 15 to 40 years, alternative C would produce carbon emissions and maintain carbon stocks and stability at a level that is greater than under alternative A (see the Carbon Supplemental Report).

Landscape Connectivity

Alternative C would result in similar impacts on connectivity as alternative B, but with more recommended wilderness and an increased likelihood of uncharacteristically large and severe wildfires. There would be a similar emphasis on restoring fire resilience of key fisher linkage areas. Restoration in the remaining area would be uncertain. There would be lower rates of mechanical thinning than under alternative A, and the thinning would be of lower intensity.

The plan objectives for prescribed fire and fire managed primarily to meet resource objectives is greater under alternative C than alternative A, but there is moderate to high uncertainty as to how much would occur over the plan period. This is because there would be less associated thinning in strategic areas, which could make it more difficult to implement prescribed burning. This is because burns would be more risky to manage with higher fuel levels and would be more costly to implement.

There are more recommended wilderness areas under alternative C than alternative A. This may provide for increased landscape connectivity for species that are impacted by more intensive management, such as mechanical treatment, or uses, such as developed recreation. See “At-risk Terrestrial Wildlife Species” for more information.

Important Seral Stages

Old Forest

Management under alternative C in old forests would be generally similar to alternative A, but alternative C would include greater limitations on restoration from additional forestwide and old forests management direction (Table 45). For example, there would be 24-inch-diameter limits restricting large tree harvest in all areas under alternative C. Under alternative C, there would also be greater retention of large, old trees, snags, and downed logs in all montane and upper montane landscapes than under alternative B. This is because alternative B makes exceptions for community buffers and, occasionally, the CWPZs.

There would be substantially more limits on the amount of mechanical restoration treatments in fisher and owl habitat areas, such as no exceptions in community buffers. There would be no mechanical restoration allowed in owl foraging or nesting areas.

Overall, there would be the least amount of area proposed for restoration treatment in old forest under alternative C. Moreover, the intensity of mechanical treatments would be the lowest degree of structural restoration. This would be due to the lower diameter limit and other restrictions on mechanical treatment).

There would be an increased emphasis on prescribed fire and the use of wildfires managed to meet resource objectives, but it is uncertain how much of this would occur. This is because dense forest conditions and higher fuel loads would continue to make burning difficult, particularly in areas of high tree mortality following the 2012–2016 drought.

Table 45. Forestwide plan direction for the retention of large trees, snags, and downed logs in old forests

Plan Direction	Alternative A	Alternative B	Alternative C and E	Alternative D
Conifer diameter limit (inches)[1]	30 inches	30 inches, with exceptions for trees 30 to 40 inches[2]	24 inches	Same as alternative B
Increase forest heterogeneity and retain large trees, snags and logs	Does not apply	Forestwide, except community buffer	Forestwide	Forestwide, except community buffer
Mechanical treatments should include retention of snags, logs	Does not apply	Forestwide, except community buffer	Forestwide	Forestwide, except community buffer and focus landscapes
40 to 80 percent of forest landscape contains old forest	Does not apply	Montane and upper montane forests	Same as alternative B	Same as alternative B
Desirable densities and distribution of large trees	Does not apply	Montane and upper montane forests	Same as alternative B	Same as alternative B
Large snags and logs are distributed across the landscape	Does not apply	Montane and upper montane forests	Same as alternative B	Same as alternative B
Retain largest and oldest trees and wildlife habitat trees during thinning	Does not apply	Forestwide, except in community buffers and CWPZ where it does not overlap with WHMA[3]	Forestwide standard (TERR-OLD-STD-01)[4]	Forestwide, except in community buffers and CWPZ[3]
Prescribed burning should limit loss of large and old trees and very large snags	Does not apply	Forestwide, except in community buffers where it does not overlap with WHMA[3]	Forestwide standard (TERR-OLD-STD-01)[4]	Forestwide, except in community buffers

[1]Except to meet safety or equipment operability requirements for all alternatives

[2]Exceptions: (1) when public or firefighter safety is threatened (relevant to all tree diameters, including those exceeding 40 inches); (2) when removing trees in aspen, oak, or meadow restoration treatments or for cultural or tribal importance; (3) when required for equipment operability—individual trees less than 35 inches in diameter may be removed; (4) in overly dense stands to favor retention or promote the growth of even larger or older shade-intolerant trees, so as to more effectively meet tree species composition and forest structure restoration goals; and (5) in dense, homogenous, and single-aged stands, such as unthinned plantations or fir-dominated stands resulting from historical logging, followed by fire suppression.

[3]CWPZ = community wildfire protection zone; WHMA = wildlife habitat management area

[4]TERR-OLD-GDL-01 is a standard (TERR-OLD-STD-01) under alternatives C and E only.

Alternative C would retain all large-diameter trees, with very limited exceptions for safety and equipment operability. There would be retention of old forests with denser trees and canopy cover. There would be an increased likelihood that large, old trees would die from drought, insects, pathogens, and warming climate (Van Mantgem et al. 2009).

There would continue to be an increasing and moderately high likelihood of uncharacteristically large and severe wildfires, slightly lower than under alternative A. This would have a negative impact on old forests in some areas, although there is uncertainty about the resulting fire severities and how they overlap with old forests. Although there would be an increased emphasis on restoration of fire, it is unlikely that this would occur across large areas. This is because restoration is more difficult to accomplish in dense forest conditions and areas of greater tree mortality.

Overall, there would be little to no change in large tree density from the mechanical restoration treatments, because alternative C would most restrict the harvest of large trees. There could be a positive impact on old forest structure, increased heterogeneity, and increased resilience from restoration treatments, including thinning, prescribed burning, and wildfires managed to meet resource objectives. There may be some low to moderate levels of large tree mortality from the fire treatments.

The areas that are proposed for restoration and intensity of mechanical thinning are fewer under alternative C than alternative B; consequently, there would continue to be an increased likelihood of the loss of old forests to uncharacteristically large and severe wildfires, insect outbreaks, and climate change. Although it is uncertain when and where uncharacteristic wildfires would occur, these fires would have negative impacts if they were to burn larger areas of old forests at high severity. This would result in the loss of many large and old trees and large snags and logs. It also would reduce the quality and extent of late-seral forests in the montane and upper montane zones.

Complex Early Seral Forest

Under alternative C there would be slightly more complex early seral forest than under alternative A. There would be very limited salvage, only that associated with safety hazards and limited strategic fuel treatment areas. There would be little to no reforestation or herbicide use; instead natural regeneration would be emphasized to minimize disruption of natural processes. There would be the most increased likelihood of large, high-intensity wildfires and overall burned area (see Fire-Climate Supplemental Report [(Westerling et al. 2015). The spatial pattern of complex early seral forest is difficult to predict, but there is a higher likelihood of large (100 to 1,000 acres) and very large (greater than 1,000 acre) patches of mixed- and especially high-severity fires greater than 75 percent basal area mortality. There would also be an increased likelihood of very large (greater than 10,000 acre) high-severity (greater than 75 percent basal area mortality) fire patches, based on increases in fire-created weather (see the “Fire Trends”).

Early seral forest is currently within or slightly exceeding the NRV for most lower and upper montane forest vegetation types on the Sierra and Sequoia National Forests (see Vegetation Condition Assessment Supplemental Report). Projected future increases in uncharacteristic wildfire and extreme drought-related mortality will increase the early seral forest proportion outside NRV in the Sierra Nevada montane and upper montane zones. This increase in early seral forest will lead to proportionally large increases in complex early seral forest. This is because about 85 to 95 percent of montane and upper montane forests in the Sierra and Sequoia National Forests are not affected by salvage harvest or reforestation over a 30 year period.

Increased fire restoration treatment rates in these zones under alternative C would only slightly offset this trend of increasing wildfire severity. Alternative C would provide for additional acres of complex early seral habitats, based on the guideline to retain at least 20 percent of unsalvaged forests burned at high severity. This would bring the proportion of complex early seral forest to higher levels than under alternatives A and B, and early seral forest would likely be in the upper portion of the natural range of variation.

Moreover, increased levels of fire restoration without mechanical pretreatment under alternative C would lead to additional production of early seral forest and complex early seral forest. This would supplement the proportion of complex early seral forest to a level clearly exceeding the desired vegetation conditions in many montane and upper montane forest landscapes of the Sequoia and Sierra National Forests, such as snag and log densities, surface fuel loading, and canopy cover.

Unique Vegetation Types

There would be similar impacts on unique vegetation types under alternative C as under alternative B. The exception is that diameter limits in aspen stands and sequoia groves would limit the effectiveness of restoration in reducing the density and basal area of shade-tolerant conifers that influence sequoia and aspen tree health, ecological condition, and regeneration. Consequently, the ecological condition of sequoia groves and aspen stands would be considerably improved under alternative C.

Also, under alternative C, the total delineated management area for giant sequoia groves in the Sierra National Forest would be 1,234 acres greater than under alternative A. However, this increase in the grove management area would provide only slightly greater additional benefits to giant sequoia groves, compared with alterative A. This is because management direction for sequoia groves pertaining to vegetation management treatments would not differ substantially inside the added grove area; that is, the sub-watershed above the grove that does not contain sequoia trees, compared with outside the grove boundaries. In both cases, giant sequoia trees are absent and vegetation management direction is similar.

Keystone Species Groups

Pollinators—There would be similar impacts on pollinators under alternative C as under alternative A, with some greater benefits to pollinators, where fire restoration has created additional suitable habitat. There would be some increased emphasis on restoration of vegetation heterogeneity and fire restoration, which could create sunny openings and improve pollinator habitat. However, canopy cover retention in montane forests would limit these areas. In shrublands, there would be similar impacts on pollinators under alternative C as under alternative B. There would be some benefits to pollinators resulting from increased annual cover in restoration areas and some benefits from the structural diversity of tree cover.

Cavity Excavators—There would be an increase in the amount of habitat for primary cavity excavators, because there would be an emphasis on snag retention, when compared with alternative A. This would occur mostly in denser canopied forests and complex early seral forest, because there is less restoration proposed. Denser stands would have greater live tree mortality, creating more snags. There may be more habitat in areas burned at mixed severity, since there would be more prescribed fire and fire managed to meet resource objectives. However, it is uncertain how much fire restoration would occur, because there would be fewer areas treated mechanically and with prescribed fire that could assist with better management of those fires.

Tribal Uses and Biocultural Diversity

There would be an increased consideration of tribal interests in ecological restoration and coordination of some of the projects under alternative C. Overall, there would be slightly greater ecological restoration across the landscape, providing fewer benefits to ecosystems, plants, insects, and animals of tribal interest under alternative C, compared with alternative A.

Integrated Terrestrial Ecosystem Sustainability

There would be limited increases in integrated terrestrial ecosystem sustainability under alternative C, slightly greater than under alternative A. This is because there would be limited areas of restoration.

Consequences Specific to Alternative D

Fire Regimes and Fire as an Ecosystem Process

Across the entire plan area, there would be a substantial increase in the amount of restoration treatments under alternative D that would have a substantial impact on fire regimes and fire as an ecosystem process in the landscapes where these treatments occur. This would occur primarily in large areas in the montane (ponderosa pine, black oak-pine, mixed conifer) and upper montane (Jeffrey pine forest) zones. Since there would be double the amount of restoration treatments in focus landscapes, there would be up to 40 percent or more of these areas that have landscape areas with reduced fire intensity and severity.

There would be increased beneficial effects from restoring fire as an ecological process. This is because there would be more prescribed fire and opportunities to manage wildfires to meet resource objectives. Alternative D would have the greatest levels of restoration in old forests to increase their resilience to such stressors as uncharacteristic wildfires, drought, insects, and pathogens.

The consequences for subalpine and alpine and arid shrubland and woodland zones would be similar to those under alternative B. There would be some additional restoration in the foothill zone that would reduce fire intensity and severity and align current conditions with desired conditions for vegetation types in this zone.

Focus Landscapes

Three types of restoration treatments would occur under alternative D that would move the landscape toward desired conditions for fire regimes and restoration of fire as an ecosystem process. The first are the vegetation restoration treatments, especially in focus landscapes or other prioritized areas as described in the following management approaches:

- Emphasize vegetation treatments in focus landscapes (40,000 to 100,000 acres in size) to move terrestrial ecosystems toward desired conditions and increase resilience of old forest habitat, while limiting impacts to California spotted owl, fisher and Sierra marten.
- Consider partnerships with federal and state agencies and other partners to identify priority areas for restoration, including areas of high tree mortality or adjacent to communities threatened by uncharacteristic wildfires
- Prioritize fuel treatments in areas that pose the greatest threat to communities and highly valued resources

Mechanical treatments and prescribed fire throughout the focus landscapes would restore fire as a process in these areas and increase the likelihood that when large wildfires move through, fire severity would be closer to desired conditions and the natural range of variation than adjacent unrestored areas. Vegetation restoration along ridges, roads, and other landscape or artificial features would increase the likelihood that large prescribed fires could be used to restore fire to landscape areas, especially where there is steep and inaccessible terrain. In focus landscapes, the use of fuelbreaks and other fuel treatments along ridges and roads would facilitate greater use of landscape-scale prescribed fire and wildfires managed for resource objectives. This would come about by providing more fuel treatment containers or anchor points for the safe reintroduction of fire (North et al. 2015).

At higher elevations in the upper montane and subalpine areas or in the Kern River drainage, there would be additional restoration emphasizing wildfire managed to meet resource objectives. There would be less restoration along ridges and roads because there are more natural features (like rock outcrops along ridges) and recent fires to use as fire management boundaries. There would also be localized restoration of fire as part of restoring areas of tribal importance.

Carbon Stocks, Sequestration, and Stability

The impacts of alternative D on carbon would be similar to alternative B but with beneficial impacts over a larger area. Alternative D would result in the greatest area treated with mechanical thinning, prescribed fire, and wildfire managed to meet resource objectives. These restoration treatments would lower forest densities, vegetation biomass, and fuel loads on about 50 to 60 percent of the montane, upper montane, and parts of the foothill zones, with the highest percentages in focus landscapes. This would substantially decrease the likelihood of uncharacteristically large and severe wildfires, insect outbreaks, and other disturbances that reduce long-term carbon stocks and stability. Increased restoration rates would also increase forest carbon sequestration resulting from increased tree growth and regeneration following restoration treatments, including following reforestation. As a result, forest carbon stocks, stability, and sequestration would be higher and carbon emissions would be lower than under alternative A over the next 15 to 40 years (see “Carbon Supplemental Report”). However, there would be a greater reduction in carbon stocks in the short term under alternative D, compared with alternative A. This is because increased restoration treatment rates would lead to greater short-term forest carbon loss through vegetation biomass reduction and removal.

Landscape Connectivity

Alternative D would result in similar impacts on long-term landscape connectivity as alternative B but with less likelihood of uncharacteristically large and severe wildfires. Such wildfires could interrupt habitat connectivity for forest-associated species. This is due to the increased restoration treatment rates under alternative D, compared with alternative A.

There would be more prescribed fire and fire managed to meet resource objectives under alternative D, which could enhance overall long-term ecosystem resilience of fisher linkage areas and other critical habitat connections. However, there would be higher levels of mechanical thinning under alternative D, including in fisher linkage areas. Consequently, alternative D would likely result in greater long-term connectivity but significantly lower near-term (next 10 to 20 years) habitat connectivity for fisher and other forest-associated species than under alternative A.

Important Seral Stages

Old Forest

Alternative D would have environmental consequences similar to alternative B, but there would be greater positive effects of increased heterogeneity, decreased forest density, and increased old forest resilience resulting from increased restoration treatment rates. Alternative D emphasizes managing toward the desired conditions for old forests, similar to alternative B. However, it calls for fewer restrictions in focus landscapes, community buffers, and the CWPZ (Table 45). This alternative would result in the greatest reduction of uncharacteristically large and severe wildfires across all ecological zones (see “Environmental Consequences to Fire Trends”).

Increased mechanical restoration treatments would result in lower levels of large and old tree mortality from both water stress and uncharacteristically large and severe wildfires. The higher levels of mechanical restoration would increase the likelihood that more prescribed fire and wildfire managed to meet resource objectives would occur; these would have a positive impact on old forests. In areas of restoration treatments, the impact of alternative D on large trees would be the same as under alternative B, except in community buffers and the CWPZ. In these areas, alternative D would result in a greater short-term loss of conifer trees between 30 and 40 inches in diameter, due to mechanical harvest. However, there would be a greater retention of conifers exceeding 40 inches in diameter in the long term, due to reduced competition from increased rates of mechanical thinning.

The direction under alternative D for large trees focuses on desired conditions for large tree densities. It contains guidelines to meet those desired conditions in vegetation management, such as restoration thinning or timber harvest, instead of the current, more-constrained diameter limits under alternative A. This may result in some removal of large trees (30 to 40 inches in diameter). However, the Forest Service expects this to be limited to achieve specific forest restoration objectives. Also, large tree densities are generally lower than desired conditions in most landscape areas.

The conifer diameter limit exceptions are the same as those under alternative B, which is mostly consistent with the fisher conservation strategy. The specific restoration-based exceptions are as follows:

- To promote aspen, oak, or meadow restoration for cultural or tribal importance
- To favor retention of or to promote the growth of even larger or older shade-intolerant trees in overly dense stands
- To achieve ecological desired conditions in dense, homogenous, and single-aged stands outside the natural range of variation

The harvests of some large trees, even though limited, may result in a small reduction in large tree densities, greater than under alternative A. These reductions may be offset and lower than losses of large trees under alternative A from mortality. This would be due to water stress and uncharacteristically large and severe wildfires. It is unknown how much of an offset there would be.

The proposed levels of restoration in all forests under alternative D would result in numerous large landscape (greater than 10,000 acres) areas exceeding 40 percent and up to 60 percent or more of the area restored. The fire-climate scenarios show a substantially decreased likelihood of large and severe wildfires with this level of restoration (see “Fire Trends”). Therefore, the likelihood of large, high-intensity fire that could kill a lot of large trees and convert large areas to early seral vegetation is decreased, compared with current trends. This would not likely be achieved until the middle and later parts of the planning analysis period (10 to 15 years), because of the time it takes to plan and implement projects.

There may be uncharacteristically large and severe wildfires in the early part of the analysis period. If large stewardship projects occur across very large landscapes (such as focus landscapes; 40,000 to 100,000 acres or greater), then it is possible that the restoration projects may occur more rapidly due to more partnerships, fewer restoration treatment constraints (in focus landscapes), and possibly greater internal capacity to plan and implement the projects.

Inside the focus landscapes under alternative D, there would be greater ability to restore forest heterogeneity and tree density to desired conditions (Fry et al. 2015). Treatments here would increase the resilience of large and old trees to drought, insects and pathogens, air pollutants, and uncharacteristic wildfire. This would make it more likely that the amount of large tree mortality would decline to near-historic levels (Van Mantgem et al. 2009). Restoration treatments would make it more likely that medium-sized trees would grow into larger and older trees. Restoration of structural heterogeneity and fire as an ecological process would increase the biodiversity and ecological integrity of old forest ecosystems.

Exceptional climate events like the 2012–2016 drought and uncharacteristically large and severe wildfires will continue to negatively impact old forests in the southern Sierra Nevada (see the “Fire Trends,” and “Insects, Pathogens, and Changed Conditions Associated with Recent Tree Mortality”). However, these impacts would be reduced to a greater degree under alternative D than under alternative A. This would be the case particularly in focus landscapes, where there may be areas greater than 10,000 acres that have enough restoration treatments (greater than 40 to 60 percent after 10 to 15 years) of sufficient intensity to reduce fire intensity and severity across most individual focus landscapes. There would be beneficial impacts on old forests in these areas, reducing the likelihood of high-severity fire patches and large tree mortality during exceptionally long droughts. The remaining area would continue to have an increased likelihood of high-intensity fire that is slightly lower than under alternative B.

Where restoration occurs in old forests that are outside of the focus landscapes, community buffers, and CWPZs, the treatments could be lower intensity. This is because of greater vegetation management restrictions based on old forest or wildlife management direction (see Table 46). The consequences for old forest in these areas would be similar to alternative B. Under alternative D, areas in focus landscapes with extensive tree mortality (see “Changed Forest Conditions Associated with Tree Mortality”) would have lower initial densities of large and old trees, compared with pre-drought conditions. However, increased restoration treatment rates in these landscapes would enhance the health and resilience of the remaining large and old trees and would increase the growth and survivorship of small to medium diameter trees that will grow into large and old trees.

Table 46. Summary of conditions for characteristics of integrated sustainability by alternative

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Area affected by insects and pathogens outside the natural range of variation	Very high	Moderate (restored areas) to high	High	Moderate (low in focus landscapes)
Area affected by air pollutants that may cause negative effects, especially for ponderosa and Jeffrey pines	Moderate	Moderate but less than under alternative A	Moderate but slightly more than under alternative B	Moderate but less than under alternatives A or B
Area affected by invasive species	Moderate to high	Moderate	Moderate	Moderate
Area with fire condition class outside of natural range	High	Moderate	Moderate to High	Moderate (low in focus landscapes)
Area with vegetation condition outside of natural range	High	Moderate	Moderate to High	Moderate (low in focus landscapes)

Characteristic	Alternative A	Alternative B	Alternatives C and E	Alternative D
Old forest area that is highly vulnerable to stressors	High	Moderate to high	High	Moderate
Overall terrestrial ecosystem condition	Low	Low to moderate (restored areas)	Low	Moderate

Complex Early Seral Forest

There would be mixed impacts of alternative D on complex early seral forest. Greater restoration treatment rates would increase the likelihood that fires have low or mixed severity fire effects.

Increased use of prescribed fires and wildfires managed to meet resource objectives would increase the amount of fine- to medium-grained patches of complex early seral forest. There would be a reduction in the likelihood of uncharacteristically large and severe wildfires. This would also reduce the potential for very large patches of complex early seral forest. There would be the greatest amount of salvage and reforestation under alternative D. This would decrease the amount of complex early seral forest in large, high-severity fires. This would be due to the removal of snags and changes in postfire vegetation, such as reduced shrub cover, associated with postfire management. Under alternative D, the guideline to retain unsalvaged at least 5 percent of areas burned at high severity would provide for some complex early seral habitats, but often only half the amount, compared with alternative B.

Unique Vegetation Types

There would be similar environmental consequences to unique vegetation types under alternative D as under alternative B, except higher rates of restoration treatment under alternative D would result in slightly greater removal of shade-tolerant trees and forest fuels and increased structural heterogeneity, compared with alternative B. Increased treatment rates under alternative D would improve the health and condition of mature giant sequoia and aspen trees and increase the amount of giant sequoia and aspen regeneration.

Alternative D also provides greater flexibility in the removal of competing conifers in aspen stands and giant sequoia groves than alternative A. This would increase the survivorship, regeneration, and recruitment of aspen and giant sequoia to a greater degree.

Keystone Species Groups

Pollinators—Alternative D would have similar environmental consequences as alternative B but across more area.

Primary Cavity Excavators—Alternative D would have similar environmental consequences as alternative B for cavity excavators. However there would be a greater short-term loss of cavity excavator habitat due to increased rates of restoration. This includes increased rates of salvage harvest in severely burned forests, which would reduce the abundance of snags for primary cavity excavators.

Tribal Uses and Biocultural Diversity

Alternative D would have similar environmental consequences as alternative B for tribal uses and biocultural diversity, but across more area.

Integrated Terrestrial Ecosystem Sustainability

Alternative D would have similar environmental consequences as alternative B for integrated terrestrial ecosystem sustainability but for considerably more area. The amount of landscape area that would be restored would provide for a higher level of overall integrated sustainability. This is because many of the benefits increase with larger areas treated. For example, the “Fire Trends” section notes how the difference between restoring 50 to 60 percent of a landscape area lessens the increase in large fire size and area.

Consequences Specific to Alternative E

Fire Regimes and Fire as an Ecosystem Process

Overall, the consequences of alternative E would be similar to those of alternative C for terrestrial ecosystem processes and functions. It would affect fire regimes and fire as ecosystem processes, carbon stocks and sequestration, landscape connectivity, important seral stages, unique vegetation types, keystone species groups, tribal uses and biocultural diversity, and integrated terrestrial ecosystem sustainability. However, there is slightly greater certainty in restoration treatment rates under alternative E, compared with alternative C. Under alternative E there is a moderate to high uncertainty in the use of wildland fire, due to lower levels of mechanical pretreatment that would be required to reduce hazardous fuels before burning. In areas of high fuel loads, this would be required to provide adequate safeguards to ensure effective management control of wildland fire.

In the foothill, montane, and upper montane zones, there is slightly less uncertainty in treatment rates under alternative E than alternative C. This is because the lower amount of recommended wilderness under alternative E would provide greater flexibility in wildfire management options over a greater proportion of the landscape. This would be the case especially on the Sierra National Forest, where there is about half as much designated wilderness under alternative E as under alternative C. It is also the case for recommended wilderness areas close to communities. There would be slightly greater uncertainty in restoration treatment rates involving prescribed fire and wildfire managed for resource objectives under alternative C, compared with E. In the subalpine and alpine zone and arid shrublands and woodlands zone, treatment rates under alternatives C and E would be similar. This is because the amount of recommended wilderness in these two zones does not substantially differ between these alternatives. Under alternative E, management direction for backcountry management areas would provide similar management options to restore fire regimes and fire as an ecosystem process, compared with alternative C.

Cumulative Effects

Fire Regimes and Fire as an Ecosystem Process

The cumulative effects on fire regimes are described in “Environmental Consequences to Fire Trends” and “Combined Effects of Climate, Fire, Insects, and Pathogens.”

Carbon Stocks, Sequestration, and Stability

Cumulative effects for carbon are complex because there are many diverse sources of carbon stocks and emissions outside of the national forests and a number of complex carbon-related interactions between vegetation and the atmosphere. The cumulative effects analysis emphasizes those aspects of carbon that are related to vegetation, namely carbon stability, stocks, and sequestration. There is some reference to carbon release from vegetation, but more detail can be found in “Air Quality.”

Restoration treatments and wildfires on adjacent lands that can burn onto the national forests are the two primary influences on the cumulative effects on carbon and vegetation. Restoration treatments on adjacent Yosemite and Sequoia and Kings Canyon National Parks, BLM-administered lands, and the neighboring Inyo National Forest and Giant Sequoia National Monument can result in areas of increased fire resilience and carbon stability. This would make it less likely for uncharacteristically large and severe wildfires to move from these lands onto the Sequoia and Sierra National Forests (see cumulative effects section of “Environmental Consequences to Fire Trends”). However, in the Lake Isabella area and parts of the lower Kern River drainage, the lower elevation lands bordering the Sequoia National Forest are dominated by annual grasslands, oak woodlands, and chaparral. These areas burn frequently and may convert to nonnative annual grasslands, which would decrease carbon stocks, sequestration, and stability. This is because of the high human presence and source of fire starts under all alternatives.

Landscape Connectivity

The cumulative effects of the alternatives, combined with climate change, uncharacteristic wildfires, insects, and other stressors on landscape connectivity, are complex and difficult to disentangle. The Forest Service anticipates that restoration on the adjacent lands would reduce short-term forest habitat connectivity in the southern Sierra Nevada. These lands are Yosemite National Park, Sequoia and Kings Canyon National Parks, BLM-administered lands, Inyo National Forest, Giant Sequoia National Monument, and state and some larger private lands. However, under all alternatives, these cumulative restoration treatments would increase forest landscape connectivity by reducing the likelihood of uncharacteristic wildfires, widespread insect outbreaks (similar to that observed during the 2012–2016 drought), and other landscape-scale disturbances. These treatments would sever critical habitat linkages for forest-dependent species in the southern Sierra Nevada, such as fisher.

Cumulative impacts on landscape connectivity would be greatest under alternative A, due to the lack of plan direction for enhancing agency partnerships designed to protect habitat corridors or linkage areas. Alternatives C and E would result in higher levels of cumulative impacts on long-term landscape connectivity. This would be due to the fewer number of partnership opportunities involving mechanical thinning in forest ecosystems that would increase their resilience to stressors. However, alternatives C and E would also have fewer cumulative impacts on short-term landscape connectivity than would alternatives B and D. This is because of the fewer opportunities and resultant lower mechanical treatment rates that could impact forest habitat on adjacent lands.

Important Seral Stages

Old Forest

The cumulative effects of the alternatives on old forests are influenced by management on adjacent lands, factors that influence fire and status, and conservation plans for old forest-associated species, such as California spotted owl and fisher.

The combined effects of increased restoration of old forests and restoration on adjacent national park lands would move more total area in old forest toward desired conditions and the natural range of variation. There are extensive areas of old forest in the two national parks that share borders and are intermixed with the national forests in the analysis area. Yosemite National Park is to the north, bordering the Sierra National Forest. Sequoia-Kings Canyon National Park lies between the Sierra and Sequoia National Forests. The western third of Sequoia-Kings Canyon National Park has oak woodlands and chaparral at the lowest elevations and montane forests, including giant sequoia groves, at moderate elevations. The very old giant sequoia forests in these national parks and adjacent national forests (excluding the Nelder and McKinley Groves on the

Sierra National Forest) were analyzed in the Giant Sequoia National Monument Plan Environmental Impact Statement and that information is not repeated here. The Inyo National Forest, which contains areas of old forest on the eastern slope of the Sierra Nevada, borders the Sequoia and Sierra National Forests to the east.

At higher elevations, there are extensive areas of upper montane old forests in Sequoia-Kings Canyon National Park that are next to similar areas on the Sequoia and Sierra National Forests. Upper montane forests of the Inyo National Forest border the Sequoia National Forest in the northeastern portion of the Kern River drainage and the Sierra National Forest in the upper San Joaquin River drainage. Collectively, these upper montane forests form a large continuous block of old forest in the southern Sierra Nevada, most of it in wilderness. The large continuous area is the largest in the Sierra Nevada, and its ecological value to old-forest associated species is immense.

The National Park Service and Forest Service have coordinated multiple times on wildfires managed to meet resource objectives in these areas (Meyer 2015a) and would continue to do so under all alternatives. Wildfires cross administrative boundaries often, with the cumulative effect of large areas of old forests in Sequoia-Kings Canyon National Park and Yosemite National Park restored next to Sequoia and Sierra National Forests, such as the Kern River drainage. This restoration has improved the resilience of old forests to such stressors as uncharacteristically severe wildfires and increased heterogeneity and restored species composition and structure. All of the alternatives would continue this cooperative, beneficial management of fire across administrative boundaries, especially under alternatives B, C, D, and E, which emphasize more robust fire management partnerships.

Complex Early Seral Forest

Management of large fires and postfire restoration in adjacent national parks, national monuments, and national forests to the north are the primary contributors to cumulative effects on complex early seral forest. Yosemite and Sequoia and Kings Canyon National Parks and the Inyo National Forest do little postfire restoration that is likely to reduce the amount of complex early seral forest. There is no postfire salvage in national parks, except along major roads and infrastructure to remove hazard trees. There would be some postfire salvage in the Giant Sequoia National Monument, but most of it would be limited to areas along roads and infrastructure. This would be the case especially in areas of high tree mortality following the 2012–2016 drought and possibly in portions of the 2016 Cedar Fire and 2017 Pier Fire that occurs on the Giant Sequoia National Monument.

Future projected trends in large, high-intensity fires from climate warming in national parks are similar to likely trends in national forests (Westerling et al. 2015). For example, the 2013 Rim Fire, 2015 Rough Fire, and 2018 Ferguson Fire substantially increased the complex early seral forests across montane and upper montane landscapes of Yosemite and Kings Canyon National Parks. With the increased likelihood of large, high-intensity fires and limited postfire restoration, the cumulative effect would be to have an overall increase in complex early seral forest across the analysis area.

The southern portion of the Stanislaus National Forest to the north has had repeated, large, high-intensity fires, most recently the large 2013 Rim Fire and 2018 Ferguson Fire. Additionally, the 2015 Rough Fire created several large high-severity patches in forests on the Giant Sequoia National Monument and Kings Canyon National Park (as well as the Sierra and Sequoia National

Forests). This resulted in several large patches of complex early seral forest habitat and many moderate and small patches.

There has been extensive roadside hazard salvage and planned salvage across large areas of the 2013 Rim Fire. However, because of the large burn perimeter, there remains a large cumulative increase in complex early seral forest habitat in this area. Overall, with increased fire trends throughout and varying but mostly lower levels of salvage, the cumulative effect of all alternatives would increase the amount of complex early seral forest.

Unique Vegetation Types

The cumulative effects of the alternatives on aspen stands and giant sequoia groves would likely be influenced by the management actions on adjacent lands. The National Park Service frequently uses prescribed fire and wildfire managed for resource objectives to manage aspen stands and giant sequoia groves in Sequoia and Kings Canyon National Parks and Yosemite National Park. Similarly, the Sequoia National Forest manages many giant sequoia groves and some aspen stands on the Giant Sequoia National Monument. In these areas, the Forest Service uses fire restoration and some limited mechanical thinning; the same is the case for aspen stands on the Inyo National Forest.

These cumulative restoration actions would move a greater proportion of sequoia groves and aspen stands toward desired conditions and the natural range of variation. This includes reduced tree mortality rates and increased tree regeneration in giant sequoia and aspen, as well as increased resilience to the combined effects of climate change, uncharacteristic fire, and other stressors.

Keystone Species Groups

The cumulative effects of the alternatives and various stressors on keystone species groups are varied. In the next 10 to 15 years, the synergistic effects of climate change, uncharacteristic fire, air pollution, invasive species, and insect and pathogen activity would likely benefit cavity excavators and pollinators under all alternatives. This is because these stressors would increase the amount and proportion of early successional habitat and tree mortality that benefits cavity excavators and pollinators, by providing increased foraging habitat. However, greater loss of green forest may have unknown impacts on other cavity excavators and pollinators that also depend on this habitat for nesting or foraging during some stage in their life cycle, such as pileated woodpeckers, hairy woodpeckers, or Williamson’s sapsuckers. Over decades, the loss of forests due to increasing stressors, especially climate change, would reduce the habitat extent for these keystone species, regardless of episodic increases in early seral habitats following fire and other ecological processes.

Tribal Uses and Biocultural Diversity

Cumulative effects for tribal uses are a combination of what is described in the sections discussing tribal interests, vegetation ecology, fire ecology, economic and social conditions, and fire and climate trends. Overall, the trends in ecosystem conditions that support tribal uses would be improved from the restoration treatments and greater tribal cooperation and involvement. But the economic and social conditions for tribes outside of the national forests where they live can influence their ability to access and use the ecosystems. Better economic and social opportunities would provide a greater ability to use these ecosystems.

Integrated Terrestrial Ecosystem Sustainability

The varied aspects of integrated terrestrial ecosystem sustainability are complex when considered individually, as well as when considered together. However, the cumulative effects for each are similar. The effects of climate are the dominant overarching outside influence that affects all aspects, especially fire and nonnative invasive plants.

Analytical Conclusions

Fire Regimes and Fire as an Ecological Process

Foothill, Montane, Upper Montane, and Subalpine/Alpine Zones

The alternatives vary in restoration of fire regime integrity and fire as an ecological process by ecological zone and location. Alternatives B, C, D, and E would increase fire regime integrity and fire as an ecological process in the upper montane, subalpine, and alpine vegetation types and in the Kern River drainage areas. This is because of an increased potential to have wildfire managed to meet resource objectives.

In the montane and foothill zones, alternative D would create increased fire regime integrity in the focus landscapes. Uncharacteristically large and severe wildfires are less likely to occur in these restored landscapes, and restored areas would experience reduced fire severity and effects, or those more aligned with desired conditions. Alternative D would have the greatest positive benefit to fire regime integrity across the national forests because at least half of the entire forest area would be restored. Alternative B would only have half of this area restored at most. Alternative A, followed by alternatives C and E, would have the least fire regime integrity across ecological zones.

The alternatives differ in proposed restoration of fire as an ecosystem process, especially in the montane zone. Alternative B has prescribed fire objectives that would substantially increase the prescribed burning levels over alternative A, but there is a moderate uncertainty that this amount of prescribed fire would occur because of limited operating periods for California spotted owl and fisher. With warming climate, drought, and longer and drier fire seasons, spring burning is increasingly important to achieving prescribed fire objectives. This is especially true in areas of high tree mortality following the 2012–2016 drought. There are fewer limited operating periods under alternative D, especially in focus landscapes and community buffers, and a higher likelihood that prescribed fire would occur. However, there is uncertainty as to whether air quality conflicts would prevent burning at any time of the year.

Arid Shrublands and Woodlands Zone

Restoration treatment rates in arid shrublands and woodlands on the Sequoia National Forest are similar among alternatives, but with slightly greater treatment rates under alternatives B, C, D, and E. Treatment rates in the arid shrubland and woodland zone would be relatively low, compared with the montane and upper montane zones. The treatment rates would only slightly increase fire regime integrity of eastside shrublands and woodlands. Nevertheless, fire regime integrity in this zone would continue to be moderately high due to the long historical fire return intervals in these vegetation types, which may exceed 80 to 200 years in places (greater than the current fire exclusion period of the 20th and early 21st centuries). Where nonnative grasses have not invaded, these vegetation types are less departed from the desired conditions than other vegetation types in the analysis area, with the exception of the subalpine and alpine zones.

Carbon Stocks, Sequestration, and Stability

Alternative D, followed by alternative B, would have the greatest positive impact on long-term carbon storage, sequestration, and stability. Both alternatives have the greatest proportions of vegetation restoration that would decrease the likelihood of large, high-intensity fires and increase the resilience of vegetation to fires. This would result in less tree mortality and greater retention of forest carbon stocks. Carbon sequestration would be more stable and would likely increase; this is because of less competition between trees for water, light, and openings that would improve understory shrub and plant vigor. Alternative D would have the greatest positive impact; this is because there is enough of the low and mid-elevation areas restored that could reduce the amount of large, high-intensity fires (see “Fire Trends”).

Alternatives A, C, and E would likely result in a continued condition of high instability of carbon in the long term. The likelihood of uncharacteristically large and severe wildfires, insect outbreaks, and low climate adaptive capacity would continue to increase. There would continue to be large areas of the landscape with low ecological fire resilience and resilience to insects and pathogens (see “Insects and Pathogens”). This means that there would likely be large areas burned as crown fires during large, high-intensity fires or areas with widespread tree mortality. This would be due to moisture stress and insect and pathogen activity. While dead trees can store much of their carbon in the stems and branches, it is short-term carbon storage. This is because decay and other ecological processes, such as fire, release carbon to the atmosphere (North and Hurteau 2011).

Carbon sequestration could increase because of more young vegetation growing after large fires. This increase in sequestration would likely be short term under alternatives C and E. Under alternative C, there would be little to no reforestation; therefore, there would be lower levels of sequestration in postfire landscapes characterized by large high-severity fire patches with increased tree regeneration failure (Ritchie and Knapp 2014, Collins and Roller 2013). Under alternative A, while there might be some reforestation, there is a moderate to high likelihood that these plantations would not survive additional uncharacteristic wildfires and climate change. This would be due to lack of sufficient plan direction for creating future resilient stands, for example higher planting densities without future climate considerations.

There is often, but not always, a pattern of repeated fires in the same vicinity, that burn intensely through plantations. The most notable examples are on the Stanislaus National Forest, near and in the 2013 Rim Fire area, which were often established following earlier uncharacteristically severe wildfire events, such as the 1987 Stanislaus Complex.

Landscape Connectivity

Alternative B potentially provides for short- and long-term habitat connectivity, especially for forest-associated species, such as fisher. Key linkage areas for fisher are prioritized for restoration. However, the 2013 Aspen Fire and 2015 Rough Fire burned through key linkage areas before they could be restored.

Alternatives C and E provide the greatest short-term connectivity, but at the cost of elevated exposure or sensitivity to uncharacteristically severe fire, climate change, and other stressors that reduce long-term habitat connectivity. Alternative D may support the greatest long-term habitat connectivity. However, it would be at the cost of significantly reduced short-term habitat connectivity resulting from elevated mechanical and prescribed fires in the next 10 to 20 years.

Alternative A provides the lowest connectivity for forest-associated and other wildlife species under both short- and long-term horizons. It provides the lowest restoration treatment rates and lacks management approaches that are specifically focused on habitat linkage and dispersal corridor areas otherwise promoted under alternatives B, C, D, and E for wildlife species, such as fisher. Consequently, alternative D would result in the greatest long-term habitat connectivity for forest-associated and other species.

Important Seral Stages

Old Forest

Alternative D, followed by alternative B, would result in the greatest restoration of old forests. There would be more old forests with restored desired tree density, heterogeneity, tree canopy cover, fire regime integrity, and fire as an ecosystem process of the alternatives. This would restore old forests toward conditions reflecting the natural range of variation. There would be substantially increased resilience of large, old trees to moisture stress, drought, insects and pathogens, ozone, and large, high-intensity fires. There is a potential for some large trees to be harvested under alternatives B and D. This is because the direction to limit the size of trees removed is provided by desired conditions for old forests, compared with fixed harvest diameter limits. It is unknown how many large trees would be harvested, but the Forest Service assumes that it would be low. This is because many areas are below desired condition levels for large trees.

The greatest impact on old forests, aside from direct harvest of large trees, is of trees dying from large, high-intensity fires and the combined effects of drought, insects, and pathogens. Large, high-intensity fires can kill many large trees, across large areas at one time. The fire-climate research by UC Merced (Westerling et al. 2015) reports there has been and will continue to be an increase in the size, number, and area burned in large fires due in part to warming climate. In restoration scenarios, the trend did not change or reverse until 60 percent of the foothill and montane landscape was restored (similar to alternative D). Restoration levels of 15 percent (alternatives C and E) and 30 percent (alternative B) showed less increase of large fires, compared with no treatment, especially alternative B. However, compared with today, there would still be increases in large, high-intensity fires, with related increases in the loss of old forests.

Future droughts, similar to the 2012–2016 drought, and bark beetle outbreaks will also have negative, widespread impacts on old forests. The greatest drought-induced mortality associated with the lowest treatment rates, least flexibility, and lowest treatment effectiveness of restoration treatments would be under alternative A, followed by alternatives C and E. Alternative D, followed by alternative B, would result in the greatest degree of old forest integrity and resilience. This is because these alternatives promote the greatest degree of effectiveness, in part due to more strategic treatment prioritization and ecological monitoring, and the highest restoration treatment rates and most flexibility. This would be true especially in focus landscapes under alternative D and within community buffers under alternatives B and D.

Under all alternatives, the Kern River drainage would reach the 60 percent restoration level rapidly, because it is already near or exceeding 30 percent in many areas. For all other areas, alternative D is the only alternative that comes close to the 60 percent restoration level. It is most likely to have the least loss of old forest from large, high-intensity fire. Alternative B would have a similar impact in some areas but not all.

Under all alternatives, there is uncertainty as to what proportion of large fires would be dominated by high-severity, mixed-severity, or low-severity effects, even though relative qualitative comparisons could be made among alternatives. Larger proportions of high-severity fire are likely under alternatives A, C, and E; higher proportions of low and moderate severity fire are more likely under alternatives B and D. Even with the very large 2013 Rim Fire and 2014 King Fire, there were significant portions of the fires that burned at moderate or low severity, especially in the upper montane zone. Similar patterns occurred with the 2013 Aspen Fire, 2014 French Fire, and 2015 Rough Fire. These areas of low and moderate fire severity may result in some large trees dying, but overall they would provide the benefits of increased heterogeneity, desirable habitat features, such as snags, and resilience on some parts of fires. However, there would be severe effects on old forest in other parts of the fires that burn at high severity.

Old forests can also be greatly impacted by drought, insects, and pathogen-related mortality, as evident during the 2012–2016 drought. Where forest density is high, all trees are vulnerable to mortality, including large trees. Current levels of mortality in ponderosa pine and some mixed conifer forests are elevated. Mortality of younger and medium-sized trees from surrounding younger forests increases the likelihood that large trees will die. This is because elevated insect levels increase the extent and rate of infection.

Alternative D would have the greatest reduction in vulnerability to future drought, insect, and pathogen-related large tree mortality. This is because the greatest intensity of forest thinning across large areas would occur. Alternative B would have some increases in resilience in treated forest landscapes. The net result is that only a small portion of remnant large old trees would benefit from restoration treatments of intensity needed to increase resilience. This may be less than 10 percent of the areas with large, old trees. Alternatives A, C, and E would have even lower levels of benefit from restoration, because treatments would be less intense and less extensive.

Complex Early Seral Forest

The increase in complex early seral forest would be greatest under alternatives C and E, followed by alternative B, and the least would be under alternatives A and D. There would be a moderately high level of uncertainty about the specific distribution of the complex early seral forest patches. This is because of the high uncertainties associated with wildfire occurrence and fire effects. However, there is a high likelihood of increased fires under all four climate scenarios used to project large fires (Westerling et al. 2015) and a moderate to high certainty regarding regional trends in the extent, proportions, and spatial pattern, such as patch size, of complex early seral forest.

Current proportions of early seral forest in the montane and upper montane zones of the Sequoia and Sierra National Forests are either within or slightly exceed the natural range of variation NRV. Projected future increases in uncharacteristic wildfire and extreme drought-related mortality will increase the proportions of early seral forest outside NRV in the next few decades. This increase will lead to proportionally large increases in complex early seral forest. This is because there is no salvage harvest or reforestation more than 90 percent of the montane and upper montane forests burned in wildfires.

The amount of complex seral forest would likely remain within or would exceed the terrestrial vegetation desired conditions under most alternatives, especially alternatives C and E. This is because of the following:

- Large-scale disturbances would continue to create early successional forest habitat (to the detriment of old forests) with the interaction of wildfire, drought, insects, and climate change, especially in the absence of sufficient restoration treatment rates to offset these impacts (see “Agents of Change”)
- Recent tree mortality associated with the 2012–2016 drought can exacerbate future uncharacteristic wildfires and can result in larger mass fires that lead to large and contiguous areas of complex early seral forests
- Relatively low levels of postfire management on the Sequoia and Sierra National Forests—6 to 10 percent of montane and upper montane forests over the past 30 years—would have negligible impacts on complex early seral forest habitat, especially in about 83 percent of the total acreage of the Sequoia and Sierra National Forests, that are mechanically inaccessible (North et al. 2015)
- Even in areas that are mechanically accessible, management would retain a proportion of complex early seral habitat following stand-replacing disturbances. For example, one guideline retains a minimum of 5 to 20 percent of complex early seral in severely burned areas across alternatives.

Alternatives A, C, and E would likely result in some landscapes with an excessive level of early seral forest that exceeds the NRV and complex early seral forest that exceeds terrestrial ecosystem desired conditions. This would be due to reduced restoration treatment rates and increased levels of uncharacteristic wildfire and other large-scale disturbances. Alternatives B and D may still exceed these levels of early seral and complex early seral forest, but these levels would be closer to the NRV and desired conditions than other alternatives.

Unique Vegetation Types

Alternatives B and D all provide similar increases in the ecological condition of giant sequoia groves and aspen stands, because they provide similar management direction for sequoia groves and aspen. However, higher restoration treatment rates under alternative D would result in a slightly greater ecological condition, compared with alternative B. Alternatives C and E would provide somewhat lower increases in ecological condition, compared with alternative B or D. This would be due to lower treatment rates and diameter limit constraints on the removal of shade-tolerant trees.

The increased grove management area under alternatives C and E would not provide additional benefits to giant sequoia groves, compared with alternatives B or D. This is because no additional giant sequoia trees are included in this added area. Alternative A would provide the least protection, because it lacks sufficient plan direction to manage, restore, and protect giant sequoia groves and aspen stands.

There is also increased management direction under alternatives B, C, D, and E on fire management and sustainable recreation that can decrease trampling and disturbance impacts on these unique vegetation types.

Keystone Species Groups

Pollinators—Alternatives B and D would provide the greatest restoration to support improved pollinator habitat in forested ecosystems. There would be the greatest amount of restoration, including prescribed fire, mechanical thinning, and wildfire managed to meet resource objectives, at an intensity and spatial pattern to create openings, more open canopy, and sunlight on the forest floor. Alternative C proposes increased prescribed fire, compared with alternative A, but it is uncertain how much would occur, and mechanical restoration would retain more canopy cover. Alternative A would provide the least restoration of habitat conditions supporting pollinators. In woodlands and shrublands, alternatives B and D would provide greater benefit to pollinators that depend on annual plants, in areas where invasive species are not dominant. All alternatives would have very similar impacts for pollinators that depend on perennial flowers.

Primary Cavity Excavators—Alternatives C and E would provide the most snag habitat because of the lower levels of mechanical restoration, increased levels of prescribed fire, and higher snag retention levels. Alternative B would provide slightly higher levels than alternatives A and D. Alternative D would provide the lowest level of snags. It is uncertain under all alternatives what the distribution of snags would be on the landscape among different habitat types, for example young versus old forests and burned versus unburned forests. As described above in the complex early seral forest discussion, alternatives C and E, followed by alternative B, would have the most snag habitat in burned forests.

Tribal Uses and Biocultural Diversity

Alternative D, followed by alternative B, would provide the greatest increase in ecosystem condition for tribal uses. More restoration would occur under these alternatives, which would improve plant, animal, and insect habitat. Alternatives B, C, D, and E all provide for increased tribal coordination and restoration of areas of tribal interest. These would all increase the amount and quality of restoration benefitting tribes.

Integrated Terrestrial Ecosystem Sustainability

Table 46 provides an overall summary of conditions for characteristics of integrated sustainability by alternative. Out of all of the alternatives, alternative A provides the least likelihood of sustainability. Alternative D, followed by alternative B, is the most likely to improve the likelihood of sustainability. Alternatives C and E could improve sustainability, but there is greater uncertainty. This is because, under those alternatives, there is more reliance on fire restoration treatments with less ability to treat the areas before burning.

Sustainability of old forest condition and extent is most influenced by the amount of restoration of the entire landscape and the old forests themselves. Alternative D, followed by alternative B, would have the greatest overall levels of restoration and would increase the area's resilience to large fires. Alternative D would have the greatest amount of restoration in old forests outside of the forest protection zones. This would increase the resilience of old forests to drought, insects, pathogens, air pollution, and high-intensity fire. However, some large trees might be harvested. Alternatives A, C, and E would most restrict restoration of old forest and vegetation overall. This might provide short-term protection for old forests but also would increase the susceptibility of mortality from drought, air pollution, insects and pathogens, and uncharacteristically large and severe wildfires.

Climate, Ecological Vulnerability, and Adaptation

Background

This section summarizes ecological vulnerabilities to climate changes and the effects of adaptation strategies and plan direction addressing ecological impacts of climate change. It examines the overarching effects of climate change on terrestrial and aquatic ecosystems. It also adds detail to the general discussions in the vegetation ecology section above on individual vegetation types.

Analysis and Methods

This section summarizes the more detailed analysis of climate, ecological vulnerability, and adaptation found in the bioregional and forest assessments (United States Department of Agriculture 2013b, c, d), snapshots of the "Living Assessment" used to develop the final assessments (United States Department of Agriculture 2013h, j, k), and published scientific literature, including the "Scientific Synthesis" (Long et al. 2014), and the "Natural Range of Variability Assessments" (Safford and Stevens 2017, Safford 2013, Estes 2013a, b, Merriam et al. 2013, Meyer 2015b, Meyer 2015c, Sawyer 2013, Slaton and Stone 2015a, b). Additional information from several recent climate change vulnerability and adaptation assessments is also incorporated (Schwartz et al. 2013a, Kershner 2014, Dettinger 2017, Thorne et al. 2018).

Indicators and Measures

Ecological vulnerability indicators include tree mortality, distribution of species (elevational distribution of plants and animals), presence of nonnative invasive species, and changes in frequency, size, and severity of the stressors.

Adaptation strategies can increase the resilience of ecosystems and resources to climate change impacts (Intergovernmental Panel on Climate Change 2014). Short-term adaptations build resistance and resilience, so that ecosystems are better able to withstand undesirable effects of climate change, such as diminished ecosystem integrity and function. In Table 49, the alternatives are compared by their relative capacity to support various climate adaptation approaches that are recommended by climate vulnerability assessments and other best available science information sources. These approaches are as follows:

- Increase adaptive capacity of ecosystems through ecological restoration and climate adaptation
- Develop and use collaborative partnerships
- Apply climate vulnerability assessments in planning and prioritization
- Use monitoring and adaptation

Collaborative partnerships are addressed under "Benefits to People."

The primary adaptation strategies are based on several recent climate adaptation workshops (Partnership 2010, Nydick and Sydoriak 2011b, Kershner 2014) and on scientific literature on climate change (North et al. 2009a, Finch 2012, Lawler et al. 2012, Safford et al. 2012c, Safford et al. 2012a, Millar et al. 2007, Hanberry et al. 2015). These strategies are as follows:

- Manage for vegetation heterogeneity and diversity
- Restore or maintain key ecological processes, including fire in fire-adapted forest ecosystems

- Reduce the density of smaller diameter, shade-tolerant trees in fire-adapted forests to levels more consistent with the natural range of variation
- Reduce the chance of uncharacteristically large and severe wildfires and other climate-related stressors using ecologically appropriate treatments, including prescribed fire, mechanical thinning, and wildfires managed for resource objectives within the natural range of variation
- Implement rapid detection of and response to invasive species
- Restore ecosystem function to degraded meadows and aquatic and riparian ecosystems
- Identify and protect future climate refugia for other areas of native species persistence
- Maintain and restore habitat connectivity across the ecoregion to facilitate species' movements under rapidly changing conditions
- Enhance recruitment and expansion in species that are ecologically underrepresented, such as aspen and giant sequoia, functionally important, such as whitebark pine, or climate resilient, such as oaks and fire-tolerant pines; this includes, during reforestation, taking into consideration plant species and genotypes that may be adapted to warmer or drier climates

Assumptions

- Ecological response models assess the response of such ecosystems as vegetation and wildlife habitat to climate change. These models include additional assumptions that increase the existing level of uncertainty in climate model projections (Glick et al. 2011).
- The outcomes of management actions with climate change are also highly uncertain. However, best strategies for adapting to future change will be based on adaptive land management strategies that consider historical, current, and future projected changes in climate and climate-related processes (Wiens et al. 2012). This provides a more comprehensive evaluation of the effects of climate change in the absence of robust projections of future climate and climate-related processes (Safford et al. 2012a).
- Plan components that specifically address climate change, including desired conditions and management approaches, will result in improved climate adaptation.
- Climate change is a primary stressor that has wide-ranging impacts and a strong interaction with other ecological stressors in the plan area. Such stressors are wildfire, drought, insects, pathogens, air pollution, and invasive species. The impacts of drought may be addressed in some ecological response models through simulated variation in precipitation, including extended periods of reduced precipitation.
- Plan components that increase the pace and scale of restoring vegetation to a more resilient condition—desired conditions that reflect the natural range of variation—will substantially improve the capacity for climate response of major vegetation types. Thus, the increased pace and scale of restoration treatments will provide greater support of climate adaptation strategies focused on enhancing ecosystem resilience.
- Increased pace and scale of restoring vegetation will include proportionate measures to prevent or control nonnative invasive plant species, to the extent possible.

The Forest Service assumes that the different adaptation strategies are equally important. However, depending on the vegetation type, species, or ecosystem process, some strategies may be more important than others in a particular situation. Differences in the importance of adaptation strategies by vegetation type, species, or ecosystem processes are analyzed under "Terrestrial Ecosystems," "Aquatic and Riparian Ecosystems," and "Species of Conservation Concern."

Affected Environment

Studies of terrestrial mammals, birds, and butterflies show that ranges of many species have been shifting to higher elevations and shrinking in high elevation zones, probably in response to warming temperatures and changing precipitation patterns (Safford et al. 2012a). Similar sensitivities are suggested for aquatic and riparian species (Hauptfeld and Kershner 2014a).

As described under "Agents of Change," "Terrestrial Vegetation Ecology," and "Terrestrial Ecosystem Processes and Function" above, there have been changes in wildfires, tree mortality, and insect populations, related in part to climate changes that affect species habitat and distribution. Wildfire frequency, size, total area burned, and fire severity have all been increasing in the Sierra Nevada over the last 2 to 3 decades. Larger trees are also dying from factors other than fire throughout many parts of the Sierra Nevada (Dolanc et al. 2014, Van Mantgem et al. 2009). This pattern is frequently associated with increasing moisture stress and bark beetle activity related to increasing temperatures across western North America (Logan et al. 2003, Van Mantgem et al. 2009).

More recently, during and following the 2012–2016 drought, extensive tree mortality has occurred (see "Insects, Pathogens, and Changed Conditions Associated with Recent Tree Mortality"). These elevated levels of tree mortality are likely due to the interacting effects of drought, bark beetles, forest densification, and warming temperatures. For instance, higher winter temperatures permit greater overwintering insect survival and reproductive success; increased summer temperatures and drought further increase bark beetle population growth through increased probability of successful attack: drought-weakened trees are less defensible to attack. Moreover, tree drought stress and consequent tree mortality resulting from reduced soil moisture availability and increased evaporative demand is becoming worse, due to warming climate trends (Van Mantgem et al. 2009).

Projected Future Trends in Ecological Indicators

Climate vulnerability assessments for the plan area anticipate broad-scale changes in ecosystem conditions, such as fire regimes, vegetation, insect activity, and species distribution patterns. Table 47 shows the climate vulnerability, ranked from high to low based on relative vulnerability, among types of different major vegetation types. The assessment is based on the degree of climate exposure, sensitivity to climate change, and capacity to adapt to changing conditions.

Table 47. Climate vulnerability[1] of major vegetation types in the plan area

Vegetation Type	Climate Vulnerability
Subalpine forest and alpine	High
Red fir forest	High
Wet meadow	High
Riparian	Moderate to high
Mixed conifer and yellow pine forest	Moderate to high
Sagebrush	Moderate
Pinyon-juniper woodland	Low to moderate

Vegetation Type	Climate Vulnerability
Montane and foothill chaparral	Low to moderate
Oak woodland	Low to moderate
Grassland	Low

[1]Climate vulnerability indicates the degree to which a vegetation type or species is vulnerable to the effects of climate change, with the most vulnerable types—high climate vulnerability—indicative of high climate exposure, high sensitivity to climate change, and low capacity to adapt to future changes. Vulnerability is based on a relative scale of low to high.

Models suggest the area of conifer-dominated forest in the southern Sierra Nevada will decrease substantially, especially for high elevation forests, such as subalpine areas. In contrast, hardwoods and shrubs are expected to respond positively to warmer nighttime temperatures and shifting disturbance regimes, such as increased fire intensity and bark beetle activity, that favor oaks or shrubs over conifers. This would result in some of the ponderosa pine and lower mixed conifer forests shifting to hardwood or shrub-dominated types, including black oak woodlands or chaparral.

Many scenarios also show an increase in grassland area at lower and middle elevations, as woody vegetation retracts in the face of increased fire frequency and invasion by nonnative annual grasses. This is expected to occur especially at the lower elevations, where blue oak woodlands will shrink in distribution or will move upward in elevation in the coming decades.

Current trends of larger burned areas and increasing fire activity, such as longer fire seasons and changes to fire frequency, are expected to continue in most vegetation types under almost all future climate scenarios (see “Fire Trends”). Moisture stress and the frequency and severity of bark beetle outbreaks are projected to increase dramatically with increasing temperatures in the Sierra Nevada, resulting in widespread tree mortality (Bentz et al. 2010, Hicke et al. 2006). This occurred during and following the 2012–2016 drought on much of the Sierra and Sequoia National Forests in ponderosa pine and mixed conifer forests; in many of these areas, the amount of dying conifers is moderate to very high, as shown in Figure 37 and discussed in “Insects, Pathogens, and Changed Conditions Associated with Recent Tree Mortality.” Note in the photo that ponderosa pine mortality, as evident by the red needles, is highly patchy and extensive across the landscape.

Regional climate trend assessments (Safford et al. 2012a), climate vulnerability assessments (Kershner 2014), and natural range of variation assessments suggest that climate change will have impacts on individual plant and animal species. Table 48 shows the climate vulnerability of selected species or species groups in the plan area. This is not an exhaustive list but instead represents species that are vulnerable in the different ecosystems in the Sierra Nevada.

There will likely be increasing vulnerability of species from direct and indirect effects of climate change. Direct effects will include increasing evaporative demand for plants, with warming temperatures and resultant increased water stress. Indirect effects will include habitat loss from vegetation changes. For example, Clark’s nutcracker depends on whitebark pine in subalpine and alpine areas for food. If whitebark pine and these forests are heavily impacted by climate change, then Clark’s nutcracker will be heavily impacted.

Figure 37. High levels of dead and dying trees in ponderosa pine and black oak-ponderosa pine forests in the Sierra National Forest

Table 48. Climate vulnerability of select species or species groups in the plan area

Species or Species Group	Climate Vulnerability
High-elevation white pines[1]	High
Alpine chipmunk	High
Fisher and marten	High
Mountain and Sierra yellow-legged frogs	High
Giant sequoia[2]	Moderate to high
Great gray owl	Moderate to high
Aspen	Moderate
Clark’s nutcracker	Moderate
Swainson’s thrush	Moderate
Canyon and interior live oak	Low
Stellar’s Jay	Low

[1] Includes whitebark pine, foxtail pine, and limber pine

2 Overall climate vulnerability is moderate, but mature and old trees may be highly vulnerable.

Note: See Table 47 for a description of climate vulnerability.

Many models project significant range contractions in some species distributions: those with high climate sensitivity and low adaptive capacity. For example, alpine plants and animals in the highest elevations will have few if any of the colder environments they are adapted to. Species with low adaptive capacity include those that have small and isolated populations, low genetic variation, limited ability to move widely, and low reproductive rates. Vulnerable species also include those with habitat tied to vulnerable vegetation types. For example, The conditions that support marten presence in California are likely to change greatly over the next century, potentially causing a pronounced loss of suitable habitat (Lawler et al. 2012). Marten are closely associated with red fir forests, which depend on snowpack. Lawler and others suggest that marten will be highly sensitive to climate change, with the largest impacts in the southern Sierra Nevada (Lawler et al. 2012).

Environmental Consequences to Climate, Ecological Vulnerability and Adaptation

The Forest Service contrasted the alternatives qualitatively as to the opportunity, likelihood, and rate of application of adaptation strategies. We focused on building adaptive capacity of ecosystems from restoration actions (Table 49). A rating of high means that there were likely to be numerous opportunities and a high likelihood of applying adaption strategies in multiple locations. A rating of low meant that there were few opportunities and a low likelihood of applying adaptation strategies on no locations or on only a few. Moderate would be between low and high, either with a lower likelihood or fewer locations where adaptation strategies would be applied.

Table 49. Rating of the amount of climate adaptation strategies applied, by alternatives

Climate Adaptation Strategy	Alternative A	Alternative B	Alternatives C and E	Alternative D
Manage for vegetation heterogeneity and diversity	Low	Moderate (in 15 to 25% of area)	Low	Moderate to high (in 30 to 60% of area)
Restore or maintain key ecological processes, such as fire	Low	Low to moderate (moderate to high in Kern River drainage)	Low	Moderate
Reduce density of small-diameter trees in stands exceeding NRV	Low	Moderate (in 15 to 25% of area)	Low	Moderate to high (in 30 to 60% of area)
Reduce impacts of climate-related stressors, including drought	Low	Moderate	Low	Moderate to high
Rapid detection and rapid response to invasive species	Low to moderate	Low to moderate	Low to moderate	Low to moderate
Restore and maintain watershed function	Low	Moderate	Low	Moderate
Restore function of non-meadow riparian vegetation	Low	Low to moderate	Low	Low to moderate
Restore function of meadow ecosystems	Low	Low to moderate	Moderate	Low to moderate
Improve resilience of aquatic ecosystems	Low	Low to moderate	Low	Low to moderate
Protect future climate refugia	Low	Low	Low	Low

Climate Adaptation Strategy	Alternative A	Alternative B	Alternatives C and E	Alternative D
Use post-disturbance, climate adaptation, response strategies	Low	Moderate	Low to moderate	Moderate
Enhance ecologically important species	Low	Moderate	Low to moderate	Moderate (high in some areas)
Maintain and restore dynamic habitat connectivity	Low	Moderate to high	Low to moderate	Low to high
Overall	Low	Moderate (few high, some low)	Low (some moderate)	Moderate to high (some low)

We assumed the climate adaptation strategies to be equally weighted. There may be different ways to weight them, emphasizing the importance of some over others, such as reducing vegetation density or protecting future climate refugia. Because this analysis is general and not specific to individual species, it would be difficult to provide ecological justification for a specific weighting scheme, since it would likely vary by individual species. For analysis specific to individual vegetation types or specific species of conservation concern, see "Wildlife, Aquatic, and Plant Species."

Consequences Common to All Alternatives

Decades of fire exclusion coupled with intensive logging in forest ecosystems of the southern Sierra Nevada have resulted in uncharacteristically high fuel loads and homogenous forest structure (Kilgore and Sando 1975, Mckelvey and Johnston 1992). These conditions increase the susceptibility of fire-adapted forest ecosystems to climate change and related influences on ecosystems, including uncharacteristically severe wildfire, insect or disease outbreaks, and drought-triggered mortality (North et al. 2009a, Stephens et al. 2010) as observed during the 2012–2016 drought (see "Changed Forest Conditions associated with Tree Mortality"). All alternatives include the reduction of small-diameter, shade-tolerant trees to increase forest resilience, although the amount varies considerably by alternative.

All alternatives would continue to maintain and restore vegetation in the Kern River drainage using wildfire managed for resource objectives. These areas currently have greater resilience to climate change and related trends in increased fire. This is because the Forest Service has managed many wildfires for resource objectives over the last 15 years to 20 years, which restored extensive forested areas of the Kern Drainage (Fites-Kaufman et al. 2005, Vaillant 2009, Meyer et al. 2015). The Kern River drainage's large landscapes have reduced forest density and fuel conditions. Fires are smaller in size when they reach previously burned areas (Ewell et al. 2012, Reiner et al. 2016).

Aggressive eradication and containment of established invasive species will be an important component of ecosystem management under a changing climate. This is especially true considering that, while fire plays an essential role in vegetation restoration, it can introduce and spread invasive plant species (Keeley 2006). Projections are for an increase in burned area with climate change (see "Fire Trends"). All alternatives include controlling invasive species and preventing their introduction.

No alternatives have identified future climate refugia for native species, except for a desired condition for special habitats, which would apply to alternatives B, C, D, and E. However, when conducting vulnerability assessments for the southern Sierra Nevada, the Forest Service could identify future climate refugia that can be prioritized for restoration or monitoring. Alternatives B, C, D, and E would share desired conditions that address connectivity and the ability of species to move and persist across larger areas.

No alternatives have addressed prioritization of restoration to address specific vulnerabilities to climate change. However, alternatives B, C, D, and E provide climate adaptation response strategies. They emphasize prioritized vegetation restoration to reduce climate-related stressors, including large and severe wildfires, insect outbreaks, invasive species, and drought (see "Environmental Consequences to Fire Trends").

Monitoring and adaptive management approaches are fundamental to understanding how to respond to the impacts of climate change. All alternatives include monitoring and adaptive management as a component of their plan management strategies, approaches, and tools. Alternatives B, C, D, and E apply the new 2012 planning rule that was developed in part to use a more flexible and adaptive planning process. This allows for more frequent and streamlined plan amendments and revisions. This adaptive process provides greater potential under alternatives B, C, D, and E to monitor, learn, and adapt to rapidly changing climate.

Under all alternatives, the trend of increasing temperature, earlier snowmelt, and increased level of fluctuating precipitation would continue. Exceptional droughts, such as the 2012–2016 drought, are likely to become more frequent, given projected warming climate and increasing precipitation variation trends in the 21st century. These trends and their impacts on terrestrial, riparian, and aquatic ecosystems will become more pronounced in the future with the interaction of multiple stressors (see "Combined Effects of Climate, Fire, Insects, and Pathogens").

Consequences Specific to Alternative A

Alternative A has no management direction specific to climate adaptation or resilience. There is some ecological restoration aimed at reducing forest density, but it is limited in intensity and extent. Alternative A has the lowest potential to reduce the risk of undesirable wildfires. This is because the reduced fuel treatment rates under this alternative have resulted in a significant fuel treatment backlog and fuel buildup in Sierra Nevada forest ecosystems. Alternative A would not emphasize forest heterogeneity approaches to promote resilience to the same degree as the other alternatives.

Although there is an ability to restore heterogeneity, the limits on allowed changes to forest canopy cover in California spotted owl habitat limit the degree to which heterogeneity can be restored. Compared with the other alternatives, alternative A has the lowest rate of watershed restoration (less focus on priority watersheds). It has an increased potential for wildfires burning at increased severity outside the historical range of variation; this could impair watershed function, such as by increasing soil erosion and sedimentation.

Alternative A would result in fewer fuel reduction treatments, less watershed restoration, and less emphasis on heterogeneity restoration would likely result in less prescribed burning and fewer wildfires managed primarily for resource objectives. The risk of weed invasion from wildfires would be greatest under alternative A. However, certain areas would be less vulnerable to weed invasions due to restrictions on restoration activities, such as prescribed fire and mechanical treatments.

Alternative A provides the least benefit to certain ecologically important species, such as aspen, giant sequoia (in the Sierra National Forest), and whitebark pine. This is because it has the lowest treatment rates in unique vegetation types (giant sequoia and aspen) and whitebark pine stands and the lowest potential use of wildfire managed primarily to meet resource objectives. Alternative A may incorporate some of these recommendations, but they are not part of the plan direction and there is uncertainty that the recommendations would be implemented. Consequently, alternative A would do the least to integrate climate vulnerability assessments in planning and prioritizing. Alternative A does not address vulnerabilities to climate change for riparian and aquatic ecosystems. Also, it does not have plan monitoring components focused specifically on climate change, and there are no direct and indirect indicators of changing climate conditions.

Consequences Specific to Alternative B

There is a goal to integrate landscape or watershed approaches to restoration that integrates recreation, fuels, partnerships, and vegetation management to effectively address climate change. Alternative B emphasizes plan direction that would directly increase vegetation's resilience to climate change and would indirectly increase vegetation and watershed resilience to fire, drought, insects, and pathogens. It would emphasize desired conditions for resilience to climate change and sustainability in the face of climate change for watershed and terrestrial ecosystems and riparian and aquatic ecosystems.

Alternative B would manage for forest and shrubland vegetation heterogeneity and diversity. It would restore or maintain key ecological processes, such as fire in areas where fires are frequent, and would restore key approaches for resilience to climate change through guidelines and desired conditions. This includes restoring vegetation density and composition to vegetation types and specific desired conditions that are based primarily on the natural range of variation for those types (see "Terrestrial Vegetation Ecosystem" for more detail). Under alternative B the Forest Service assumes that fire and low resilience to drought, insects, and pathogens are the greatest risk to all ecosystems. Therefore, the emphasis is on restoring the resilience of terrestrial ecosystems.

Alternative B would likely increase structural heterogeneity based on the emphasis of mechanical thinning and prescribed fire treatments to implement concepts of ecological restoration in Sierra Nevada forests (North et al. 2009a, North 2012). This would occur on about 30 percent of the landscape, primarily in forests of the montane and upper montane zones.

Alternative B would have a moderate likelihood of reducing the chance of uncharacteristically large and severe wildfire and other climate-related stressors in portions of the plan area. This would be based on the combined rates of mechanical and prescribed fire treatments and use of wildfire to meet resource objectives (see "Fire Trends").

Alternative B has greater rates of mechanical treatments, prescribed fire, and wildfires managed for resource objectives than alternatives A and C. The greater use of mechanical treatment and fire restoration in the foothill, montane, and upper montane vegetation types would provide greater resilience to climate change, since these vegetation types are most departed from the natural range of variation. The greater use of wildfires for resource objectives would be critical to reduce fuel loading and the vulnerability of forest ecosystems across large spatial scales in the southern Sierra Nevada (Meyer 2015a). This would be true especially when considering the high level of mechanical constraints in the steep and inaccessible areas found in many parts of the analysis area (North et al. 2015).

Managing wildfires for resource objectives would apply primarily at higher elevations in the upper montane and subalpine and alpine vegetation types and in the Kern River drainage, where landscape fuel conditions are moderate to low overall. Since red fir, subalpine, and alpine ecosystems have a high vulnerability to climate change, continued restoration of fire in these areas would provide increased resilience to that stressor.

Alternative B would restore watershed function at a slightly higher rate by increasing the emphasis on priority watersheds for management actions and objectives for water quality improvement projects. Vegetation treatment rates in riparian ecosystems and meadows would also likely be higher under alternative B, compared with alternative A. This would result in greater resilience to climate change and, in some locations, resilience to fire: There would be less emphasis on direct restoration of aquatic ecosystems, resulting in limited improvements to aquatic ecosystem resilience. There would continue to be vulnerability of many aquatic ecosystems to changing hydrographs and temperature, thus increasing their vulnerabilities to climate change. The resilience of meadows to climate change would be improved as a result of meadow restoration objectives.

In the long term, greater resilience of forest and shrubland vegetation would improve climate resilience in areas where restoration is emphasized. It may maintain relatively greater levels of habitat connectivity for forest-dependent species by facilitating species movements into higher elevation forests or climate refugia. In addition to desired conditions for connectivity for wide-ranging species, there are specific standards and guidelines to ensure that restoration projects do not reduce connectivity for species vulnerable to climate change, such as fisher.

There would continue to be large, high-intensity fires, especially in unrestored areas in the foothill, montane, and upper montane zones. Only a portion of the landscape would be restored, and fire trends would continue in many areas (see “Fire Trends”). Species associated with mature forests, including fisher, the California spotted owl, and Sierra marten, would continue to have disruptions in connected habitat in many areas (see “Old Forest” and “At-risk Terrestrial Wildlife Species”). Climate change in postfire restoration would be considered. This is from numerous desired conditions that emphasize resilience to climate change and the consideration of climate change, natural fire regimes, biodiversity, and other factors following large stand-replacing events.

Restoration under alternative B would benefit ecologically important species that have a high vulnerability to climate change, such as aspen, giant sequoia, and whitebark pine. The restoration of the unique vegetation types of aspen and giant sequoia groves in the Sierra National Forest and whitebark pine stands would increase. Also, there would be specific plan direction to improve management of aspen, giant sequoia, and whitebark pine. The greater use of wildfire managed to meet resource objectives would likely improve conditions for aspen, giant sequoia, and whitebark pine. This is because they respond positively to low–moderate fires, with smaller patches of high-severity fire.

Climate vulnerability assessments provide useful insights into the regional impacts of climate change. In the southern Sierra Nevada, several recent vulnerability assessments are available for assessing climate change effects on terrestrial and aquatic ecosystems in the plan area (Nydick and Sydoriak 2011b, a). Alternative B incorporates at least some recommendations of these climate vulnerability assessments in planning and prioritization for terrestrial ecosystems, such as for whitebark pine restoration.

There is a guideline to consider refugia for species associated with small-scale special habitats that are less likely to have connected habitat. There were fewer recommendations from the Climate Vulnerability and Adaptation Strategy (Kershner 2014) to use strategies and standards to address climate change vulnerabilities for aquatic systems. Increased meadow restoration is one area where the Forest Service incorporated the recommendations.

Aquatic ecosystem vulnerabilities to climate change are already being manifested, in decreased water flows and increased temperature. Alternative B could moderately reduce the risk of uncharacteristic wildfires, which would make areas vulnerable to weed invasion. However, it also calls for more restoration activities, such as prescribed fire and mechanical treatments, which could make areas more vulnerable to being invaded by nonnative plants.

All alternatives include desired conditions, guidelines, and standards to limit the invasion and spread of nonnative invasive plants. Alternative B also incorporates objectives to control and restore infested areas that would lessen the effects of climate change on increasing invasive plant spread. However, this would not be enough to keep up with the pace of increased invasions.

Alternative B uses more flexible plan direction and an adaptive planning process that allows for more streamlined plan amendments and revisions; alternative A requires more prescriptive and restrictive plan direction developed under the 1982 Planning Rule. Under alternative B, the emphasis is on specific desired conditions at multiple spatial scales (from patches to landscapes) that allow for a wide range of site-specific actions. Under alternative B, the greatest flexibility is in the community buffers, where there would be more flexibility to evaluate the response of fisher and California spotted owl to restoring vegetation to its natural range of variation. This adaptive process in the new planning rule provides greater potential under alternative B for the Forest Service to monitor, learn, and adapt to climate change.

Consequences Specific to Alternative C

Alternative C shares many of alternative B's desired conditions for forest structural heterogeneity and diversity and restoration and maintenance of key ecological processes, such as fire. However, additional desired conditions for more forest cover in California spotted owl habitat (interim recommendations), combined with additional restrictions on reducing canopy cover and using mechanical restoration in montane mixed conifer and ponderosa pine forests would limit the amount of vegetation restored to the desired conditions. This would result in lower levels of heterogeneity.

Much of the landscape would remain in the current condition of high forest density. There would be an increased emphasis on restoration using prescribed fire and wildfires managed primarily for resource benefit. However, the opportunities for this type of restoration would be low in most areas, except for the Kern River drainage, as mentioned previously. This is because vegetation would be denser and fires harder to control under higher fuel load conditions, especially in areas of high tree mortality (see "Trends" and "Insects, Pathogens, and Changed Conditions Associated with Recent Tree Mortality"). However, the Forest Service expects there to be lower overall rates of restoration under alternative C, compared with alternative B, although rates would likely exceed those under alternative A. Consequently, mixed conifer, yellow pine, and other forest types would have lower resistance to climate change and associated stressors of drought, insects and pathogens, and uncharacteristic wildfires.

There would likely be more opportunities under alternative C, compared with alternative A, to reduce the chance of uncharacteristically large and severe wildfires and other climate-related stressors in the plan area. This assessment is based on the combined rates of mechanical and prescribed fire treatments and use of wildfire managed to meet resource objectives. The greater use of wildfires managed for resource objectives under alternative C would be critical to reduce fuel loading and the vulnerability of forest ecosystems across large areas in the southern Sierra Nevada (Meyer 2015a). This is especially true when considering the high level of mechanical constraints in the steep and inaccessible areas that occur in many parts of the analysis area (North et al. 2015). However, there is greater uncertainty in the use of wildland fire under alternative C, compared with alternative A. This is due to the low level of mechanical pretreatment to reduce hazardous fuels before burning and other factors (see “Fire Trends”). The outcome of such fires under alternative C would be larger patches of high-severity fire. This is because vegetation would remain denser throughout much of the montane landscape.

Alternative C would restore watershed function by increasing the emphasis on priority watersheds. There would be an increased emphasis on restoration, using prescribed fire and wildfires managed primarily for resource benefit. However, it is unknown whether this is sufficient to reduce the risk of large, high-intensity fire and improve resilience to climate change in riparian ecosystems and meadows. It is unlikely that alternative C would improve watershed resilience, compared with alternative B.

There would be greater consideration of climate change in postfire restoration under alternative C, compared with alternative A. This includes desired conditions that emphasize resilience to climate change and the consideration of climate change, natural fire regimes, biodiversity, and other factors following large stand-replacing events. A specific guideline for reforestation would consider climate change adaptation and a management approach that addresses native vegetation. However, under alternative C there are fewer opportunities to recover the economic value of wood products from dead and dying trees. It calls for greater retention of complex early seral habitat in post-disturbance landscapes, compared with alternative A. This would constrain the range of restoration treatment options for forest ecosystems following large stand-replacing events. Also, this would place a greater limit on the range of post-disturbance climate adaptation strategies available under alternative C, compared with alternatives A and B.

Alternative C would have varied benefits to ecologically important species, such as keystone species. Although there is an emphasis on species conservation under alternative C, the benefits to unique or important vegetation types that are especially at risk—such as aspen stands, giant sequoia groves, and whitebark pine—would be fewer than under alternative B. This would be due to less overall restoration in these areas. In aspen stands, mechanical treatments would also be less intensive and slightly less effective for restoration under alternative C, compared with B. This would be due to lower diameter limits under alternative C.

Alternative C would not improve habitat conditions or decrease vulnerabilities to climate change for those aquatic species without conservation strategies or standards and guidelines.

Like alternative B, alternative C incorporates some of the recommendations of recent climate vulnerability assessments, especially for terrestrial ecosystems, that would increase climate adaptation. Alternative C would apply only limited recommendations for aquatic ecosystems. The objectives for meadow restoration would increase, which would increase climate resilience in restored meadows and associated aquatic ecosystems, especially those downstream.

For nonnative invasive plant species, alternative C would have a more limited use of mechanical treatment and would reduce the risk of invasion. However, this may be outweighed by a likely increase in the amount of burned area predicted from climate change (see “Fire Trends”).

Consequences Specific to Alternative D

Alternative D would have consequences similar to those under alternative B, but more terrestrial, riparian, and aquatic ecosystem would be restored. The amount of restoration under alternative D could be double that under alternative B and more than double what currently occurs under alternative A. This would decrease the likelihood of large, high-intensity fires (see “Fire Trends”) and would increase vegetation resilience to climate change and related stressors. There may be increases in the spread of nonnative plants because of increased mechanical restoration. However, there would also be plan direction, similar to alternative B, designed to reduce and limit invasive plant establishment and spread. Nonetheless, nonnative plants are likely to increase to a greater degree under alternative D than under alternatives A, B, C, or E.

The risk of weed invasion from large wildfires would be smallest under alternative D. However, certain areas would be more vulnerable to weed invasions, due to a wider range of restoration activities, such as prescribed fire and mechanical restoration. Under alternative D, the risk of large wildfires would be reduced the most in focus landscapes. In such areas, there would be the most flexibility and greatest treatment rates to restore vegetation desired conditions and to enhance the long-term resilience of fisher and California spotted owl habitat.

Climate change in postfire restoration would be taken into consideration under alternative D, in ways similar to those under alternative B and greater than those under alternative A. This includes desired conditions that emphasize resilience to climate change and the consideration of climate change, natural fire regimes, biodiversity, and other factors following large stand-replacing events. Also, a specific guideline would consider climate change adaptations in reforestation and a management approach that addresses native vegetation.

Alternative D would provide greater opportunities to recover the economic value of wood products from dead and dying trees. There would be a greater range of restoration treatment options for forest ecosystems following large stand-replacing events, compared with alternative A.

Alternative D would provide the greatest benefit to ecologically important species that have a high vulnerability to climate change, such as aspen, giant sequoia (Sierra National Forest), and whitebark pine. Similar to alternative B, specific plan direction under alternative D would increase restoration effectiveness of aspen stands, giant sequoia groves, and whitebark pine stands. However, the greater use of wildfire managed to meet resource objectives under alternative D, compared with B, would likely improve conditions for these unique vegetation types to a slightly greater extent. This is because aspen, giant sequoia, and whitebark pine respond positively to low–moderate fires, with smaller patches of high-severity fire.

Alternative D has the greatest potential for short-term impacts on habitat connectivity due to the increased restoration in a relatively short period. However, it is the alternative that most reduces the risk of large, high-intensity wildfires that have long-term impacts on forest cover connectivity.

The plan components under alternative B would reduce some of the short-term impacts by considering maintaining or restoring connectivity in project design.

Consequences Specific to Alternative E

Alternative E would have consequences similar to alternative C. The amount of restoration would be similar under alternatives E and C, which would result in a similar likelihood of large, high-intensity fires (see “Fire Trends”) and similar vegetation and habitat resilience to climate change and related stressors.

Alternatives E and C would provide similar benefits to ecologically important species that have a high vulnerability to climate change, such as aspen, whitebark pine, and giant sequoia (Sierra National Forest). Specific plan direction under alternatives E and C would increase restoration effectiveness of aspen stands, giant sequoia groves, and whitebark pine stands. However, the lower use of wildfire managed to meet resource objectives under alternatives E and C, compared with alternatives B and D, would result in fewer acres of these unique forest types that receive fire restoration treatments. Consequently, alternatives C and E would be less effective at restoring a greater proportion of giant sequoia groves, aspen stands, and whitebark pine stands than alternatives B and D.

Alternative E is similar to C in that it has the low potential for short-term impacts on habitat connectivity. This is due to the decreased restoration in a relatively short period. However, it would least reduce the risk of large, high-intensity wildfires that have long-term impacts on connectivity of forest cover. Similar to alternative C, alternative E does consider climate adaptation in post-disturbance forest landscapes, but it range of restoration treatment options is more limited than under alternative A. This is due to greater constraints in economic recovery of dead and dying trees under alternative E.

Cumulative Effects

The cumulative effects of climate adaptation include the use of multiple climate change adaptation strategies on the Sequoia and Sierra National Forests or across adjacent land management agencies or other ownerships over the next 15 years.

The cumulative effects of multiple climate adaptation strategies may synergistically build greater adaptive capacity than the application of a few approaches. Combined adaptation strategies that increase climate resilience across larger areas with vulnerable ecosystems are likely to have a greater positive effect than the application of individual strategies. For example, the restoration of terrestrial, riparian, and aquatic vegetation in combination reduces the likelihood of large, high-intensity fire in entire watersheds. Likewise, the restoration of key ecological processes, such as fire, and the development of postfire restoration strategies in aspen stands and giant sequoia groves would enhance the health and resilience of these ecologically important species.

Reasonably foreseeable management activities on private, state, tribal, or other Federal land would vary in the application of climate adaptation strategies (see “Environmental Consequences to Fire Trends”). Some management activities on adjacent tribal lands, national parks, and BLM-administered lands would be similar, including vegetation restoration, aquatic and riparian restoration, and measures to enhance habitat resilience of species and vegetation types vulnerable to climate change. Private landowners may implement some similar actions in conjunction with Natural Resources Conservation Service programs to restore watershed health and function or improve grazing lands.

These actions would increase the positive benefits of climate adaptation on the national forests. Conversely, a lack of restoration in these adjacent lands could increase the vulnerability of terrestrial, riparian, and aquatic ecosystems on national forest lands. This is because the likelihood of large, high-intensity fires and limited resilience of widespread vegetation types would persist. Under all alternatives, coordinated efforts across all ownerships would provide the greatest cumulative positive impact on climate adaptation, such as coordinating fire management planning (Meyer et al. 2015).

Analytical Conclusions

Based on the climate adaptation indicators and measures, alternative D, followed closely by alternative B, is best for achieving overarching forest management goals and objectives under climate change. Alternatives B, C, D, and E share most of the same desired conditions that incorporate resilience and adaptation to climate change. They all emphasize an all-lands approach to management, encouraging partnerships with a variety of public groups, communities, and government agencies. These will increase the likelihood of successfully applying climate adaptation strategies.

Alternative D has the greatest restoration treatment rates and flexibility for vegetation restoration. It would reduce the impacts of uncharacteristic wildfire, drought, climate change, and other stressors on vegetation, particularly in the focus landscapes of alternative D. Alternative B has increased flexibility to conduct vegetation restoration in owl and fisher habitat in wildlife habitat management areas; it could triple the current levels of restoration. However, alternative D would nearly double the amount of restoration, especially the case in focus landscapes.

Compared with the current condition, alternative D could increase current non-climate stressors on ecosystems related to management activities, such as reducing habitat connectivity in the short term; nevertheless, it moves the most area of terrestrial vegetation toward the natural range of variation and desired conditions over time. It also provides for the most dynamic habitat connectivity in the long term by increasing the vegetation's resilience to disturbance.

In contrast, alternatives B and C contribute less to non-climate stressors on ecosystems in the short term and maintain current habitat connectivity. However, these two alternatives would have more areas at risk to dynamic habitat connectivity. This is because of continuing high risks of uncharacteristically large and severe wildfires. Alternatives D and B also provide the greatest flexibility and use of climate adaptation strategies in post-disturbance forest landscapes, compared with alternatives A, C, and E.

Alternatives C and E, and especially alternative A, have the lowest restoration treatment rates and the least flexibility in vegetation management. These alternatives emphasize conservation of moderate to high density canopy cover in mature forest habitat. They would retain dense vegetation conditions that have low resilience to large, high-intensity fires, drought, and temperature increases. Desired results in terrestrial ecosystem. However, there could be greater short-term impacts on habitat for at-risk species than under alternatives C and E, and possibly under alternative A.

Aquatic and Riparian Ecosystems

Ecosystem and Watershed Resilience and Adaptation to Climate Change

Aquatic and Riparian Ecosystem Integrity

Background

Ecologically sustainable management is at the heart of National Forest management. The forests have suffered unprecedented bark beetle and drought mortality of pines in the montane zones of the forest. It is these elevations where the iconic Sierra meadows, springs, seeps, and streams originate. This section summarizes the current conditions in aquatic and riparian ecosystems on the Sequoia and Sierra National Forests and the environmental impacts of the range of alternatives.

Much of the analysis was based on the premise that the natural range of variation provides important background for evaluating ecological integrity and sustainability (Wiens et al. 2012). It was used to develop plan direction and select indicators and measures for the analysis. Also important in the analysis of ecological integrity and sustainability of riparian and aquatic ecosystems was consideration of climate and associated ecological and watershed level conditions that are outside the natural range of variation. This is a concept that focuses on the dynamic nature of ecosystems, recognizing they are not static (Landres et al. 1999). It recognizes that such disturbances as drought, floods, and fire are natural processes. The Forest Service also incorporated legacy land uses and the uncertain future due to a variable climate.

To address aquatic and riparian ecosystem integrity, the proposed plan includes desired conditions designed to do the following:

- Provide resilience to climate change
- Restore or maintain the function of streams, meadows, riparian areas, seeps, and springs, including avoiding invasive species establishment
- Conserve biodiversity
- Preserve and reestablish ecological connectivity
- Promote resilience to fire in riparian ecosystems

The extent the alternatives would move toward the proposed desired conditions are analyzed in this section. The terrestrial, aquatic, and riparian ecosystems are interconnected with watershed conditions, terrestrial vegetation, and water quality and quantity. Watershed condition and function are further discussed, recognizing these connections in the "Water Quality, Water Quantity, and Watershed Condition" section.

Ecological integrity is a measure of an aquatic and riparian ecosystem's functional and structural conditions. Functional conditions are the surface flow that sustains riparian and aquatic habitats, shallow groundwater recharge, temperatures, carbon and nitrogen sequestration, and nutrient cycling. Structural conditions are habitat type and availability, migration corridors among habitats, and structure and composition of riparian vegetation. These ecosystem conditions affect suitability of habitat, diversity, connectivity, and resilience to climate change.

Aquatic and riparian ecosystem conditions in the southern Sierra Nevada vary, depending on the amount of past and current land disturbance that has occurred and the effect of climate changes on the natural integrity of the ecosystems. The severity of effects is influenced in part by the elevation, fire regime, precipitation, and management of these areas.

Analysis and Methods

This qualitative analysis is based primarily on the best available scientific information derived from forest assessments (United States Department of Agriculture 2013b, 2014c) the Bio-Regional Assessment (United States Department of Agriculture 2013d), the Science Synthesis (Long et al. 2014), recent reports and publications that assess trends in current conditions (Isaak et al. 2015, Isaak et al. 2016, Isaak et al. 2017), and where available, assessment of effects of management actions.

The Forest Service evaluated aquatic habitats and diversity, groundwater-dependent systems, and riparian ecosystem functions that have been assessed at a broad scale. We used key ecosystem characteristics common to both forests to predict whether future conditions will provide for ecological integrity under the different alternatives. Only key ecosystem characteristics that could be influenced by management following the alternatives plan direction or by climate change were selected. For this analysis, these indicator measures were assessed across both forests.

Indicators and Measures

We assessed the sustainability of aquatic habitat (including invasive species), ecological connectivity, aquatic species diversity, resilience to climate change, and riparian vegetation. This is because we could assess them across the landscape and because they are indicators of the desired conditions and important measures of aquatic and riparian ecosystem integrity. All fens, wet meadows, springs, stream, lakes, ponds, and rivers are referred to as aquatic ecosystems in the analysis. Aquatic indicators cover all the various aquatic and semi-aquatic habitats.

Sustainability of Habitat

We looked at predicted changes to the function of streams, meadows, riparian areas, seeps, and springs and the establishment of invasive species. Specific indicators were changes in habitat for all life stages of aquatic and riparian species and changes in numbers of invasive aquatic species.

Ecological Connectivity

In the analysis, we looked at predicted changes in ecological connectivity of habitat and evaluated how well the alternatives preserve or reestablish ecological connectivity. Specific indicators were management to reduce or improve road crossings and small dams and diversions affecting aquatic at-risk species and management of connectivity among habitats for aquatic or riparian associates.

Biodiversity

In terms of biodiversity, we looked at predicted changes and evaluated how biodiversity was being conserved. Biodiversity involves both at-risk species and more common species. The specific indicator was management that improves biodiversity by improving aquatic and riparian species persistence and resilience, including rare and common native species.

Resilience to Climate Change

The Forest Service looked at predicted changes in resilience to climate disturbances in aquatic systems, including an evaluation of how well the alternatives provide for resilience to these disturbances. “Climate, Ecological Vulnerability and Adaptation” section evaluates climate resilience in non-aquatic systems. Specific indicators were as follows:

- Rate of restoration to improve resilience of priority habitats for all life stages of aquatic and riparian associates to climate disturbances, including the change in timing and availability of water from snowmelt and fire
- Rates of ecological restoration, including thinning upland species, reducing fuels, and restoring native riparian species to improve fire resilience

Riparian Vegetation

In the analysis, the Forest Service looked at predicted changes in resilience to fire and climate disturbances in riparian areas. This included an evaluation of how well the alternatives provide for native species, such as shrubs and other understory species. Specific indicators were as follows:

- Management of riparian conservation areas to promote native species, including understory vegetation, as indicated by management direction
- Rate of ecological restoration to reduce risk of high-intensity wildfires and promote native shrub diversity in riparian areas
- Rate of restoration of riparian areas to promote native species, reduce the risk of high-intensity wildfires, and promote wildfires managed to meet resource objectives

“Environmental Consequences” provides a qualitative assessment of forecasted trends in indicator measures by alternative. The assessment was based on the effects from potential watershed restoration; meeting objectives for meadow, stream, aquatic organism passage, and riparian area restoration; forest vegetation restoration activities; fire management, recreation use, and recreation management; trails and road crossings management; invasive species management, and climate change management.

Assumptions

The following are key assumptions about why, when, where, and how restoration treatments will occur in aquatic and riparian areas that were used in the analysis:

- Functioning watersheds deliver the highest quality water.
- The headwaters for many streams and lakes are in high elevation areas; best management practices, streamside management, and riparian conservation protect these headwater areas, ensuring that impacts on water quality are minimal.
- Restoration will be targeted in conservation watersheds, where the greatest ecological gains can be made with the least amount of funding. Aquatic habitat integrity across both forests is generally better in the higher elevation.
- Active restoration of fire in riparian conservation areas is considered a treatment tool.
- Aquatic passages will be restored, as resources permit, on forest roads where aquatic at-risk species occur and where appropriate. However, no desired barriers to invasive fish will be opened where they might impact at-risk species. Culverts and road crossings that are associated with roads used to access treatment areas will be examined for restoration opportunities.

- National forest managers will use an integrated restoration approach to designing projects that strive to balance watershed restoration with terrestrial restoration. Partnerships may provide increased funding and capacity for restoration treatments of all types and build opportunities to restore aquatic habitats on the Sierra and Sequoia National Forests and adjacent lands using an "all lands approach."
- In riparian areas, vegetation will be moved toward the desired conditions. This will be done primarily to restore native species composition and reduce the encroachment of such species as conifer trees, salt cedar, and sagebrush, where appropriate. The end result of the treatments will generally be more diversity of riparian hardwood species and sizes, as well as vigorously growing herbaceous vegetation.
- Most riparian vegetation restoration will be done in areas where the adjacent upland areas are being restored.
- Aquatic habitat restoration in streams, meadows, and other special aquatic habitats will be primarily to maintain or improve habitats for at-risk species and to improve downstream beneficial uses. Aquatic habitat restoration will be integrated into landscape treatment designs, where appropriate. The Forest Service will seek partnerships and additional funding opportunities from outside sources to increase the pace and scale of aquatic habitat restoration.

Affected Environment

Aquatic habitat integrity in the two national forests is generally highest in the higher elevation portions of the analysis area and in protected areas, due to fewer alterations than lower elevation areas. There are several aspects of aquatic habitat integrity that are outside the natural range of variation across the two national forests, including species assemblages and flow regimes altered by fish stocking, diversions, and dams.

During the extreme drought, from 2012 to 2016, levels of drought stress and associated tree mortality were most severe and extensive on the west slope of the southern Sierra Nevada, centered on the Sierra and Sequoia National Forests (Preisler et al. 2017, Young et al. 2017). Tree mortality has influenced stream hydrology and patterns of runoff from forested areas (Bales et al. 2018, Klos et al. 2018, Bales et al. 2011).

The Watershed Condition Framework data[12] were used to evaluate the condition class of watersheds (hydraulic unit code [HUC] 12 size class). In the Sierra National Forest, 40 percent of watersheds are functioning properly and 60 percent are functioning at risk. In the Sequoia National Forest plan area, 60 percent of watersheds are functioning properly, 36 percent are functioning at risk, and 2 percent are at risk. These ratings are based on several criteria, such as aquatic habitat, vegetation condition, water quality and quantity, soil, cover, invasive and rangeland condition. These data are baseline indicators and provide valuable information for forest management and downstream users who rely on these watersheds for municipal uses, agriculture, and economic value.

The current plans developed critical aquatic refuges to preserve, enhance, restore, or connect habitats for aquatic species at the local level and to ensure the persistence of aquatic or riparian-dependent species. Critical aquatic refuges on the two forests provide additional protection to

[12] Watershed Condition Framework Website: https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml

watersheds with high biodiversity of native species or that contain sensitive, threatened, or endangered species.

Many critical aquatic refuges are wholly encompassed within areas of high aquatic integrity and inventoried roadless areas or wilderness, especially those delineated for Little Kern golden trout, Kern River rainbow trout, California golden trout, Yosemite toad, and yellow-legged frog. Table 50 summarizes the current critical aquatic refuges (see Figure 38 and Figure 39) and riparian conservation areas (see Figure 40 and Figure 41) on the two national forests. It shows the overall conditions in the watersheds containing these critical aquatic refuges (see "Water Quality, Water Quantity, and Watershed Condition").

Table 50. Summary of CARs and watershed conditions in the Sequoia and Sierra National Forest[1]

National Forest	Number of CARs in Current Plans	CARs Watersheds in Good Condition	CARs Watersheds in Fair Condition	Forest Service Acres in CARs
Sequoia	5	3	2	162,180
Sierra	7	2	5	42,387

[1]No CARs are in poor condition or have impaired function in either national forest.

Across the Sierra Nevada, aquatic biodiversity is vulnerable, as indicated by declining trends in native fish, amphibians, and other species (Moyle and Randall 1998, Moyle et al. 2011, Baumsteiger and Moyle 2017, Purdy et al. 2012, Viers and Rheinheimer 2011, Viers et al. 2013, Vredenburg et al. 2007, Frissell et al. 2012, United States Department of the Interior 2015b). Depending on the species groups, 40 to 80 percent of all aquatic species in California, including in the Sierra Nevada, are now facing extinction, unless current trends are reversed through management and conservation (Frissell et al. 2012, Howard et al. 2015, Grantham et al. 2017, Howard et al. 2018, Katz et al. 2013, Quiñones and Moyle 2015, Pyne and Poff 2017).

The primary threats from humans to fish biodiversity are alien species and major dams and associated water diversions (Moyle et al. 2011). In the plan area, the primary threats to aquatic biodiversity are stocking reservoirs with nonnative game fish, the prevalence of diseases from chytrid fungus (Bd) infestations, which results in mass die-offs of native amphibian species, and historical stocking of nonnative fish that pose a threat to native trout species from hybridization.

Climate change was the primary threat for native cutthroat and golden trout (Moyle et al. 2011). Amphibians (including most slender salamanders) and reptiles are threatened by changes in precipitation patterns that influence spring snowmelt runoff and timing (Wright et al. 2013).

Aquatic invasive species will likely continue to spread throughout streams, rivers, and reservoirs via boats, fishing equipment, and other water sports gear (California Department of Fish and Wildlife 2008). Nonnative bullfrogs are known to be detrimental to native amphibians (Schwartz et al. 2013b). The New Zealand mud snail is established in California and has been found to disrupt stream food chains (Moore et al. 2012). Nonnative and invasive species are a continual and pervasive threat to native species; this is because they can be difficult and expensive to control once they become established. Aquatic invasive species would also continue to be a primary issue of concern affecting aquatic ecosystems in the future.

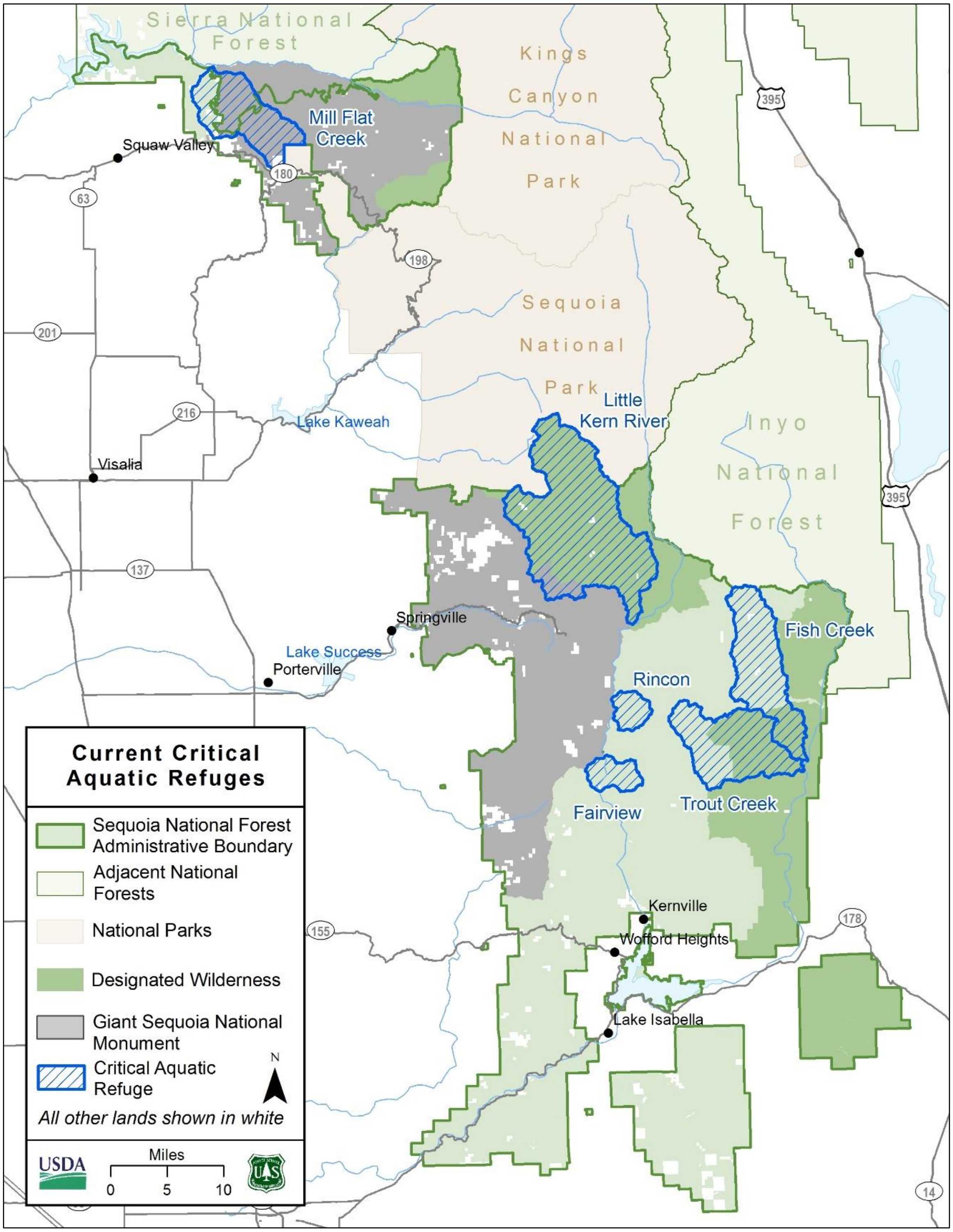

Figure 38. Critical Aquatic Refuges Locations for the Sequoia National Forest

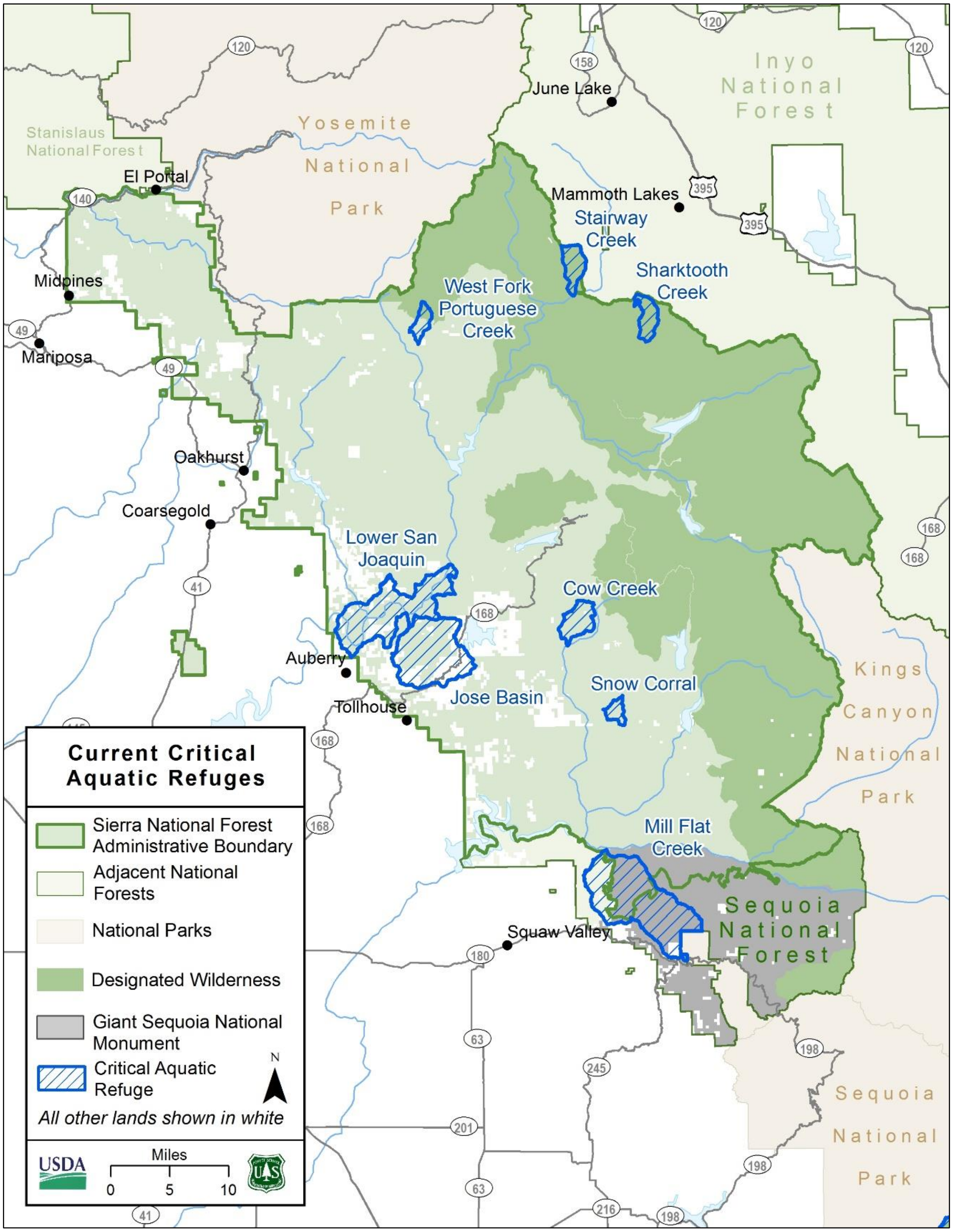

Figure 39. Critical Aquatic Refuges Locations for the Sierra National Forest

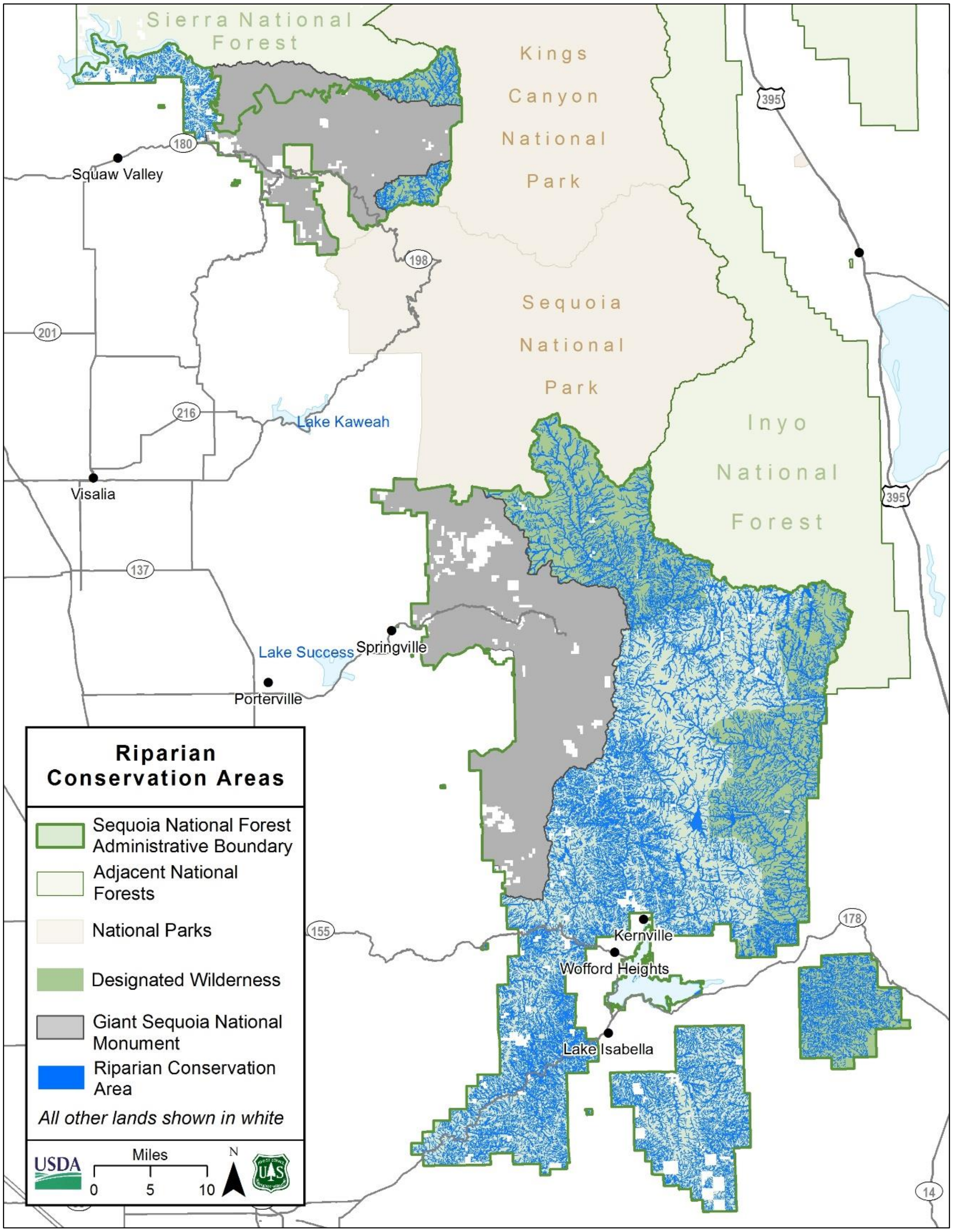

Figure 40. Riparian Conservation Areas for the Sequoia National Forest

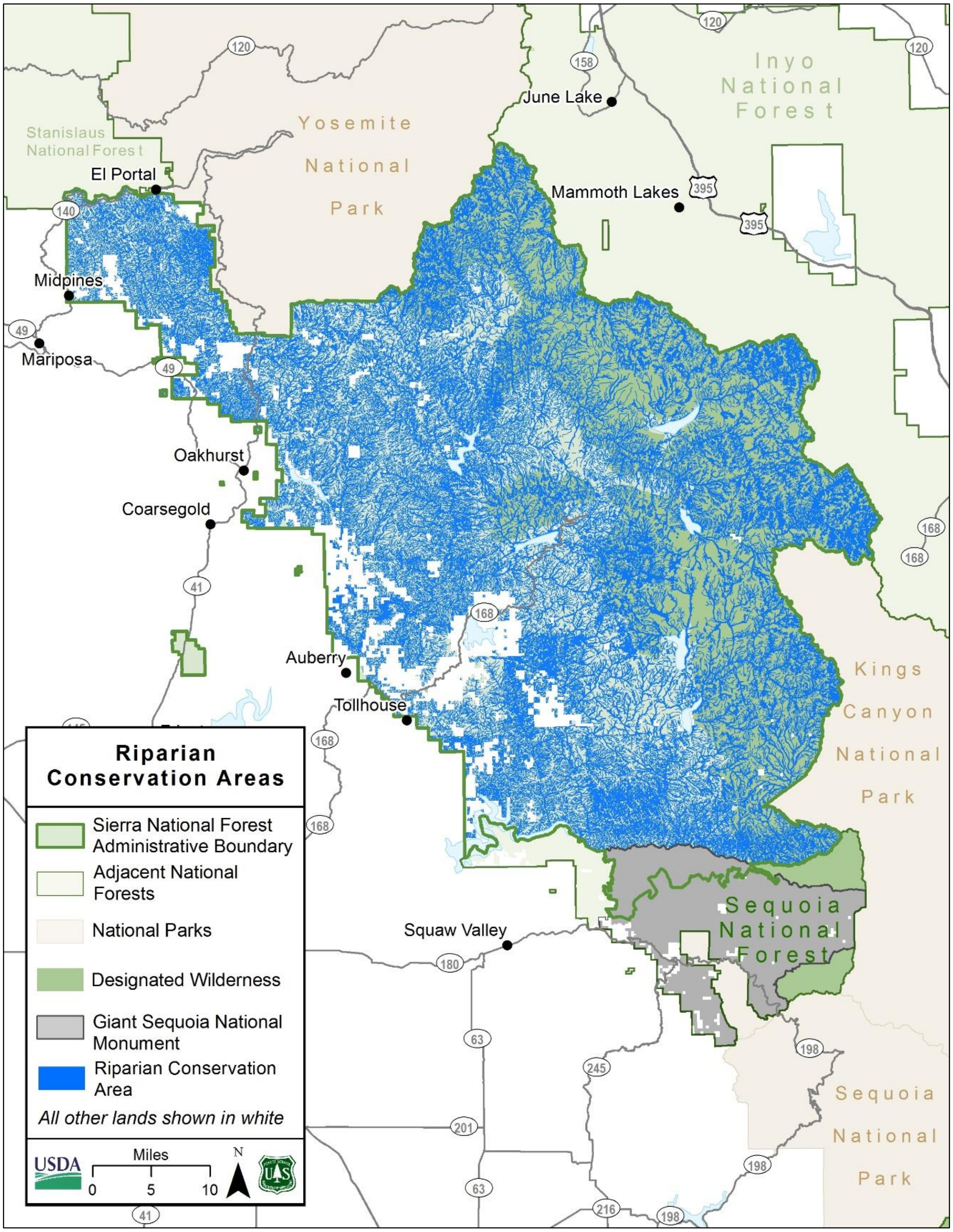

Figure 41. Riparian Conservation Areas for the Sierra National Forest

Broad guidance for the management and control of invasive species is provided by the Forest Service National Strategic Framework for Invasive Species Management (FS-1017 2013). While that document mentions nonnative fish in the context of maintaining genetically pure native trout, it does not focus on such aquatic invasive species as New Zealand mud snail or other aquatic nuisance species.

There is also illegal marijuana cultivation on public lands. In aquatic and riparian ecosystems, this can have alarming effects on soil, water, and wildlife. Eradication and remediation of illegal marijuana growing operations turn up miles of irrigation piping used to divert water to support growing marijuana plants. Water demand for marijuana cultivation could divert substantial portions of streamflow in the watershed (Bauer et al. 2015). Fertilizers, pesticides, and poisons are used. Invertebrates can accumulate rodenticide compounds in their tissue without negative effects and can move beyond the grow site, thereby facilitating secondary poisoning (Gabriel et al. 2012).

Rivers and Streams

Large river systems on the two national forests drain the highest peaks in the Sierra Nevada. On the Sequoia National Forest, the Kern River flows north to south through the Kern Plateau, which has many springs and meadows that maintain perennial streams.

One of the few riparian forested areas lies at the confluence of the south and north forks of the Kern River, upstream of Lake Isabella. The Kings River drains both the Sequoia and Sierra National Forests to the west. These rivers historically flooded the Tulare Lake Basin, but today they supply water for agriculture, industry, and residential use in Kern, Tulare, and Kings Counties.

Dams and water impoundments developed for irrigation and flood control block movements of fish, amphibians, and aquatic insects, resulting in a lack of habitat connectivity. Large dams on the San Joaquin and Merced Rivers and their tributaries block salmon from reaching former habitat on the Sierra National Forest (United States Department of Agriculture 2013c). The San Joaquin River and its major tributaries, the Chowchilla, Fresno, and Merced Rivers, flow north through the San Joaquin Valley to the Sacramento and San Joaquin Rivers delta.

Before large dams and nonnative trout stocking, the Kings River and of the Kern River and their tributaries provided a much larger range for native trout species (Moyle 2002). Many species of warm water nonnative fishes have been introduced into lower elevations on the Kern, Kings, and San Joaquin Rivers associated with reservoirs. The clear, cold waters that flow from upper elevations of the Sequoia and Sierra National Forests are prime habitat for cold water salmonid fish, which were native to these waters. Now native golden trout are confined to small headwater streams on the north and south forks of the Kern River.

Nonnative fish are often predators in aquatic systems, and they can disrupt the connectivity of habitat and reduce populations of amphibian species (Schwartz et al. 2013b). Ecological connectivity of aquatic habitat is an issue at mid elevations, due to aging road culverts and dams in the Sierra Nevada that block aquatic species passage. By contrast, where at-risk fish or amphibian species are present, it is often desirable to maintain barriers to aquatic connectivity to keep invasive fish from at-risk species.

Within the last 100 years, native mountain yellow-legged frogs in the Sierra Nevada have gone from being the most abundant frog to the rarest. This was due to fish stocking and the arrival of chytrid fungus (Bd) in Kings Canyon National Park from 1960 to 1970, which completely extirpated some frog populations (Knapp 2017). Brown, brook, and rainbow trout were introduced into Sierra Nevada streams and lakes because they are prized by anglers, but they prey on native amphibian populations. The fish stocking program in the Sierra National Forest allows for trout species to persist throughout the plan area and provides fishing in these areas. In the Sequoia National Forest plan area, native Kern River rainbow trout will be the only stocked fish in the upper Kern River, where fly -fishing is popular.

The California Department of Fish and Wildlife manages fishery resources and has changed fish stocking policies, using fish that are unable to reproduce. It encourages restoring native fish and managing for native species where possible (Frissell et al. 2012). The Forest Service works closely with California Department of Fish and Wildlife to return native species to the landscape, in balance with managing for recreational fishing.

The Forest Service calculated watershed condition ratings for aquatic habitat in both forests. In the Sequoia National Forest plan area, 60 percent of the aquatic habitat was properly functioning and 24 percent was functioning at risk. In the Sierra National Forest, 21 percent of the aquatic habitat was properly functioning and 79 percent was functioning at risk. The Forest Service found 78 percent of streams to be in good condition on national forest lands in southern Sierra Nevada. We based this on an assessment of macroinvertebrate populations (Furnish 2013). However, ecological connectivity of aquatic habitat is an issue at mid elevations, due to aging road culverts that block aquatic species passage. By contrast, where at-risk fish or amphibian species are present, it is often desirable to maintain barriers to aquatic connectivity to keep invasive fish from at-risk species.

Prolonged drought and fewer days with a snowpack are a source of concern for aquatic species in the southern Sierra Nevada. Warmer temperatures can also warm rivers and streams (Isaak et al. 2017), making lower elevation rivers and streams favorable to invasive or native cool water fish. Drying also has implications for frequency and intensity of fire in riparian areas.

Headwater streams make up a large proportion of the total length and watershed area (Wipfli et al. 2007, Richardson and Danehy 2007). Networks of ephemeral streams contain organic matter, such as large wood, detritus, and dissolved organic matter, which are exported to downstream reaches. These headwater systems provide riparian and aquatic habitat (Richardson and Danehy 2007).

The relative rates, timing, and conversion processes that carry inputs from small streams to downstream reaches are reasonably well quantified (Wipfli et al. 2007). Since these streams send sediment straight into intermittent and perennial streams, thus influencing downstream water quality (Alexander et al. 2007), it is important not to unravel soils. On steep slopes and fire damaged soils and in areas with aquatic and semiaquatic species, protecting soils also protects the species habitat.

These streams are controversial regarding the management required to ensure their conservation as part of sustainable forest practices (Richardson and Danehy 2007, Richardson et al. 2012). Headwaters offer species refuge from temperature and flow extremes and invasive species. They contain a rich source of food and create migration corridors throughout the landscape (Meyer et al. 2007). Degradation and loss of headwaters and their connectivity to ecosystems downstream threaten the biological integrity of entire river networks (Meyer et al. 2007). Even 50-meter buffers do not maintain most terrestrial organisms at levels comparable to undisturbed sites (Marczak et al. 2010). The habitats for endemic salamanders would be at risk.

Meadows, Fens, and Springs

The Sequoia National Forest has more than 10,000 acres in meadows and the Sierra National Forest has more than 15,000 acres in meadows. Although meadows occupy around 2 percent of forest lands above 6,000 feet elevation, they provide critical ecosystem function (Fryjoff-Hung and Viers 2013). The Kern Plateau on the Sequoia National Forest is an exception, as meadows occupy an estimated 10 percent of the landscape. The forest assessments provide information about a subset of meadows overall. Other meadow and stream assessments covering the Kern Plateau, the Breckinridge Mountains, and the Sierra National Forest indicated\ that most meadows exhibit such features as ingrowth of trees, unstable banks, off-highway vehicle trails, headcuts, and gullies (Fryjoff-Hung and Viers 2013)

Meadow condition depends on vegetation, hydrology, stream channel condition, and invasive species (Purdy et al. 2012). During the recent drought in the Sierra Nevada, vegetation cover and bare ground cover ranged from natural condition to moderately or heavily impacted, depending on the montane meadow location (Viers et al. 2013). Meadows with incised channels are less resilient to water flow changes over time and face increased risk of damage from wildfire. Bank erosion, small streambed materials, and wide and shallow streams in Sierra Nevada meadows degrade habitat for aquatic species (Micheli and Kirchner 2002). Habitat quality in meadow habitats for rare aquatic species has been degraded (Frissell et al. 2012), (Purdy et al. 2012), (Henery et al. 2011). This is due to an ingrowth of conifers, bank trampling by cattle, off-highway vehicle use, and destabilized banks. These are the result of roads, culverts, ranching, and intensive timber harvest on adjacent uplands on the two national forests (Fryjoff-Hung and Viers 2013). Where meadow conditions are degraded, it may be necessary to restore hydrologic functions for dependent vegetation, such as willows, to recover in highly degraded meadows (Frissell et al. 2012).

In 1999, the Forest Service initiated its Pacific Southwest Region Range Program, a regionwide, long-term meadow condition (vegetation condition) and trend monitoring program. The primary purposes of the program were to document baseline meadow conditions and to examine long-term trends in meadow condition after implementing riparian standard and guidelines.

In 2012, the Forest Service Pacific Southwest Region and the University of California, Davis Rangeland Watershed Laboratory partnered to analyze meadow conditions. They also looked at trends and the relationships between meadow conditions and trends, livestock management, weather, and environmental drivers (Oles et al. 2017). In this analysis, the number of plots available with at least 8 years between their earliest measurement (1997 to 2002) and the latest measurement (2007 to 2012) was 25 in the Sequoia National Forest and 23 in the Sierra National Forest. The species richness and diversity in the meadow plant community significantly increased on both national forests from 1999 to 2012 (Oles et al. 2017). In the Sequoia National Forest, when they examined macroinvertebrate communities in grazing allotments, they found macroinvertebrate species richness to be medium low or low: in the Sierra National Forest, species richness was medium, medium low, and low. populations (Furnish 2013). While range condition has improved, much work is still required to restore hydrologic connectivity and function in meadows with gullies.

Fens are special sensitive habitat types, with deep organic soils found at high elevation on the both national forests (Wolf and Cooper 2015) (Kattelmann and Embury 1996). While the exact number of fens in both national forests is not known and no consistent assessment exists, fens are estimated to represent about 10 percent of the meadows on the Sequoia National Forest and about

1 percent of the landscape (M. Linton, personal communication). Farther north, fens cover approximately 0.2 percent of the landscape in Sequoia and Kings Canyon National Parks (Hopkinson et al. 2013).

Springs and seeps are a result of both precipitation and geologic structure and are generally found throughout the plan area. From the highest passes and valleys into the lower elevations, springs are found throughout the southern Sierra Nevada. Fully functioning springs are typically considered biodiversity hotspots, supporting many species that only occur there, most notably spring snails. Spring habitats are vulnerable to damage from on- or off-site changes in water or land uses, and species associated with springs typically have limited mobility; therefore, effective spring protection is necessary to protect endemic species (Frissell et al. 2012). There is little information about the current trends for springs across the landscape (United States Department of Agriculture 2013d). However, drought has influenced flow in many springs, so the uncertainty of climate change may influence this habitat.

Lakes

The Sierra National Forest contains 11 reservoirs, covering 17,310 acres: the Redinger, Wishon, Florence, Bass, Mammoth Pools, Huntington, Courtright, Edison, Shaver, and Pine Flat Reservoirs. In addition, there are 1,602 lakes larger than 1 acre and totaling 14,273 acres, plus 3,366 lakes, ponds, and other water bodies less than 1 acre and totaling 1,006 acres (United States Department of Agriculture 2013c). Due to the lack of glaciation, high-elevation lakes and ponds are rare in the Sequoia National Forest, which has 96 acres of natural lakes and ponds. However, lower elevation reservoirs such as Lake Isabella provide lake habitat and recreation opportunities for residents and visitors.

Historically the lakes of the high Sierra Nevada were fishless and supported native fauna, such as amphibians, aquatic insects, abundant zooplankton, and phytoplankton. However, many of the high-elevation lakes now support introduced brook, brown, rainbow and golden trout, which has had an impact on native frog populations (Knapp et al. 2007) (Knapp and Matthews 2000a) (Knapp and Matthews 2000b).

The historic introduction of trout into lakes throughout the Sierra Nevada has eliminated the yellow-legged frog from over 95 percent of its historic range (Vredenburg et al. 2007). The introduction of trout into these lakes has also altered the life cycle and reduced the population numbers of macroinvertebrates and zooplankton in lakes (Knapp 2005) (Schindler et al. 2001). The loss of these keystone species changes the food web and biodiversity.

Aquatic ecosystem biodiversity in many of these lakes is outside the natural range of variation. A few lakes have remained fishless, or have had fish removed to protect amphibians. They are being protected from additional fish stocking by changes in stocking rules by the state fish and wildlife agencies. These fishless lakes provide important refuges for some amphibians, which support their persistence.

Fishing is an important economic benefit to the local communities, and reservoir systems are highly used by visiting anglers during open fishing season. The California Department of Fish and Wildlife determines the schedule for stocking lakes and streams in and next to both national forests.

Riparian Ecosystems

Riparian ecosystems are a critically important component of biodiversity, supporting a higher concentration of species diversity than most terrestrial ecosystems. They serve in part as a link between aquatic and terrestrial ecosystems and play numerous important roles in the broader landscape; for example, they provide wildlife habitat, including habitat corridors, nutrient cycling, and proper watershed function. Despite these systems' importance, (Kattelmann and Embury 1996) estimated that riparian vegetation currently makes up less than 1 percent of the Sierra Nevada bioregion.

Riparian vegetation composition and structure are influenced by the size and type of stream, the amount of flooding, and the surrounding upland ecosystems and vegetation (Kondolf et al. 1996) (Kattelmann and Embury 1996). In most of the analysis area, fire is an important influence on riparian vegetation (Dwire et al. 2016), especially in the foothill, montane, upper montane, sagebrush, and pinyon-juniper ecosystems.

Lake Isabella has the largest mature fluvial riparian forest remaining in Southern and Central California. Mature Fremont cottonwoods and black willow trees dominate the overstory, interspersed with shrub willows and grassy areas. At higher elevations throughout the analysis area, riparian vegetation is more limited in width in the subalpine and alpine areas. In pine and conifer forests, narrow bands of herbaceous riparian plants and often such deciduous shrubs as creek dogwood or willow are interspersed with upland forest trees, mostly conifers, growing next to the streams. Riparian plants can include grasses, sedges, shrubs, and trees. Along larger streams and rivers and in meadows, willow shrubs are common, with a variety of species that vary by elevation.

Riparian ecosystems are formed by the interacting effects of flooding, soil wetness, water table level, proximity to streams, height above water level, sediment, and ice scouring. Meadows are areas where grasses, sedges, and rushes are dominant and flowering plants are common. Willows, alders, cottonwoods, and other woody vegetation dominate non-meadow riparian ecosystems, but flowering plants, sedges, and grasses are often present. Aspen is often present in riparian ecosystems.

In the absence of fire within the natural range of variation, conifers have grown into riparian areas; they often are taller and now shade riparian hardwood trees, shrubs, and herbaceous plants in many areas. This has occurred especially at low and middle elevations, where fire was historically more frequent and trees grow relatively fast.

Many riparian areas have become more uniform with dense overstory cover, especially of conifers, and less vigorous and diverse understory deciduous shrubs, grasses, sedges, and herbaceous plants. Many riparian plant species are adapted to disturbances such as floods, and vigorously resprout after disturbance. This makes them resilient to fire as well (Pettit and Naiman 2007). When composition and structure of riparian vegetation becomes dominated by conifers, especially at a high density, it becomes less resilient to fire. Many of the riparian areas in the analysis area are in this condition of low resilience. Fire return intervals are not within the natural range of variation over much of the landscape, and thus not within the range of variation for the interspersed riparian areas. Understory condition and abundance of native sun-loving and fire enhanced plants is affected by lack of fire.

Climate Disturbances Influence to Aquatic and Riparian Ecosystems

The climate in the southern Sierra Nevada normally varies by year, season, elevation, and slope and aspect. Average annual precipitation ranges from 39 to 49 inches along the western foothills, 9 to 20 inches along the southern end of the Sierra Nevada, Kern River, and eastern slope, and up to 49 to 59 inches at higher elevations (Wolf and Cooper 2015).

Changes in climate have influenced the quantity, quality, and seasonality of water and can have significant impacts on the ecological integrity of aquatic systems. Increasing air temperatures and decreasing summer flows associated with climate change are well documented across the western U.S. (Isaak et al. 2017). In an assessment of water temperatures in 343,000 kilometers of western perennial streams (including the southern Sierra) stream warming occurred at the rate of 0.178°C per decade between 1976 and 2015 (Isaak et al. 2017). Variation will occur in and among river networks due to differences in local climate forcing and stream responsiveness. In mountain streams in the Pacific Northwest, warming rates were relatively low from 1968 to 2011 (average warming rate = 0.101°C per decade), when air temperatures warmed at twice the rate (Isaak et al. 2016). Forecasts of refuge locations could protect key watersheds and provide a foundation for climate smart planning of conservation (Isaak et al. 2015) for native trout and amphibians (Wright et al. 2013). Streams' resilience to climate change is influenced by sources of water, riparian forest cover, and meadow area (Frissell et al. 2012).

Changes in timing of snowmelt are already influencing stream flow patterns (Hunsaker et al. 2014). Flood potential is predicted to increase, as is the proportion of precipitation falling as rain instead of snow (Overpeck et al. 2013, Safford et al. 2012a). This is likely to continue (Null et al. 2010) and will impact aquatic ecosystems through seasonal changes, decreased water flows, and increased water temperatures. Stream flows in summer are declining and floods are occurring in winter rather than spring in areas dominated by snowmelt (Luce and Holden 2009, Isaak and Rieman 2013). These changes, along with increases in stream temperature, are expected to shift distributions of native fishes according to their water temperature requirement (Isaak et al. 2012, Rieman et al. 2007, Wenger et al. 2011a, Wenger et al. 2011b, Isaak et al. 2015, Isaak et al. 2016). Warming temperatures and loss of stream flows were the primary threats to aquatic invertebrate communities in the Sierra Nevada.

The forests have suffered unprecedented bark beetle and drought mortality of conifers in the montane zones in the last 5 years. During the extreme drought of 2012 to 2015, levels of drought stress and associated tree mortality were most severe and extensive on the west slope of the southern Sierra Nevada, centered on the Sierra and Sequoia National Forests (Preisler et al. 2017, Young et al. 2017).

Studies in headwater systems, indicated that vegetation loss from beetle kill can increase flows early in the season (Bearup et al. 2014), although decreased transpiration from tree death may be offset by increased understory evapotranspiration and ground evaporation (Mikkelson et al. 2013, Penn et al. 2016). The changes in flow from tree mortality and climatic warming combined have greater changes to streamflow amount and timing (Pribulick et al. 2016). However, forest cover loss changes in runoff are reduced at the large watershed scale (Zhang et al. 2017, Penn et al. 2016). Compared with historical data, there is little difference in flows (Biederman et al. 2015). Other processes, such as increased snow sublimation and evaporation from the sub canopy, occur following die-off in water-limited, snow-dominated forests; this further reduces flows (Biederman et al. 2015). This same drought put stress on aquatic and semiaquatic ecosystems (Vose et al. 2016a) and the species that depend on them (Pyne and Poff 2017).

Over the next century, climate change is predicted to alter hydrologic and precipitation patterns, riparian vegetation, and the role of fire in riparian areas. This will have important effects on aquatic and riparian ecosystems, since they are shaped by and depend on the amount and pattern of water. Riparian areas will also be strongly shaped by climate-related changes in fire (see "Fire Trends").

Climate change can affect surface and groundwater flows. If there are more severe floods that follow severe droughts, stream channel erosion could increase. The rain-snow interface zone is predicted to occur at higher elevations, causing streams to warm earlier in the season. Streambank vegetation could decrease in vigor and extent if summer base flows become much lower or some perennial streams become intermittent. Then, during high flows, there would be a greater chance of channel scour and possible widening or gully incision.

Environmental Consequences to Aquatic and Riparian Ecosystems

Consequences Common to all Alternatives

Sustainability of Habitat

All alternatives provide riparian conservation area direction to ensure that the Forest Service considers the effects on aquatic and riparian habitat in all project decisions. Best management practices are expected to benefit water quality and, to a limited extent, riparian-dependent species habitat forestwide. The Forest Service would continue to follow agency direction to implement an annual best management practices evaluation and adaptive management program, following established agency monitoring protocols.

Plan components under all alternatives address the treatment of headcuts in meadows and streams, impaired hydrologic connectivity, and impacts on legacy grazing, on recreation, and on sediment from roads. All alternatives would also continue to implement work in priority watersheds, as defined by the Watershed Condition Framework, for short-term restoration focus. These project-level decisions and site-specific restoration actions could be similar under all alternatives.

The aquatic and riparian plan components include forestwide watershed and riparian conservation area plan direction. A watershed restoration action plan is developed for all priority watersheds that identify essential projects to restore legacy erosion sites and degraded aquatic and riparian habitats. Continuing to implement restoration projects in priority watersheds also contributes to achieving desired conditions (including streams and streams and meadows). The projects are designed to improve overall biodiversity and ecosystem conditions.

Dams and diversions would be managed the same way under all alternatives, with their management mostly outside the control of the Forest Service. There would continue to be effects on aquatic and riparian ecosystems that are fundamentally altered from their natural condition.

Ecological connectivity of aquatic habitat is an issue when dams block aquatic species passage. These effects would continue to improve over time, as they have over the past few decades. This is because the Forest Service and other agencies work through FERC relicensing projects and other processes to alter flow patterns and diversion methods to minimize effects on aquatic and riparian systems. However, these water uses are important forest uses, and they will remain fundamentally the same as the current altered condition.

Grazing levels may change over time with changing conditions, but grazing decisions would be made on a project-specific basis. All permits contain language that livestock will not enter the allotment prior to range readiness. Within the plan area, the following species overlap active allotments: Little Kern golden trout, Kern River rainbow trout, California golden trout, Piute and Lahontan cutthroat trout. the Mountain and Sierra yellow legged frogs, and Yosemite toad. Typically, spawning and egg-laying coincides with spring melt-off in suitable habitats and is a consideration addressed in determining the timing of range readiness. Nothing in any of the alternatives will alter the methods for determining range readiness and preventing impacts on breeding habitat.

Restoring aquatic ecosystems is a regional priority, as outlined in the "Ecological Restoration Leadership Intent" established by the Regional Forester (United States Department of Agriculture 2015d). Both forests, with help from partners, are implementing restoration actions to repair meadows, reduce the risk of unmanaged wildfire, clean rivers, and regulate dispersed camping areas. These efforts are expected to continue under all alternatives, thereby improving water quality and aquatic habitat conditions by reducing erosion and improving and restoring degraded areas.

Consequences Specific to Alternative A

The aquatic management strategy would continue to be used to manage riparian habitats, according to the riparian conservation objectives. This would maintain the ecology of riparian areas to buffer sediment from entering aquatic habitats. Standards and guidelines for alternative A emphasize protecting water quality and riparian conservation areas by limiting management within a variable buffer distance around riparian features. This would protect narrow bands for species-specific needs, such as for amphibians, fish, and aquatic snails. Alternative A would continue to follow the current forest plan direction of the Sequoia and Sierra National Forests for aquatic species and habitat management.

The number of critical aquatic refuges would remain unchanged, so some watersheds containing refugia or concentrations of rare species would remain outside of a CARs. Because Riparian Conservation Areas (RCAs) include most primary habitat for these species, their habitat has the same protections as CARs, but over a smaller area.

Sustainability of Habitat

The emphasis on limiting management in riparian areas, CARs, and meadows means that projects will continue to minimize short-term effects on riparian and aquatic habitat. In general, this alternative could maintain suitability of aquatic species habitat in fair to good condition. The lack of plan direction to address aquatic invasive species will not help prevent invasions by nonnative predatory game fishes that can harm habitat for native fish at lower elevations, leading to fair conditions. At higher elevations, lack of good native riparian vegetation in the understory, because the absence of fire has led to a rating of good. Native riparian vegetation is a source of leaves and other food resources for macroinvertebrates, which are food for many aquatic species.

Improving aquatic habitat conditions is primarily related to mitigating the effects of roads and designated trails near and on the edges of meadows and streams. These standards and guidelines have been in place since 2004; along with best management practices, they have worked well to protect most stream habitats from sedimentation. The probability of having a 10- or 50-year storm occurring after a watershed has burned was estimated to be between 1.2 percent (recurrence interval of 87 years) to 3.8 percent (recurrence interval of 27 years) (WEST Consultants 2011).

High and moderate severity portions of wildfires increase runoff and erosion rates by two or more orders of magnitude (Elliot et al. 2010); nevertheless, postfire floods apparently rejuvenated stream habitats by exporting fine sediments and importing large amounts of gravel, cobble, woody debris, and nutrients. This resulted in higher fish productivities than before the fire (Burton 2005).

While fish may be able to recolonize a stream after wildfire, the recovery of less mobile species, such as salamanders and frogs, may take longer than 5 years. Fire positively affected limiting habitat for certain life stages; high-quality juvenile salmonid habitat increased in all watersheds (Flitcroft et al. 2016). Management direction will reduce sediment and improve suitability of habitat for aquatic species over time, and the habitat should remain in fair to good condition. Invasive species, such as rainbow trout, are valued by anglers.

Ecological Connectivity

Hydrologic connectivity is addressed under this alternative, which may or may not supply ecological connectivity for most aquatic species and riparian associates. Restoration of ecological connectivity by improving road crossings or mitigating water diversions would occur at a slow pace under this alternative. Maintenance of aquatic habitat connectivity is emphasized only for some aquatic species, primarily trout. Ecological connectivity for many species will not be considered.

Biodiversity

Under alternative A, direction and best management practices reduce the impacts of management actions locally but do not address the biodiversity, sustainability, or persistence of aquatic and riparian associates. Plan direction under alternative A does not emphasize management of invasive species or restoration of ecological connectivity. Alternative A is sufficient to protect these species from direct project impacts. However, alternatives B, C, D, and E better protect against indirect impacts of climate disturbances and the absence of fires. Biodiversity would not improve from its current poor to good condition, depending on the elevations of the species under consideration.

Resilience to Climate Change

Adaptively managing aquatic habitats for resilience to future climate disturbances or the improving adaptive capacity of aquatic ecosystems through ecological restoration and climate adaptation are not explicitly addressed under alternative A. It is sufficient to protect aquatic habitat, but the other alternatives are better at protecting watersheds with at-risk aquatic species against the indirect impacts of climate disturbances or the absence of fires.

Riparian Vegetation

In the long term, no reduction in the fuels or restoration of riparian associates would occur. Under alternative A, prescribed fires would not originate in riparian areas, thereby limiting the Forest Service’s ability to return natural fire to riparian ecosystems and limiting conifer removal. Alternative A would only occasionally improve riparian composition and structural heterogeneity resilience to climate disturbances and lack of fire.

Fire, wind, and bark beetles in riparian areas can have negative effects on ecosystem services but positive effects on native riparian species diversity (Thom and Seidl 2016)). Alternative A does not address climate stressors or protect and improve the condition of riparian habitat. The limited amounts of restoration would result in most riparian areas continuing to trend toward a decrease in heterogeneity and degraded condition of hardwoods. Protection from soil disturbance has maintained soil integrity of these areas.

This alternative maintains most riparian habitat for animal species in fair to good condition, depending on fire history. For riparian vegetation species composition without a change in management direction, the conditions would remain fair to poor.

Consequences Specific to Alternative B

Alternative B introduces conservation watersheds, or aquatic reserves, to the two forests as management areas for at-risk species and water quality (Table 51 and Table 52). These large-scale conservation watersheds allow for connectivity of habitat where appropriate for species to shift their distributions in response to climate change. Their focus is on maintaining high quality habitat. To support this, the Forest Service proposed conservation watersheds, which are crucial to at-risk aquatic species and providing high quality water. The advantage of the proposed conservation watersheds is that they are anchored in watersheds in good condition (see the Aquatic and Riparian Strategy Appendix to Plans).

Conservation watersheds on both forests are anchored to wilderness or inventoried roadless areas (see Figure 43 and Figure 44). These large watersheds have several subwatersheds, mostly at lower or mid elevation, that over time can be a focus for watershed health and aquatic ecosystem restoration, using priority watersheds. Restoration of meadows, streams, floodplains, habitat connectivity, and fire as a natural process are some of the ecosystem structures and processes that might be restored.

Table 51. The proposed differences in the riparian conservation areas, critical aquatic refuges, and conservation watersheds management areas among alternatives for the Sequoia National Forest

Alternative	Conservation Watersheds	Critical Aquatic Refuges	Riparian Conservation Areas excluded from Timber Suitability
A	No	Yes, original CARs	Yes
B	Yes	No	Yes
C	Yes	Yes, CAR additions	Yes
D	No	No	Yes, not ephemeral
E	Yes	Yes	Yes

Table 52. The proposed differences in the riparian conservation areas, critical aquatic refuges, and conservation watersheds management areas among alternatives for the Sierra National Forest

Alternative	Conservation Watersheds	Critical Aquatic Refuges	Riparian Conservation Areas excluded from Timber Suitability
A	No	Yes, original CARs	Yes
B	Yes	No	Yes
C	Yes	Yes, CAR additions	Yes
D	No	No	Yes, except ephemeral streams
E	Yes	Same as alternative C	Yes

Alternatives C and E would have both conservation watersheds and CARs. Alternative D has no CARs or conservation watersheds for managing at-risk and other aquatic species. (CARs were removed as a management area under alternative B.) Conservation watersheds are intended to maintain large landscapes where high quality water contributes to beneficial uses and conservation of at-risk species. The average size of CARs is 10,000 to 40,000 acres; conservation watersheds are typically larger. The names and acreages of the conservation watersheds for each forest are shown in Table 53 and Table 54.

Table 53. The proposed conservation watersheds management areas under alternatives B, C, and E in the Sequoia National Forest

Conservation Watershed	Acres in Conservation Watersheds on Forest Service Land	Percent of Watershed Protected by Either Wilderness or IRA	Total Acres
Upper North Fork Kern	210,605	80	211,872
Upper South Fork Kern	109,142	73	109,570
Lower Kern	61,366	76	63,910
Total Sequoia National Forest Acreage	381,113	77	385,352

Table 54. The proposed conservation watersheds management areas under alternatives B, C, and E in the Sierra National Forest

Conservation Watershed	Acres in Conservation Watersheds on Forest Service Land	Percent of Watershed Protected by Either Wilderness or IRA	Total Acres
Kings	242,127	63	247,509
San Joaquin	180,053	41	182,561
Total Sierra National Forest Acreage	422,180	58	430,070

Conservation watersheds on both forests have a combination of HUC 10 and 12 watersheds. The HUC 12 watersheds can be designated as priority watersheds, if necessary. In the Sequoia National Forest, three conservation watersheds encompass 381,113 acres and range between 61,366 and 210,605 acres (Figure 42). The conservation watersheds in the Sequoia National Forest have from 73 to 80 percent of the areas in either wilderness or inventoried roadless areas (Table 53). In the Sierra National Forest, three conservation watersheds encompass 422,180 acres and range between 80,759 and 180,053 acres (Figure 43). In the Sierra National Forest, four of the CARs were not included in alternative B, adding up to 34,430 acres that are no longer covered by CARs or conservation watersheds. Two of these are in wilderness, and species at risk in all four should be covered by other plan direction. The conservation watersheds in the Sierra National Forest have from 41 to 63 percent of the areas in either wilderness or inventoried roadless areas (Table 54).

Conservation watersheds will complement, not replace, priority watersheds identified through the 2011 Watershed Condition Framework (WCF). By definition, priority watersheds under the WCF are designated as such for relatively short periods of time (3 to 5 years), chosen to improve an indicator’s functional rating. In contrast, implementing conservation watershed direction is intended to help protect and maintain functioning aquatic systems and restore degraded watersheds. This would benefit aquatic and riparian resources over the long term.

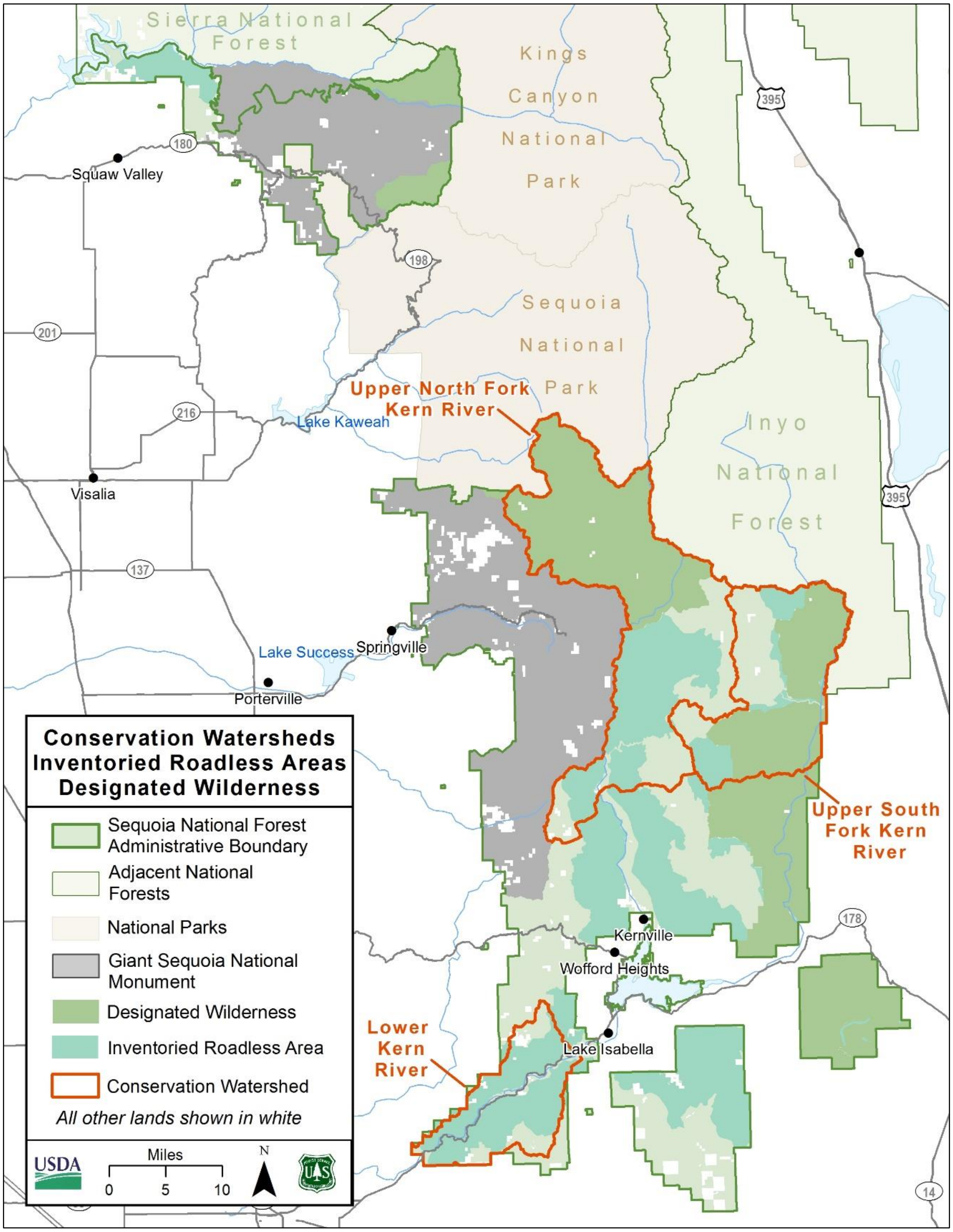

Figure 42. Conservation Watersheds showing relationship to wilderness and Inventoried Roadless Areas for the Sequoia National Forest

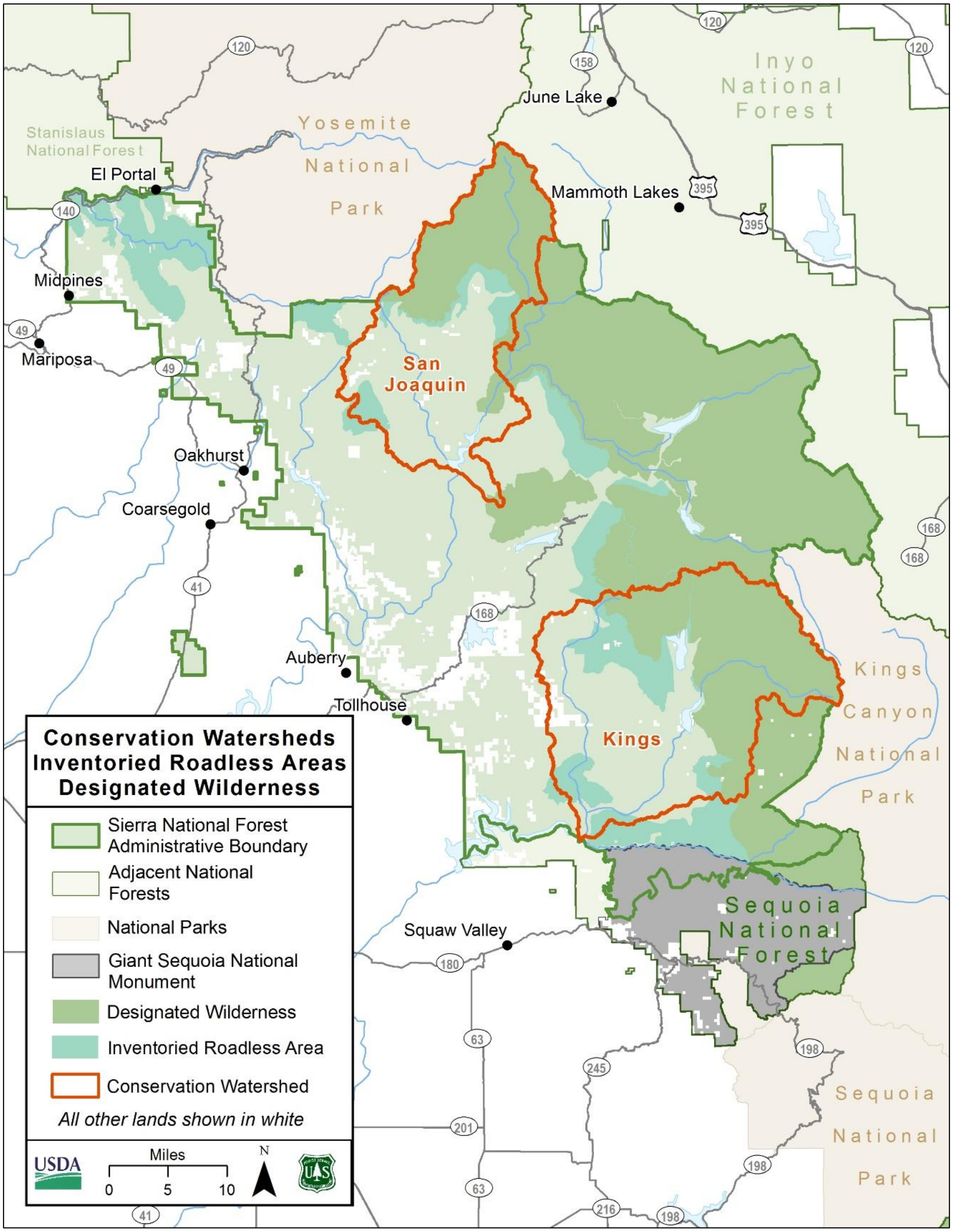

Figure 43. Conservation Watersheds showing relationship to wilderness and Inventoried Roadless Areas for the Sierra National Forest

Alternative B manages the same riparian conservation areas as alternative A, but it uses the full suite of plan components—desired conditions, standards, guidelines, goals, and potential management approaches—to better move riparian ecosystems toward resilience to fire and climate change. Riparian conservation areas for all streams, including ephemeral streams, are not designated as timber suitable.

Desired conditions for watersheds, meadows, seeps, springs, streams, and other aquatic habitats strive for ecological integrity. Desired conditions for watersheds address ecological structure and function, species diversity, resilience to natural and human disturbances, and climate change. Desired conditions for hydrologic connectivity and sustaining long-term soil productivity support the ability of the ecosystem to maintain ecological processes. Desired conditions for high-quality water, stream and shallow groundwater recharge, and riparian community maintenance support important ecosystem services that fully functioning ecosystems can provide. Desired conditions for RCAs are ecological connectivity among habitats, the conditions to support the persistence of native aquatic and riparian plants and animals, perpetuating unique aquatic habitat functions and diversity, habitats that support self-sustaining populations of native aquatic species, and adequate water tables to support riparian species.

Under the 2012 Planning Rule every project proponent must address how it is meeting desired conditions. The desired conditions address ecological integrity by addressing the structure and function of ecosystems, including species diversity. They address other structural, ecological, functional, and biodiversity aspects of ecosystems, which are components of ecological integrity.

Sustainability of Habitat

Across the whole plan area, much of the plan direction from alternative A for riparian conservation areas has been carried forward. The riparian areas are all conserved, including those protecting ephemeral streams with structure. Treatments to improve fire resilience in riparian ecosystems over the long term would be designed to protect water temperature, native riparian vegetation, and other conditions that provide quality habitat for wildlife over the short and long term.

Improving fire resilience would improve conditions of riparian areas under alternative B, compared with alternative A. Under alternative B, streamside equipment exclusion areas would be 150 feet for perennial streams, meadows, and other perennial aquatic habitat, 75 feet for intermittent streams, and 25 feet on ephemeral streams (see Glossary). These should protect streams from sedimentation and, to a large degree, protect core areas for ground dwelling species, such as the slender salamanders, small mammals, riparian birds, and reptiles. On steep slopes or fire-damaged soils or in areas where aquatic and semiaquatic species occur, this guideline suggests increasing the width to protect the species habitat.

Headwaters offer species refuge from temperature, flow extremes, and invasive species. They contain a rich source of food and create migration corridors throughout the landscape (Meyer et al. 2007). Protecting headwaters and their connectivity to ecosystems downstream also protects the biological integrity of entire river networks. Watershed plan directions protect and improve aquatic habitats and will over time help to improve aquatic habitat.

Desired conditions, standards, and guidelines for forest management activities, such as vegetation management, maintenance and development of infrastructure, restrict surface-disturbing activities near aquatic systems. Protections for fen ecosystems, riparian areas, meadows, other aquatic and species habitats, and water quality (temperature) are addressed in standards and guidelines.

Protections for streams and rivers would be maintained, so habitats would remain in good or fair condition. Such species as the western pond turtle that depend on good quality water and quiet riparian areas in lower elevations would benefit from many of the positive changes. Over time, across the forests, removing invasive species would continue to keep the higher elevation habitats in good condition and would improve lower elevation habitats.

The risk of wildfire may not be reduced as well under alternative B as under alternative D. However, the effects of wildfire can be rarer than the harvesting of trees in a focus landscape every 10 years, as is proposed under alternative D. The probability of having a 10- or 50-year storm occurring after a watershed has been recently burned was estimated to be between 1.2 percent (recurrence interval of 87 years) to 3.8 percent (recurrence interval of 27 years) (WEST Consultants 2011).

Postfire floods apparently rejuvenate stream habitats by exporting fine sediments and importing large amounts of gravel, cobble, woody debris, and nutrients. This results in higher fish productivities than before the fire (Burton 2005). While fish may be able to recolonize a stream after a wildfire, less mobile species, such as salamanders and frogs, may take longer than 5 years to recover. Positive links between wildfire and aquatic habitat have been found for fish. Therefore, despite the fact that alternative B would not reduce wildfire as much as alternative D, suitability of habitat is expected to improve under alternative B, compared with alternative A.

On both forests, the change to conservation watersheds protects water quality in headwater areas (see Figure 44 and Figure 45 for both forests). This helps protect the aquatic species and their food webs both at higher elevations and lower in the watersheds. While CARs focus on aquatic species, conservation watershed plan direction recognizes the value of biodiversity in adjacent uplands habitat and aquatic and riparian ecosystems. Such plans incorporate direction that supports long-term functionality of these watersheds.

Conservation watershed plan direction includes desired conditions for resilience to floods, wildfire, and landslides in all aquatic, riparian, and terrestrial ecosystems. Plan direction calls for minimizing temporary roads and landings in riparian areas, closing user-created routes, decommissioning low priority roads during projects, and improving designated roads and trails to reduce effects on streams. These watersheds, with their focus on biodiversity, at-risk species, and clean water, would over time lead to improved conditions for aquatic habitats for species. Alternatives B, C, and E have these protections; neither alternative A nor alternative D has them. Habitat suitability in these watersheds is expected to stay good or to increase from fair to good.

Alternative B provides management direction to increase partnerships and promote ecological restoration. Partnerships can increase the amount of thinning and fuels reduction, restore meadows, build bridges to protect streams, and remove trash from rivers. These partnerships could have a positive effect on ecosystem integrity at the watershed scale. Therefore, we expect the partnerships to help maintain or improve habitats for aquatic species, moving them from fair to good or from good to very good.

Alternative B has protections for riparian conservation areas that limit the effects of vegetation management. Conservation watersheds promote the health and resilience of riparian vegetation. This alternative would improve riparian ecosystem resilience to fire and climate change and would more balance with the needs of animal species, compared with alternatives A, C, D, and E.

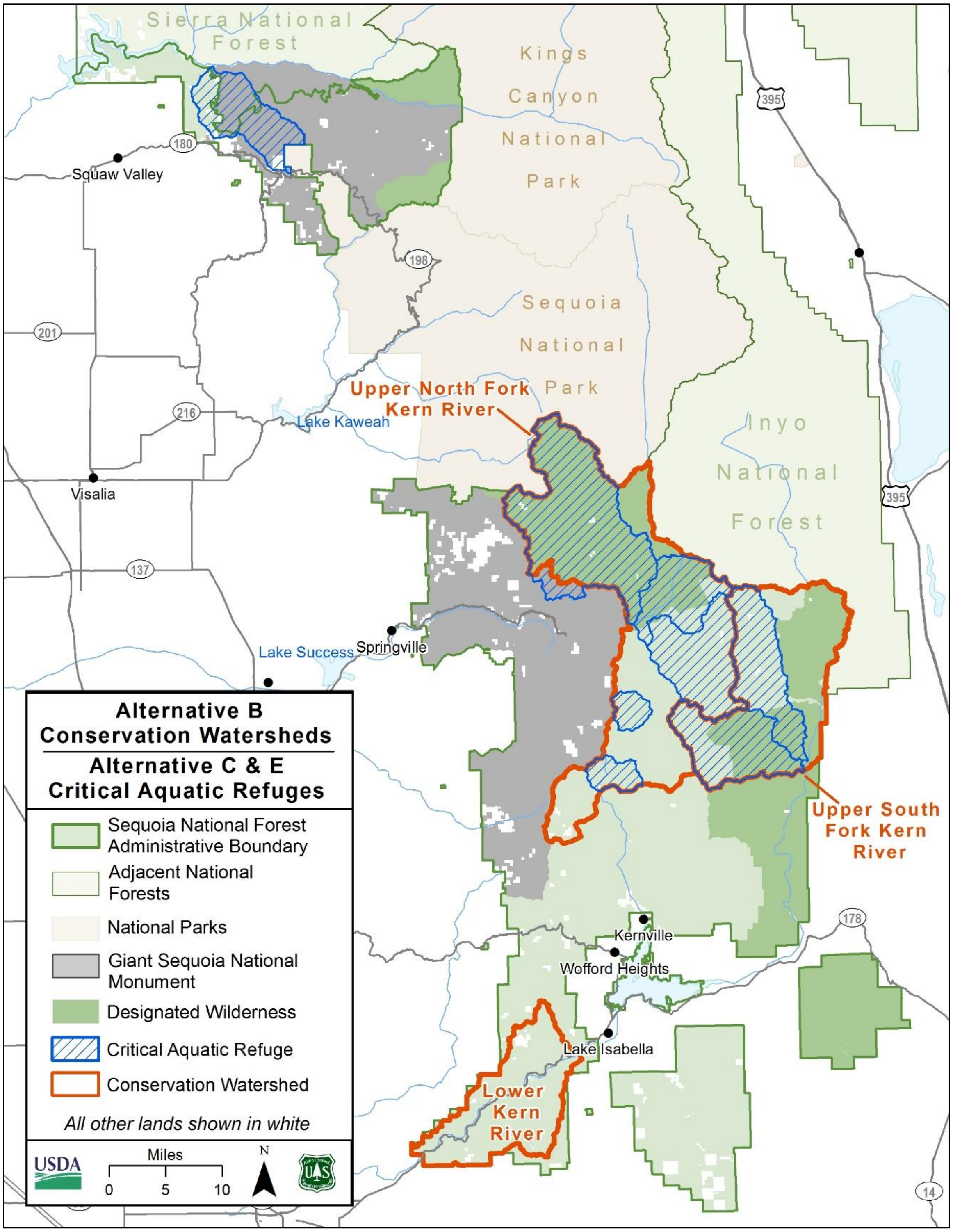

Figure 44. Conservation Watersheds overlap with Critical Aquatic Refuges on the Sequoia National Forest.

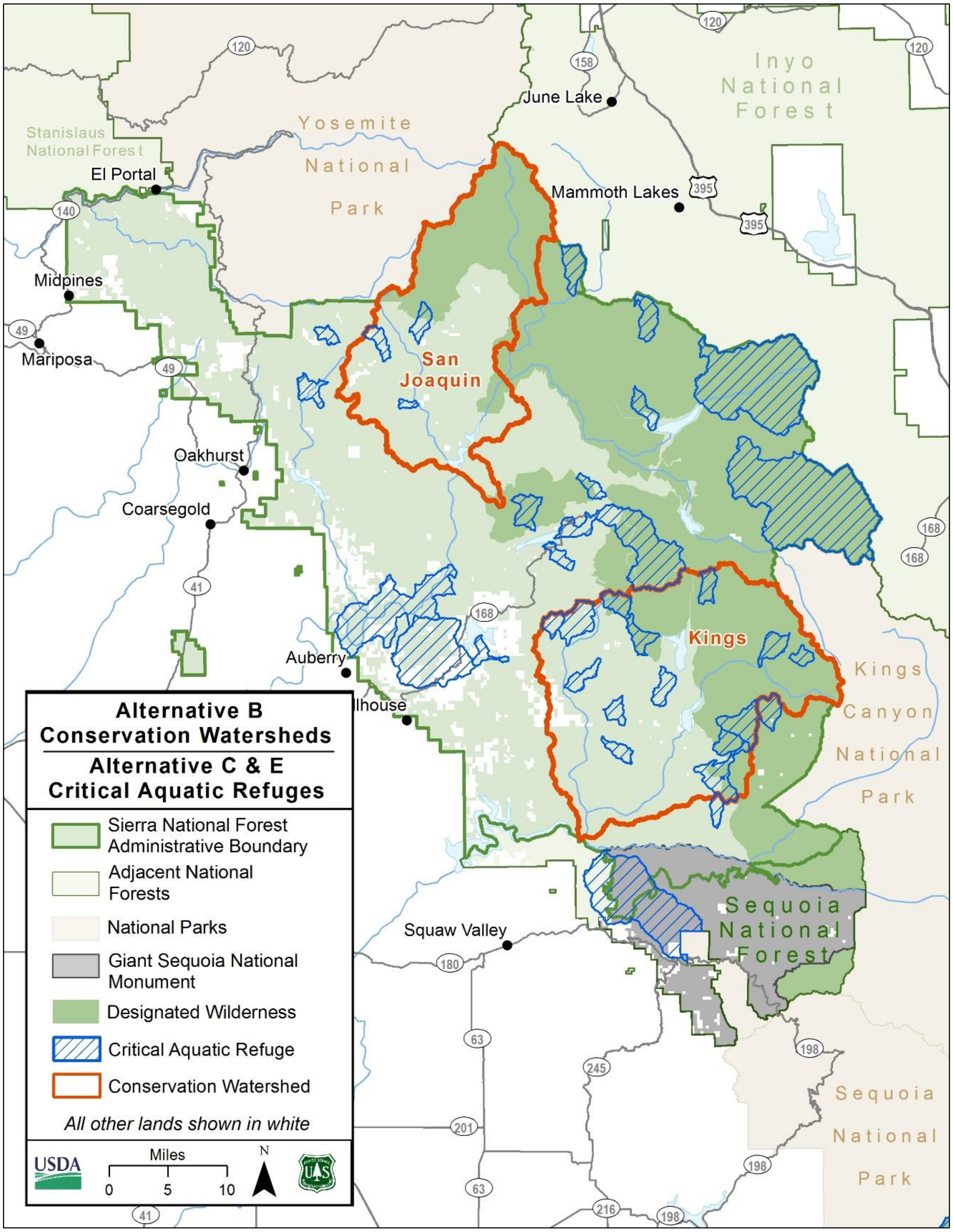

Figure 45. Conservation Watersheds and Critical Aquatic Refuges on the Sierra National Forest.

The reduction of high-intensity wildfire risk, especially in riparian areas in CWPZs, would improve some aspects of watershed health. However, it would unlikely have an effect on aquatic habitat conditions over the forest and over the long term. Treatment in these zones has the potential for localized, long-term impacts on slow-moving species, such as slender slamanders, concentrated in moist riparian area. This would be the result, unless the timing of prescribed burning and potential ground-disturbing activities is outside of species' activity periods.

Ecological Connectivity

The desired conditions added under alternative B address the maintenance and restoration of ecological connectivity among habitats for aquatic or riparian associates. Conservation watersheds address the connections between floodplains, wetlands, upland slopes, headwaters, and tributaries to provide for breeding, dispersing, overwintering, and feeding habitats for at-risk species.

Headwater streams make up a large proportion of the total length and watershed area (Richardson et al. 2012). Protecting headwaters and their connectivity to ecosystems downstream improves the ecological integrity of entire river networks (Meyer et al. 2007).

Riparian areas are the interface between terrestrial and aquatic ecosystems, and across the landscape they function as a network (González et al. 2017). Protections under Alterative B support properly functioning streams, from headwaters down to rivers, and support restoration of habitat connectivity for many species. The increase in the pace of restoration, compared with alternative A, especially in concert with an increased use of partnerships, should allow aquatic connectivity restoration to increase, moving connectivity from poor to fair or fair to good, depending on elevation or if the habitat is in a conservation watershed.

Biodiversity

Conservation watersheds introduced for alternative B, address the connections between floodplains, wetlands, upland slopes, headwaters, and tributaries. They provide breeding, dispersing, overwintering, and feeding habitats for at-risk species. Conservation watersheds include desired conditions to provide high-quality habitat. They also provide functionally intact ecosystems that contribute to the persistence of species of conservation concern and the recovery of threatened, endangered, proposed, and candidate species. Improvements in the resilience of habitats for aquatic, riparian, and terrestrial ecosystems would improve the resilience of species in these watersheds. Protecting aquatic species and habitats across the landscape would further protect a variety of aquatic species.

Biodiversity would be maintained similarly under alternatives A and B if these were the only protections. Increased partnerships to restore aquatic habitats would improve ecological conditions that support the persistence of native species and aquatic diversity. Restoring degraded habitats would increase resilience for native aquatic species and therefore maintenance of biodiversity over time under alternative B.

Resilience to Climate Change

Managing aquatic habitats for resilience to climate change and improving adaptive capacity of aquatic ecosystems through ecological restoration are adressed in the desired conditions for alternative B. Alterantive A does not address climate changes or improving resilience to fire or changing hydrographs. Riparian plants that shade streams can be restored or protected to cool streams across the landscape to counteract the warming temperatures that are already occurring. Adaptively managing aquatic habitats for resilience to climate changes and improving adaptive capacity of aquatic ecosystems through ecological restoration are emphasized under alternatives B, C, and E. Restoring fire in riparian areas and limited thinning in riparian areas, which minimizes ground disturbance, could remove pines, firs, and cedars to favor native riparian species. Ladder and ground fuels would be reduced so as not to reduce habitat for many riparian animal species. Introducing prescribed and managed wildfire into these areas at the right time of year would reduce impacts on species and would improve the resilience of these areas to drought and changing climate.

Riparian Vegetation

The change from alternative A allows for fire in riparian areas to promote resilience and native riparian species. In general, in the montane zone, riparian species, such as willows, sedges, grasses, and flowering plants, do better when fire is introduced. Fire discourages reinvasion by pines, incense cedar, and white fir. Removing encroaching conifers would be governed by the need to minimize soil disturbance and to protect species that depend on these areas. In conservation watersheds, working toward ecological integrity, including resilient riparian vegetation, helps maintain or improve watershed conditions under the Watershed Condition Framework.

Under alternative B, an increased emphasis on wildfire managed to meet resource objectives would continue to improve riparian vegetation conditions and reduce the risk of intense fire across large landscape areas. This is especially true in higher elevations, where there are fewer opportunities for more direct restoration. All restoration that increases heterogeneity in riparian areas would move riparian vegetation composition and structure toward the natural range of variation.

Limited vegetation management, bounded by the plan direction, would improve growing conditions for riparian hardwoods and shrubs that are often shaded by upland trees and shrubs. Prescribed fire and wildfire managed to meet resource objectives would improve the condition, vigor, and health of most native riparian plants. Many native riparian plants sprout as an adaptation to flooding, and this often allows them to respond positively to fire as well (Fites-Kaufman et al. 2006, van Wagtendonk and Fites-Kaufman 2006). Composition and structural heterogeneity of native plant species would move from fair or poor condition to good or very good under alternative B, when compared with alternative A.

Consequences Specific to Alternative C

Alternative C would have the least restoration using mechanical treatment, compared with alternatives A, B, and D. It would increase the emphasis on using prescribed fire and managing wildfires to meet resource objectives. Although there is more emphasis on managing wildfires to meet resource objectives proposed under alternative C, there is a high uncertainty about how much would actually occur. This is because of low levels of mechanical restoration. If there is more fire, there could be a greater benefit under alternative C, but it would be in more limited locations, compared with the other alternatives. Also, the intensity of prescribed fire might be higher than under the other alternatives, due to higher levels of fuels being burned.

Given higher fuel loads, the prescription windows for burning would be narrower. Throughout a year, narrower burn windows means fewer windows to get the work done. Plan direction would increase protections for aquatic species under alterative C, when compared with alternative B.

The Sequoia National Forest added two new CARs (221,560 total acres in the plan area) and conservation watersheds (381,113). However, these two management areas overlap the Sequoia National Forest. For the Sierra National Forest, alternative C would add the 28 new CARs (198,625 total acres) and conservation watersheds (422,180 acres), when compared with alternative A. The overlap on the Sierra National Forest between these two management areas was 26 and 3 percent for the Kings and San Joaquin conservation watersheds, respectively. Much more habitat would have a focus on aquatic and other species habitats than under alternatives A, B, and D. While parts or all of these management areas occur in wilderness, permitted activities still occur in wilderness. By highlighting these areas, the Forest Service can ensure high quality water and track conditions.

Sustainability of Habitat

Plan direction under alternative C provides increased protections of aquatic habitat, compared with alternatives A, B, and D, and is similar to alternative E. The CARs and conservation watersheds under alternative C that occur in existing designated wilderness areas or areas recommended for management as wilderness can provide high quality water downstream for aquatic species. In the Sierra National Forest, this alternative protects the small CARs for native fish. In the Sequoia National Forest, due to the nature of the Kern River, the conservation watersheds are anchored in wilderness and inventoried roadless areas and extend beyond these areas. However, the conservation watersheds overlap the CARs in the Sequoia National Forest, so protection provided by the conservation watersheds is similar to that under alternative B.

Under alternative C, direction calls for a 50-foot-wide mechanical exclusion zone on ephemeral streams. Since these streams send sediment straight into intermittent and perennial streams, thus influencing downstream water quality (Alexander et al. 2007), this alternative would do a better job of protecting soils, species habitats, and water quality than alternatives A, B, and D.

Integrated plan direction addresses infrastructure in sensitive aquatic areas. This should improve aquatic habitat conditions over the long term, compared with alternatives A and D. The potential for short-term effects from the increased pace and scale of restoration under alternatives B and D would be reduced under alternative C.

Restoring aquatic habitat with partners could improve the sustainability and resiliency of aquatic ecosystems to climate change, similar to alternative B. Therefore, despite the uncertainty associated with fire treatments, this alternative, with the increased land allocations set aside for protections from ground disturbing activities, would improve habitat at the higher elevations from fair or good to very good and would move habitat at lower elevations toward a good category.

Ecological Connectivity

Alternative C would provide for ecological connectivity among habitats for aquatic or riparian associates similar to alternative B, with more emphasis on restoring connectivity associated with critical aquatic refuges and conservation watersheds. Conservation watersheds address the connections between floodplains, wetlands, upland slopes, headwaters, and tributaries to provide for breeding, dispersing, overwintering, and feeding habitats for at-risk species. Headwaters offer species refuge from temperature and flow extremes, and invasive species. They contain a rich source of food and create migration corridors throughout the landscape (Meyer et al. 2007). Alternative C protects ephemeral streams from mechanical incursion, which in turn protects connectivity of habitat. Alternative C should be similar to alternatives B and E for restoring connectivity of habitats. Therefore, connectivity may increase from fair to good in areas where roads, culverts, or small diversions provide barriers.

Biodiversity

Alternative C identifies additional areas as critical aquatic refuges that contain at-risk aquatic species and includes conservation watersheds, which protect water quality and biodiversity. These two management areas are consistent with one another. Conservation watersheds address the connections between floodplains, wetlands, upland slopes, headwaters, and tributaries to provide for breeding, dispersing, overwintering, and feeding habitats for biodiversity and at-risk species. Improvements in resilience of habitats for aquatic, riparian, and terrestrial ecosystems will improve the resilience of species in these watersheds.

Conservation watersheds include plan direction for desired conditions to provide high-quality habitat and functionally intact ecosystems that contribute to the persistence of species of conservation concern and the recovery of threatened, endangered, proposed, or candidate species. These watersheds, with their focus on biodiversity, at-risk species, and clean water, would lead to improved resilience for aquatic habitats for species over time. Downstream CARs on the Sierra National Forest would benefit from the conservation watersheds in upstream areas. In the Sierra National Forest, this alternative protects the small CARs for native fish and amphibians.

Aquatic restoration could be focused on habitat, including riparian areas to maintain biodiversity or at-risk species. Aquatic species would be protected from ground-disturbing activities in these environs if they are in wilderness. Thus, increases in sedimentation should be least under this alternative, compared with alternatives A, B, and D. Like alternatives B and E, the goal to increase aquatic habitat restoration would address species needs and improve aquatic biodiversity.

Increased partnerships to restore aquatic habitats would improve ecological conditions that support the persistence of native species and aquatic diversity. Restoration of degraded habitats would increase resilience for native aquatic species. Desired conditions address native aquatic species and encourage aquatic restoration across the landscape to provide for the persistence of species. Increasing restoration and improving resilience to climate change would maintain biodiversity over time.

Resilience to Climate Change

Adaptively managing aquatic habitats for resilience to future climate change or improving adaptive capacity of aquatic ecosystems through ecological restoration and climate adaptation actions are addressed under this alternative similar to alternatives B and E. However, with the increase in recommended wilderness and the ability to use managed wildfire, vegetation including riparian vegetation should move closer to the natural range of variation. However, there is a high uncertainty about risk of large, high-intensity fire in other areas of the forest under this alternative.

Adaptively managing aquatic habitats for resilience to future climate change, or improving adaptive capacity of aquatic ecosystems through ecological restoration and climate adaptation actions often includes thinning of the riparian area and removing encroaching conifers. In both CARs and Conservation Watersheds treatments in the watershed are considered as part of the overall needs for aquatic systems. With partnerships more active watershed-level restoration as well as restoration of aquatic habitat, can increase in habitat or species resilience to climate change similar to B and E.

Riparian Vegetation

Limited restoration using mechanical treatments and an increased emphasis on fire, both prescribed and wildfire managed to meet resource objectives, would be the basis for managing riparian areas under alternative C. Increases in recommended wilderness areas could allow for more managed wildfire, which could return the natural range of variability for riparian areas. The species that depend on fire in riparian areas would be more diverse.

Although there is more managed wildfire proposed under alternative C, there is a high uncertainty as to how much would occur. This is because of the low levels of mechanical restoration used to create strategic areas to anchor large prescribed fires and wildfire to meet riparian resource objectives. If there were an increase in low- to moderate-intensity wildfire, there could be a benefit to riparian species and composition under alternative C, similar to alternatives B, D, and E. However, if the rate of managed wildfire and prescribed fire remains low, then riparian vegetation restoration and improvement in ecological conditions would not be achieved as well as it is under alternatives B or D.

Consequences Specific to Alternative D

Alternative D proposes focus landscapes designed to reduce risks of wildfire more effectively than the scattered treatment approach of alternatives A and B. Increased treatment of upland areas and associated riparian conservation areas would be designed to improve fire resiliency in riparian areas. Eliminating riparian conservation areas of 50 feet for ephemeral streams (see Glossary) would increase the risk of sedimentation to intermittent and perennial streams. Due to the expected return to the landscapes every 10 years, this effect would accumulate in the watersheds over time.

On the Sequoia National Forest, under alternative D, 173,267 riparian acres are unsuitable for timber production. This is 64 percent fewer riparian acres than proposed under alternatives A and B. On the Sierra National Forest, 393,338 riparian acres are unsuitable for timber production. This is 45 percent fewer than under alternatives A and B. (See Figure 46 for an example of changes in timber suitability in RCAs between alternatives B and D.) As the pace and scale of restoration is increased, including the use of mechanical thinning and increased area where wildfires are managed to meet resource objectives, the landscapes could become more resilient to the effects of climate change, especially increases in wildfire.

Sustainability of Habitat

Alternative D would provide fewer protections of aquatic habitats and water quality than alternatives A and B. RCAs designed to protect aquatic ecosystems from sediment are reduced in headwater ephemeral streams under alternative D. Degradation and loss of headwaters threaten the biological integrity of entire river networks (Meyer et al. 2007). Lessening riparian protections can increase inputs of sediments in streams, which in turn negatively affect aquatic habitat necessary for amphibians (Marczak et al. 2010).

The proposed increase in ecosystem restoration, including increased allowance for equipment use in riparian areas in drainages high in the watersheds would substantially increase amounts of sediment and other disturbances in ephemeral streams if performed on slopes over 30 percent. Once sediment enters these ephemeral streams, it will move downstream into perennial streams over time.

Under alternative D increased restoration actions in focus landscapes would result in a larger area where these changes would occur. The reduction of a filter strip to protect aquatic habitat and the reduction in buffers for species that use riparian areas would not improve aquatic habitat.

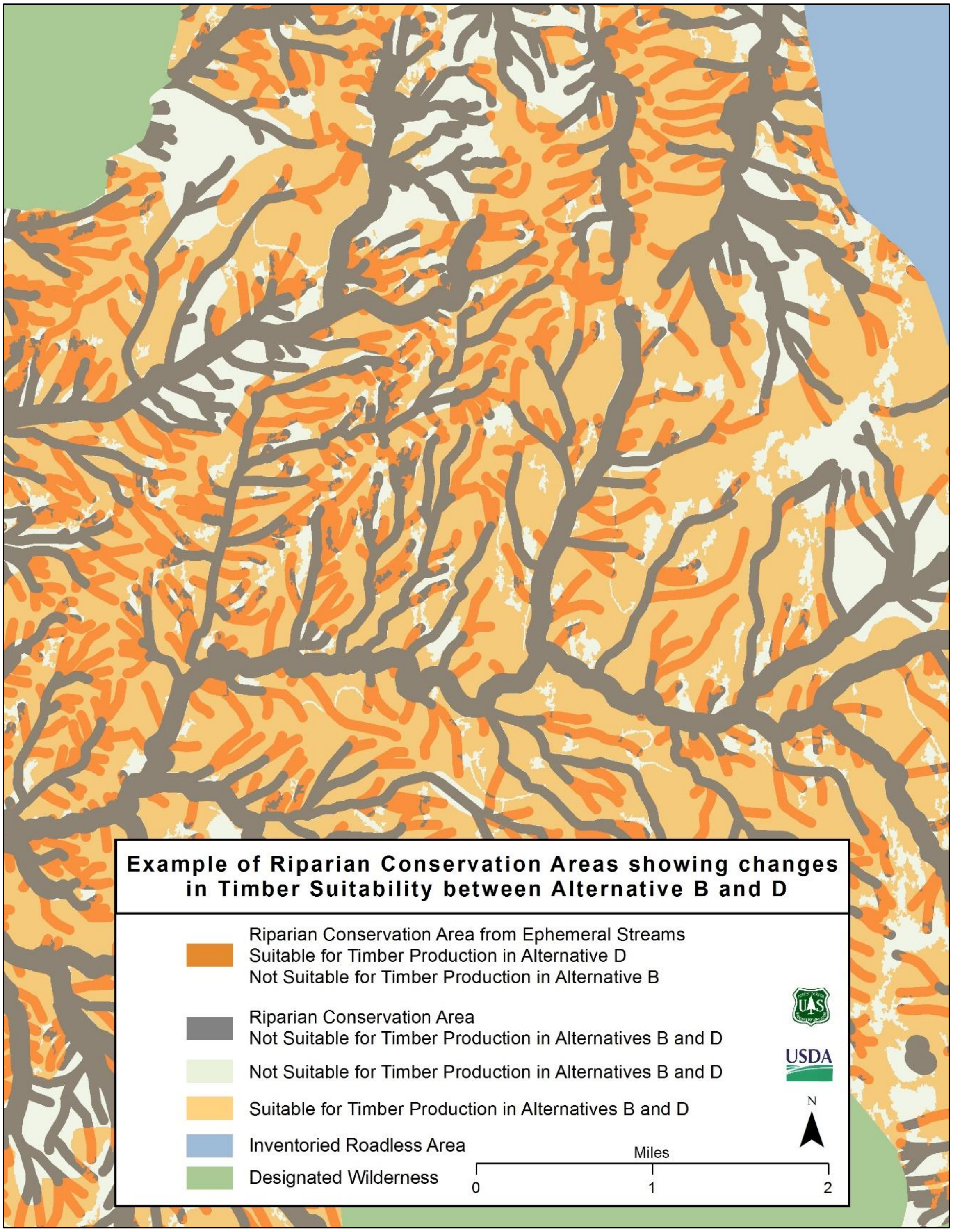

Figure 46. Example of Riparian Conservation Areas, showing changes in timber suitability between alternatives B and D.

Under alterative D, because of the lack of protections of headwater streams (neither buffers nor riparian conservation areas), the large landscape-level scale of projects, and the likelihood of effecting a subwatershed, this alternative would allow water quality and aquatic and riparian habitat to degrade, leading away from the desired conditions for riparian areas and watersheds. This alternative would negatively affect aquatic habitat, compared with alternatives A and B. Habitat suitability would decline over time, from fair or good to poor.

Ecological Connectivity

Desired conditions under alternative D address the maintenance and restoration of ecological connectivity among habitats for aquatic species, similar to alternatives B, C, and E.

Riparian conservation areas in perennial and intermittent drainages would provide conditions for species to use these areas close to streams as corridors for movement and foraging habitat. However, connectivity of habitat higher in the watersheds may be disrupted. Therefore, at higher elevations, the lack of connectivity of habitat would occur for amphibians, riparian birds, and mammals, compared with alternatives A and B. Ecological connectivity would go from fair or good to poor for aquatic species and amphibians that depend on seeps and ephemeral streams.

Biodiversity

Alternative D may have negative long-term consequences for species that depend on clean, sediment-free habitat, such as frogs and fish, when compared with alternative A. Streamside areas provide dispersal pathways for a variety of species. For over-ridge dispersal, headwaters offer the shortest distance among riparian zones in adjacent drainages (Olson and Burnett 2013).

Examining variable riparian buffers showed that buffer width on intermittent and ephemeral drainages matters. Amphibians did best with a minimum of 50- to 240-foot buffers. Woodland salamanders used riparian forests with 50 feet of headwater streams as habitat (Mazza and Olson 2015). These widths are also important for retaining sensitive headwater stream amphibians (Olson and Burton 2014) and wood loading, an important component of the stream ecosystem (Burton et al. 2016). Without these protections, amphibians are at risk 10 years (Olson et al. 2014) or 20 years (Jockusch et al. 2012) after upland thinning.

The Southern Sierra has many endemic amphibians that are vulnerable to habitat destruction, climate change (Wake and Vredenburg 2008), and the disease chytridiomycosis, which comes into the region from overseas, due to the proximity of two major seaports (Yap et al. 2015). Therefore, this alternative could cause the loss of endemic species, with very slow recolonization ability and with limited range. The goal to support aquatic restoration using partnerships would encourage restoration of aquatic habitat to improve persistence of species and sustain aquatic diversity. However, the slow pace of this restoration may not be able to keep pace with the loss of species associated with focus landscapes.

Resilience to Climate Change

As national forest managers increase the pace and scale of restoration, including mechanical thinning and increasing the use of wildfire managed to meet resource objectives, riparian areas should become more resilient to climate change. The risk of large intense fires on riparian areas would be reduced the most under alternative D. This is because of the increased amount of planned restoration in the riparian areas and adjacent upland vegetation and surrounding watersheds. Increased fire resilience would confer benefits to watersheds and riparian areas. However, this would not translate into indirect benefits to aquatic or riparian animal species or their habitat. Ground disturbance and crushing of endemic species would decrease their resilience to climate changes, such as drought. An increase in sedimentation would also decrease the resilience of fish and other aquatic species to climate changes, including rain on snow events.

While high-severity wildfires in forested basins can increase the production and delivery of sediment by several orders of magnitude (MacDonald and Coe 2007), the effects depend in part on whether the sediment delivery is episodic or chronic (MacDonald and Coe 2007). Sediment yields recovered to pre-harvest levels within 1 to 6 years in several paired catchment studies. However, once a slug of sediment is in a headwater channel, the resulting sediment wave can move downstream (MacDonald and Coe 2007). Delayed mass movements related to roads and harvesting may produce elevated suspended sediment yield one or more decades after logging (Gomi et al. 2005). It is this long-term movement into downstream reaches that can undermine the ability of the streams to support species that depend on clean water. While alternative A would not address climate change, it would protect ephemeral streams so that sediment would not increase. Alternative D would not improve resilience to climate change in aquatic ecosystems, compared with all other alternatives.

Riparian Vegetation

Alternative D may reduce the risk of uncharacteristically large wildfires, when compared with alternative A. Under the new plan components, treatments are permitted in riparian areas to reduce hazardous fuels, so as to decrease the risk of high-severity fire. Fuel reduction projects that include near-stream environments bring new challenges to riparian management (Dwire et al. 2016). Riparian areas, like their upland areas, have been affected by fire suppression, land use, and human disturbance, so limited manipulative treatments of vegetation and other fuels may be needed in some locations to maintain riparian biodiversity and restore valued functions (Dwire et al. 2016).

If vegetation management could pave the way for more managed wildfire, then the Forest Service would anticipate improvements in riparian vegetation, as long as soil has not been lost. With the increased pace and scale of restoration under alternative D, riparian areas should become more resilient to fire, and the vegetation community would more closely reflect the natural range of variation. There would be beneficial impacts on composition, structure, and function of riparian vegetation, including a decrease in conifer density, provided soil productivity is not lost. Riparian species composition and structure would be in good condition in the focus landscapes but not in other areas of the forests under alternative D.

Consequences Specific to Alternative E

Alternative E would have riparian protections similar to alternative A. However, the recommended wilderness or backcountry areas and an emphasis on the use of prescribed fire and managing wildfires to meet resource objectives would protect riparian areas from ground disturbance. It also would allow the use of managed fires or wildfires to improve the functioning of riparian areas. Although there is an emphasis on managing wildfires to meet resource objectives proposed for alternative E, there is a high uncertainty about how much would actually occur; this is because of the low levels of mechanical restoration. Under alternative E, more wilderness and backcountry areas could enable more wildfire managed for resource benefits.

Alternative E would add the CARs and conservation watersheds found under alternative C, which are compatible with backcountry areas and wilderness found under alternative E.

Sustainability of Habitat

Plan direction under alternative E is similar to that under alternative C and provides increased protections of aquatic habitat, compared with alternative A. Integrated plan direction addresses infrastructure within sensitive aquatic areas. This should improve aquatic habitat conditions over the long term, compared with alternative A. The potential for short-term effects from the increased pace and scale of restoration under alternatives B and D would be reduced under alternative E. In the Sequoia National Forest, due to the nature of the Kern River, the conservation watersheds are anchored in wilderness and inventoried roadless areas and extend beyond these areas. In the Sierra National Forest, this alternative protects both the large conservation watersheds and the small CARs for native fish. Restoring aquatic habitat with partners could improve sustainability and resiliency of aquatic ecosystems to climate change, similar to alternatives B and C.

Ecological Connectivity

Alternative E would provide for ecological connectivity among habitats for aquatic or riparian associates, similar to alternatives B and C. There would be more emphasis on restoring connectivity in both critical aquatic refuges and conservation watersheds. Conservation watersheds address the connections between floodplains, wetlands, upland slopes, headwaters, and tributaries to provide for breeding, dispersing, overwintering, and feeding habitats for at-risk species.

Biodiversity

Alternative E uses the same critical aquatic refuges and conservation watersheds as alternative C. These two management areas are consistent with wilderness and backcountry areas and with one another. Improvements in resilience of habitats for aquatic, riparian, and terrestrial ecosystems would improve the resilience of species in these watersheds. Conservation watersheds include plan direction, such as desired conditions to provide high-quality habitat and functionally intact ecosystems that contribute to the persistence of species of conservation concern and the recovery of threatened, endangered, proposed, or candidate species. These watersheds, with their focus on at-risk species and clean water, would over time improve resilience for aquatic habitats for species in these watersheds.

Downstream CARs in the Sierra National Forest would benefit from the conservation watersheds in upstream areas. Aquatic restoration could be focused on habitat, including riparian areas, to maintain biodiversity or at-risk species.

Increases in recommended wilderness areas could allow for managed wildfire and reaching the natural range of variability for riparian areas. Biodiversity of fire-dependent riparian species would increase. Aquatic species would be protected from ground-disturbing activities in these environs if they were in recommended wilderness or backcountry areas. The emphasis on backcountry areas and recommended wilderness would reduce the conflicts between management, permitted activities, and natural resources. Thus, increases in sedimentation should be least under alternative E, compared with alternatives A, B, and D. Like alternatives B and D, the goal to increase aquatic habitat restoration would address species needs and improve aquatic biodiversity.

Increased partnerships to restore aquatic habitats would improve ecological conditions that support the persistence of native species and aquatic diversity. Restoring degraded habitats would increase resilience for native aquatic species. Desired conditions address native aquatic species and encourage aquatic restoration across the landscape to provide for the persistence of species.

Resilience to Climate Change

Alternative E addresses adaptively managing aquatic habitats for resilience to future climate change and improving adaptive capacity of aquatic ecosystems through ecological restoration and climate adaptation; this is similar to alternatives B and C. However, similar to alternative C, with the proposed backcountry areas and recommended wilderness, the ability to use managed wildfire should bring riparian vegetation closer to the natural range of variation. However, there is a high uncertainty about risk of large, high-intensity fire in other areas of the forests under this alternative.

Adaptively managing aquatic habitats for resilience to future climate change or improving the adaptive capacity of aquatic ecosystems through ecological restoration and climate adaptation often includes thinning the riparian area and removing encroaching conifers. In CARs and conservation watersheds, treatments in the watershed are considered as part of the overall needs for aquatic systems. With partnerships, more active watershed-level and aquatic habitat restoration can increase habitat or species resilience to climate change; this is similar to alternatives B and C.

Riparian Vegetation

Limited restoration using mechanical treatments and an increased emphasis prescribed fire and wildfire managed to meet resource objectives would be the basis for managing riparian areas under alternative E. Although managed wildfire proposed for alternative E is similar to that of alternative C, there is a high uncertainty as to how much would occur. This is because of the low levels of mechanical restoration used to create strategic areas to anchor large prescribed fires and wildfires managed to meet riparian resource objectives. If there is an increase in low- to moderate-intensity wildfire, there could be a benefit to riparian species and composition under alternative E, similar to alternatives B, C, and D. However, if the rate of managed wildfire and prescribed fire remains low, then riparian vegetation restoration and improvement in ecological conditions would not be achieved as well as under alternatives B or D. However, more improvement to riparian areas functions should be achieved under alternative E, compared with alternative A.

Cumulative Effects

The analysis area is part of the greater southern Sierra Nevada ecosystem, and the most of the lands are administered or owned by the several Federal agencies, the State of California, water and power utilities, Native American tribes, and private landowners. The present and foreseeable actions of these public land management agencies and private landowners, in combination with management direction under the range of alternatives, will determine the cumulative consequences to aquatic habitat conditions.

Most lands in the analysis area that are managed by Federal land management agencies have individual resource management plans or shared, collaborative programs in place to guide the protection of natural resources, particularly in the management of wildfires. The focus of the 2012 Planning Rule on ecosystem integrity, resilience, and diversity is in close alignment with new direction for the National Park Service, which is to build ecosystem resilience for coping with changing climates. Updates to plan direction resulting from the new rule have provided for ecological response to climate change to be a focus. The “Strategic Framework for Science in Support of Management in the South Sierra Nevada Ecoregion” was developed collaboratively by Federal land managers in the Southern Sierra Nevada ecoregion (including the Sierra and Sequoia National Forests and Giant Sequoia National Monument) to help mitigate impacts from, and adapt to, climate change (Nydick and Sydoriak 2011a, b). For aquatic ecosystems, the long-term cumulative effects of future management actions across the landscape would vary by alternative.

Where water quality and riparian ecosystem function is addressed, as under alternatives B, even while increasing the pace and scale to achieve resilience to wildfire and climate change, the cumulative effects of management actions on habitat sustainability and biodiversity may be beneficial. The conservation watersheds require all future projects under alternatives B, C, and E to improve water quality and reduce roads and their effects. These future actions over time would sustain aquatic habitat, improve connectivity, and address resilience to climate and lead to beneficial cumulative effects on conditions in these watersheds. Alternatives C and E, with the reduced effect of soil disturbance on species, would protect and sustain habitat and biodiversity. User-created motorized trails in riparian areas and next to meadows and dispersed recreation sites effects on habitat sustainability, biodiversity, riparian vegetation, and habitat connectivity would be reduced the most in conservation watersheds under alternatives B, C, and E. Cumulative effects of actions under these alternatives would be beneficial.

Under alternative D, reasonably foreseeable future actions would result in a cumulative increase in sediment inputs to aquatic habitats. The cumulative effects of these landscape level actions of alternative D on riparian vegetation are expected to improve biodiversity and habitat connectivity. Riparian vegetation resilience to fire should improve under this alternative.

Dams on major rivers would continue to have effects on connectivity of habitat in aquatic ecosystems. Fishing is a valued pastime in the Sierra Nevada and planting of nonnative sport fish is expected to continue, although some changes would occur as State wildlife agencies adjust their policies and practices.

Analytical Conclusions

Desired conditions designed to achieve habitat sustainability, ecological connectivity, resilience to climate change, and wildfire in aquatic and riparian ecosystems on the two national forests would improve aquatic biodiversity or riparian vegetation in the plan area under alternatives B, C, and E, when compared with alternatives A or D. Alternative B improves resilience and restores health across the forest with less uncertainty than either alternative C or E.

Improving habitat sustainability for at-risk species will require partnerships and good stewardship to accomplish. Plan direction under alternatives B, C, and E support the improvement of persistence and resilience of habitats to improve sustainability. Alternative D is likely to negatively affect habitat sustainability for aquatic ecosystems, due to the persistence and effects of sediment moving from headwaters downstream. Since focus landscapes would be reoccupied within 10 years under alternative D, these effects would be persistent over time. Alternatives B, C, and E would not have these long-term effects. Alternatives B, C, D, and E have flexibility of management in riparian conservation areas to improve resilience to wildfire and improve plant species composition, structure, and function.

Improvement of ecological connectivity (including reduction or improvement of road crossings and water diversions and the accompanying improvement in number of rivers with unimpeded aquatic organism passage) would improve under alternatives B, C, D and E. This is because the goal to address aquatic restoration includes restoration of connectivity. Alternative A does not specifically address ecological connectivity of habitat; the other alternatives' plan direction does address this. Lack of connectivity associated with large dams would not be effected by the alternatives.

Improving sustainability and resilience of aquatic habitat for aquatic at-risk species would contribute toward improving biodiversity; involvement with partners would help achieve these desired conditions more quickly. Desired conditions to improve habitat and address aquatic biodiversity can help reverse the downward trend in biological diversity and effects of climate change currently found in the Sierra Nevada. However, alternative D is unlikely to help reverse the downward trend in biological diversity, due to the potential to increase sediment movement in streams and subsequent negative effects on habitat. Since desired conditions for restoration address invasive species, alternatives B, C, D, and E are more likely to assist the national forests in meeting desired conditions for aquatic invasive species. Reductions in invasive species would maintain or increase native aquatic biodiversity.

Improving resilience to climate change for aquatic habitats and species requires prioritization across the landscape. Increasing the rate of restoration of priority habitats for aquatic species and improving adaptive capacity through ecological restoration and climate adaptation actions is necessary to conserve diversity of aquatic species. Uncertainty in the rates of climate change, funding availability, and the number of National Forest Service staff working on watershed restoration would affect accomplishments under all alternatives. Partners can assist with increasing restoration of aquatic ecosystems by increasing the work on surveys, designs, NEPA, permitting and implementation done by partners, rather than the forests. Alternative A does not specifically address climate change; the other alternatives do address climate change.

Improving riparian area resilience to fire would most improve, as restoration creates a fire regime more aligned with historical patterns under alternatives B and D. Alternatives C and E would have fewer ground disturbances to the riparian conservation areas than alternatives B and D. Alternative D would benefit riparian areas by improving resilience to climate change and wildfire, compared with alternatives A, B, C, and E. Riparian vegetation condition, function, composition, and structure would improve under alternatives B and D, with more certainty than alternatives A, C, and E. This would be due to the greater amount of area restored, with a combination of limited mechanical treatments, prescribed fire, and wildfires managed to meet resource objectives.

Water Quality, Water Quantity, and Watershed Condition

Background

This section summarizes the hydrologic environment on the Sequoia and Sierra National Forests and the consequences of implementing the revised plan or its alternatives. Figure 47 and Figure 48 show the major drainages on the Sierra and Sequoia National Forests.

Water originating on the two national forests supplies municipal and agricultural water to Central and Southern California. Stream flows in the two national forests provide recreation opportunities for visitors. Water is integral to ecological sustainability. Streams, lakes, springs, and their associated riparian areas are relatively rare and important habitats in the forests.

As illustrated in Figure 47, the Sierra National Forest contains the headwaters of the Merced, San Joaquin, and Kings Rivers, while the Sequoia National Forest contains the headwaters of the Kings, Kaweah, Tule, and Kern Rivers. These rivers are all major contributors to the State’s municipal, agricultural, and industrial water supply.

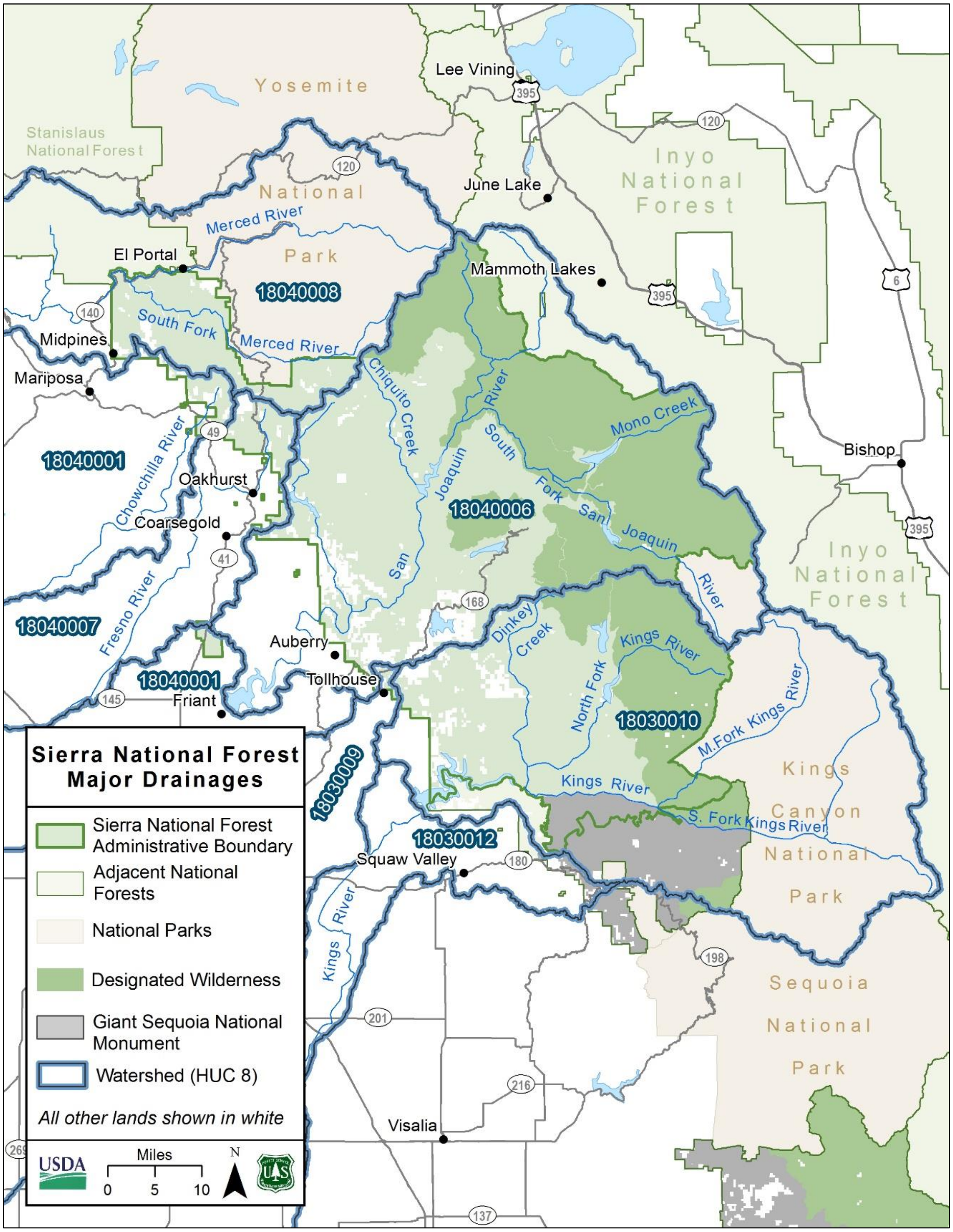

Figure 47. Principal Drainages of the Sierra National Forest

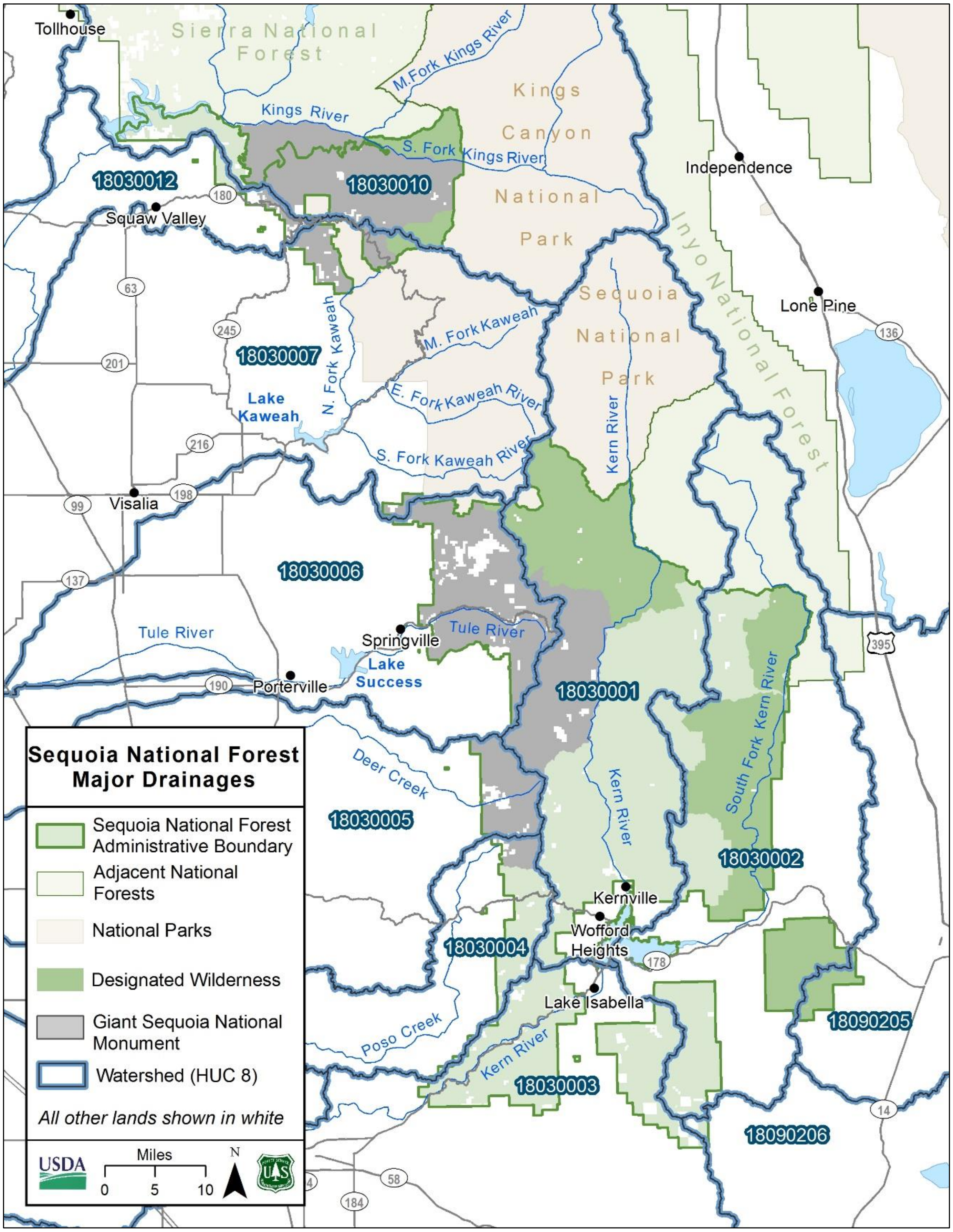

Figure 48. Principal Drainages of the Sequoia National Forest

Table 55 illustrates the relative sizes of the areas managed by the Forest Service in the four major rivers that flow from the southern Sierra Nevada. Overall, these forests account for about half of the total drainage area above the floor of the Central Valley. Because the forest lands are at the higher elevations, where most of the rain and snowfall occur, the forests account for the bulk of the runoff that flows into streams and reservoirs in most of these river systems and for a significant percentage of the groundwater recharge to the valley aquifers.

Table 55. Characteristics of the major drainages originating in the plan area

Watershed (HUC-8)[1]	Elevation Range (Feet)	Precipitation (Min.–Max.) (Inches/Year)	Total Area (Square Miles)[2]	Plan Area (Square Miles)[3,4]	Plan Area (Acres)[3,4]	Percentage in Plan Area
Merced River (18040008)	804–13,091	19.7–62.7	1,037	149	95,606	14
San Joaquin (18040001, 18040006)	318–13,858	14.0–62.6	1,666	1,230	787,441	74
Kings River (18030010)	581–14,268	19.7–60.8	1,544	658	421,285	43
Kern River (18030001, 18030002, 18030003)	561–14,495	9.6–58.0	2,310	1,120	717,101	49
Total:	318-14,495	9.6-62.7	6,557	3,157	2,021,433	48

[1]HUC = hydrologic unit code
[2]Null et al. 2010
[3]USDA FS 2018a
[4]Excludes area in Giant Sequoia National Monument. Acres are approximate.

As shown in Table 55, the Kern River, which drains most of the Sequoia National Forest plan area, has the largest drainage. Above about 560 feet above mean sea level, where the Kern River flows onto the Tulare Basin after leaving the foothills of the Sierra Nevada, the drainage area of the Kern River covers more than 2,300 square miles. About half of that area is in the Sequoia National Forest. A total of 50 HUC-12 watersheds within the boundaries of the plan area drain to the Kern River.

Lake Isabella operated by the U.S. Army Corps of Engineers, is the principal water storage reservoir and power generating facility on the Kern River drainage. The lake has a storage capacity of 570,000 acre-feet (AF). Lake Isabella Dam and water levels are managed by the Army Corp of Engineers. However, the lakeshore and recreation access was transferred to the Forest Service and is in the plan area. One small power plant on the Kern River above Isabella Lake, and another small power plant on the Lower Kern River below Isabella Lake are in the plan area.

Farther to the north, 18 HUC-12 watersheds in the plan area of the Sierra National Forest drain to the Kings River. The plan area contains about 42 percent of the drainage area of the Kings River above an elevation of 581 feet. This is just below Pine Flat Reservoir, which is partly in the plan area and has a storage capacity of more than 1 million AF. In addition to Pine Flat Reservoir, two other major water storage reservoirs, Wishon Reservoir and Courtright Reservoir, with a combined storage capacity of more than 250,000 AF, are in the Kings River drainage in the plan area. These reservoirs also generate hydroelectric power.

About 1,230 square miles of 40 HUC-12 watersheds in the drainage of the San Joaquin River, north of the Kings River, are in the plan area in the Sierra National Forest. This represents about 74 percent of the total drainage area of the San Joaquin River above Friant Dam, about 15 miles west of the Sierra National Forest boundary. Major reservoirs in the San Joaquin River drainage include Lake Thomas A. Edison, Florence Lake, Huntington Lake, Mammoth Pool Reservoir, Shaver Lake, Redinger Lake, Kerckhoff Reservoir, and Bass Lake, with total storage capacity of 630,000 AF.

Although the upper watershed of the Merced River is in Yosemite National Park, a total of 121,870 acres in 11 HUC-12 watersheds drained by the Merced River, lie in the plan area. This represents about 18 percent of the total drainage area above an elevation of 804 feet (the elevation of Lake McClure, about 8 miles west of the Sierra National Forest). The Merced River forms the boundary between the Sierra National Forest and the Stanislaus National Forest to the north. There are no reservoirs or hydroelectric generating facilities in the Merced River drainage in the plan area.

Some of the plan area in the Sequoia National Forest drains to several relatively smaller drainages that are not tributaries to the six major drainages listed. These include the following:

- Five HUC-12 watersheds, with a total area of about 40 square miles, in the Sequoia National Forest that drain to the Fresno River
- Parts of three watersheds, covering a total area of about 6.3 square miles that drain to Mill and Deer Creeks
- Part of one watershed that drains to intermittent stream channels on the margin of the Tulare Basin
- Parts of six watersheds on the southern margins of the Piute and Scodie Mountains that drain to the Indian Wells Valley, southeast of the Sequoia National Forest

Overall, a total of 149 HUC-12 watersheds are partially or fully in the plan area.

Figure 49 shows historical average annual precipitation for the Sierra Nevada. Precipitation varies widely by elevation and location, but it also varies significantly from one year to another due to large-scale climate influences. Average precipitation on the order of 9 inches per year falls in the semiarid area of the Piute and Scodie Mountains at the southern extent of the Sequoia National Forest. In the highest elevations along the crest of the Sierra Nevada, it can exceed 60 inches per year. Over most of the plan area, however, precipitation ranges between 20 and 40 inches annually.

Streamflow also varies greatly seasonally and from year to year. For example, streamflow records from a gauge on the Kern River north of Isabella Lake show that, while average annual discharge from 1961 to 2017 was about 360,000 AF, the annual discharge ranged from as low as 2,600 AF in 1961 to 1.2 million AF in 1969, a range of nearly three orders of magnitude. Similar large variations in annual streamflow occur in other watersheds.

Watersheds contain a wide range of features defined by varying physical attributes, including geology and soils, elevation, precipitation and runoff, vegetation, slope, and many others, historical uses, and natural and human-caused stresses. All of these features can affect hydrologic conditions. Meadows and corridors of riparian vegetation, which are usually found in the lower

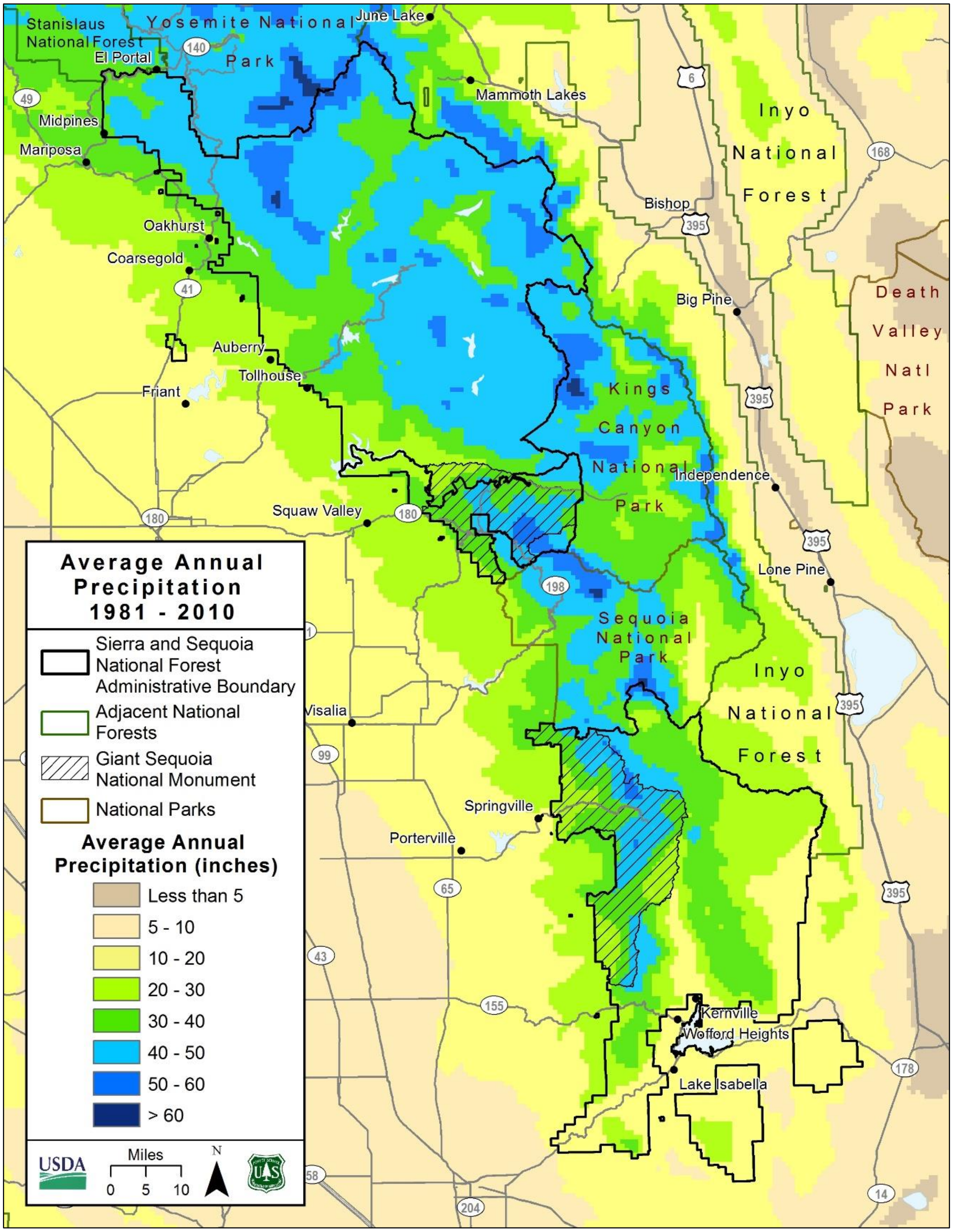

Figure 49. Average Annual Precipitation in the Plan Area and Surrounding Region

elevation portions of watersheds, provide wildlife habitat and recreation opportunities and store and release water year round. The surrounding slopes of the watershed collect and channel surface runoff and groundwater to the streams that drain the watersheds. The quality and quantity of water is of critical importance because these watersheds supply water that is used by millions of municipal, agricultural, and industrial customers downstream. The waters from the southern Sierra Nevada are essential for population centers, ranging from small communities to large metropolitan areas.

Streams and rivers support multiple uses across the forest. Many of these uses have a long history on the two national forests and have made aquatic and riparian systems the most altered and impaired habitats of the Sierra Nevada. As the population of California has grown, so has the demand for water, leading to a potential for greater diversion and dewatering in Sierra Nevada hydrologic systems. For more detailed information on water conditions, see the assessment for the Sequoia National Forest (United States Department of Agriculture 2013b) and Sierra National Forest (United States Department of Agriculture 2013c).

Analysis and Methods

For the purposes of analysis, overall watershed conditions are described in terms of HUC-12 watersheds.[13]

The analysis evaluates and compares estimated future conditions for each alternative to the desired conditions. The indicators, measures, and assumptions described below are used to evaluate how the alternatives move toward desired conditions and identify potential consequences from management actions across the forests. The indicators are used to predict future conditions related to water resources and overall watershed conditions under the alternatives.

The qualitative analysis is based primarily on the best available scientific information derived from the forest assessments (United States Department of Agriculture 2013b, c), the bio-regional assessment (United States Department of Agriculture 2013d), the Science Synthesis to Support Socioecological Resilience in the Sierra Nevada and Southern Cascade Range (Long et al. 2014), and recent reports and publications that assess current conditions and trends in the forests.

The Forest Service reviewed soil and water best management practices (BMPs) monitoring data to evaluate the effectiveness of current constraints on management actions. In addition, we examined watershed condition assessments using the Forest Service Watershed Condition Framework for the forests to assess the existing watershed condition ratings and identify restoration opportunities (United States Department of Agriculture 2011f). Stream condition inventory monitoring and assessment data and State 303(d) listing information, were also examined where available (State Water Resources Control Board 2018b), to evaluate restoration opportunities across the two national forests.

[13] The USGS has assigned HUC numbers to watersheds of increasingly higher orders for the entire United States. Each increasing order is given a 2-digit number. A first order watershed includes all of the drainage area above the mouth of all of the major rivers that drain to the sea or to terminal basins. There are 78 first order watersheds in the continental United States. Moving upstream, the watersheds of tributary streams are assigned additional 2-digit codes. HUC-10 watersheds (shown in Figure 48) represent fifth order watersheds in this progression, and HUC-12 watersheds are the next smaller (sixth order) watersheds, nested within the HUC-10 watersheds. The size of a watershed of a given order depends on the size of the first order watershed and the nature of the drainage network. HUC-12 watersheds in the plan area range from about 10,000 to 60,000 acres or more.

Indicators and Measures

This analysis uses three indicators: water quality, water quantity, and watershed condition. These indicators are evaluated over the two general time periods to compare and contrast how the different alternatives would affect the aquatic resources: Short-term impacts generally run for 1 to 5 years after an event, and long-term impacts generally run from 5 years through the life of the plan

Water Quality

Water quality may affect the health of aquatic habitat and other beneficial uses of both surface water and groundwater, as defined by the State Water Resources Control Board (State Water Resources Control Board 2018a). The two most critical parameters with the potential to influence surface water quality at the landscape scale, or to be influenced by climate change, are sediment loading and water temperature (Hunsaker and Neary 2012, Neary et al. 2005, Young et al. 2009). Other water quality parameters, such as nutrient inputs (such as nitrogen and phosphorus), high or low pH, high alkalinity, low dissolved oxygen, toxicity,[14] metals, and bacteria (such as *E. coli*), are also a concern to water quality. However, they are best addressed at the project level, considering requirements of the Clean Water Act, including evaluation and development of total maximum daily loads (TMDLs).

Surface water and groundwater occurrence and quality are often closely related. This is because groundwater is recharged by infiltration of surface water. Surface water, especially in mountains with shallow groundwater, is often replenished by groundwater, which reaches the surface in springs and seeps and inflows to streams, lakes, ponds, and meadows.

Water Quantity

Water quantity refers to the timing, overall distribution, and volume of water produced from forest watersheds and includes both surface and groundwater resources. Water quantity depends largely on the amount, type, and timing of precipitation. Soil conditions and impervious surfaces affect how precipitation is distributed, whether through runoff or ground infiltration. Shallow groundwater recharge and storage redistributes the water not captured by plant roots as streamflow and as springs and seeps.

Watershed Condition

In March 2011, the Forest Service assessed the condition of National Forest System lands for all HUC-12 watersheds on the forests. We used standardized protocols developed to implement the Watershed Condition Framework (United States Department of Agriculture 2011f, Potyondy and Geier 2011).

The watershed condition classification system, known as the Watershed Condition Framework, uses 12 indicators, consisting of attributes related to watershed processes. The indicators and their attributes are surrogate variables representing the underlying ecological functions and processes that affect soil and hydrologic function. They include three indicators of the physical condition of the aquatic environment (water quality, water quantity, and aquatic habitat), two indicators of the biological condition (aquatic biota and riparian and wetland vegetation), two indicators of the physical condition of the terrestrial environment (roads and trails and soils), and five indicators of the terrestrial biological condition (fire regime or wildfire, forest cover, rangeland vegetation, terrestrial invasive species, and forest health). Each indicator consists of one or more attributes

[14] A nonspecific measure of the ability to support aquatic biota

and is assigned a weighted score. The overall watershed rating is based on amalgamated values of these attributes and indicators.

For most of the indicators, the Forest Service can take direct action that can contribute to maintaining or improving watershed condition, integrity, and functionality. This provides a direct link between the classification system and management or improvement activities the Forest Service conducts on the ground (United States Department of Agriculture 2011f).

The three aquatic physical condition indicators have the most direct relation to hydrology, which is the subject of this section.

The watershed condition framework and the FSM 2521.1 uses three classes to describe the aggregate watershed condition:

- Class 1 watersheds are considered to be functioning properly
- Class 2 watersheds are considered to be functioning at risk
- Class 3 watersheds have impaired function

Assumptions

There are several assumptions about ecological restoration and how different management tools may affect water quality, water quantity, and overall watershed condition that are described in the assumptions section in the “Aquatic and Riparian Ecosystem Integrity” section. There are some additional assumptions that inform this analysis as well.

Water Quality

- Proponents of projects developed under all alternatives will implement established BMPs to protect soil and water quality. The National BMP Program consists of four main components: (1) the National Core BMP Technical Guide (Volume 1, FS-990a, April 2012) (United States Department of Agriculture 2012e), (2) the National Core BMP Monitoring Technical Guide (Volume 2, FS-990b, in preparation), (3) revised national direction, and (4) a national data management and reporting system (United States Department of Agriculture 2018a).
- Based on results of past monitoring, BMPs are expected to reduce both short- and long-term adverse impacts to less than significant levels. The Forest Service will continue to follow agency direction to implement an annual BMP evaluation and adaptive management program. These results will then be reported to the jurisdictional regional water quality control boards.
- The Forest Service will continue to work with the jurisdictional regional water quality control boards to identify management strategies to address current 303(d) watersheds and sources of nonpoint source pollution and to develop TMDL listings. Project proponents will comply with requirements of the Clean Water Act.
- The Forest Service will continue the transportation analysis planning process to systematically identify and address segments of roads that are impairing the hydrologic function or accelerating erosion.
- The Forest Service will continue to pursue opportunities to retrofit, relocate, or decommission roads and trails to reduce potential sediment transport to rivers and streams, especially within priority watersheds, as outlined in watershed restoration action plans.

System trails are currently undergoing a similar assessment and retrofit program, but they are not considered to present the same degree of water quality threat as the road network, because of their relatively small footprint.

- While uncertainty surrounds the degree of climate change, observed warming air temperatures, combined with fire suppression and insect outbreaks have changed fire behavior, creating the potential for increased size, intensity, and frequency of wildfires and observed increases in water temperatures during late summer. This is expected to continue (Null and Viers 2013, Knowles and Cayan 2002).
- Some management activities and national forest infrastructure, such as mechanical vegetation management treatments, roads, campgrounds, and grazing management, could cause both short- and long-term adverse impacts on water quality that are evaluated and mitigated at the site-specific project level when projects are proposed and designed.
- Forest Service restoration activities, such as landslide stabilization, road decommissioning, and stream channel, floodplain, and meadow restoration, reduce sedimentation and restore resiliency to watershed processes that affect water quality.
- Shallow groundwater serves as a filtering system for surface water and helps maintain beneficial temperatures for native fish.

Water Quantity

- The quantity of shallow groundwater is reduced under drought conditions and where infiltration is limited by development or hydrophobic soils, which occur in areas of high burn intensity after wildfires.
- The Sequoia National Forest contains portions of the Kern River Valley groundwater basin (basin 5-025) and the Indian Wells Valley groundwater basin (basin 6-054). The Sierra National Forest does not overlie any groundwater basins. The alternatives considered in detail will not affect the use of groundwater in these basins.
- The Forest Service will work with the State of California on regulated water rights, particularly during droughts.
- Meadow restoration will help regulate and extend the season of water flows and may help mitigate climate change effects, as flows become more erratic and the season for ephemeral flows changes.
- Climate predictions include increased warming, less snowpack, and earlier spring snowmelt. These changes would influence the amount and timing of water that originates from National Forest System lands and from precipitation.
- Climate changes, especially where rain replaces snowfall, tend to increase runoff and reduce infiltration and shallow groundwater recharge.
- The amount of impervious surface throughout a watershed affects the timing and flow characteristics, because a greater area of impervious surface reduces infiltration of rain and snowmelt into the soil.

Watershed Condition

- Management direction will provide opportunities to improve watershed conditions to protect and restore the high-value ecological functions of aquatic and riparian ecosystems. Restoration of terrestrial ecosystems will also improve or maintain the watershed condition by increasing fire resilience and reducing risk of large, high-intensity wildfire. Under all alternatives, projects listed in the watershed restoration action plans will continue to be planned and completed within the priority watersheds.

- There will continue to be a risk of adverse resource effects associated with wildfire under each of the alternatives, which could degrade the overall watershed condition. The relative difference in wildfire risk between alternatives is described in “Fire Trends” and “Fire Management.” The Forest Service assumes that the level of risk of adverse effects on soil and water resources can be estimated by the level of risk of catastrophic wildfire.
- Under all the alternatives, stream channel and floodplain restoration efforts planned and implemented will improve resilience to and mitigate some effects of climate change. Geomorphically stable stream channels and floodplains that exist in a state of dynamic equilibrium are better able to adjust to climate change impacts on hydrology without resulting in adverse impacts on aquatic habitat, water quality, or water quantity.

Affected Environment

Current Conditions and Trends

Water Quality

Overall, water quality in the plan area is very good. It has benefited from restoration projects to treat legacy impacts and from implementing protective standards and guidelines in the current forest plans. In general, recent changes in management to focus more on restoration and forest health and resilience, rather than on timber production and fire suppression, have focused on improving overall watershed function, which includes a much wider set of desired conditions than just improvements in water quality. However, as discussed below, many of the characteristics that contribute to overall improvement in watershed function can indirectly assist in maintenance and improve water quality.

Soil erosion, pollutants, dams, roads, and management in or outside the national forests can directly affect the quality of their waters. Water quality on the two national forests is generally good, in part because the forest lands tend to be topographically higher than affected areas outside the forests (United States Department of Agriculture 2013b, c, d). Relatively few areas in the forests have widespread accelerated erosion beyond the natural range of variation. Erosion rates outside of the natural range of variation have been observed mainly along roads in steep areas, in developed areas, such as ski areas, and after high-intensity wildfires. Overgrazing, roads, and ground-disturbing recreation can also adversely affect water quality.

Road and trail construction, use, and maintenance can all contribute to erosion and sediment transport to aquatic ecosystems. Roads and trails can influence water quality by removing or reducing soil cover, destroying roots that bind soil, removing woody debris that slows runoff and erosion, and reducing infiltration. Sedimentation and barriers from road and trail crossings have also contributed to degraded conditions (United States Department of Agriculture 2013d).

There are an estimated 1,646 miles of National Forest System roads in the Sequoia National Forest and 1,969 miles in the Sierra National Forest. This represents an average road density of only about 0.002 miles per square mile, but the road densities range up to about 4 miles per square mile in individual HUC-10 watersheds. The median road density in the HUC-10 watersheds in the plan area is about 2.5 miles per square mile (United States Department of Agriculture 2001a). The estimated sediment yield from these roads is between 0.01 and 0.09 tons per acre per year. Road-related sediment yields vary across the bioregion from 0.007 to 0.13 tons per acre per year (United States Department of Agriculture 2013d).

Increased soil erosion and sedimentation in streams is often the most common effect on water quality following fire. Maintaining a vegetation cover or a cover of litter and other organic material on the soil surface of a watershed is the best means of preventing excessive soil erosion rates. However, fire can cause the loss of these protective covers and in turn cause excessive soil erosion and soil loss from burned areas.

Watersheds that have been severely denuded by a wildfire are often vulnerable to accelerated rates of soil erosion and, therefore, can yield large and often variable amounts of postfire sediment. In the southern Sierra Nevada, fires are often increase erosion, both from water and wind, and to a lesser extent from sediment transport by gravity (so-called "dry ravel") (Berg and Azuma 2010). Erosion rates as high as 30 to 44 tons per acre per year have been measured following high-severity wildfire. These high erosion rates seen after a fire typically decline within 3 to 5 years as vegetation recovers (United States Department of Agriculture 2013d).

Short-term increases in soil erosion rates may occur after mechanical fuels reduction treatments, but the amount of increase depends on the methods used, amount of bare soil exposed, slope, soils, and other factors that make it difficult to predict rates in general. In New Mexico (Cram et al. 2007), relatively small increases in erosion occurred after vegetation treatments minimized disturbance, even on steep slopes, but a 22-fold increase occurred on steep slopes where soil was exposed. One study, based on erosion prediction modeling, estimated that thinning treatments result in about 70 times lower sediment erosion rates than rates following wildland fire; prescribed burning was estimated to result in about 1.6 times the sediment yield as thinning treatments (United States Department of Agriculture 2005). Applied to the estimated 30 to 40 tons per acre per year after wildland fires mentioned above, this would suggest post-fuel treatment erosion rates on the order of 0.5 tons per acre per year and post-prescribed burn rates on the order of about 0.8 tons per acre per year. These results provide a broad order of magnitude comparison only, and they probably vary greatly, depending on the particular site location and characteristics.

By contrast, fuels reduction treatments, including road construction, when accompanied by BMPs, have been estimated to result in long-term erosion rates on the order of 0.14 tons per acre per year (United States Department of Agriculture 2013d). This suggests that after 3 to 5 years, erosion rates in treated areas would be quite low.

The large inputs of sediment into a stream following a wildfire can tax the transport capacity of the stream and lead to channel deposition (aggradation). However, prescribed burns by their design do not normally consume extensive layers of litter or accumulations of other organic matter and often leave soil structure intact (Busse et al. 2014).

Chemical residues can be transported to receiving waters and groundwater by runoff and infiltration that comes in contact with the burned materials. Peak flows in streams tend to increase after fires not only because it removes vegetation and forest litter that would normally delay runoff; high temperatures also can reduce rates of water infiltration through the surface soils by making them more repellant (hydrophobic) to water.

The effects on chemical water quality following a fire depend on a number of factors, including fire temperature, the nature of vegetation, use of fire suppressants, and land use, and because of the amount of human-made materials in the burned area (Tecle and Neary 2015). The runoff from burned areas can transport sediment, ash, and chemical contaminants of burn residues to receiving waters. It also can carry increased nutrients and minerals, increasing algal production and reducing dissolved oxygen in the receiving waters.

The development of fixed-width riparian conservation areas and standards and guidelines in the current forest plans have provided an effective level of protection to water quality throughout the two national forests. The Sequoia and Sierra National Forest plans incorporate a default "half-the-width" equipment exclusion zone. This can be adjusted as projects are designed, considering site-specific conditions. The riparian conservation areas have reduced soil disturbance and erosion in areas that have the highest risk of contributing sediment to aquatic environments.

The current plans also retain critical aquatic refuges, as described in "Aquatic and Riparian Ecosystems." Critical aquatic refuges focus restoration needs when projects occur in or near them. Where roads are used for management actions, managers would look for opportunities to maintain, repair, reroute, or improve aquatic organism passages across them through stewardship or partnership opportunities. In some cases, critical aquatic refuges may overlap priority watersheds, where essential projects would benefit aquatic species and the watershed condition overall.

In compliance with the Federal Clean Water Act and state law, the state and regional water quality control boards have established lists of impaired waters on or immediately downstream of the national forests. However, these data are primarily used for screening and are not sufficient to identify causes nor to evaluate trends. Every 2 years, the U.S. EPA must review and approve the list of impaired waters, required under Section 303(d) of the Clean Water Act. The 303(d) list reports on the results of repeated sampling of selected stream segments and lakes identified as impaired for one or more pollutants. Impaired means these water bodies do not meet one or more of the Federal and state standards used to indicate whether the water quality in the segment is sufficient to support the beneficial uses established for the given water body (State Water Resources Control Board 2018a).

Further detailed studies are required for chronically impaired water bodies, to identify sources (causes) of impairment and to establish TMDLs for the pollutants that indicate impairment. TMDLs have not yet been established for the water bodies in or next to the forests. Impaired waters are identified through assessment and monitoring programs conducted by volunteer networks and local, state, and Federal agencies. Table 56 shows the 303(d) listed water bodies in or near the Sequoia and Sierra National Forests and the possible causes of impairment.

Most of the impaired water bodies are either outside the plan area or on its margin. For example, a 58-mile reach of Deer Creek begins on the margin of the Sequoia National Forest. This reach is listed for chlorpyrifos,[15] toxicity, and elevated pH .

A segment of Willow Creek below Bass Lake in the Sierra National Forest is listed for temperatures outside the optimal range for fish habitat. Outflow to Willow Creek is regulated by diversions from Bass Lake to generate hydroelectric power; the Forest Service has little control of these operations. The ultimate sources of the impairments have not been identified and TMDLs have not been prepared. However, the temperature data that are the basis for the listing are from 2002, prior to FERC relicensing in 2003, which required additional temperature monitoring of this reach. The Central Valley Regional Water Quality Control Board decided to keep the listing, pending evaluation of the monitoring results. In any event, it is unlikely that Forest Service practices are a significant factor in the impairments in the plan area.

[15] A restricted, wide-spectrum pesticide formerly used on many crops, including cotton, grapes, and almonds

Table 56. 303(d) Listed waterbodies in or next to the Sequoia and Sierra National Forests

National Forest	Water Body Segment (HUC-12 Watersheds Involved)	Reason(s) for Listing (Pollutant)	Beneficial Uses Listed as Impaired	Source(s) of impairment(s)	Expected TMDL Completion Dates
Outside plan area (downstream of Giant Sequoia National Monument	Deer Creek, 58-mile segment beginning inside Sequoia National Forest (180300050103, 180300050103)	Chlorpyrifos, toxicity, pH (high)	Fish habitat	Not identified	2027, 2021, 2021
Sequoia (outside the plan area)	Lake Isabella (180300010607, 180300020702)	Mercury, dissolved oxygen, pH	Sport fishing	Not identified; high-use recreation, populated area	2027
Outside plan area (downstream of Giant Sequoia National Monument)	Kaweah Lake (180300070902)	Mercury (bass tissue samples)	Sport fishing	Not identified; some historic silver/galena mining occurred in the Mineral King area	2027
Outside plan area (in Giant Sequoia National Monument)	Hume Lake (180300100701)	Dissolved oxygen, pH	Sport fishing	Not identified; high visitor-use area	2027
Sequoia and Sierra	Pine Flat Reservoir to Island Weir (180300100806)	alkalinity, toxicity (sediment)	Sport fishing	Not identified	2027, 2021
Sierra	Willow Creek below Bass Lake (180400061103)	Temperature	Fish habitat	Not identified	2019
Outside plan area (downstream of Sierra National Forest)	Fresno River above Hensley Reservoir to Nelder Creek and Lewis Fork (180400070103)	Low dissolved oxygen	Fish habitat	Not identified	2021

Based on an evaluation of BMPs throughout the Pacific Southwest overall from 2003 to 2007 and using protocols and procedures established for the Regional Best Management Practice Effectiveness Monitoring Program (United States Department of Agriculture 2001a), 86 percent of BMPs were rated as implemented, and 93 percent of those implemented were rated as effective (United States Department of Agriculture 2009). Many of the BMPs were rated as ineffective because they were not implemented. The evaluation found improved implementation of BMPs as the single most useful step that can be taken to improve water quality protection on national forests in California (United States Department of Agriculture 2009).

Based on BMP effectiveness data collected from 2011 to 2014 for the Sequoia National Forest, 92 percent of the BMPs evaluated were rated as implemented and effective in preventing adverse impacts on soil and water quality (Kelley 2015). The Sierra National Forest rated 77 percent of the BMPs as implemented and effective (Kelley 2015).

Approximately 465 miles of perennial stream channels on the Sierra National Forest were evaluated to rate channel type and stability. Stream reaches composed of bedrock or boulders had low sensitivity to management activities and made up about 60 percent of the streams evaluated. Fifty-four percent of the moderately sensitive channels were found to have poor channel stability, meaning they are susceptible to bank and bed erosion (United States Department of Agriculture 2013c). Conditions on the Sequoia National Forest are expected to fall within a similar range.

Among the key measures of water quality most relevant to forest management are temperature and sediment loading. This is because these are critically important to aquatic species and the overall health of the aquatic system. Climate change is expected to alter the hydrologic regime in the Sierra Nevada in ways that could adversely affect water quality.

Overall average annual precipitation may continue to increase as it has over the past 50 years in the southern Sierra Nevada. However, higher ambient air temperatures will continue to cause earlier snowmelt, earlier and larger peak flows, and lower base flows in the summer and fall throughout the southern Sierra Nevada. Higher peak flows could increase erosion and nutrient loading.

Water temperatures will increase, not only because of increased ambient temperatures, but because of slower stream flows, shallower water depths, and greater heat absorption of water made more turbid by higher concentrations of suspended sediments and micro-organisms supported by increased nutrient loads. The effects of climate change will be further exacerbated in at-risk watersheds.

Groundwater

The Sierra National Forest does not overlie any groundwater basins large enough for the California Department of Water Resources to map. However, the southern Sequoia National Forest overlies part of two alluvial groundwater basins (California Department of Water Resources 2016a). The Kern River Valley groundwater basin (basin 5-025), which is in the Tulare Lake Hydrologic Region, contains Isabella Lake, and is bounded on the west by the Greenhorn Mountains and on the south by the Piute Mountains and the Scodie Mountains. It extends north about 12 miles into the North Fork Kern River Valley, and east along the south fork of the Kern River, beyond the Sequoia National Forest boundary (California Department of Water Resources 2018). The basin covers an area of 74,000 acres. To the southwest the margins of the Sequoia National Forest affect the basin in the drainages of Bodfish and Erskine Creeks and to the southeast in the watershed of Dry Meadow Creek.

Recharge comes primarily from the north and south forks of the Kern River and its tributaries and from direct precipitation. Groundwater is the primary water supply for the Kern River Valley, and groundwater extraction from the basin for agriculture and domestic uses frequently exceeds recharge (County of Kern 2011). The average thickness of the alluvial deposits in the basin ranges from about 30 feet in the North Fork Kern River arm of the basin to about 200 feet in the South Fork Kern River segment and about 100 feet in the southern parts of the basin.

Groundwater quality varies, and some domestic wells sometimes fail to meet state and Federal drinking water standards. Naturally occurring arsenic, iron, manganese, and radon-222 are the principal groundwater concerns, as well as bacteria due to leaching from septic systems. About 20 percent of the recharge to the basin is treated municipal wastewater or infiltration from irrigation, most of which originates from private lands.

The southeast margin of Sequoia National Forest affects the Indian Wells Valley groundwater basin (basin 6-054) on the southeastern side of the Scodie Mountains. Indian Wells Valley is a terminal basin that contains China Lake.

Most of the lands in the plan area are underlain by relatively shallow bedrock and localized accumulations of alluvial deposits. Groundwater occurs in these thin, unconsolidated deposits or in bedrock fractures. There are few data on groundwater quality in these areas. Most water supply is from surface water sources. There are few human-made sources of contamination outside of the small settlements. Potential sources of groundwater contamination are petroleum hydrocarbon spills and releases, spills and releases of chemicals used for construction, and infiltration of nonpoint source contaminants, such as may be present in runoff from roads or parking lots.

Water Quantity

Climate change is expected to affect a wide range of conditions that will alter hydrologic conditions in the Sierra Nevada. Climate change effects include rising minimum ambient air temperatures, earlier snowpack melting and runoff, a shift from snowfall to rainfall at higher elevations, changing stream hydrology, vegetation cover, and evapotranspiration, and increased frequency of large, high-severity wildfires (Bales et al. 2011, Safford et al. 2012a).

Climate change is also expected to change the pattern, frequency, and intensity of disturbances. One result will be increased wildfires, with some simulations suggesting a 5 to 8 percent increase in the annual burned area across California by the end of the 21st century (Safford et al. 2012a). By contrast, predictions for the analysis area and all of the Sierra Nevada are that the burned area will double or quadruple over the next 20 to 30 years (Westerling et al. 2015).

Counterintuitively, while mean annual temperature in the southern Sierra Nevada has increased slightly during the past 50 years (Safford et al. 2012a), spring snowpack has actually increased, attributed to higher precipitation in the higher elevations of the southern Sierra Nevada.

While a continuation of these trends would increase runoff and may help to offset some of the reduced water supplies from the northern Sierra Nevada, increased and more rapid runoff might also increase erosion, which would worsen if the burned area increases.

Meadows play an important role in retaining and releasing groundwater. There are an estimated 345 square miles of meadows in the 10 national forests of the Sierra Nevada (a little less than 2 percent of the total acreage) (Hunsaker et al. 2015). There is an estimated 86,000 to 114,000 acre-feet of groundwater storage capacity, roughly the capacity of Huntington Lake. This groundwater could be restored by restoring all the meadows that have been damaged by gully erosion and stream incision in the Sierra Nevada (Viers et al. 2013). Assuming that the loss of storage capacity is a fraction of the remaining storage capacity, this suggests that, although they represent a relatively small percentage of total forest lands, the groundwater storage capacity and other ecological services provided by meadows, including habitat, water quality improvement, flood attenuation, are important.

There are limited data on the effects of watershed restoration on water quantity in the Sierra Nevada. (Podolak et al. 2015) found evidence in one study that meadow restoration had the potential to change the timing of flows. However, pond-and-plug meadow restoration projects completed in the northern Sierra Nevada have found no significant differences between pre- and post-project late season flows (Hoffman et al. 2013). Given the variability of seasonal and yearly fluctuations of precipitation, it is difficult to clearly attribute increased flows to restoration.

Most meadows on Forest Service lands are found at elevations above 4,000 feet in all geologic environments. (Weixelman and et al. 2011) identified 14 types of meadows, based on their hydrogeomorphic characteristics. Many meadows are sustained by groundwater inflows, but dry meadows are sustained primarily by direct precipitation. Some meadows have through-flowing streams, and others are maintained by groundwater underflows. Some meadows form in depressions, and others on slopes. Riparian (stream-fringing) and lacustrine (lake-fringing) meadows can store and release large quantities of groundwater, but the amount of storage capacity is highly variable. The sizes of meadows also vary considerably.

Meadows are very important in storing water, maintaining groundwater levels, and maintaining water quality. About one-quarter of all meadows surveyed are the headwater sources of surface water outflows (Hunsaker et al. 2015). The Forest Service estimates that there are 358 meadows of at least an acre in the Sequoia National Forest plan area. They range up to 1,820 acres and account for a total of 7,650 acres, or about 1 percent of the total plan area in the forest.

The Sierra National Forest features a larger number of meadows that are generally smaller than the meadows in the Sequoia National Forest. About 3,628 meadows greater than 1 acre have been identified in the Sierra National Forest, covering a total of nearly 17,000 acres (about 1.5 percent of the plan area in the forest) and ranging up to about 240 acres (UC Davis Center for Watershed Sciences and United States Department of Agriculture 2018).

An estimated 42 percent of the total meadow area on National Forest System lands in the Sierra Nevada show evidence of erosion of up to about 2 feet (0.6 meters), and another 29 percent show evidence of an average of a little more than 3.5 feet (1.1 meters) of erosion. Historically, much of this erosion is believed to be due to human-related causes, such as grazing of livestock, roads, and timber harvesting, and most of it has occurred since the 1910s (Hunsaker et al. 2015). Ratliff identified four major problems affecting the condition of meadows in the Sierra Nevada: livestock overgrazing, lodgepole pine incursion, fire, and gully erosion (Ratliff 1985).

Gully erosion typically begins at the downstream end of a meadow and works its way upstream. As the erosion migrates upstream, it incises the stream channel. The deeper channel drains groundwater from the meadow. The net effect is to reduce groundwater retention in flow-through meadows. Channel plugging is one technique used to restore incised meadows. Slowing the flows through these incised streams by placing obstacles in the channels can help to deposit sediment in the channel.

Grazing practices have affected forest meadows since heavy grazing by sheep began in about 1900. Past overgrazing by livestock has resulted in the loss of many acres of productive meadows. Overgrazing has been largely controlled by implementing a permit system and monitoring, which has limited the intensity and timing of grazing; nevertheless, some of the effects, such as soil compaction and soil loss, have been long lasting.

Lodgepole pine is particularly adapted to meadow invasion, since it can withstand soil saturation. Lodgepole pine seedlings tend to become established in years with low snowpack (Ratliff 1985), which are expected to be a more frequent with climate change. As the trees take hold along the margins of a meadow, they contribute to dewatering of the meadow through evapotranspiration.

The established lodgepole pine is able to obtain water from greater depths than the surficial grasses. Under natural conditions, frequent small and moderate fires would help to prevent the incursion of lodgepole pine, but fire suppression policies of the past century have enabled the pine incursion to continue.

Hunsaker et al. reported that about half of the meadows they surveyed in national forests in the Sierra Nevada have streams running through them, and the other half are supplied by groundwater, with no identifiable stream inflows or outflows (Hunsaker et al. 2015). They reported that streamflow records for locations downstream of eroded meadows showed less consistency in relation to precipitation than records for the Merced River downstream of large but unincised meadows. This suggests that, for meadows containing streams, eroded meadows detain streamflows less effectively, allowing the runoff to flow through more quickly. Meadows with unincised channels are more likely to overflow their banks and flood the meadows, which allows time for infiltration of the floodwaters, leading to more groundwater storage.

Climate predictions indicate that changes in flow patterns will stress meadows, streams, and rivers in several ways. In areas where rain replaces snow, the opportunity to infiltrate and recharge shallow groundwater is reduced; this is because more precipitation immediately runs off the land. Peak flows will be earlier and more intense, possibly increasing erosion and leaving less water later in the summer (Long et al. 2014). Pulses of soil erosion and flooding caused by higher rainfall intensity will increase, but the pattern will be highly variable.

Severe wildfire often leads to high erosion rates from hill slopes and stream channels. Because of this, as climate change leads to more intense and larger wildfires, the plan area as a whole is expected to experience higher erosion rates. This would be the case especially at middle elevations, where soil thickness tends to be greater. More infrequent but more extreme runoff will transport larger amounts of sediment to stream channels. Streams will tend to dry out earlier in the summer, or formerly perennial streams will become intermittent, and riparian areas will decrease.

Climate change threatens to alter the timing and magnitude of the various components of the water budgets at all scales of watersheds. In general, climate change can be expected to bring about less snowfall, more intermittent snowpack at all but the highest elevations, more rain-on-snow events, reduced spring snowmelt, earlier and likely lower peak spring runoff, higher evapotranspiration rates for vegetation, and greater extremes in the range of conditions from year to year (Podolak et al. 2015).

These impacts reduce snowmelt timing and quantity, which reduces the effectiveness of precipitation to refresh shallow groundwater and, in turn, stream flow. As less snow is stored on the landscape, evapotranspiration returns a higher percentage of the remaining soil moisture to the atmosphere. As the period in which snowmelt is available is reduced and shifts to earlier in spring, rather than being distributed over many months, overall water quantity is reduced. This reduces water percolation into shallow groundwater storage and reduces base flow in streams that are groundwater dependent (Bales et al. 2011). Climate change will reduce the overall quantity of water produced by the Sierra Nevada, affecting both on-forest and downstream beneficial uses.

High-intensity fires reduce storage by removing vegetation that holds soils in place and slows runoff. High-intensity fires remove organic litter and change the characteristics of surface soils, making them repel water and reduce infiltration. These effects are most severe in middle-elevation conifer forests, where a significant portion of watershed storage is in the form of groundwater.

High-intensity fires are expected to increase in frequency due to climate change. The effects of fire are less severe at high elevations, where more of the storage is in the form of snowpack and soils are thinner or nonexistent. In these areas, water runs off to stream channels or infiltrates to rock fractures. In the southern Sierra Nevada, annual precipitation has actually increased during the past 50 years; because of the high elevations of the southern Sierra Nevada, snowpack has remained relatively steady. However, climate change is expected to continue to reduce snowpack, as higher temperatures migrate to higher elevations.

High-intensity fire can have severe effects on soils and groundwater infiltration at the landscape scale; nevertheless, low- to moderate-intensity fire is an important factor in maintaining forest health and preserving soils that increase water retention in the watershed and support the its many functions. Reducing the fuels on the forest floor helps to keep fire temperature within a range that allows some of the trees to survive, improving the resilience of the forest to future fires. Reducing forest stand and canopy cover density can also reduce evapotranspiration rates, leaving more water available for the remaining trees and making the forest more resilient to drought.

The high density of forests today is not a natural condition but the result of many years of fire suppression. Boisramé et al. reported on the effects of managed fire on hydrology in burned areas of Yosemite National Park (Boisrame et al. 2017). A managed fire is one that is allowed to burn naturally and is suppressed only under defined conditions. The study showed how the pattern of distribution of trees and other vegetation in the study area had changed after 40 years of managed fire. Forest cover was reduced in this case by 22 percent, meadows increased by 200 percent, and shrublands increased by 24 percent. Large increases in soil moisture content were observed in areas that transitioned from tree cover to meadow.

Based on their observations, Boisramé et al. hypothesized that, due to the past fire suppression regime, trees had encroached on, desiccated, and replaced former meadow lands (Boisrame et al. 2017). Reintroducing managed fire returned the area to a more heterogeneous, presuppression regime condition. This in turn increased the resilience of the stand to both pests and high-intensity fires.

Watershed Condition

There are 149 HUC-12 watersheds inside the boundaries of the plan area, 76 of which are in the Sierra National Forest and 73 in the Sequoia National Forest. Three watersheds extend into both forests. The percentage of land that the Forest Service owns and manages in the HUC-12 watersheds in the plan area ranges from 5 to 100 percent and averages about 70 percent. Seventeen of the 149 watersheds in the plan area are less than 1,000 acres. Some of these small watersheds extend into adjacent national forests or into the Giant Sequoia National Monument; because of this, they are under Forest Service management even if they are not in the plan area. The watershed condition class of 9 of the 149 watersheds that lie mostly outside national forest boundaries have not been surveyed. These 9 watersheds account for only about 3,829 acres, so they are not a significant percentage of the 2.1 million-acre plan area.

The Forest Service developed the Watershed Condition Framework to systematically evaluate and maintain or improve the watershed condition for the following:

- Biotic integrity

- Resilience to natural and human disturbances
- The degree of vertical and longitudinal connectivity
- The ability to provide a broad natural range of ecosystem services
- The ability to maintain soil productivity

Properly functioning watersheds perform well against these criteria, while impaired watersheds are significantly lacking in some of these characteristics.

An array of resource program areas affect watershed condition class ratings, for example hazardous fuel treatments, invasive species eradication, abandoned mine restoration, riparian area treatments, aquatic organism passage improvement, road maintenance and obliteration. Changes in a watershed that are significant in scope and involve treatments to multiple resource areas are generally necessary to achieve a change in watershed condition class.

The discussion and analysis of the watershed condition and consequences of selecting forest plan alternatives is focused on individual or aggregated effects on HUC-12 watersheds. Some adjacent HUC-12 watersheds are hydrologically connected to each other and others are not; therefore, it is possible to have one or more HUC-12 watersheds that exhibit poor ecological integrity next to highly functioning watersheds.

The current condition classification of the 140 HUC-12 watersheds in the Sequoia and Sierra National Forests that have been surveyed is summarized in Table 57. The areas listed for each condition class represent the land in the plan area. Condition Class 1 refers to watersheds that are considered to be functioning properly; Class 2 represents watersheds considered to be functioning at risk; Class 3 represents watersheds that are considered to have impaired function.

Table 57. Number, size, and percentage of HUC-12 watersheds by condition class in the Sequoia and Sierra National Forests

Condition Class	Sequoia				Sierra			
	Number	Percent	Acres	Percent	Number	Percent	Acres	Percent
Condition Class 1	44	59	454,799	56	35	46	568,719	44
Condition Class 2	26	34	341,264	42	37	47	719,744	56
Condition Class 3	1	1	13,780	1.7	0	0	0	0
Not classified	4	5	641	0.1	5	7	3,188	0.2
Total	75	100	810,484	100	77	100	1,290,881	100

Source: Watershed Condition Framework.[16] This includes portions of watersheds in the plan area; it does not include watersheds entirely in the Giant Sequoia National Monument.

Note: Three watersheds are shared between Sequoia and Sierra National Forests. Acres are approximate.

The table includes watersheds that lie partly in the plan area but excludes watersheds that are entirely win the Giant Sequoia National Monument. Three watersheds extend into both forests, and they are tallied in the table under both forests. Nine watersheds that are partially in the plan

[16] Watershed Condition Framework Website

area have not been assigned a condition class; this is mainly because the areas of these watersheds that are in the national forest are small.

Table 57 shows that 44 of the 75 watersheds (59 percent of the watersheds and 56 percent of the acres) on the Sequoia National Forest are classified as functioning properly (Class 1), that 26 watersheds (35 percent of the watersheds and 42 percent of the acres) are functioning at risk, and that 1 watershed (Isabella Lake) is impaired.

Four watersheds have not been classified, but they total only 641 acres. The Sierra National Forest has nearly an equal number of watersheds classified as functioning properly or functioning at risk. Watershed condition is assigned based on a scoring system that takes into account 12 watershed characteristics, each of which are in turn based on a number of criteria. Disaggregating the 12 indicators from the watershed condition class provides a more detailed picture of the basis for the classification of the watersheds. It also allows a more focused look at those that are directly or indirectly related to hydrologic condition. Table 58 and Table 59 show the numbers of watersheds and the number of acres, respectively, in each indicator category for each forest.

In the Sequoia National Forest, the water quality condition is rated as good (functioning properly) in all but two watersheds next to Isabella Lake; water quality is rated good in all of the watersheds in the Sierra National Forest. The Isabella Lake watersheds are rated as poor based on conditions that are largely not under the Forest Service's control. This is because Isabella Lake is affected by such activities as agriculture and septic systems. These conditions are best addressed by state and local government regulation. However, other indicators suggest conditions that, unless addressed, could reduce the ability of the Forest Service to achieve or maintain desired water quality and water quantity condition in the forest in the future.

Poor aquatic biota condition, riparian vegetation, and the aquatic habitat condition can be indirect indicators of conditions that may affect water quality or quantity. Forest health, forest cover, and fire effects regimes are broader indicators of potential future effects on water quality and water quantity.

The watershed condition indicators in the Sequoia National Forest that are rated most frequently as poor are forest health (43 of 71 watersheds), aquatic biota (16 of 71 watersheds), forest cover (10 of 71 watersheds), and soil (10 of 72 watersheds). For the Sierra National Forest, the four indicators most frequently rated poor are forest health (50 of 72 watersheds), aquatic biota (41 of 72 watersheds), aquatic habitat (25 of 72 watersheds), and water quantity (15 of 72 watersheds). Soil condition is not rated poor in any watersheds in the Sierra National Forest. As noted above, the poor water quantity ratings of watersheds in the Sierra National Forest are due to the relatively high number of reservoirs and diversions associated with development of hydroelectric power in the Kings River and San Joaquin River drainages.

Where watersheds have been rated poor for multiple characteristics, there seems to be relatively little consistency as to which combinations of characteristics receive the poor rating. Of the 26 watersheds rated poor for multiple characteristics in the Sequoia National Forest, 17 watersheds were rated poor for only 2 characteristics, 8 for 3 characteristics, and 3 for more than 3 characteristics (Lower Pine Flat Reservoir and the two Isabella Lake watersheds). Watersheds in the Sierra National Forest are more frequently rated poor for multiple characteristics. Seventeen are rated poor for 2 characteristics, 14 for 3 characteristics, 9 for 4 characteristics, and 3 for 5 or more characteristics.

Table 58. Number of HUC-12 watersheds in the Sequoia and Sierra National Forests by watershed indicator

Watershed Classification	Aquatic Biota Condition	Riparian Wetland Vegetation Condition	Water Quality Condition	Water Quantity Condition	Aquatic Habitat Condition	Roads And Trails Condition	Soil Condition	Fire Effects Regime Condition	Forest Cover Condition	Forest Health Condition	Invasive Species Condition	Rangeland Vegetation Condition
Sequoia National Forest												
Good	8	11	69	53	51	47	43	29	49	0	64	13
Fair	47	60	0	12	16	20	18	37	12	28	7	58
Poor	16	0	2	6	4	4	10	5	10	43	0	0
Sierra National Forest												
Good	1	10	72	48	16	44	65	16	71	0	56	6
Fair	30	60	0	8	31	19	7	53	0	22	15	61
Poor	41	2	0	16	25	9	0	3	1	50	1	1
Sequoia and Sierra National Forests Combined												
Good	9	21	141	101	67	91	108	45	120	0	120	19
Fair	77	120	0	20	47	39	25	90	12	50	22	119
Poor	57	2	2	22	29	13	10	8	11	93	1	1

Key: Good = Properly functioning; Fair = Functioning at risk; Poor = Impaired. The table does not include unclassified watersheds.

Source: Watershed Condition Framework.[17]

[17] Watershed Condition Framework Website

Table 59. Acres in the Sequoia and Sierra National Forests by watershed indicator

Watershed Classification	Aquatic Biota Condition	Riparian Wetland Vegetation Condition	Water Quality Condition	Water Quantity Condition	Aquatic Habitat Condition	Roads And Trails Condition	Soil Condition	Fire Effects Regime Condition	Forest Cover Condition	Forest Health Condition	Invasive Species Condition	Rangeland Vegetation Condition
Sequoia National Forest												
Good	167,809	154,046	758,372	548,163	570,639	522,760	489,742	432,193	585,654	0	687,778	182,228
Fair	472,446	655,797	0	159,141	210,242	271,439	136,168	313,206	150,393	174,832	122,065	627,615
Poor	169,588	0	51,471	102,539	28,962	15,644	183,933	64,444	73,796	635,011	0	0
Sierra National Forest												
Good	19,288	129,939	1,288,463	753,109	315,102	850,104	1,158,031	223,031	1,287,693	0	1,079,540	94,929
Fair	534,916	1,118,534	0	155,631	435,273	265,738	130,432	1,042,800	0	210,337	206,615	1,166,878
Poor	734,259	39,990	0	379,723	538,088	172,621	0	22,632	770	1,078,126	2,308	11,881
Sequoia and Sierra National Forests Combined												
Good	187,097	283,985	2,046,835	1,301,272	885,741	1,372,864	1,647,773	655,224	1,873,347	0	1,767,318	277,157
Fair	1,007,362	1,774,331	0	314,772	645,515	537,177	266,600	1,356,006	150,393	385,169	328,680	1,794,493
Poor	903,847	39,990	51,471	482,262	567,050	188,265	183,933	87,076	74,566	1,713,137	2,308	11,881

Key: Good = Properly Functioning; Fair = Functioning at Risk; Poor = Impaired. Table does not include unclassified watersheds. Acres are approximate.

Source: Watershed Condition Framework.[18]

[18] Watershed Condition Framework Website

The characteristics most commonly rated fair in the Sequoia National Forest are riparian vegetation and rangeland vegetation (60 and 58 of 71 watersheds, respectively). No watersheds are rated poor for either of these two conditions, suggesting that degradation has occurred across broad areas without being concentrated in particular watersheds. Aquatic biota and fire effects condition are the next most frequently rated as fair.

Forest health is the least frequently rated as good, followed by aquatic biota, riparian vegetation, and rangeland vegetation. Thus, forest health and rangeland vegetation appear to be the most frequent upland reasons why watersheds are not functioning properly; aquatic biota and riparian vegetation are the two conditions in lower lands near water bodies that most frequently prevent watersheds from functioning properly. These same conditions are also the ones that most frequently prevent watersheds in the Sierra National Forest from functioning properly. The direct indicators of water quality and water quantity are among the most frequently rated as good in both forests.

Poor road and trail conditions contribute more frequently to watersheds functioning at risk in the Sierra National Forest than in the Sequoia National Forest: nine watersheds in the Sierra National Forest are listed as having poor road and trail condition. Since roads and trails in poor condition can contribute to erosion and poor water quality, it is noteworthy that roads and trails appear to be in relatively good condition in both forests.

Approximately 40 percent of the total area of the watersheds in the Sequoia National Forest and about 34 percent in the Sierra National Forest are not National Forest System land. Forest Service guidelines call for areas of watersheds that the Forest Service does not manage, and therefore cannot be evaluated, to be classified with the same condition that applies to the portion of the watershed that is National Forest System land. Most of these lands of other ownership lie outside the administrative boundary of the forests. In the administrative boundary of the forests there are also private lands, including settlements, land owned by electric utility companies, and other lands in private ownership. The Forest Service does not manage about 4 percent of the land in the administrative boundary of the Sequoia National Forest, and about 7 percent of the land in the administrative boundary of the Sierra National Forest.

In some cases, the actual condition of the lands of other ownership may be different from National Forest System lands. The Forest Service has limited ability to affect the condition of these watersheds through direct management. In practice, however, the Forest Service is sometimes able to work with adjacent landowners through partnerships and coordination efforts on projects that can benefit watershed condition.

Priority Watersheds

As of 2019, the Sequoia and Sierra National Forests each have two priority watersheds. However, those in the Sequoia National Forest are in the Giant Sequoia National Monument, not in the plan area. In the Sierra National Forest, the two priority watersheds are the Upper Big Creek watershed (HUC 180300100801, in the Kings River drainage above Pine Flat Reservoir) and the South Fork Willow Creek watershed (HUC 180400061103), which drains to the San Joaquin River. Watersheds are reevaluated for prioritization about every 5 years.

The priority watershed strategy enables resources to be focused on producing benefits to a small number of watersheds, rather than dispersing these resources across disparate locations throughout the forests. Watershed restoration action plans (WRAPs) are developed for these watersheds to identify essential projects intended to address the specific issues affecting them. The WRAPs provide each national forest with a list and schedule of projects to be completed. They are designed to expedite improvement in the condition class of the selected watersheds. The Forest Service develops funding strategies, focuses resources, and develops appropriate partnerships to complete the identified projects to maintain or enhance the watersheds.

The Sequoia and Sierra National Forests are focusing restoration in their respective priority watersheds to minimize past impacts of the following:

- High road density
- High fire risk due to bark beetle infestation
- Channel destabilization caused by runoff and debris flows from high-severity wildfires

Watershed managers do not use the forest plans to determine the development of new priority watersheds; instead, they use the watershed condition framework process to recommend new priority watersheds to the appropriate responsible officials, after assessing the need to restore degraded aquatic and riparian habitats. Recommendations are based on national forest inventory and monitoring data and on such factors as interest and availability of partners, the presence of a listed or species of conservation concern, and the risk of large, high-intensity wildfire. Managers also consider watersheds already identified for fuel reduction and other ecological restoration. As new priority watersheds are selected, essential projects are identified in WRAPs.

Environmental Consequences to Water Quality, Water Quantity, and Watershed Condition

This section evaluates how the alternatives affect water quality and quantity and watershed condition, based on the pace and scale of ecological restoration and plan components. The first part describes consequences that are common to all alternatives. It is followed by a discussion that summarizes the environmental consequences of each alternative.

Consequences Common to All Alternatives

Water Quality

Watershed Restoration. Desired conditions under each alternative are either the same or similar for each management action. All alternatives seek to increase the resilience of watersheds and therefore to mitigate some of the adverse effects associated with climate change. This is accomplished by maintaining vegetation and soil cover that helps to slow runoff, increase groundwater infiltration, and provide shade for streams; other services directly or indirectly maintain water quality and reduce erosion. The alternatives differ in the amount of restoration that would be accomplished and the methods that would be used to accomplish each alternative's specific objectives.

The two national forests and their partners are implementing restoration to reduce erosion from roads, trails, dispersed camping areas, grazed areas, and developed and undeveloped recreation areas. Such restoration is expected to continue, further reducing erosion and sediment loading to receiving waters in the plan area. Water quality would be maintained or improved where the Forest Service and partners restore watersheds.

Impaired Water Bodies. Many of the water quality impairments identified in 303(d)-listed water bodies (see Table 56) probably result from causes unrelated to forest management. This includes legacy issues and impairment caused by sources outside of National Forest System lands. Forest

Service management, or partnerships and coordination between adjacent landowners and the Forest Service, may improve some of these; others will probably not be changed despite improved forest management. This is due to the causes of the impairments being outside the Forest Service’s control.

Some 303(d) impairments, such as temperature, pH, alkalinity, and dissolved oxygen, may be due to complex factors. Sources for many of these impairments have not been clearly established, and the state water resources control boards will further evaluate them in preparing TMDLs. The Forest Service will coordinate with the state water boards in preparing TMDLs.

Rangeland Management. Livestock can affect water quality by trampling soils, damaging vegetation, and defecating. Livestock tend to congregate in riparian areas. Cattle can contribute to nutrient loading and can be a source of pathogens (Derlet et al. 2012). Grazing livestock can have particularly high impacts on meadows. For example, animals compact and disturb fragile soils, resulting in the loss of vegetation cover, faster runoff, and enhanced erosion. Forest plan direction includes grazing management protections for meadows.

All alternatives maintain the same level of livestock grazing as current direction (alternative A) and as updated to reflect the 2012 Planning Rule. There would be no change to existing management direction for livestock grazing. Current management direction for term grazing permits and allotment management plans remain in place. Continuation of existing management is expected to gradually improve water quality in areas where previous impacts have occurred.

Fire Retardants. Most fire retardants used to fight forest fires consist of ammonium phosphate or ammonium sulfate solutions, similar to fertilizers. The retardants are mixed with water, clay, or a gum-thickening agent, and a coloring agent. This creates a slurry that is used to coat foliage in advance of a fire so as to slow the its spread. DC-10 aircraft can carry approximately 11,000 gallons of retardants, while larger Boeing 747s can carry up to 19,200 gallons (Moore 2017, Weiser 2017). Larger capacity aircraft are capable of treating fire more effectively, but this may come at the expense of accuracy and greater potential to impact stream water quality.

The Forest Service maintains a list of qualified products for use as long-term retardants. These chemicals can have harmful effects on aquatic life, for example, by stimulating growth of algae, when they enter a water body. For this reason, the Forest Service has developed standards for the use of retardants on fires so as to protect ecosystems.

On National Forest System lands in the United States, aerial retardants are not allowed in areas mapped to avoid threatened, endangered, proposed, candidate, or sensitive species or within a 300-foot buffer around waterways. The exception is in cases where human life or public safety is threatened and retardant use in avoidance areas can be reasonably expected to alleviate the threat (United States Department of Agriculture 2011e).

Excluding fire retardants in areas within a 300-foot buffer around waterways includes RCAs of perennial streams and lakes and other permanent water features. The EPA determined that the 300-foot buffer zone around surface water features would ensure that fire retardant would not be discharged into waters of the United States (United States Department of Agriculture 2011e). The Forest Service minimizes the use of fire retardants in designated wilderness, except where there is a threat to life or property, and uses water instead of retardant where possible.

Water Quantity

Watershed Restoration. All alternatives would work toward ecological restoration. This could mitigate some effects of climate change in the short term, possibly allowing natural systems to adjust to the longer-term trends.

All alternatives would remove vegetation through hand thinning, mechanical treatments, prescribed fire, and wildfire managed to meet resource objectives. The alternatives differ in the pace and quantity of restoration that would be accomplished.

A relatively minor change is expected in the annual average discharge from watersheds in the short term. This is due to implementing forestwide watershed management improvements common to all alternatives. The expected increase in variability from climate change is likely to be moderated somewhat, so that peak streamflows will be maintained at lower levels than would otherwise occur. Also, summer low flows may be maintained at higher levels, as a result of climate change.

As discussed above, range management would stay the same under all alternatives. The hydrologic function of meadows and other aquatic features would be evaluated during range management analysis to ensure that, at a minimum, the features are functioning at risk with an upward trend. If a downward trend is observed, management would be modified to achieve proper functioning condition within 5 years. Grazing would be monitored in riparian areas to ensure that indicators of overgrazing are not exceeded.

Combined with restoration actions directed at restoring hydraulic function of streams in flow-through meadows, these standards are expected, over the long term, to reverse conditions that have contributed to erosion, incision, and less-than-optimal groundwater infiltration and retention.

Watershed Condition

Restoration of watersheds to better-functioning condition and greater resiliency is expected to benefit water quality and quantity under all alternatives. However, the alternatives have different likelihoods of success to accomplish improvements that would benefit water quality and quantity; the management actions would be implemented through different means involving different tradeoffs and at different scales.

Consequences Specific to Alternative A

Water Quality

Alternative A does not change the pace and scale of riparian and aquatic habitat restoration; it retains the restrictive and prescriptive standards and guidelines in the current forest plans. While these standards and guidelines serve to protect water quality in the short term in areas where projects occur, the pace and scale are not likely to be sufficient to reduce the anticipated long-term negative effects from increased high-intensity wildfire across the landscape.

Moreover, water quality is expected to decline as a result of various indirect effects under alternative A. The indirect effects of this are more rapid runoff and consequent higher sediment erosion rates from burned areas, with consequent increased turbidity or sedimentation. Also, toxic substances would be transported from the combustion residue.

Fixed-width riparian conservation areas and associated standards and guidelines in the current forest plans provided an effective level of protection to water quality throughout the southern

Sierra Nevada. The RCAs have reduced local soil disturbance and erosion in areas of highest risk of sediment entering a stream or lake or around springs, seeps, vernal pools, fens, bogs, and marshes. While the focus is on protecting and improving aquatic habitat, water quality can be improved directly and indirectly as a result of improvements in habitat.

In RCAs, management ensures that meadows dissipate stream energy, reduce erosion, and enhance groundwater retention; it also ensures that streams filter sediment and capture bedload and that riparian vegetation stabilizes banks against erosion.

RCAs, which are defined by buffer size, would not change from current management. However, the identification of ephemeral and perennial segments is subject to changes in precipitation and groundwater storage and release as climate changes.

The buffer around perennial streams is 300 feet on both sides; for intermittent streams it is 150 feet. The area in RCAs in a given watershed depends on the number of stream miles in the watershed. Based on stream densities reported from other Sierra Nevada watersheds, the density of perennial and intermittent streams together (stream miles per square mile) probably ranges from about 1 to 2 miles per square mile throughout the plan area (Tetra Tech 2007) If stream density is assumed to average 1.5 miles per square mile for perennial streams and 0.75 miles per square mile for intermittent streams, then approximately 25 percent of the plan area would be within RCA buffers. However, drainage densities would be higher if ephemeral streams were included.

As with RCAs, water quality has improved in critical aquatic refuges directly and indirectly as a result of improvements in aquatic habitat. CARs extend beyond the limits of RCAs, in some cases incorporating entire HUC-12 watersheds and portions of adjacent watersheds; in other cases CARs target more limited subwatersheds of specific tributary streams in a HUC-12 watershed.

Both forests will continue to complete restoration work in critical aquatic refuges. Six CARs have been specified in Sequoia National Forest and seven in Sierra National Forest. Most are in ecologically sensitive, higher-elevation areas in or near wilderness areas. In CARs such as the San Jose Creek watershed west of Shaver Lake and adjacent areas of the lower San Joaquin, human development and road density in the range of about 2.65 miles per square mile present risks to aquatic habitat. Where roads are used for management, managers would look for opportunities to maintain, repair, reroute, or improve aquatic organism passages across them through stewardship or partnership opportunities. The number and size of critical aquatic refuges would not change from current management under alternative A.

In the long term, as restoration of riparian habitat fails to keep pace with the increased higher-intensity fire, erosion and sediment and nutrient loading to streams, ponds, and lakes are expected to increase. Water temperatures are expected to increase with higher ambient temperatures, reduced inflows to streams and meadows from groundwater storage, and reductions in riparian shade vegetation. Higher water temperatures and nutrient loading will reduce dissolved oxygen. Impairments to water quality supporting beneficial uses such as cold water habitat are likely to become more frequent at increasingly higher elevations. Reductions in water quality, increased fire damage, and increased pest damage in some areas may shift recreation uses to less damaged areas, increasing intensity of use in these areas, and leading to further water quality impacts.

Water Quantity

Alternative A would continue to contribute to reduced flows. This would be due to higher evapotranspiration rates of dense forests over broad landscapes, worsened by lower precipitation and higher temperatures from climate change. The decrease of winter snowpack and the increased proportion of rain versus snow would reduce infiltration and increase runoff. This could cause earlier peak flows, lower late spring and early summer runoff, and lower base flows during the dry season.

Vegetation and ground cover losses would increase with increased high-intensity fires, which would decrease evapotranspiration. Short-term runoff patterns would become flashier in response to reduced infiltration by hydrophobic soils; the potential for downstream flooding, soil erosion, and sediment loading of streams would increase. The overall annual yield of surface water is likely to be lower and more difficult to manage and store for beneficial downstream uses (Bales et al. 2011).

Changes in the amount and timing of precipitation and runoff due to climate change would affect groundwater recharge. Effects on groundwater tend to mimic these changes, but the response is delayed by rates of infiltration and groundwater flow. Capacity for groundwater storage at higher elevations in the forests is limited, due to relatively thin sedimentary deposits. Because of this, groundwater levels respond relatively rapidly to changes in precipitation and runoff from snowmelt.

During the wet spring and fall, streamflows tend to be fed by runoff, but during dry periods, streamflows are increasingly fed by inflows from groundwater. High runoff caused by the loss of vegetation and creation of hydrophobic surface soils following high-intensity fires reduces groundwater recharge during periods of high precipitation and snowmelt. This could leave a groundwater storage deficit during lower recharge periods, reducing groundwater inflows to streams at lower elevations.

Groundwater is also reduced by evapotranspiration losses from vegetation, so changes in vegetation cover can be reflected in groundwater levels. Warmer ambient temperatures will increase losses from evapotranspiration, while loss of vegetation will reduce evapotranspiration. Variability in these conditions is expected to increase.

Restoration designed to improve resistance to high-intensity fire may help to delay these effects in selected watersheds. However, overall groundwater levels are expected to decline more and for longer periods across both national forests. This would be due to the relatively low pace of restoration under alternative A.

Watershed Condition

Alternative A emphasizes restoration in priority watersheds to maintain or improve watershed condition. Under the current forest plans, additional watershed restoration occurs in areas where there are mechanical thinning and stewardship opportunities. Additional sources of funding and assistance through partnerships could be used to improve watershed conditions throughout the plan area. Riparian and aquatic habitat restoration projects would help to offset the effects of climate change on stream temperatures and better maintain base flows. This could in turn enhance riparian vegetation. However, the overall watershed condition would be increasingly at risk from high-intensity fire and previous disturbances.

The existing forest plans contain specific standards and guidelines and implement BMPs to protect soils on steep slopes, especially in the RCAs. Limiting soil disturbance and compaction is critical to maintaining soil productivity. Alternative A maintains the current pace and scale of ecological restoration and all RCA protections in the current plans. The critical aquatic refuges in the national forests were created to protect and enhance habitat for aquatic species. Alternative A would not add new critical aquatic refuges and would continue to minimize ground-disturbing activities in them.

Alternative A is not likely to adequately address watershed condition indicators, such as water quantity, fire regime, and forest cover. Nor is it likely to address forest health issues, such as tree mortality and insect infestation over the long term. This is because these require an increase in pace and scale of terrestrial restoration to moderate the risk of large, high-intensity fire at a landscape scale. Riparian area conditions may also decline over time due to the increased risk of high-intensity wildfire in the riparian conservation areas.

Consequences Specific to Alternative B

Water Quality

Alternative B proposes to increase the pace and scale of ecological restoration across the plan area, compared with alternative A. Among the goals of this restoration is to improve forest health to a more natural condition that is more resilient and resistant to increasing threats from fire and pests resulting from climate change. Over a decade, riparian vegetation restoration would almost double, targeting 500 to 1,000 acres in each forest, compared with the current rate of 300 to 400 acres.

Alternative B emphasizes the role of fire in restoring ecological integrity to the landscape and would moderate the upward trend of wildfire frequency and intensity, relative to alternative A. The emphasis on restoring low- and medium-intensity fires across the landscape, including riparian areas, would limit the accumulation of fuels and encourage vigorous riparian habitats. The long-term potential for indirect impacts of sediment delivery to streams would be lower than it would be under alternative A. The estimated number of acres of mechanical treatments to remove fuels would be nearly doubled in the Sequoia National Forest, from 9,000 acres to up to 15,000 acres, and would double in the Sierra National Forest, from 35,000 acres to as much as 70,000 acres.

Fire would be used increasingly to reduce fuels buildup. Prescribed burn treatments would probably increase in the Sequoia National Forest, from about 8,000 acres in the last decade to up to about 15,000 acres in the next 10 years. In the Sierra National Forest, burns would increase from about 15,000 acres in the last decade to about 50,000 to 60,000 acres in the next 10 years.

These increases would occur in the context of an increased threat from high-intensity wildfires. Burned area is expected to double in the lower elevation, west-facing slopes of the foothills and to quadruple in some of the higher elevation upper montane to subalpine areas; this includes parts of many wilderness areas. In the middle elevations, burned area is expected to double or triple from past years. Much of the forest that historically was commercially logged and now contains similar-aged forests with low resilience to fire is found at these elevations. This is also the area where the largest impacts on water resources are likely, such as from loss of vegetation cover, soil erosion, and a change in the character of riparian areas.

Under alternative B, opportunities to manage wildfire for resource benefits would be used to a greater extent to reduce fuel buildup. The goal would be to allow low-intensity fires to burn without intensifying to the point of catastrophic damage. In the Sequoia National Forest, about

31,000 acres have been subject to such managed conditions in the past 10 years; that amount is expected to nearly triple in the next 10 years. In the Sierra National Forest, fire suppression has been practiced more widely, with only about 5,000 acres of managed wildfire in the past 10 years. The managed wildfire is expected to increase to about 170,000 acres in the next 10 years under alternative B.

These treatments are expected to reduce the likelihood of large, high-intensity fire, compared with alternative A. However, the implementation time may be lengthy, and there would continue to be an increasing trend in large, high-intensity wildfires, due to climate change during the implementation period.

Although the Forest Service has little control over watershed conditions outside the forests, it has a significant role in managing fires on lands of other ownership, in coordination with the California Department of Forestry and Fire Protection (CalFire). Implementing coordinated fire-management techniques to reduce high-intensity fire could indirectly improve downstream water quality in watersheds on lands contiguous with the plan area.

There would be no change in the size or number of RCAs, compared with alternative A. Under alternative B, five of the critical aquatic refuges under alternative A are not among the two conservation watersheds that encompass 430,000 acres in the Sierra National Forest (Table 53). Three conservation watersheds encompass the critical aquatic refuges and cover about 385,000 acres in the Sequoia National Forest (Table 54).

The Sequoia and Sierra National Forests contain three and two conservation watersheds, respectively. The Lower Kern River is the southernmost conservation watershed on the Sequoia National Forest. It covers an area of about 61,400 acres bordering the Lower Kern River, from the southern end of the Sequoia National Forest to Clear Creek, south of Lake Isabella. The Upper North Fork Kern River and Upper South Fork Kern River conservation watershed are north of the Lower Kern River and have areas of about 210,600 and 109,100 acres, respectively.

The Sierra National Forest contains the Kings and San Joaquin conservation watersheds. The Kings River conservation watershed has an area of about 242,100 acres and includes the drainage of the north fork of the Kings River, including Dinkey Creek, as well as Courtright and Wishon Reservoirs. The San Joaquin conservation watershed has an area of about 180,100 acres and includes tributaries to the west side of the San Joaquin River, between the middle fork and the dam of Mammoth Pool Reservoir.

About 261,000 acres, or about 70 percent of the land in the conservation watersheds in the Sequoia National Forest, are in HUC-12 watersheds that are currently functioning properly; in the Sierra National Forest, about 40 percent of the land in the conservation watersheds is in watersheds that are functioning properly.

The purpose of conservation watersheds is to maintain habitat connectivity and provide refugia to support sensitive species. The Forest Service has set the very modest objective of maintaining, improving, or restoring the condition of at least three HUC-12 watersheds in the conservation watersheds of both forests during the plan period. However, the conservation watershed designation will likely provide indirect additional support and incentive for maintaining or improving water quality and quantity in areas where water resources are important for the persistence of at-risk species. Examples of this are restoring meadows or restricting ground-disturbing activities.

Increasing the pace and scale of restoration treatments involves a trade-off between short-term impacts and long-term benefits. The increased use of mechanical treatments may result in short-term impacts on water quality, due to increased soil disturbance from higher levels of equipment use and traffic in these areas. BMPs would be used in project design and implementation to reduce the short-term effects of soil erosion and sediment delivery to receiving waters.

Restoration of riparian areas would help to restore riparian vegetation that shades streams and cools water, offsetting some of the effects of higher ambient air temperatures. Restoring riparian areas and meadows, combined with upland reintegration of fire into the landscape, would likely enhance groundwater infiltration and recharge, increasing base flows in streams. This would also tend to maintain lower water temperatures.

Although some short-term increases in sediment and nutrient loading may occur as a result of increased prescribed burning, the reintroduction of fire would increase forest resiliency and have a better chance of maintaining healthy soil conditions in the long term.

Forest Service standards and guidelines under alternative B call for it to protect water quality in RCAs by the following:

- Limiting chemical use
- Restricting the types of equipment used
- Using minimally disruptive techniques appropriate to the more sensitive riparian environment
- Restoring and maintaining hydrologic connectivity and avoiding disruption by roads and other disturbances
- Monitoring disturbances;
- Implementing corrective actions if disturbances occur

Alternative B would continue to support and rely on salvage cutting to achieve economic and ecosystem restoration goals. The objective would be potentially doubling production from both forests. This would be accompanied by planting an average of 1,000 acres per year in the Sequoia National Forest and 3,500 acres per year in the Sierra National Forest to increase resiliency. Increased salvage cutting could increase soil disturbance and sediment and nutrient loading to receiving waters in the short term. These effects would be minimized by adhering to BMPs.

Compared with alternative A, alternative B is expected to allow the volume of timber sold from salvage and thinning to double over 10 years. The feasibility of such an increase is not assured, however, since it would depend on whether private businesses were willing and able to increase their operations. Assuming that the pace and scale of these operations increase, the salvage and thinning operations would increase the potential for short-term water quality impacts from soil disturbance. However, impacts on water quality would be minimal with implementation of BMPs.

In the long term, any reductions in high-intensity wildfire and reduced tree mortality from implementing the management actions under alternative B would benefit water quality. The benefits would be greater than under alternative A, but they are not expected to offset the effects of climate change.

Alternative B identifies new river segments in the Sequoia and Sierra National Forests for inclusion in the Wild and Scenic Rivers System. It defines a management area up to 1 mile wide for the Pacific Crest Trail (PCT) to protect the visual experience. All but 13 miles of the PCT in the Sequoia National Forest is in wilderness areas. However, in both wilderness and non-wilderness areas, heavy equipment would be limited by this PCT management buffer. This would have minor localized effects, since use of heavy equipment in these areas is currently minimal.

Other prohibitions, such as against road construction**,** although intended to protect scenic values, could have indirect beneficial effects on water quality by reducing the potential for spills and erosion. The magnitude of the beneficial effects might be limited if roads were simply rerouted outside the management zone to avoid the PCT. Ultimately, any effects would be minimized by implementing BMPs.

Meadows have an important role in maintaining water quality by helping to retain groundwater, which is then available to be released into streams, as precipitation and runoff decline seasonally. This helps to maintain lower water temperatures. Evidence suggests that meadows retain a significant quantity of the annual outflows from forest lands, possibly representing several percent (Hunsaker et al. 2015). Alternative B calls for enhancing or improving the condition of at least five meadows over the 15-year period following adoption of the plan. It also calls for restoring aquatic species habitat on 5 miles of streams in each forest. Meeting these objectives would improve local water quality.

Water Quantity

Mechanical thinning of trees and prescribed burning would reduce evapotranspiration and would maintain, slightly increase, or extend the timing of stream flows (Hunsaker et al. 2014). Alternative B would treat more areas than alternative A, and the increased pace and scale of treatments intended to improve resiliency to high-intensity fire would help to maintain soils; this, in turn, allows groundwater to infiltrate and be retained for as long as possible in the watershed.

Landscape-scale use of fire to reduce fuels would also improve forest resiliency in the face of stressors resulting from climate change, allowing the forest more time to adapt to these changes. While these effects may delay the most severe effects of climate change, they cannot offset the expected changes in the amount and timing of precipitation. This will lead to lower average annual streamflows, longer periods of drought, and more rapid spring runoff.

As discussed above, water quantity may be improved by improving the watershed condition in three watersheds in the conservation watershed areas under alternative B.

Operating reservoirs for electricity generation, recreation, water supply, and aquatic habitat is not under the Forest Service’s control. However, these reservoirs, as well as natural lakes, depend on runoff from their watersheds. Alternative B would help to maintain and improve the soil and vegetation that help to maximize the retention of water in the watershed, so that the retained groundwater would be released more gradually to streams, optimizing the use of the water.

Most of the forest lands are above the regional groundwater basins, but the Kern River Valley basin is an exception. Runoff from the north and south forks of the Kern River are the primary sources of recharge to the Kern River Valley basin and the primary inflow to Isabella Lake. Increasing the pace and scale of mechanical treatments and prescribed burning to reduce fuel loads in and next to meadows would help to maintain base flows of streams, potentially increasing groundwater recharge to the Kern River Valley basin in the long term.

Watershed Condition

Alternative B would address watershed condition factors, such as road improvements, water quantity timing, fire regime, forest cover, and forest health issues. This is because of the increased pace and scale of terrestrial restoration at a landscape scale.

Soils may be affected more in the short term due to ground disturbance during restoration, when compared with alternative A. However, conditions would improve over the long term where restoration reduces the risk of high-intensity wildfire and improves sustainability. Buffers on perennial, intermittent and ephemeral streams would protect water quality by reducing the potential for stream sedimentation.

Under alternative B, compared with alternative A, no change is expected in the way that watersheds are prioritized for restoration and improvement under the watershed condition framework. The exception is that, as mentioned above, one of the objectives for the conservation watersheds identified under alternative B is to maintain, improve, or restore the condition of at least three HUC-12 watersheds in the conservation watersheds of the forests during the plan period.

Consequences Specific to Alternative C

Water Quality

Alternative C proposes to reduce high-intensity fire risk by increasing the use of prescribed fire and managing wildfire to meet resource objectives. However, there would be less opportunity to pretreat fuels under this alternative, due to the increase in recommended wilderness area. The largest percent increase in high-intensity wildfire is expected to occur in upper montane and subalpine forest areas. Because of this, there is uncertainty as to how much land area could feasibly be treated by prescribed fire under alternative C without the use of mechanical treatments.

The threat to water from high-intensity fire occurs at every scale, and the locations where fires start and the paths where they burn are inherently difficult to predict. By shielding large areas from fuel reduction treatments, alternative C reduces the effectiveness of the treatments on the other areas. Alternative C proposes to reduce fuel loading more than alternative A, using fire as the primary treatment method. However, the challenges of actively managing fire without mechanical treatment to reduce fuels in the landscape may prevent treating more acres than under alternative A. Mechanical treatments would have greater short-term effects on water quality than prescribed burning; therefore, alternative C, in effect, would trade the potential future benefits of fuel reductions and forest resiliency from mechanical treatments for the short-term benefits of reducing erosion, nutrient loading, and other effects.

Under alternative C, the acres of mechanical treatments are estimated to be about one-quarter to one-half the amount under alternative A. The use of prescribed fire without the use of mechanical pretreatment, under current conditions of relatively high fuel loading, is likely to result in greater burn intensities than under other alternatives. This could increase the potential for adverse effects on soil hydrophobicity and reduce infiltration.

The number of low- to moderate-intensity wildfires estimated to be managed for fuel reduction under alternative C would be about the same as alternative A. But under alterative C, fires, once initiated, may be curtailed earlier than under alternative A. This would result in fewer acres achieving the desired condition over the planning period.

The opportunities for use of fire would differ between the two forests. The Forest Service estimates that prescribed burning could be implemented on fewer acres in the Sequoia National Forest than under alternative A; it could be used to treat up to nearly three times the acres that would be treated under alternative A in the Sierra National Forest. Both of these estimates are less than the number of acres that would be treated under alternative B.

Fuel reduction by either prescribed burning or opportunistic management of wildfires would result in short-term effects on water quality, from increased erosion and transport of chemical contaminants to surface and groundwater; nevertheless, these effects are expected to be relatively small and temporary. Low- to moderate-intensity fire has long been a normal feature in forest watersheds and is within the range of conditions that have shaped naturally functioning watersheds.

Compared with current management under alternative A, alternative C would decrease the volume of timber sold from salvage and thinning operations over the planning period. The decrease would be about one-quarter to one-half of current levels. A reduction in the scale of salvage and thinning operations would have short-term benefits from less soil disturbance.

Alternative C would retain the fixed-width riparian conservation areas and associated standards and guidelines in the current forest plans. However, it would increase the number of critical aquatic refuges, compared with alternative A. This would increase the number of acres of CARs on the Sequoia National Forest by about one-third and on the Sierra National Forest by about four and a quarter times. Critical aquatic refuges can be areas of focused restoration when needed for species conservation, which tends to directly or indirectly improve water quality.

Alternative C would also include the large conservation watersheds of alternative B, with similar potential beneficial effects on water quality. It would do this through efforts to improve or maintain the condition classification of at least three HUC-12 watersheds in the conservation watershed area.

Alternative C recommends the addition of 4,906 acres to Monarch Wilderness in the Giant Sequoia National Monument. Wilderness designation would add plan direction that eliminates the use of mechanical treatments. Among the effects would be to reduce short-term impacts on water quality that might otherwise occur as a result of ground disturbance in these areas.

As under all of the alternatives, alternative C requires the use of BMPs, standards, and guidelines in project design and implementation. They are designed to mitigate soil compaction, erosion, and sediment delivery to streams to protect watersheds. Short-term sediment impacts from emphasizing prescribed fire and managed wildfire to achieve restoration goals would be similar to those under alternatives A and E. Given the large increase in proposed wilderness, alternative C would reduce ground disturbance from mechanical thinning.

Indirect impacts on water resources at the landscape scale from high-intensity wildfire would be greater than those under alternative B and similar to those under alternatives A and E over the long term. High-intensity fires are trending larger and may affect entire or multiple watersheds, causing adverse effects on hillslopes, stream channels, infiltration, and runoff. It is these effects that contribute to accelerated soil erosion, impaired water quality, and reduced watershed function (Neary et al. 2005).

Alternative C would treat only a small proportion of the lands needing treatment to substantially reduce the risk of high-intensity wildfire. The pace and scale would not be sufficient to reduce the long-term negative effects from increased high-intensity wildfire across the landscape that would result from climate change; therefore, overall water quality and watershed function would decline in the long term under alternative C.

Water Quantity

Alternative C emphasizes a greater reliance on prescribed fire and managed wildfire to reduce the threat of large, high-intensity wildfires, compared with alternative A. Although alternative C increases reliance on fire to reduce fuel, compared with alternative A, it recommends including about 430,000 additional acres of wilderness to expand existing wilderness areas. As discussed above, this would limit the use of mechanical treatments, which may lower the feasibility and opportunity for conducting prescribed burns. The acreage objective for wildfire management under alternative C is about 55,000, an area equivalent to two average HUC-12 watersheds. This relatively small increase in acres of managed fire would result in effects on groundwater retention and surface water runoff, similar to the effects under alternatives A and E.

Watershed Condition

Alternative C would provide similar direction for protecting RCAs and would place similar emphasis on watershed restoration as alternative B to maintain or improve the watershed condition. However, the overall watershed condition would continue to be at risk, due to large, high-intensity wildfires.

Some watershed condition factors, such as water quantity, fire regime, forest cover, and forest health issues, such as widespread tree mortality, may decline under alternative C. This is because the pace and scale of terrestrial restoration would need to increase to keep up with the effects of climate change. Maintaining an adequate pace and scale would be more difficult if the increase in proposed wilderness acres prevents effective and efficient use of fire in these areas.

Alternative C proposes about 59,000 acres in additional CARs, compared with alternative A, on both national forests for the benefit of various aquatic species. These CARs are well distributed throughout the plan area, both inside and outside wilderness area boundaries. CARs are areas where restoration would be undertaken to maintain high water quality for the benefit of aquatic species and aquatic habitat. About half the current CAR watersheds in each forest are classified as at risk. CAR designation does not guarantee improvement in watershed condition, but it provides additional assurance that the condition would be maintained.

Consequences Specific to Alternative D

Water Quality

Alternative D would not change the management of RCAs, but it proposes to approximately triple the acres of aquatic and riparian restoration across both national forests, compared with alternative A. The scale of the increase is relatively moderate, increasing from about 300 to 400 acres under alternative A to about 1,000 to 1,500 acres under alternative D. Alternative D is similar to alternative B in the number of stream miles restored, but it would improve by two to three times the number of meadows as alternative B over the planning period.

The more substantial shift in management represented by alternative D would be the greater use of mechanical treatments and fire to address the threat of high-intensity wildfire at the landscape scale. The scale of mechanical treatments would be doubled or tripled in both forests over the planning period, compared with the rate expected under alternative A. Acres treated by prescribed burning could double (similar to under alternative B) in the Sequoia National Forest, but they would increase sevenfold to tenfold in the Sierra National Forest. Furthermore, a far greater effort would be made to manage low- to moderate-intensity wildfires to reduce fuel loading.

The Forest Service estimates that, under alternative D, the number of managed fires would double in the Sequoia National Forest and would be used on approximately five times the acreage as under alternative A. In the Sierra National Forest, approximately 10 times the number of wildfires would be managed, resulting in treatment of approximately 300,000 acres over a 10-year period. This is a little less than double the pace and scale of wildfire management for resource purposes under alternative B.

From the perspective of water quality, the increased pace and scale of fire use for fuel reduction carries with it a potentially large trade-off between short-term effects and long-term benefit. Alternative D is designed to make both forests resilient to high-intensity wildfire at a pace and scale that might greatly counter the increasing threats of climate change. However, this would come at the expense of greatly increased risk to water quality in the short term, due primarily to the elimination of the RCAs for ephemeral streams. Just as the threats of high-intensity wildfire and tree mortality from pest infestations occur rapidly across the landscape, so would the short-term increases in erosion in relatively large areas over a short period.

The effects from mechanical fuel-reduction treatments would be minimized by implementing BMPs. The Forest Service would analyze individual fuels reduction treatments and would select appropriate BMPs for the vegetation type and terrain affected. These mitigation measures could not be fully protective, and monitoring would be required to maximize their effectiveness and enable corrective action to be taken where necessary.

Given that the average size of HUC-12 watersheds in both forests is about 25,000 acres, the acres of prescribed burning under alternative D would be roughly equivalent to six to seven average watersheds; this compares with one watershed under alternative A. The acres that would be mechanically treated under alternative D would be on a similar scale, which would be equivalent to four to six average-sized watersheds; this compares with the equivalent of about one watershed under alternative A. The number of acres that would be managed using low- to moderate-intensity wildfire would be equivalent to about 18 average watersheds, compared with the equivalent of fewer than two watersheds under alternative A.

Altogether, the combined short-term effects on water resources under alternative D would be distributed over larger areas, rather than concentrated in individual watersheds. Also, they would be distributed over a 15-year planning period so that the treated areas would have a chance to recover over several years, while new areas undergo treatment. Still, the short-term effects might be substantial. The effects would vary in intensity, depending on the specific conditions in each watershed. This is because sediment and nutrient loading would increase downstream in drainages, with treatments occurring simultaneously in multiple tributary watersheds.

Alternative D allows a much higher degree of flexibility to forest managers to implement the proposed treatments than alternative C. This is because alternative D does not recommend any additional wilderness protections.

Compared with current management, alternative D is expected to make possible a large increase in the volume of timber sold from salvage and thinning operations. The Forest Service estimates that alternative D might double or nearly quadruple the volume of timber sold over the planning period, compared with alternative A. Assuming it is feasible to increase the pace and scale of these operations, they would contribute to increased water quality impacts from soil disturbance. Operators would be required to implement BMPs to reduce these impacts, but the impacts would not be eliminated.

Creating fuelbreaks and fuel-reduced areas to manage wildfires in focus landscapes of watershed scale (10,000 to 80,000 acres) may have short-term impacts on patterns of infiltration and runoff. They also could impact the distribution of snowpack by increasing snow accumulations in less densely wooded treatment areas. Small, local clearings can increase snowpack, compared with areas with a denser canopy.

Alternative D would require the use of BMPs in project design and implementation. It would maintain RCAs similar to alternative B, with the exception of reduced protections from ground disturbance for ephemeral streams. As discussed under alternative B, the Forest Service would analyze individual fuels reduction treatments and would select appropriate BMPs for the vegetation type and terrain affected. These mitigation measures cannot be expected to be fully protective; monitoring would be required to maximize their effectiveness and enable corrective action to be taken where necessary. Nevertheless, the BMPs would reduce soil compaction, erosion, and sediment delivery to streams to protect watersheds.

Short-term sediment impacts would likely be higher than they would be under the other alternatives. This is because of increasing the pace and scale of restoration, waiving some of the requirements for pre-project surveys, and increasing the overall number of treated acres. However, implementing BMPs should minimize the impacts on water quality.

Alternative D emphasizes restoring ecological integrity to the landscape at an overall pace and scale that would reduce the current upward trend of wildfire frequency and intensity. The long-term potential for indirect impacts of sediment flows on streams is lower than it is under all other alternatives considered in detail. This is because alternative D would be most effective across more areas at reducing high-intensity wildfire. The emphasis on low- and medium-intensity fires across the landscape, including in the riparian areas, would limit the accumulation of fuels, would restore understory plants of cultural importance to Sierra Nevada tribes, and would encourage vigorous riparian habitats. The long-term benefits of an increased pace and scale of restoration would be reduced impacts on watersheds, soils, riparian areas, streams, and aquatic habitats from large, high-intensity wildfires (Neary et al. 2005).

Water Quantity

As under alternative B, mechanical thinning of trees and low-intensity under burning of vegetation under alternative D would reduce evapotranspiration and slightly increase or extend the timing of stream flows (Hunsaker et al. 2015). However, alternative D would increase the amount of treated area more than other alternatives. Combined with potentially more meadow restorations, alternative D could increase infiltration on a landscape level and encourage more groundwater storage. Encouraging shallow groundwater storage could mitigate some of the impacts from climate change. This would come about by increasing aquatic ecosystem resilience, providing more stable stream flows, and benefitting wildlife dependent on springs.

Alternative D would have the greatest potential for reducing encroachment of conifer forests into meadows and increasing the number of meadows by encouraging a “patchy” forest configuration. This configurations is more like the one that existed before fire suppression began. Large reductions in fuels and vegetation would also reduce evapotranspiration. The expanded meadows and reduced evapotranspiration would allow more precipitation to infiltrate and be stored as groundwater and to be released over a longer period to mitigate the effects of drought.

Overall, alternative D would likely maintain current shallow groundwater recharge and storage under conditions of warming climate better than the other alternatives. This is because it would more aggressively address the conditions that lead to high-intensity wildfire and would more quickly restore larger areas of forest to the natural range of variation. Furthermore, reducing dense vegetation (fuel loads) would reduce the rates of evapotranspiration, leaving more groundwater in storage.

Focus landscapes tend to be dominated by drier sites, with treatments focused in upland areas along roads and ridges. Treatments would result in small increases in water retention and runoff, but these would occur over large areas. This would have proportionally more pronounced beneficial effects on groundwater and increased streamflows. Lower and middle elevations would be treated, in areas with no restrictions on mechanical treatments, although not in wilderness areas.

Watershed Condition

Alternative D would address such watershed condition factors as water quantity, fire regime, forest cover, and some forest health issues. This would come about by increasing the pace and scale of terrestrial and aquatic restoration.

Modeling indicates that alternative D would best achieve landscape-scale reductions in the risk of high-severity wildfire. It provides the greatest resilience to the effects of climate change. Riparian conditions may decline in the short term, due to increased activity in RCAs and the increased short-term sediment loading from treated upland areas. However, these conditions would improve over the long term. The potential for short-term effects from an increased pace and scale of restoration would be a potential trade-off for the long-term benefits to riparian areas. The Forest Service would need to closely monitor the effectiveness of implementing BMPs to mitigate short-term increases in sediment loading to riparian areas. This is to avoid potential long-term effects on riparian biota.

Consequences Specific to Alternative E

Water Quality

Alternative E is similar to alternative C, except that it includes less recommended wilderness. In the recommended wilderness areas, management direction would generally be the same as it is for the wilderness areas recommended under alternative C. The exception is that tree thinning and mechanical treatments might be allowed if justified to reduce uncharacteristic wildfire effects on species of conservation concern.

In the short term, this would reduce the potential for erosion and other water quality impacts associated with ground disturbance in these areas after implementing BMPs. In the long term, it would make these areas more vulnerable to high-intensity fire, which could have a more severe effect on water quality. The extent to which high-intensity fire would occur in the recommended wilderness areas is uncertain. Conversely, the potential for short-term effects to occur is more certain, assuming that the mechanical treatments and prescribed burning activities would be implemented.

Water Quantity

The effects of alternative E on water quantity would be similar to those described for alternative C. The designation of five new wilderness areas would limit the use of mechanical treatments in those areas, potentially reducing the ability of forest managers to reduce fuel loadings. This would make these areas more vulnerable to high-intensity wildfire, as discussed for alternative C.

Watershed Condition

The effects on watershed condition of alternative E would be similar to those under alternative C, except that watersheds in the recommended wilderness areas would be somewhat more vulnerable to high-intensity wildfire.

Cumulative Effects

The present and foreseeable actions of forest managers and landowners determine cumulative consequences to water quality, water quantity, and watershed condition. The watersheds of the plan area are part of the greater southern Sierra Nevada ecosystem and are administered or owned by the Forest Service, the National Park Service, the BLM, the State of California, the Los Angeles Department of Water and Power, Southern California Edison, several tribes, and thousands of private landowners. The Forest Service manages most of the headwaters of Sierra Nevada rivers and some watersheds in their entirety, and it shares management in parts of many watersheds where ownerships overlap.

The cumulative effects of each alternative on water quality, water quantity, and watershed condition depend on the amount and types of activities proposed under each alternative. Under alternative A the activities currently being undertaken by the Forest Service would continue at the current pace and scale. Short-term effects on water quality, water quantity, and watershed condition would be similar to those currently occurring. Over longer time frames, under alternative A, activities would not occur at a pace or scale great enough to offset the effects of climate change. The risk of impacts on water resources would increase as the risk of uncharacteristic fire behavior increases.

Alternatives B and D propose the greatest amount of restoration activities and have the greatest potential for beneficial effects on water resources over the long term. Both alternatives propose to increase the pace and scale of restoration, with the greater increase occurring under alternative D. That alternative allows for the greater amount of mechanical treatments to facilitate the reintroduction of fire in large landscapes.

Short-term impacts on water quality would be possible under alternatives B and D, with the greater potential for water quality effects under alternative D. Over the long term, reentry every 10 years into the focus landscape would increase the amount of sedimentation possible, despite the BMPs. Alternatives B and D could result in the greatest cumulative benefits to watershed condition over time. This is because of the increased pace and scale of restoration, with the greater benefits potentially occurring under alternative D.

Alternatives C and E would reduce the amounts of mechanical treatments and more prescribed burning undertaken. This would be done to reintroduce fire and increase forest resilience, while increasing habitat protections. The uncertainty surrounding alternatives C and E makes it difficult to calculate cumulative effects. Both alternatives would result in a lower likelihood of short-term effects on all hydrologic indicators, due to less mechanical treatments. However, they would also increase the uncertainty associated with reintroducing fire to large landscapes. Using prescribed fire could also become more difficult in areas that are not pretreated, resulting in hotter burns. This could impact aquatic and riparian habitats and watershed conditions.

The establishment of conservation watersheds under alternatives B, C, and E and the addition of new CARs would benefit water quality and improve watershed condition over time. This is because of the increased emphasis on restoring aquatic and riparian habitats in these watersheds. The cumulative effects of watershed restoration to reduce roads and associated impacts would benefit all hydrologic indicators.

The effectiveness of Forest Service management under all alternatives may be reduced or enhanced by the cumulative efforts of adjacent landowners. Under all alternatives, without concerted efforts by many landowners, especially in the foothill and lower montane zones, the potential for long-term adverse cumulative watershed impacts from high-intensity wildfire remains high.

Successful management of shared and adjacent watersheds requires a concerted effort of the various landowners and a variety of partners. The Forest Service will continue to work with State agencies to develop TMDL strategic action plans for 303(d)-listed streams. If sources of impairment are identified related to Forest Service management, the action plans may identify mitigation strategies. This would include implementing BMPs, maintaining or decommissioning facilities, roads, and trails, implementing planned restoration projects, and removing stressors.

Management activities on lands outside of the Sierra and Sequoia National Forests influence water quality, water quantity, and watershed condition. Large amounts of protected lands in the adjacent Yosemite, Sequoia, and Kings Canyon National Parks benefit water resources, as does the Sequoia National Monument.

Activities on neighboring forests that share drainages with the Sierra and Sequoia National Forests would also contribute to cumulative effects. In the case of the Sierra National Forest and Stanislaus National Forest, these effects may occur on the Merced River; in the case of the Inyo and Sequoia National Forests, they may occur on the south fork of the Kern River.

Numerous hydroelectric projects and reservoirs are active in or near the national forests. Managing these facilities will continue to influence water quality, quantity, and watershed conditions. Many of these FERC-regulated projects are currently in or will be in the relicensing process. During this process, new license conditions could be developed that may improve water quality and quantity and provide many other resource benefits.

In addition to the aforementioned FERC projects, the U.S. Army Corps of Engineers plans to modify the Isabella Lake Dam to improve seismic safety and reduce seepage, including raising the main and auxiliary dams by 16 feet. Construction is expected to extend through most of 2021. During construction in the wet season, the water level in Isabella Lake will be drawn down to a minimum level, from October to March. The preparers of the DEIS for the project concluded that there would be less than significant effects on water users downstream of the dam, when higher than normal releases occur to draw down the lake. There would be an increased potential for hazardous algal blooms and low dissolved oxygen levels in the lake during periods of low water levels. Kern County tracks hazardous algal blooms, which necessitates the closure of areas of the lake in summer. The shallower the water level, the more likely the lake will experience hazardous algae blooms.

Analytical Conclusions

The alternatives considered in detail outline different approaches to achieving the same overall set of goals for maintaining and enhancing watershed health. This section summarizes how well the alternatives are expected to achieve these goals expressed in terms of the indicators: water quality, water quantity, and watershed condition. A comparison of the environmental consequences of each alternative on these qualities can be found at the end of chapter 2 (Table 3).

Water Quality

The short- and long-term effects on water quality vary among the alternatives. Alternative A emphasizes management at the HUC-12 watershed scale, focusing on RCAs and improving individual watershed function. Alternatives B and D emphasize a long-term approach, through an increased pace and scale of ecological restoration across the landscape. Alternative C emphasizes protection of wildlife habitat and reintroduction of fire in restoring forest resilience, while minimizing mechanical treatments and other intrusive interventions. Alternative E has essentially the same effects as alternative C, combined with effects of adding five wilderness areas.

Alternative D best reduces the long-term risks of high-intensity wildfire in the plan area. It would trade off short-term impacts that could increase erosion and deliver more sediment to streams, due to increased mechanical treatments and soil disturbance, and greater use of fire at a greater pace and scale than the other alternatives. Fire has not been used before on the scale proposed under alternative D; therefore, the ability of alternative D to meet its objectives is uncertain. This would depend on a number of factors, including availability of funding, manpower, and other resources and unpredictable wildfires. But if alternative D is successful in achieving these objectives, it has the greatest potential for achieving long-term and sustainable benefits to water quality and quantity. Alternative B limits the pace and scale of restoration. The result could be that it may not keep pace as well with the increased threat of high-intensity fire expected to result from climate change.

Climate change is increasing the risk of higher ambient temperatures, less reliable snowpack and precipitation, earlier and faster runoff, more extreme peak flows, less groundwater retention, and higher water temperatures throughout the plan area. Countering these trends would require restoring meadows and riparian areas. Alternative D provides the greatest opportunity to mitigate the effects of climate change, because it would restore the greatest amount of acreage to a more sustainable condition.

Water Quantity

The alternatives differ in approach, pace and scale, and amount of ecological restoration necessary to improve shallow groundwater recharge and retention. Current science suggests that climate change will lead to more extreme and variable precipitation events, later and higher elevation snowfall, and earlier snowmelt. These conditions will probably combine to reduce water retention in the Sierra Nevada watersheds.

In the southern Sierra Nevada, climate change may not rapidly decrease average annual precipitation, but greater extremes in precipitation are likely. Warmer temperatures and dense vegetation can increase evaporative losses, even without high-intensity fire. High-intensity fire will reduce forest cover over large areas, reduce infiltration, and increase runoff and erosion, threatening loss of soil and sedimentation of streams and shallow water bodies.

Each of the alternatives would address these threats to different degrees. Alternative D is the most ambitious in addressing the problems that are expected to adversely affect water quantity. Alternatives C and E would be very similar in maintaining water quality and quantity in the face of threats from climate change. If climate change were not such an overriding threat to water resources, the focus of alternative C on protecting wildlife habitat and increasing wilderness might be more protective of water resources than alternatives B and D. This would be the case especially in terms of reducing the potential short-term effects from soil-disturbing activities associated with mechanical treatments. However, alternative C would probably improve forest resilience less, with greater long-term vulnerability to high-intensity fire than alternatives B and D. This long-term vulnerability would eventually have the greatest impact on water resources.

Alternative A would perform the worst in the long term. This is because it does not address the effects of climate change at the landscape scale, and it continues to focus on gradual improvement of individual watershed conditions at a moderate pace.

Watershed Condition

The watershed condition framework provides a standardized way of evaluating the deviation of watersheds from desired conditions. It allows watershed restoration actions to be prioritized by identifying watersheds where the largest improvements can be made with the fewest resources. Periodic revaluation and updating of watershed condition surveys provides a means of evaluating the success of overall management actions, as well as individual project actions. With few exceptions, water quality–one of the 12 indicators of watershed condition—is currently considered good throughout the plan area.[19] However, stressors associated with future climate change may lead to declines in many of the other indicators, which in turn may lead directly or indirectly to declines in water quality.

Management actions proposed under each of the alternatives are designed to offset, to various degrees, the future stresses resulting from climate change. Alternative A continues to address these stresses through the current program of prioritizing individual watershed improvements. Projects developed to maintain and enhance these selected watersheds would continue to move forward under all alternatives. As WRAPs in current priority watersheds are completed, new priority watersheds will be identified, considering restoration needs that are developed and implemented over a 5- to 7-year period. All the alternatives offer additional opportunities for restoration in these priority watersheds through partnerships.

Alternatives B, C, D, and E introduce additional landscape-scale goals and objectives intended to increase the pace and scale of restoration across watershed boundaries. Each of the alternatives relies, to different degrees, on fire to restore the basic water capture and retention functions of watersheds to a more sustainable condition. Initially, these landscape-scale actions may result in declines in some of the indicators that constitute the watershed condition framework. However, over the long term, either improving trends or at least a maintenance state is expected. The alternatives rely on different approaches to achieve the same or similar long-term outcomes.

Alternative B defines landscape-scale conservation watersheds where wildlife would be provided refugia along riparian corridors. Conservation watersheds represent a long-term prioritization for

[19] The water quantity indicator in the watershed condition framework is primarily a measure of conditions associated with reservoirs and human-made water diversions, which are outside the Forest Service's control and therefore are not likely to be affected by the alternatives.

maintenance and restoration of watersheds particularly focused on aquatic resources. In the process, water quality and quantity would also be maintained or improved.

Alternatives C and E substantially increase the use of prescribed fire to restore watershed condition. However, they emphasize wildlife protection and relatively low levels of human intrusion, possibly limiting the effectiveness of and the ability to implement these treatments in many parts of the plan area. Alternatives C and E create most new CARs, many outside of wilderness boundaries, that could benefit from watershed restoration focused on enhancing habitat and improving water quality for the benefit of aquatic species.

Alternative D makes the most effective use of fire throughout the plan area. Therefore, it has the highest potential to restore the most watersheds to higher levels of function in the face of climate change. It has the greatest potential to reduce evapotranspiration, retain groundwater, restore streamflows, and avoid high-intensity fire over the long term, although this comes at some risk of short-term impacts on water quality.

Wildlife, Aquatic, and Plant Species

Introduction

This section summarizes current affected environment and environmental consequences as is relates to wildlife, aquatic, and plant species in the Sequoia and Sierra National Forests. The diverse landscapes of the Sequoia and Sierra National Forests provide a rich array of ecosystems and habitat types that support thousands of wildlife, fish, and plant species. These diverse landscapes encompass the west side of the Sierra Nevada, with elevations extending from approximately 1,000 feet to 14,000 feet above mean sea level. They include a variety of topography, geology and soils, and are influenced by a wide range of precipitation and temperature regimes. This diversity is also reflected by three major biological provinces present in these two national forests: Sierra Nevada, San Joaquin Valley, Tehachapi Mountains (Long et al. 2014).

- The Sequoia National Forest has approximately 304 species of terrestrial wildlife, consisting of 194 birds, 85 mammals, 25 reptiles, 13 amphibians, and 9 native fish; there are over 2,000 native plant species (United States Department of Agriculture 2013b). There are also 24 introduced fish species.
- The Sierra National Forest has approximately 302 terrestrial wildlife species, consisting of 198 birds, 82 mammals, 22 reptiles; 15 amphibians, and 9 native fish species; there are more than 2,000 native plant species (United States Department of Agriculture 2013c). There are also 22 introduced fish species.

As shown and discussed previously in “Agents of Change” and “Terrestrial Ecosystems,” the Sierra and Sequoia National Forests have had extensive tree mortality due to insect and disease outbreaks, drought, and wildfire. These national forests have the highest rate of tree mortality in California, with an estimate of over 52 million dead trees from 2010 to 2017 (California Department of Forestry and Fire 2018). Widespread tree mortality is expected to continue and has become a significant threat to native wildlife, aquatic, and plant species through loss of habitat, degradation of water quality, and increase potential for severe wildfire events from excessive fuel loading as dead trees fall down.

The Evaluation of At-Risk Species

Forest plans are developed to guide the maintenance and restoration of structure, function, composition, and connectivity of ecosystems to provide ecological conditions that will maintain a diversity of plant and animal communities and support the persistence of most native species in the plan area. The analysis in this section focuses on evaluating the consequences of the plan alternatives on at-risk species. Forest Service at-risk species are under two categories: federally designated species and habitat (species listed as threatened or endangered, species that are proposed or candidates for Federal listing, and species with designated critical habitat in the national forests) and Forest Service-designated species of conservation concern.

Other native wildlife that are not included as at-risk species are not analyzed in detail, but ecosystem-level plan components are expected to provide for the broad ecological conditions that support native species persistence. Analysis of native species associated with recreation, such as wildlife viewing, hunting, and fishing are addressed in Revision Topic 3 under Benefits to People and Communities.

In contrast to categories of federally designated species described and derived under the Endangered Species Act, species of conservation concern is a new category developed and used by the Forest Service under the 2012 Planning Rule to describe animal and plant species that are known to occur in the plan area, and for which the Regional Forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long term in the plan area.[20]

In coordination with the Sequoia and Sierra National Forests, and pursuant to responsibilities and authority under the 2012 Planning Rule (36 CFR 219.7(c)(3)), the Regional Forester designated the terrestrial wildlife, aquatic wildlife, and plant species of conservation concern for the Sequoia and Sierra National Forests[21] (Moore 2019). Designation of these species is not a forest plan decision. The Regional Forester has authority to change species of conservation concern lists to reflect new information.[22]

The Forest Service's sensitive species concept is not carried forward as part of the 2012 Planning Rule and species of conservation concern replaces that concept in land management plans going forward. The draft forest plans include plan components that help provide ecological conditions for these at-risk species and the revised Draft Environment Impact Statement evaluates the effects of management on these species at the landscape-level. Additional documentation is found in Appendix D.

The primary context for the evaluation of at-risk species, including species of conservation concern, is that forest plan components for ecological conditions provide for ecosystem integrity and ecosystem diversity. The 2012 Planning Rule requires that forest plan direction be integrated across resources and that the plans need to provide for the ecological conditions that will provide for the persistence of at-risk species within the inherent capabilities of the national forest plan area (36 CFR 219.5 and 219.8-219.9). For the purpose of this analysis, a viable population is defined as a population of a species that continues to persist over the long term with sufficient

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[20] 36 CFR 219.9

[21] There is a Regional Forester's species of conservation concern list for each of the Sequoia and Sierra National Forests.

[22] See Forest Service Handbook 1909.12, chapter 20, section 21.22b

distribution to be resilient and adaptable to stressors and likely future environments (36 CFR 219.19).

The basis for the analysis of at-risk species requires a determination of whether plan components such as desired conditions, objectives, standards, guidelines, and goals support direction to provide the ecological conditions necessary to contribute to the recovery of federally recognized species and maintain the persistence of species of conservation concern in the plan area. Plan components were developed in an iterative way by identifying whether proposed plan components are sufficient to address ecological conditions required by species. The analysis for species persistence first considered ecosystem-level plan direction and, as needed, developed species-specific plan direction, such as modifying desired conditions or addressing potential threats to species (FSH 1909.12 12.52.c-d).

For some species, the plan area may be unable to provide the ecological conditions necessary to maintain a viable population, due to circumstances that are either not within the authority of the Forest Service or not consistent within the inherent capability of the land. For example, for many species of conservation concern there is uncertainty as to whether a viable population truly exists in the plan area of a national forest. Several at-risk species have only a few known occurrences and have limited potential habitat on National Forest System lands. In some cases, little is known about the distribution of species because they are not well surveyed. In these cases, we assess the effects of implementation of plan components on local populations, and how well the alternatives address known threats to persistence of the populations in the plan area and consider the contribution to maintaining a viable population within the species range.

The analysis also discloses the uncertainty of moving toward desired conditions given the wide departure of the current condition in some areas and the limited opportunity for restoration treatments in the Sequoia and Sierra National Forests. When this occurs, the analysis documents this and where possible, focuses on other efforts that are within the capability and authority of the Forest Service.

Conservation Planning As It Relates To Forest Plans

Conservation strategies and assessments provide science-based guidance for conserving and recovering species and their habitat. They are developed to recommend conservation measures specific to a species or group of species. Conservation strategies and assessments, as opposed to conservation agreements, are not commitments of Federal action (decision documents), and are therefore not subject to environmental analysis and public review. In addition, management recommendation in conservation strategies are often developed to optimize benefits to the species regardless of the authority and responsibility of the Forest Service and other multiple-use considerations. Where appropriate, the forest plan alternatives have incorporated some of the science-based management recommendations from various strategies and assessments, but the elements incorporated may vary by alternative.

The various conservation strategies, assessments, and agreements and approved species recovery plans and other related recovery documents are also used by forest managers when analyzing the consequences of site-specific project activities. These guiding documents are expected to be revised, replaced, or supplemented as new scientific information based on new data and reports becomes available over time. Therefore, the list below only includes the most relevant documents known to be available at this time and is not intended to be a complete or exhaustive list. These documents are referenced because they serve as a tool to guide forest plan development.

- California Bird Species of Special Concern (Shuford and Gardali 2008)
- Landbird Strategic Plan (United States Department of Agriculture 2000)
- North American Landbird Conservation Plan (Rich et al. 2004)
- Mountain Yellow-Legged Frog Conservation Assessment for the Sierra Nevada Mountains of California, USA (Brown et al. 2014a)
- Sierra Nevada Bighorn Sheep (*Ovis canadensis sierrae*) Recovery Plan (United States Department of the Interior 2007)
- Southern Sierra Nevada Fisher Conservation Assessment (Spencer et al. 2015)
- Southern Sierra Nevada Fisher Conservation Strategy (Spencer et al. 2016)
- Southwest Willow Flycatcher Recovery Plan (United States Department of the Interior 2002)
- Tricolored Blackbird Conservation Plan (Tricolored Blackbird Working Group 2009)
- Willow Flycatcher Conservation Assessment (Green et al. 2003)
- Yosemite Toad Conservation Assessment (Brown et al. 2015)
- Draft Conservation Strategy for the California Spotted Owl (United States Department of Agriculture 2018b)
- Draft Recovery Plan for the Least Bell’s Vireo (United States Department of the Interior 1998a)

Migratory Birds

Migratory birds are birds that have a seasonal and somewhat predictable pattern of movement. For the sake of forest planning, migratory birds are defined as all species covered by the Migratory Bird Treaty Act. Generally, this includes all native birds in the United States, except those non-migratory species such as quail and turkey that are managed by the states.

Under the National Forest Management Act, the Forest Service is directed to “provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives.” (P.L. 94-588, Sec 6(g)(3)(B)). Direction for integrating migratory bird conservation into forest management and planning includes the January 2000 USDA Forest Service Landbird Conservation Strategic Plan; the Partners in Flight Landbird Conservation Plans; the 2001 Executive Order 13186; and the 2017 Department of Interior Solicitor’s Opinion M-37050.

In the national forests, migratory bird conservation focuses on providing a diversity of bird habitats at multiple spatial and temporal scales over the long term. Our actions also include promoting migratory bird conservation through enhanced collaboration and cooperation with the U.S. Fish and Wildlife Service as well as other Federal, state, tribal and local governments.

The forest plan revision addresses the conservation of migratory bird habitat and populations by considering the list of birds of conservation concern published by the U.S. Fish and Wildlife Service (United States Department of the Interior 2008a) when determining the species of conservation concern. Of the bird species of conservation concern, all are considered migratory birds except for the Mount Pinos sooty grouse. These species are evaluated in the species persistence analysis (Appendix D in Volume 2) and in the rationale documents for animal species considered for species of conservation concern for each forest (United States Department of Agriculture 2019a, b).

In 2000, the Forest Service released a Landbird Strategic Plan (United States Department of Agriculture 2000) to provide very general guidance for the agency's landbird conservation program. Among the suggested actions was the incorporation of landbird management into forest plans. Recent reports produced by the North American Bird Conservation Initiative, and known as state of the birds reports, have been issued by several organizations and Federal agencies to summarize the general condition of birds across the United States. These reports use the latest bird monitoring and scientific data to assess the status and health of all U.S. bird species and promote birds as indicators of overall environmental health and human well-being.

These reports paint a picture of declines in multiple species across a variety of habitats. Climate change was one of the contributing factors to these declines, and is likely to continue impacting birds into the future. As the climate warms, breeding seasons and migrations are being altered and may become out of sync with prey abundance and availability. This reinforces the need to have resilient and diverse habitat that can help species adapt to climate change. The 2011 report focused on public lands and waters and stated that "[n]atural processes must be restored to ensure functional and resilient ecosystems through management actions such as control of nonnative species and diseases, prescribed cuts and burns to reinvigorate forests and grasslands, and water delivery and management to sustain wetlands" (North American Bird Conservation Initiative 2011). For western forests, the report identified the need to focus on the "loss of pines, especially pinyon and whitebark pine, due to spread of white pine blister rust, mountain pine bark beetle, and other invasive pests" and "restoration of natural fire regimes" (North American Bird Conservation Initiative 2011).

The coordinating group, Partners in Flight, also produced a North American Landbird Conservation Plan in 2004 (Rich et al. 2004) and a revision of the plan in 2016 (Rosenberg et al. 2016), and keeps a Strategic Action Plan updated (Partners in Flight 2017). These plans promote the conservation of migratory and other birds and have two main components: helping bird species at risk and keeping common birds common.

Migratory birds are ubiquitous and use virtually all habitat types across a range of elevations. Therefore, restoration of many vegetation types at various elevations would benefit habitat for migratory bird species, especially in cases where restoration focuses on moving the vegetation toward the natural range of variation, improving resilience to wildfire and changing climate conditions, protecting and restoring riparian and watershed conditions, and controlling or eradicating invasive species (see discussion in "Terrestrial Ecosystems" and "Aquatic and Riparian Ecosystems").

Alternative A provides for migratory birds by providing for broad habitat conditions and assessing project impacts on some birds as management indicator species and as Regional Forester's sensitive species and through project-level evaluations of effects. In the action alternatives, plan components help identify and guide projects to address threats and other risks to ecological conditions important for at-risk species, including migratory birds that are species of conservation concern.

Some plan components are broader and apply to all native species that occur in the plan area. In general, forest plan components and plan content were designed to meet the needs of migratory birds and other species by addressing high priority habitats and their associated vegetation type or aquatic system where they depart from desired ecological conditions. These components include guidance on restoration approaches that reduce and limit short-term impacts while focusing on improving landscape resilience. Examples of emphasis habitats are systems that are highly altered such as some meadows where water tables have been lowered or vegetation reduced, altered montane forests and riparian areas that lack resiliency to wildfire under changing climatic conditions, and sagebrush ecosystems that have been impacted by conifer encroachment and invasive annual grasses.

Common migratory birds are expected to persist on the landscape because the plans strive to retain ecosystem diversity to provide for a range of habitats and provide the ecological conditions expected for the plan area to provide for ecological integrity. Although the different alternatives emphasize different approaches to moving toward desired conditions and would have different rates of movement over the life of the forest plan, they all include plan components to provide for the essential elements of migratory bird habitat. Habitat for migratory birds is anticipated to persist under all alternatives.

Federally Listed Threatened, Endangered, Proposed, and Candidate Wildlife, Fish and Plants

Background

This section evaluates and discloses the potential environmental consequences of the forest plan alternatives on federally listed, proposed, and candidate wildlife, fish, and plant species and critical habitat. This analysis evaluates the effectiveness of the alternatives to provide direction to create the ecological conditions to contribute to the recovery of federally listed threatened and endangered species and conserve proposed and candidate species in the plan areas (each national forest).

Relationship between Forest Plans and the Endangered Species Act Consultation Process

Information and science-based recommendations for federally listed species is included in species recovery plans, species reviews and assessments, conservation assessments, and critical habitat designations. This information was considered in developing plan components that are designed to provide, as appropriate, ecological conditions in the plan area necessary to contribute to the requirements for each federally designated species.

The Forest Service will prepare a biological assessment for the preferred alternative in the final environmental impact statement and for submittal to the U.S. Fish and Wildlife Service for formal consultation. This will be done to comply with Section 7 of the Endangered Species Act and in accordance with agency policy and practices (United States Department of Agriculture 2017a). A biological opinion will be received and considered before issuing a decision. Through the consultation process, the U.S. Fish and Wildlife Service may provide additional information that could lead to refined plan components to better conserve habitats and contribute to the recovery of listed species.

Some existing forest plan directions has been retained because it supports existing conservation measures or conservation recommendations from past biological opinions. For example, the 2014

Programmatic Biological Opinion for the Sierra Nevada Yellow-Legged Frog, Northern Distinct Population Segment (DPS) of the Mountain Yellow-Legged Frog and Yosemite Toad (United States Department of the Interior 2015b) applies to ongoing project activities under the current forest plan direction. Some, but not all, of this existing forest plan direction was applied as ecosystem or species-specific plan components. Where direction was not retained in the action alternatives, it was primarily because of clarifications in the definition of plan components in the 2012 Planning Rule. In some cases, existing forest plan direction that was originally written generally to be applied across the entire Sierra Nevada range was re-written to be more applicable to the Sierra or Sequoia National Forest plan areas.

Under the Endangered Species Act, adopting a forest plan is considered a framework programmatic action, which establishes only a framework for the development of specific future actions but does not authorize any future actions on National Forest System lands (50 CFR 402.02). Under those circumstances, the programmatic action in and of itself would not result in incidental take of listed species, so it does not require an incidental take statement (see 80 FR 26832- 26845 and 50 CFR 402.14(i)(6)).

To address federally listed species in the forest plans, the Forest Service generally relies on broad plan direction to contribute to the recovery of listed species. The agency considers relevant guidance in species recovery plans during project planning. This allows the plans to be adaptive; adjustments in project design can be made for newly listed species and new critical habitat designations or as new information becomes available. Once forest plans are approved, consultation on the forest plans will be reinitiated, as required by law.[23] Existing consultation obligations will still apply to site-specific Forest Service actions, as required by the Endangered Species Act and agency procedures. An analysis for the preferred alternative is documented in a draft biological assessment, which is available in the project record.

Analysis and Methods

Analysis Area

The primary analysis area includes all National Forest System lands in the Sequoia and Sierra National Forests, except for lands managed by the 2012 Giant Sequoia National Monument Management Plan (United States Department of Agriculture 2012c). In some cases, the best available scientific information for the ecological relationships of federally listed species originated outside the analysis area. However, the Forest Service used indicator measures and threat information from in the analysis area in making conclusions.

In evaluating effects, we also considered the following secondary areas:

- The area of designated or proposed critical habitat that overlaps and is adjacent to the forest
- The recovery units identified in approved recovery plans that overlap the forest
- The range of the species when described in listing documents or recovery plans relative to the plan area
- The area of recent detections; This may also include historic detections, depending on the species and recovery plan

[23] See, for example, 16 USC 1604(d)(2) (addressing requirements for additional consultation after approval of land management plans).

Indicators and Measures

The Forest Service evaluated the following two primary aspects for federally listed species:

- Existence of plan direction that functions to avoid, minimize, or mitigate potential adverse effects on federally listed species and candidate species focusing on the relevant threats in the Sequoia and Sierra National Forests to individuals in occupied habitat
- Existence of plan direction that functions to protect, maintain, and restore habitat elements or primary constituent elements of designated critical habitat

For each species, we evaluate if alternatives maintain or restore habitats in the plan area to provide the ecological conditions necessary to contribute to recovery of threatened and endangered species and if they contribute to preventing candidate species from becoming federally listed in the future.[24] We focused the analysis by considering the program areas (types of activities) that might affect the species in the locations they occur in the plan area, including critical habitat.

We examined six program areas: fire management, vegetation and fuels management, range management, recreation management, restoration, and roads and infrastructure. We also evaluated the authority of the Forest Service and the inherent capability of the plan area to provide for federally listed at-risk species.

When developing ecosystem and species-specific plan components to conserve federally listed species, we did the following:

- Considered recovery actions and recovery tasks in approved recovery plans for listed species
- Considered limiting factors and key threats to species identified in published rules from the U.S. Fish and Wildlife Service for species listing and designation of critical habitat
- Considered limiting factors and key threats identified in species reviews and candidate species assessments from the U.S. Fish and Wildlife Service
- Solicited and considered comments and feedback from the U.S. Fish and Wildlife Service in the evaluation of plan components designed to conserve federally listed species
- Considered collaboration and cooperation beyond the plan area boundary with the U.S. Fish and Wildlife Service, States, tribes, other partners, landowners, and land managers to support an all-lands approach to conserve proposed and candidate species
- Considered conservation measures identified in existing conservation strategies relevant to federally listed species in the plan area

Assumptions

- Site-specific projects will be evaluated for effects on federally listed species and will follow agency consultation procedures in compliance with the Endangered Species Act.
- Program areas addressed by existing biological opinions will continue to be managed under the existing terms and conditions until and unless consultation is reinitiated and a new or updated biological opinion is issued and incorporated into the project decision.

[24] Forest Service Handbook 1909.12

- The Forest Service will coordinate with and support surveys, species monitoring, habitat evaluations, and other species recovery action initiated by the U.S. Fish and Wildlife Service or California Department of Fish and Wildlife.
- All alternatives will prioritize habitat restoration opportunities identified as important by the U.S. Fish and Wildlife Service, but alternatives B and D would have greater potential to fund the work as part of stewardship projects. Under all alternatives, the Forest Service will seek special funding and partner funding to accomplish the work.
- The forest plan, by itself, does not restrict public access or uses. Any actions that restrict public access or uses in order to minimize or avoid disturbance to federally listed species will require site-specific analysis and project level decisions. These are typically implemented through forest orders or regulation.

Species Evaluated

Table 60 to Table 61 list the federally threatened, endangered, proposed, and candidate species and designated or proposed critical habitat that occur in the Sequoia and Sierra National Forests. Candidate species are plants and animals for which the U.S. Fish and Wildlife Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Candidate species do not have formal protection under the Endangered Species Act but the 2012 Planning Rule requires that forest plans are developed to conserve candidate species (36 CFR 219.9).

Table 60. Federally listed threatened, endangered, and proposed species evaluated in detail

Common Name	Scientific Name	Status	National Forest
California condor	*Gymnogyps californianus*	Endangered	Sequoia, Sierra
Least Bell's vireo	*Vireo bellii pusillus*	Endangered	Sequoia
Southwestern willow flycatcher	*Empidonax trailii extimus*	Endangered	Sequoia
Western yellow-billed cuckoo western DPS[25]	*Coccyzus americanus*	Threatened	Sequoia
Sierra Nevada bighorn sheep	*Ovis canadensis sierra*	Endangered	Sequoia, Sierra
Fisher, West Coast DPS	*Pekania pennanti*	Proposed	Sequoia, Sierra
Mountain yellow-legged frog, northern DPS	*Rana muscosa*	Endangered	Sequoia, Sierra
Sierra Nevada yellow-legged frog	*Rana sierrae*	Endangered	Sequoia, Sierra
Yosemite toad	*Anaxyrus canorus*	Threatened	Sequoia, Sierra
Lahontan cutthroat trout	*Oncorhynchus clarki henshawi*	Threatened	Sierra
Paiute cutthroat trout	*Oncorhynchus clarki seleniris*	Threatened	Sierra
Little Kern golden trout	*Oncorhynchus aquabonita whitei*	Threatened	Sequoia
Bakersfield cactus	*Opuntia basilaris* var. *treleasii*	Endangered	Sequoia
Mariposa pussypaws	*Calyptridium pulchellum*	Threatened	Sierra
Whitebark pine	*Pinus albicaulis*	Candidate	Sierra

[25] DPS stands for Distinct Population Segment as recognized by the U.S. Fish and Wildlife Service.

Table 61. Federally designated and proposed critical habitats evaluated in detail

Common Name	Type of Designation	National Forest
California condor	Designated critical habitat	Sequoia
Southwestern willow flycatcher	Designated critical habitat	Sequoia
Western yellow-billed cuckoo, western DPS	Proposed critical habitat	Sequoia
Sierra Nevada bighorn sheep	Designated critical habitat	Sequoia, Sierra
Mountain yellow-legged frog, northern DPS	Designated critical habitat	Sequoia
Sierra Nevada yellow-legged frog	Designated critical habitat	Sequoia, Sierra
Yosemite toad	Designated critical habitat	Sierra
Little Kern golden trout	Designated critical habitat	Sequoia

Table 62 lists additional species identified by the U.S. Fish and Wildlife Service in the official species lists generated for the plan revision project that were determined to not occur in the plan area. The Forest Service will not evaluate these species in detail for the plan revision for these national forests. Additional information for each species can be found in the biological assessment in the project record.

Table 62. Federally listed species not evaluated in detail

Common Name	Scientific Name	Status	National Forest
Blunt-nosed leopard lizard	*Gambelia sila*	Endangered	Sequoia, Sierra
California jewelflower	*Caulanthus californicus*	Endangered	Sequoia
California red-legged frog	*Rana draytonii*	Threatened	Sequoia, Sierra
California tiger salamander	*Ambystoma californiense*	Threatened	Sequoia, Sierra
Conservancy fairy shrimp	*Branchinecta conservatio*	Endangered	Sierra
Delta smelt	*Hypomesus transpacificus*	Threatened	Sequoia, Sierra
Desert tortoise	*Gopherus agassizii*	Threatened	Sequoia
Fleshy owl's-clover/Succulent owl's-clover	*Castilleja campestris* var. *succulenta*	Threatened	Sierra
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	Endangered	Sierra
Giant garter snake	*Thamnophis gigas*	Threatened	Sequoia, Sierra
Keck's Checker-mallow	*Sidalcea keckii*	Endangered	Sequoia, Sierra
Kern primrose sphinx moth	*Euproserpinus euterpe*	Threatened	Sequoia
North American wolverine/California wolverine	*Gulo gulo luscus*	Proposed Threatened	Sequoia, Sierra
Owens tui chub	*Gila bicolor snyderi*	Endangered	Sierra
San Joaquin adobe sunburst	*Pseudobahia peirsonii*	Threatened	Sequoia
San Joaquin kit fox	*Vulpes macrotis mutica*	Endangered	Sequoia, Sierra
San Joaquin orcutt grass	*Orcuttia inaequalis*	Threatened	Sierra
San Joaquin wooly-threads	*Monolopia congdonii*	Endangered	Sequoia
Springville clarkia	*Clarkia springvillensis*	Threatened	Sequoia
Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*	Endangered	Sequoia
Vernal pool fairy shrimp	*Branchinecta lynchi*	Threatened	Sequoia, Sierra
Vernal pool tadpole shrimp	*Lepidurus packardi*	Endangered	Sierra

Affected Environment

Table 63 provides a general summary of the primary ecological zones or vegetation types and primary stressors that affect each species. It also identifies any special habitat needs or key ecological conditions and identifies if primary stressors are in or outside of the control or authority of the Forest Service to address. Although candidate species do not have formal protection under the Endangered Species Act, we will include an analysis of whitebark pine in this section and in the biological assessment being prepared for this project.

Table 63. Summary table of ecological zones or types, key ecological conditions, and primary stressors or threats to persistence for federally listed species

Species	Primary Ecological Zones or Vegetation Types	Special Habitat Needs/Key Ecological Conditions	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control	Program Areas
California condor	Westside Foothill Zone; Westside Montane Zone	Rocky cliffs and large conifer trees, including giant sequoia trees	Collision with human-built structures and large, high-severity fire	Habitat loss from land conversion, lead poisoning	Vegetation and fuels, recreation, roads and infrastructure
Least Bell's vireo	Low elevation riparian habitat near Lake Isabella	Riparian shrubs	Loss of riparian habitats by tamarisk invasion and fire	Climate change affects to riparian areas	Fire, range, recreation
Southwestern willow flycatcher	Low elevation riparian habitat near Lake Isabella	Riparian shrubs	Loss of riparian habitats by tamarisk invasion and fire	Climate change affects to riparian areas	Fire, range, recreation
Yellow-billed cuckoo, western DPS	Low elevation riparian habitat near Lake Isabella	Riparian forests	Loss of riparian habitats by tamarisk invasion and fire	Climate change affects to riparian areas	Fire, range, recreation
Sierra Nevada bighorn sheep	Upper Montane Forest, Alpine and Subalpine Zones; Meadows	Cliffs and rocky features, escape terrain	Predation related to hiding cover from increasing tree and shrub cover	Epizootic pneumonia and contact with stray goats and sheep; climate change and loss of snow pack	Fire, Recreation
Fisher, West Coast DPS	Montane Forest	Cavities in large snags and down logs	Loss of habitat due to high-severity fire and insect outbreaks; connectivity	Illegal use of pesticides	Fire, vegetation and fuels, recreation, roads and infrastructure
Mountain yellow-legged frog, northern DPS	Rivers and streams, lakes, ponds, riparian areas	Streams, ponds, pools, lakes, and riparian wetlands.	Nonnative fish; habitat fragmentation; disease	Climate change; small populations	Fire, recreation, restoration

Species	Primary Ecological Zones or Vegetation Types	Special Habitat Needs/Key Ecological Conditions	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control	Program Areas
Sierra Nevada yellow-legged frog	Rivers and streams, lakes, ponds, seeps, springs, riparian areas	Streams, ponds, pools, springs, lakes, and riparian wetlands.	Nonnative fish; habitat fragmentation; disease	Climate change; small populations	Fire, vegetation and fuels, range, recreation, restoration, roads and infrastructure
Yosemite toad	Meadows	Wet meadow habitats and lakeshores	Degradation of meadow hydrology; conifer encroachment of meadows; disease	Climate change	Fire, vegetation and fuels, range, recreation, restoration, roads and infrastructure
Lahontan cutthroat trout	Rivers and streams (out of basin)	Perennial, cold water streams and rivers	Alteration in stream channels and morphology; loss of spawning habitat; fire	Hybridization; over fishing	Fire, vegetation and fuels, range, recreation, restoration, roads and infrastructure
Paiute cutthroat trout	Rivers and streams (out of basin)	Perennial, cold water streams and rivers	Destruction or modification of habitat; sedimentation	Hybridization; limited distribution; disease; over fishing	Fire, range, recreation
Little Kern golden trout	Rivers and streams, lakes, ponds	Cold streams, rivers and lakes.	Nonnative species; degradation of stream, meadow, and upland riparian habitats from land uses	Hybridization; climate change	Fire, range, recreation, restoration
Bakersfield cactus	Outcrops, blue oak woodland	None	Rarity	Road maintenance by state	Fire, recreation, roads and infrastructure
Mariposa pussypaws	Blue oak woodland	None	Livestock trampling, invasive plants, infrastructure maintenance	None	Fire, range, restoration, roads and infrastructure
Whitebark pine	Alpine and subalpine	None	Fire suppression; insects and disease	Climate change	Fire, recreation

California Condor

Status: The California condor was listed as endangered in 1967 (United States Department of the Interior 1967). Critical habitat was designated in 1976 and includes 507 acres identified in the Giant Sequoia National Monument (United States Department of the Interior 1976, 1977). In the Sequoia National Forest plan area, there is an 8-acre parcel around the Springville Work Center that is in the Tulare County Rangelands critical habitat unit, which is west of the forest. There is no designated critical habitat in the Sierra National Forest. Recovery plans were written and revised in 1975, 1979, 1984, and 1996 (United States Department of the Interior 1996).

The expanding population of condors in southern California has recently resumed the use of a number of traditional roosting sites (Johnson et al. 2010). Based on historic and contemporary condor travel patterns and continued observations at historically used roost sites in the Sequoia National Forest, the highest quality habitat for the condor in the analysis area is represented by the upper two-thirds of forested slopes on the west side of the Greenhorn and Breckenridge Mountains. Recently, a California condor attempted to nest on the Sequoia National Forest in the general area of Lake Isabella. Some fly-overs have been recorded over the Sierra National Forest, but there are no known modern-day records of foraging or nesting in the Sierra National Forest itself.

Threats: As part of its 5-year review in 2013, the U.S. Fish and Wildlife Service assessed the causes of California condor mortality since the condor reintroductions began in 1992 (United States Department of the Interior 2013b). It found the current primary threats to the population are as follows:

- Loss or change in habitats from such activities such as rangeland conversions and power line and wind energy development
- Predation and disease
- Lead poisoning, shooting, micro-trash ingestion, organochlorines (especially for birds that feed on marine mammals), and climate change

Of these threats, the threat of rangeland conversion, predation and disease, and micro-trash ingestion are not likely to be factors for the plan area.

Lead ingestion by California condors and the subsequent behavioral and physiological effects of lead poisoning, including death, is the single most significant threat to the species. The risk of condors ingesting lead is mitigated by a 2007 State of California law[26] that bans the use of lead ammunition for hunting big game and non-game species within the range of the condor, which includes the Sequoia and Sierra National Forests. This ban on lead ammunition will be extended to hunting of all wildlife in California by July 2019.[27] Although this ban does not affect ammunition used for target shooting, the risk of lead ingestion to condors is primarily from foraging on large animals that contain lead bullets or fragments. Thus, reducing the risk of lead poisoning is being managed by the State of California and is outside the authority of the Forest Service.

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[26] Assembly Bill No. 821, the Ridley-Tree Condor Preservation Act signed October 13, 2007 and implemented in July 2008.

[27] Assembly Bill No. 711, signed October 11, 2013 expands the ban on lead ammunition for hunting big game and coyotes within the state by July 2019.

California condors are expected to forage primarily outside of the plan area in the rangelands, but since they have very large daily flights, they could also forage on carrion, especially large mammals and potentially dead livestock, in the national forest. Although the risk of organochlorines was identified as primarily from accumulation in marine mammals, the risk of secondary poisoning from organochlorines and other toxicants used in illegal marijuana cultivation could be a concern. Because California condors have nested in large giant sequoia trees, threats to giant sequoia trees from high-severity fire may also affect potential nest sites. Restoring fire broadly across the forests may also improve ecological conditions for deer, which could improve foraging opportunities in the plan area.

Least Bell's Vireo, Southwestern Willow Flycatcher, and Western Yellow-Billed Cuckoo

These species are grouped together because they occur primarily in similar habitat in the South Fork Wildlife Area in the Sequoia National Forest and they are affected similarly by the alternatives.

Least Bell's Vireo

Status: The least Bell's vireo was listed as endangered in 1986 (United States Department of the Interior 1986). Critical habitat was designated in 1994, but none is found in the Sequoia National Forest (United States Department of the Interior 1994a). A draft recovery plan was completed in 1998 but has never been finalized; it remains in draft status (United States Department of the Interior 1998a).

Habitat includes riparian vegetation with cottonwoods. This species had been sporadically reported in the Kern River Valley in the early 1990s with one singing male reported in the South Fork Wildlife area during surveys conducted between 1998 and 2003 (United States Army Corps of Engineers 2004). The Southern Sierra Research Station has conducted surveys for the southwestern willow flycatcher and least Bell's vireo in the South Fork Wildlife Area and adjacent Kern River Preserve at various times since 1989 (Whitfield 2018). They report that most recent nesting occurred in 2016. They found no nesting in the areas searched in 2017 or 2018, but they noted that it was possible that southwestern willow flycatcher were occurring in unsurveyed areas. Before that, a nesting attempt was made adjacent to the wildlife area in 2014 (Whitfield 2014). Nesting attempts have also been made in willows and riparian vegetation below the high water line of Lake Isabella, although these nests often get inundated as water levels rise (Whitfield 2018).

Threats: Across the range of this species, primary threats are the loss or degradation of habitat and nest parasitism by brown-headed cowbirds (Franzreb 1989, United States Department of the Interior 2006, 2009b). Poorly managed livestock grazing and other agricultural practices can also degrade habitat in some areas (United States Department of the Interior 2006). Currently livestock grazing and agriculture development are not practiced in the South Fork Wildlife Area. Livestock grazing adjacent to this area is managed under a Forest Service allotment management plan and grazing permit, which incorporates appropriate measures to eliminate potential impacts on habitat (see "Threats" under "Southwestern Willow Flycatcher"). The primary threats to occupied and potentially suitable habitat in the South Fork Wildlife Area that are within the authority of the Forest Service are high-severity wildfire, recreation, and loss of native riparian forest. This includes heterogeneity and structural diversity, due to the invasion of tamarisk (*Tamarix* spp.) and giant reed (*Arundo donax*). Populations in Mexico, outside of the authority or control of the Forest Service, also are subject to ongoing habitat loss and uncontrolled cowbird parasitism (United States Department of the Interior 2006).

Southwestern Willow Flycatcher

Status: The southwestern willow flycatcher, subspecies *extimus*,[28] was listed as endangered under the Endangered Species Act in 1995 (United States Department of the Interior 1995a). A final recovery plan was completed in 2002 (United States Department of the Interior 2002) and critical habitat was designated in 2013 (United States Department of the Interior 2013c). Designated critical habitat includes the riparian vegetation communities in the South Fork Wildlife Area.

The primary areas of suitable nesting habitat in the southern Sierra Nevada are located on the Kern River Preserve, owned and managed by the California Audubon Society, and the South Fork Wildlife Area, managed by the Sequoia National Forest. Other areas of potentially suitable habitat have been identified on National Forest System lands around Lake Isabella, Hanning Flat, Tillie Creek, and the north fork of the Kern River. Currently the Sequoia National Forest has approximately 1,050 acres of suitable habitat, all of which is potentially occupied. The California Department of Fish and Wildlife manages the Canebrake Ecological Area, upstream from the national forest, and is actively restoring riparian vegetation to create suitable habitat.

Surveys for the flycatcher have been conducted in the Kern River Valley since 1989 (Whitfield 2018). Most of the nesting records for this species have been found in the South Fork Wildlife Area and the adjacent (upstream) Kern River Preserve. Since 1989, the total number of flycatchers documented for this population has ranged between 27 and 44 pairs. Of this number, 5 to 12 pairs have been recorded breeding each year in the South Fork Kern Valley in the Sequoia National Forest (Whitfield 2014).

Threats: The principal cause of this species' decline is believed to be the alteration and destruction of riparian habitats (United States Department of the Interior 2002, 2014e). Other factors contributing to the decline are nest parasitism by brown-headed cowbirds, grazing disturbances, loss of riparian habitat due to reservoir and hydroelectric development, fires in riparian habitats, and disturbances on wintering grounds outside of the United States (Serena 1982).

Locally, tamarisk has become established and is spreading rapidly at Lake Isabella (United States Department of Agriculture 2015e). If left untreated, tamarisk could spread and possibly replace currently suitable native willow-cottonwood habitats used by the southwestern willow flycatcher and the western yellow-billed cuckoo (United States Department of Agriculture 2015e). The inundation of infested areas in 2016 and 2017 by high water coupled with local removal of remaining plants has mitigated the current risk, but periodic surveillance is needed to rapidly respond to any new populations.

Although livestock grazing is a general threat identified by the U.S. Fish and Wildlife Service, the South Fork Wildlife Area is fenced to exclude livestock. Approximately 100 acres of habitat for this species is outside the fenced and protected South Fork Wildlife Area in the Lake Isabella Grazing Allotment. Livestock grazing practices in this allotment complies with formal biological opinions rendered by the U.S. Fish and Wildlife Service for the southwestern willow flycatcher, least Bell's vireo, and for proposed critical habitat for western yellow-billed cuckoo. Livestock grazing is not considered a major threat in this area for a variety of reasons including that the

[28] The other subspecies (*brewsteri* and *adastus*) are managed as species of conservation concern.

current timing and intensity of grazing minimizes impacts on mature riparian forest. In addition, this area lacks potential to be considered long-term suitable habitat due to frequent and long duration inundation episodes under routine operation of the Lake Isabella Reservoir which is outside the authority of the Forest Service.

Western Yellow-Billed Cuckoo[29]

Status: The western DPS of the yellow-billed cuckoo was listed as a threatened species in 2014 (United States Department of the Interior 2014b). Critical habitat has not yet been designated for this species but proposed critical habitat (United States Department of the Interior 2014a) occurs in the Sequoia National Forest in the upstream area of Lake Isabella, the South Fork Wildlife area, and occurs in the Lake Isabella grazing allotment.

Currently, the 1,050 acres of suitable riparian habitat in the South Fork Wildlife Area is potentially occupied by this species during the breeding seasons. Surveys between 1985 and 2000 in the South Fork of the Kern River Valley documented an annual average of 10.5 pairs (range 2–24) (United States Department of the Interior 2011b). Year-to-year population fluctuations may be influenced by water-level fluctuations at Lake Isabella, adverse conditions in the migratory routes or destinations outside of the Sequoia National Forest, or some other mechanism that has not yet been identified (Henneman 2010). In 2010, surveys for the species were conducted along the South Fork of the Kern River, yielding 71 detections, which potentially represented 20 individual birds, the maximum detected during any one survey period (United States Department of the Interior 2011b). In 2017, only 13 cuckoos were detected (Stanek 2017).

Threats: Much of the substantial historical decline in California has been directly attributed to breeding habitat loss from clearing and removal of huge areas of riparian forest for agriculture, urban development and flood control (Gaines 1974, Gaines and Laymon 1984, Laymon et al. 1987, Launer et al. 1990, Hughes 2015). Locally, in the Sequoia National Forest, habitat for the species is threatened by high-severity wildfire and potential conversion from native riparian forest to a monoculture of lower value from the spread of tamarisk and giant reed (United States Department of Agriculture 2015e).

As mentioned above for the southwestern willow flycatcher, the risk of tamarisk spread has been currently mitigated to a low risk. In 2011, the Cove Fire burned in the southern portion of the South Fork Wildlife Area north of Highway 178. This fire removed some mature riparian habitat, which has yet to recover. Outside of the authority or control of the Forest Service, the species also experiences impacts on their wintering grounds from loss of riparian habitat and exposure to the pesticide dichlorodiphenyltrichloroethane (DDT) and loss of habitat on the international winter range (United States Department of the Interior 2014b). Cuckoos spend only approximately 3 months of the year on the breeding grounds, with 4 months in migration and 5 months on the winter range. Another unknown threat could be indirect effects of offsite pesticide use on cuckoo prey species (Stanek 2017).

Sierra Nevada Bighorn Sheep (Sequoia and Sierra)

Status: The Sierra Nevada DPS of the California bighorn sheep (now considered the Sierra Nevada bighorn sheep) was listed as an endangered species in 1999 in an emergency listing (United States Department of the Interior 1999). At the time, the population was thought to total no more than 125 animals distributed across five areas of the southern and central Sierra Nevada (United States Department of the Interior 2007). Critical habitat was designated in 2008 (United

[29] Reference to the Western yellow-billed cuckoo herein refers to the Western distinct population segment

States Department of the Interior 2008b) and although the majority occurs on the east side of the Sierra Nevada crest, in the Inyo National Forest, there are approximately 5,400 acres in the Sequoia National Forest and 22,600 acres in the Sierra National Forest, all in designated wilderness.

In critical habitat, the relevant primary constituent elements identified in the recovery plan (United States Department of the Interior 2007) are as follows:

- Non-forested habitats or forest opening in the Sierra Nevada from 4,000 feet to 14,500 feet in elevation with steep (greater than or equal to 60 percent slope), rocky slopes that provide for foraging, mating, lambing, predator avoidance, and bedding as well as seasonal elevation movements between these areas
- Presence of a variety of forage plants as indicated by the presence of grasses (for example, *Achnanthera* spp. and *Elymus* spp.) and browse (for example, *Purshia* spp.) in winter and grasses, browse, sedges (for example, *Carex* spp.) and forbs (for example, *Eriogonum* spp.) in summer
- Presence of granite outcroppings containing minerals such as sodium, calcium, iron, and phosphorus that could be used as mineral licks in order to meet nutritional needs

Recent population estimate show the population climbing to over 600 animals and range expansion into all 12 essential herd units (Runcie et al. 2016). The Inyo National Forest has the majority of the population. In the Sierra National Forest, the species has two summer populations that migrate to and from winter ranges at lower elevations in the Inyo National Forest (Stephenson 2013). The Sequoia National Forest has a relatively small amount of designated critical habitat, compared with the other two national forests. Bighorn sheep have recently been found to occupy critical habitat in the Golden Trout Wilderness.

Threats: Most of the critical habitats are comprised of the alpine and subalpine vegetation type with smaller amounts of other vegetation types. Due to the rocky and harsh conditions, the alpine and subalpine vegetation types are still largely similar to the expected natural range of variation with some increases in small tree densities as a result of fire suppression (Meyer 2013b).

The main mortality factors for Sierra bighorn are diseases and parasitism and predation (United States Department of the Interior 2007). Numerous diseases of bighorn sheep have been documented (Bunch et al. 1999); of these, pneumonia and psoroptic scabies have had the greatest population-level effects. Bighorn sheep show a high susceptibility to pneumonia, usually caused by a bacteria, which can weaken the immune system and allow secondary infections to destroy lung tissues and often, lead to morality (Besser et al. 2008, Besser et al. 2014). The greatest risk of disease transmission is between bighorn sheep and domestic sheep and goats, which are carriers of the bacteria that can affect bighorn sheep (Clifford et al. 2007).

The potential for the transfer of disease from domestic sheep to bighorn sheep was a key factor in the endangered species listing (United States Department of the Interior 2000). The Sierra and Sequoia National Forests do not have any domestic sheep or goat livestock grazing allotments. Recreational pack goat use, primarily in wilderness areas, could expose bighorn sheep to disease if there is animal to animal contact. The U.S. Fish and Wildlife Service, working with the Inyo National Forest, has developed a risk assessment model to identify areas where there could be a risk to bighorn sheep from disease transmission.

In the Sierra Nevada, mountain lions have been identified as the primary predator of bighorn sheep (United States Department of the Interior 2007). The amount of predation increased in the 1970s, possibly contributing to Sierra Nevada bighorn sheep decreasing the use of winter range (Wehausen 1996). The California Department of Fish and Wildlife has the primary responsibility for managing mountain lions and has implemented an adaptive management strategy with regard to mountain lion predation. Since listing in 1999, the California Department of Fish and Wildlife, working with USDA Wildlife Services, has selectively removed mountain lions that preyed on bighorn sheep in the Central and Southern Recovery Units (Stephenson et al. 2012), lessening the pressure on bighorn sheep populations.

Fisher (Proposed)

Status: The fisher was petitioned for listing under the Endangered Species Act in 1990, 1994, and 2000. Following a series of findings and legal actions, the fisher was identified as a threatened species proposed for Federal listing in October 2014 but the proposed rule was withdrawn in April 2016. Subsequent court action vacated the 2016 withdrawal and requires reconsideration of the proposed rule to list the species by September 2019 (United States Department of the Interior 2016b, 2019, 2014c). In 2015, the California Fish and Game Commission found the Southern Sierra Nevada Evolutionarily Significant Unit to be threatened under the California Endangered Species Act (California Fish and Game Commission 2012).

Population estimates for the southern Sierra Nevada are fewer than 500 (Spencer et al. 2011), and the population in northern California through southwest Oregon is estimated at about 3,200 (Furnas et al. 2017). Long-term monitoring results indicate that fishers are well-distributed in portions of the Sequoia and Sierra National Forests, with annual proportion of sites occupied consistently higher in the Sequoia National Forest than the Sierra National Forest. Fisher are well distributed on the west-slope from the Kings River south through the Greenhorn Mountains, including the Giant Sequoia National Monument and Sequoia National Forest plan area. The Sequoia National Forest is at the southernmost range of the fisher (Greenhorn Mountains and Kern Plateau). Fisher historically occurred in the west slope of the Sierra Nevada but are currently absent from the northern and central Sierra Nevada except for a recently translocated population in the northern Sierra Nevada (Spencer et al. 2015).

The fisher has been studied extensively in the Kings River Project in the Sierra National Forest since the mid-1990’s and additional studies occurred between 2007 and 2013 on portions of the Sierra National Forest with the Sierra Nevada Adaptive Management Project before the widespread tree mortality in the last several years. Fishers are secretive in their use of den sites and frequently move young between den sites as they grow and often seek out new den sites with a low rate of reuse (Spencer et al. 2015).

The Kern Plateau provides a unique habitat for fisher. Current habitat and occupancy models are developed for the more forested sites and thus predict low quality habitat for fisher in this area, primarily due to the lower tree density and more open canopy of the forest in the area. However, consistent detections in the area over the years suggest fisher use the more open habitats for foraging and may use the denser steep, north-facing slopes with higher tree density for den sites.

Key ecological conditions for fisher are montane forest consisting of low to mid elevation conifer, mixed conifer, and conifer hardwood forests with dense canopy cover; large cavities in both live and dead trees; and large downed logs used for denning and resting (Zielinski et al. 2004, Spencer et al. 2015). Fisher tend to avoid large open areas (Weir and Corbould 2010). Resting and denning sites are the most critical habitat elements.

Threats: Threats to the persistence of fishers are loss or degradation of habitat due to uncharacteristic wildfire and widespread tree mortality due to insects and diseases, vegetation and fuels management, habitat fragmentation, climate change, poisoning from rodenticides, predation, and vehicle strikes.

Loss of habitat from high-severity wildfires is considered one of the most significant threats to the persistence of fishers (Spencer et al. 2008, United States Department of the Interior 2012). High-severity wildfires have been increasing over the past several decades, and this trend is predicted to continue (Westerling et al. 2006, Miller et al. 2009b). Many fires within the current range of the fisher have resulted in the loss of important denning, resting, and foraging habitat. There is no research available regarding fisher use of high-severity fire in the first few years after fire. While fisher occupancy was lower in extensively burned forest, they remained present suggesting foraging opportunities remain (Sweitzer et al. 2016a). The late seral forested conditions required by fishers could take centuries to return to areas that burn at high-severity.

Vegetation management and prescribed fire may lower habitat quality by reducing key ecosystem components such as the extent of continuous dense canopy cover, snags, downed logs, and understory vegetation, and can result in negative short-term impacts on fishers and fisher habitat (Truex and Zielinski 2013, Zielinski et al. 2013a, Sweitzer et al. 2016a). However, these treatments may also prevent or reduce more adverse effects on habitat associated with drought and wildfire. Vegetation treatments have been identified as a primary threat to fisher persistence. However, these treatments may prevent or reduce more adverse effects associated with drought and wildfire.

Vegetation management and prescribed fire may lower habitat quality by reducing key ecosystem components such as the extent of continuous dense canopy cover, snags, downed logs, and understory vegetation, and can result in negative short-term impacts on fishers and fisher habitat (Truex and Zielinski 2013, Zielinski et al. 2013a, Sweitzer et al. 2016a). One study found that a combination of mechanical and fire activities result in a significant negative predicted effect on resting habitat suitability, but not from either mechanical or prescribed fire treatments alone (Truex and Zielinski 2013). The greatest impact on predicted resting habitat suitability was from the reduction in canopy closure and there was no effects of any treatment type or combination on predicted foraging habitat (Truex and Zielinski 2013).

Another study found that, although fishers avoid using areas treated for fuel reduction (including mechanical thinning and prescribed fire), their home ranges tend to include larger proportions of treated areas than in the landscape as a whole, and they do not shift home ranges in response to treatments (Garner 2013). That study concluded that treatments do not render the habitat unsuitable and may, in fact, increase fire resiliency, provided management focuses on surface and ladder fuels.

Finally, another study found that local persistence decreased in areas when hazardous fuels reduction treatments or prescribed fire increased (Sweitzer et al. 2016a). That study also found that there was no evidence that timber removal between 2002 and 2013 resulted in reduced occupancy or persistence in the Sierra National Forest but recognize there could be a variety of factors that explain this finding. It should be noted that these studies occurred prior to the widespread and extensive tree mortality that has affected these forests and the response of fishers to these changed conditions is largely unknown.

Fisher are known to avoid crossing areas with low overhead cover, thus minimizing habitat fragmentation and maintaining habitat connectivity has been identified as integral in fisher conservation (Spencer et al. 2016). High-severity fire, vegetation and fuels reduction treatments, roads, utility corridors, and rights-of-way clearances may result in the loss of habitat connectivity resulting in a negative impact on fisher distribution and abundance. Key linkage areas important to maintain or create connectivity between larger core areas of fisher habitat across the Sierra Nevada and Cascade Ranges in California have been identified (Spencer and Rustigan-Ramsos 2012).

Predation has been documented as the primary cause of mortality of fishers (Lofroth et al. 2010, Sweitzer et al. 2016b). Most likely predators are cougar, bobcat, and coyote (Wengert et al. 2014). Activities, such as vegetation management and widespread bark beetle tree mortality can remove hiding cover and contribute to fisher exposure to predation (Lofroth et al. 2010). Predators are also known to travel along roads and linear paths cleared of vegetation. The number of fisher killed by predators may increase if predators have greater access to the forested areas used by fishers.

Rodenticide and insecticide poisoning, most likely in association with illegal marijuana cultivation, has been documented in 85 percent of fisher carcasses across two project areas in the southern Sierra Nevada and exposure rates to these toxicants has been increasing over time (Thompson et al. 2013a). Although more research is needed, it is likely that exposure to rodenticides may predispose an animal to dying from other causes. Effects on fisher populations are unknown at this time.

Vehicle strikes are documented as another source of mortality (Sweitzer et al. 2016b) and the number of roads and the volume and speed of traffic may contribute to this source of mortality. Although 24 roadkill deaths have been documented between 1992 and 2014 for the fisher West Coast population segment, from what is known, vehicle strikes are not a major source of mortality (Sweitzer et al. 2016b). However, because injured fisher may die away from roads and road edges and not be found, this source of mortality could be underestimated.

Mountain Yellow-Legged Frog[30] and Sierra Nevada Yellow-Legged Frog

Status: Both species of yellow-legged frog were petitioned for listing under the Endangered Species Act in 2000. The U.S. Fish and Wildlife Service determined that listing was warranted as threatened or endangered for this species in 2003, however, the listing was precluded at the time based on other higher priorities (United States Department of the Interior 2003). Both species were listed as an endangered species in 2014 (United States Department of the Interior 2014d), and final critical habitat for each species was designated in 2016 (United States Department of the Interior 2016a).

For the mountain yellow-legged frog, portions of three critical habitat subunits, covering approximately 9,622 acres, occur in the Sequoia National Forest. There is no designated critical habitat for mountain yellow-legged frog in the Sierra National Forest. For the Sierra Nevada yellow-legged frog, portions of four critical habitat subunits covering approximately 86,490 acres occur in the Sierra National Forest. In the Sequoia National Forest, approximately 4 acres of

[30] Reference to the Mountain yellow-legged frog herein refers to the northern distinct population segment

critical habitat subunit 3E is mapped to overlap the forest boundary, essentially due to GIS (geographic information system) mapping inaccuracies along the forest border. No recovery plan has been completed for either species.

The mountain yellow-legged frog occurs primarily west of the Sierra Nevada crest in the Sequoia and Kings Canyon National Parks near the border with the Inyo National Forest. In the Sequoia National Forest there are scattered recent detections in the Golden Trout Wilderness and historic records outside of designated wilderness. This species is also found in the Giant Sequoia National Monument. Small portions of the 5A-Blossom Lakes and 5B-Coyote Creek critical habitat units overlap the forest in the Golden Trout Wilderness. There are no records in the California Natural Diversity Database (CNDDB) for this species in the Sierra National Forest plan area.

The Sierra Nevada yellow-legged frog occurs primarily west of the Sierra Nevada crest in Yosemite and Kings Canyon National Parks. In the Sierra National Forest there are many records in designated wilderness, but there are also several other records outside of designated wilderness. The designated critical habitat is all in designated wilderness. Portions of the 3D-Mono Creek and 3E-Evolution/Le Conte critical habitat units overlap the forest in the John Muir Wilderness. There are no records in the CNDDB for this species in the Sequoia National Forest plan area.

The California Department of Fish and Wildlife, in conjunction with the Forest Service, has been removing nonnative fish in some lakes to allow for reintroduction or recovery of yellow-legged frogs.

Threats: The 2014 conservation assessment for both mountain yellow-legged frog species provides a detailed examination of risks to the mountain yellow-legged frog complex throughout its range (Brown et al. 2014a). Across the species range, it identified 13 risk factors relevant to land and resource management. Three are considered focal risk factors that are linked to declines: introduced fish and other predators, disease, and habitat loss and fragmentation.

Introduced fish and predators: Predation by introduced fish, especially nonnative salmonids (rainbow trout, golden trout, brook trout, and brown trout), is a recognized cause of decline of mountain yellow-legged frogs in the Sierra Nevada. In 2010, the California Department of Fish and Wildlife and U.S. Fish and Wildlife Service adopted direction that prohibits fish stocking where it conflicts with conservation goals of Federal recovery plans or in federally designated critical habitat for considered species, which include the currently listed Sierran amphibian species (ICF Jones & Stokes 2010). Thus, fish stocking no longer occurs in the areas occupied by these species. Although continued fish stocking has ended, many trout populations are self-sustaining and are likely to continue to persist unless purposely removed.

Some areas with fish removal have shown success at improving yellow-legged frog populations. The California Department of Fish and Wildlife has removed some fish in native species restoration projects in the Sequoia National Forest and additional opportunities for fish removal and subsequent reintroduction of yellow-legged frogs exist in the forest (California Department of Fish and Wildlife 2017).

Disease: The risk of disease, particularly chytridiomycosis, is a serious contributor to mountain yellow-legged frog declines. Major population crashes have resulted from chytridiomycosis infections, and the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) has been confirmed as a widespread threat to mountain yellow-legged frog persistence in the Sierra

Nevada (Brown et al. 2014a). Other pathogens may be contributors to declines, but their status is unknown. The Conservation Assessment recognized that little can be done to manage for this risk factor unless vectors of these pathogens are identified. Unfortunately, the interactive effects between pathogens and other stressors remain largely unstudied (Brown et al. 2014a).

Habitat loss and fragmentation: Direct habitat loss is not a relevant factor for the Sequoia or Sierra National Forests given the extent of habitat and because the majority of populations and critical habitat are located in designated wilderness or in other remote areas.

The conservation assessment identified ten additional risk factors that are within the authority of the Forest Service to address, but which are not currently linked to declines. These are fire suppression activities, habitat restoration, livestock grazing, locally applied pesticides, mining, recreation activities (including pack stock), research activities, roads, vegetation and fuels management, and water development and diversion. Of these, the most relevant to the Sequoia and Sierra National Forests are fire suppression, habitat restoration, livestock grazing, and recreation, including pack stock. These are similar to the risks identified by the U.S. Fish and Wildlife Service (United States Department of the Interior 2016a).

Fire suppression: In the parts of the species' range that occurs in wilderness areas, intensive fire suppression is rarely conducted and mechanized equipment generally is not used. In these remote areas, minimum-impact fire suppression techniques are used and may represent the best alternative to protecting mountain yellow-legged frogs and their habitat.

Concerns regarding the effects of aerial application of fire retardant on aquatic systems and federally listed species were addressed in the Forest Service decision that directs aerial retardant tanker pilots to avoid application of retardant or foam within 300 feet of waterways (United States Department of Agriculture 2011e). A waterway is considered to be any body of water including lakes, rivers, streams and ponds irrespective of whether they contain aquatic life. Although the initial analysis was completed before these species became federally listed, the analysis is being updated; areas to avoid for the mountain yellow-legged frog, Sierra Nevada yellow-legged frog, and Yosemite toad are currently included on aerial retardant avoidance maps.

Livestock grazing: In the Sierra National Forest, livestock grazing occurs in ten active allotments currently occupied by Sierra Nevada yellow-legged frog. These allotments are located in wilderness and non-wilderness areas and are Iron Creek, Beasore, Soquel, Chiquito, Mono, Dinkey, Markwood, Patterson Mountain, Collins, and Blasingame. There is current livestock grazing in designated critical habitat of the Mono allotment.

Six of the allotments currently have only one known small Sierra Nevada yellow-legged frog population located in meadow/stream habitat. Meadows with occupied habitat in the Iron Creek, Beasore, Markwood and Dinkey allotments are at least partially located on non-Federal land with portions of the meadow that overlap National Forest System lands. The remaining four allotments have up to three occupied meadow/stream habitats within the boundary. The Collins, Blasingame and Mono allotments have at least half of the allotment acres in wilderness. Occupied meadows in the Soquel and Chiquito allotments are currently partially fenced to protect breeding habitat for the Sierra Nevada yellow-legged frog.

In the Sequoia National Forest, there is no livestock grazing in active allotments that overlap with occupied habitats for mountain yellow-legged frog.

Recreation, including pack stock: The risk level of recreation impacts on the mountain yellow-legged frog is unknown, but the nature of many recreation activities places humans in direct contact with mountain yellow-legged frogs or their habitat. Most recreation activities have short-term, localized effects, but in some cases, such as those along trails and at campsites, activities have longer-term, area-wide effects. In high-use areas, recreation is likely to add cumulatively to stressors on small populations, especially those already stressed with nonnative fish. Dispersed recreation, such as hiking and camping, may pose a more moderate risk to the species because they may have localized impacts.

Numerous areas in wilderness have restrictions on the number of visitors with or without pack stock and commercial pack stock is managed with quotas. These management restrictions are designed to limit the impact on resources while providing for the highest quality wilderness experience. All designated wilderness in the Sierra National Forest operate with daily trailhead quotas, while no quotas are established for the designated wilderness areas in the Sequoia National Forest. No specific data exists for this risk factor relative to the mountain yellow-legged frog but the U.S. Fish and Wildlife Service stated that "[p]ackstock use is likely a threat of low significance to mountain yellow-legged frogs at the current time, except on a limited, site-specific basis" (United States Department of the Interior 2014d). Habitat changes due to pack stock grazing may pose a risk to some remnant populations of frogs and, in certain circumstances, may slow recovery of populations in heavily used areas, although no specific sites where this situation occurs are known.

Other risk factors: Locally applied pesticides, mining, research activities, and water development and diversion are other risk factors evaluated in the Conservation Assessment (Brown et al. 2014a) that are not expected to be a substantial risk to yellow-legged frogs in the forest. Since most occurrences are in wilderness, pesticide application, mining, and water development and diversion would rarely, or never, occur. Current forest plan direction (United States Department of Agriculture 2004b) requires that any pesticide application within 500 feet of known occupied sites would avoid adverse effects on individuals or their habitats. Research activities affecting federally listed species require permits from the California Department of Fish and Wildlife and U.S. Fish and Wildlife Service, who will ensure the species' protection.

Yosemite toad

Status: The Yosemite toad was listed as a threatened species in 2014 (United States Department of the Interior 2014d). Final critical habitat was designated in 2016 (United States Department of the Interior 2016a). Of the 16 critical habitat units across the species range, eight are located in the Sierra National Forest, covering approximately 343,254 acres as shown in Table 64. Of those, two contain only minor amounts of overlap with the Sierra National Forest along the forest boundary (Units 5 and 9). No designated critical habitat occurs in the Sequoia National Forest plan area. A recovery plan for Yosemite toad has not been completed.

Yosemite toad occurs primarily along the Sierra Nevada crest and west of the crest. In the Sierra National Forest, most critical habitat units and most recorded populations occur in the Ansel Adams, John Muir, Kaiser, and Dinkey Lakes Wildernesses. However, some critical habitat units and populations do occur outside of designated wilderness, particularly most of critical habitat units 11 and about half of critical habitat unit 14. There is one location with known occurrence of Yosemite toad that is outside of designated critical habitat in Jackass Meadow. There is no record in the CNDDB for this species in the Sequoia National Forest plan area.

Table 64. Area of Yosemite toad critical habitat units in the Sierra National Forest

Unit Number	Unit Name	Total Acres	Acres on Sierra National Forest	Acres in designated wilderness, Sierra National Forest
5	Tuolumne Meadows/Cathedral	139,431	10	10
9	Triple Peak	10,798	157	157
11	Iron Mountain	19,011	17,733	1,258
12	Silver Divide	98,578	62,754	62,694
13	Humphreys Basin/Seven Gables	50,930	41,647	41,647
14	Kaiser /Dusy	174,988	174,103	84,641
15	Upper Goddard Canyon	36,730	16,591	16,591
16	Round Corral Meadow	31,332	31,106	26,588

Threats: The conservation assessment for Yosemite toad was completed after the species' listing and provides a detailed examination of risks to the Yosemite toad throughout its range (Brown et al. 2015). It identified several risk factors that currently are not likely to be major causes of rangewide declines but may be important in specific situations, particularly where toad populations are small. Seven of these factors are relevant in the Sierra National Forest. These are as follows:

- Fire management, including fire suppression
- Introduced fish and other predators
- Livestock grazing
- Locally applied pesticides
- Recreation, including pack stock
- Roads
- Vegetation and fuels management

Legacy effects from some of these risk factors (for example, livestock grazing) may have contributed to Yosemite toad declines, particularly those that resulted in meadow drying, shortened hydroperiods of breeding habitats, and potentially, lowered breeding success and some improved management may have lessened the impacts of some of these risk factors.

Fire Management: Wildfires and fire management are most likely to affect Yosemite toads through effects from on-the-ground actions taken to manage fires in or near Yosemite toad habitats. Since Yosemite toads are associated with wet meadows, standing water, and associated adjacent uplands (for movement), the direct effects of implementing vegetation treatments are more likely to effect the species than the indirect effects of treatments on habitat.

Introduced fish and other predators: Introduced fish and other predators are a legacy threat that persists where introduced fish populations have sustained their populations. The California Department of Fish and Wildlife, working with the U.S. Fish and Wildlife Service, has reduced stocking to areas where native trout or other native aquatic species occurred (ICF Jones & Stokes 2010). While high mountain lake stocking ceased in 90 percent of previously stocked lakes by 2010 (Lentz and Clifford 2014), some high elevation waters still contain remnant populations from previously stocked fish. The conservation assessment authors discuss the risks of introduced fish on Yosemite toad and determined that the risk appears low and addressing the direct effects of introduced fish is not a high priority for conservation options (Brown et al. 2015). However, it recognizes that indirect effects on changes in food webs, nutrient cycling, and pathogen transmission are unknown and warrant future studies.

Livestock grazing: Livestock graze in some areas with Yosemite toad habitat. Table 65 shows the critical habitat units and livestock grazing allotments. Yosemite toad have also been located just outside of designated critical habitat in the Chilkoot Lake area in the Beasore Allotment and near the Jackass Meadows area outside of the South Jackass Allotment. Where livestock graze near occupied sites, concerns are trampling of individuals and alteration of habitat, primarily from hoof chiseling. Where livestock graze in occupied habitats, monitoring of populations and cattle disturbance has been ongoing and is used to evaluate and adjust grazing operations as part of the project-level allotment management planning process.

Table 65. Livestock grazing allotments in critical habitat units, Sierra National Forest

Unit Number	Unit Name	National Forest Service acres in active allotments	National Forest Service acres in vacant allotments
5	Tuolumne Meadows/Cathedral	0	0
9	Triple Peak	0	137
11	Iron Mountain	17,733	0
12	Silver Divide	37,279	0
13	Humphreys Basin/Seven Gables	0	0
14	Kaiser /Dusy	138,578	0
15	Upper Goddard Canyon	0	0
16	Round Corral Meadow	14,774	0

Locally applied pesticides: Current forest plan direction requires that any pesticide application within 500 feet of known occupied sites would avoid adverse effects on individuals and their habitats, so pesticide use is not a threat in the plan area.

Recreation, including pack stock: Recreation, including pack stock grazing is widespread across the range of the Yosemite toad, and generally has high overlap with the species and its habitats because of the human attraction to meadows, ponds and other water bodies. The specific impacts of this risk factor to the species in the forest are unknown. Recreation may locally affect meadow hydrology (as with pack stock grazing or a trail intercepting water flow) or potentially the toads themselves, including in nonbreeding habitats. In general, the level of risk is low at the broader range scale because of the dispersed nature of many recreation activities. In the forest, numerous areas in wilderness have restrictions on the number of visitors with or without pack stock. Commercial pack stocks have limited quotas as well. These restrictions are designed to limit the impact on resources while providing for the highest quality wilderness experience. Commercial pack stock grazing is not allowed in occupied habitat until after the breeding cycle. The chronology is based on annual precipitation.

Roads: The construction, reconstruction, and maintenance of roads, as well as the use of roads can affect Yosemite toads by direct collision with vehicles or by impacts on habitat from changes in water flow or increased sediment. There are existing roads in the vicinity of several of the occurrences that are outside of designated wilderness and there have been documented mortality of individuals. The Sierra National Forest, in cooperation with the U.S. Geological Survey (USGS) Western Ecological Research Center and California Department of Transportation, are studying methods to reduce road related mortality and have developed an elevated road platform to allow road crossing by toads.[31]

Vegetation and fuels management: Vegetation management could occur in the non-wilderness portions of the critical habitat and in the vicinity of the population in Jackass Meadows. Vegetation management would primarily be focused on improving the resilience of forest vegetation to contribute to the scenic character of this heavily used recreation area and providing for public safety by managing dead and dying trees. Fuels management, primarily management of surface and ladder fuels, where it may increase the risk of adverse wildfire behavior and threaten recreation sites, could occur around roads and campgrounds and facilities. This could involve large, heavy equipment, but is more commonly accomplished by smaller equipment. Work by hand often involves piling and burning smaller fuels and prescribed burning.

Lahontan Cutthroat Trout and Paiute Cutthroat Trout

Lahontan cutthroat trout

Status: Lahontan cutthroat trout was listed as endangered in 1970 (United States Department of the Interior 1970) but was subsequently reclassified as threatened in 1975 to facilitate management and allow regulated angling (United States Department of the Interior 1975). Critical habitat has not been designated for this species. There are two out-of-basin populations in the Sierra National Forest, which are outside of the historical range of the species. The species is managed according to the recovery plan published in 1995 (United States Department of the Interior 1995c).

The Lahontan Cutthroat Trout Recovery Plan has a delisting criterion that population segments have management direction to enhance and protect habitat required to sustain appropriate numbers of viable self-sustaining populations (United States Department of the Interior 1995c).

The Lahontan cutthroat trout was established in two out-of-basin populations. Fish occupy approximately 2 miles of Cow Creek and 1.5 miles of the West Fork of Portuguese Creek. In 2001, the 4,360 acre Cow Creek and the 2,010 acre West Fork of Portuguese Creek critical aquatic refuges were established around these stream reaches to be managed for the recovery of this species (United States Department of Agriculture 2001b). These populations are managed to provide potential stocking sources for reintroduction in the future and to maintain genetic diversity. The population is periodically surveyed by forest staff or the California Department of Fish and Wildlife.

Threats: The severe decline in occupied range and numbers of Lahontan cutthroat trout in its endemic range is attributed to a number of factors, as follows (United States Department of the Interior 1995c):

- Hybridization and competition with introduced trout species
- Alteration of stream channels and morphology

[31] https://www.usgs.gov/center-news/toad-crossing-ahead-new-study-tests-elevated-roads-underpasses-rare-toad?qt-news_science_products=1#qt-news_science_products

- Loss of spawning habitat due to pollution and sediment inputs from logging, mining, livestock grazing practices
- Urbanization
- Migration blockage due to dams
- Reduction of lake levels and concentrated chemical components in lakes
- Loss of habitat due to channelization
- Dewatering due to irrigation and urban demands
- Overfishing.

However, in the out-of-basin populations, the following are relevant threats to consider.

Loss of habitat: For both out-of-basin populations, the primary threat to the populations is due to effects from potential wildfire to streamside and upland vegetation and potential resulting sedimentation. Both populations occur in forested watersheds.

Other threats: Other threats are impacts from dispersed recreation, such as camping and fishing, where there is road access near the occupied streams.

Paiute cutthroat trout

Status: The Paiute cutthroat trout was originally listed as endangered in 1967 (United States Department of the Interior 1967) but was subsequently reclassified as threatened in 1975 to facilitate management and allow regulated angling (United States Department of the Interior 1975). Critical habitat for this species has not been designated. A recovery plan for the Paiute cutthroat trout was developed in 1985, and revised in 2004 (United States Department of the Interior 2004). The most recent 5-year review was completed in 2013 (United States Department of the Interior 2013d).

The Paiute cutthroat trout occurs in two out-of-basin populations in the Sierra National Forest in Stairway Creek (2.2 miles in the Ansel Adams Wilderness) and in Sharktooth Creek (2.0 miles in the John Muir Wilderness). A review of the species in 2013 suggests that these populations appear to be stable (United States Department of the Interior 2013d). In 2001, the 3,490 acre Stairway Creek and the 3,180 acre Sharktooth Creek critical aquatic refuges were established around the genetically pure population of Paiute cutthroat trout (United States Department of Agriculture 2001b).

Threats: The recovery plan (United States Department of the Interior 2004) and subsequent 5-year review (United States Department of the Interior 2013d) was reviewed and two threats in the five-factor analysis were determined to be of higher concern to Paiute cutthroat trout and its habitat relevant to the plan area: Destruction or modification of habitat, and other natural or human-made factors.

Destruction or modification of habitat: Nonnative fish pose a threat, primarily from hybridization that can result in loss of available habitat or range restrictions.

There are threats of population isolation and habitat fragmentation due to limited stream extents for these two locations. Neither of these populations meet long-term persistence criteria for the minimum amount of stream habitat thought to be necessary to sustain at least 2,500 individuals of 5.8 miles.

Historically livestock grazing (both cattle and sheep) occurred over much of the high Sierra Nevada mountain range, wherever forage was available. Grazing of livestock is noted as having potential to degrade habitat for Paiute cutthroat trout. The Stairway Creek population is not located in a livestock grazing allotment, but the occupied habitat area in Sharktooth Creek is in the active Cassidy Allotment.

Other natural or human-made factors: Increases in water temperature as a result of increased summer air temperature and changes in precipitation affecting streamflow could increase stress levels which may increase the susceptibility to disease.

There is a risk of adverse effects if wildfires burn outside of the characteristic fire regime and affect occupied habitat because there are no opportunities for recolonization if the entire occupied segment is affected.

Little Kern golden trout

Status: The Little Kern golden trout was listed as threatened and critical habitat was designated in 1978 (United States Department of the Interior 1978). A recovery plan has not been completed. This species is endemic to Little Kern River drainage and the designated critical habitat encompasses the entire known range of the species. The designated critical habitat is almost entirely in the Golden Trout Wilderness, except for a small area on the southwest end near the Golden Trout Pack Station in the Giant Sequoia National Monument. In 2001, the Little Kern River critical aquatic refuge was established around the watershed containing this species.

Threats: Portions of the critical habitat are in active Little Kern Allotment. Grazing there was addressed by a 1994 biological opinion that sets allowable use and season of use (United States Department of the Interior 1994d). In addition, long-term management of fish barriers to prevent contact with nonnative salmonids is important to maintain the genetic purity of this species.

Bakersfield cactus

Status: Bakersfield cactus is a beavertail cactus that was federally listed as endangered in 1990 (United States Department of the Interior 1990). A multi-species recovery plan was prepared in 1998 for a variety of species found in the San Joaquin Valley, including this species (United States Department of the Interior 1998c). No critical habitat has been designated. It is found primarily outside of the national forest in the vicinity of Bakersfield where approximately one-third of the historical occurrences have been eliminated and the remaining populations are highly fragmented. There is one reported population on Sequoia National Forest in the Kern River canyon. It occurs near a highway at the interface between annual grassland and valley/blue oak woodlands. It is unknown to what extent it occurred in the national forest historically.

Threats: Outside of the national forest, it occurs mostly on private lands which are subject to habitat loss, hydrologic alterations, off-road vehicle use and nonnative invasive plants. The one population on Sequoia National Forest occurs in the steep rocky Kern River canyon, and is largely excluded from effects of land management activities, although there may be some risk of disturbance from road maintenance activities or fire suppression activities. Given the location, there is little risk of disturbance from other activities.

Mariposa pussypaws

Status: Mariposa pussypaws was listed as a federally threatened species in 1998 (United States Department of the Interior 1998b). A recovery plan has not been completed and no critical habitat has been designated. It is an annual plant that occurs in 9 or 10 population sites in chaparral or woodland vegetation in the southern Sierra Nevada foothills (Guilliams and Clines 2012). Two populations occur on national forest lands in the Sugarloaf area. Population counts suggest the long-term potential persistence is good for one population but the other population has been monitored less frequently, with an apparent downward trend. An additional population occurs on private lands adjacent to a parcel of National Forest System lands near the North Fork sewage treatment pond. Since this population does not occur on National Forest System land, it is outside the plan area and would not be affected by any of the alternatives.

Threats: Outside of the national forest, major threats are habitat loss due to development and off-highway vehicle use, competition from nonnative plant species, and possibly atmospheric nitrogen deposition. Both of the populations on the National Forest System lands are in the Sugarloaf Allotment and have been fenced to protect them from livestock trampling. Measures to address threats to this population have included invasive plant treatment, installing and improving fencing to exclude cattle, and soil stabilization to prevent erosion on adjacent areas (Guilliams and Clines 2012). One population is in the right-of-way clearance zone for transmission lines and could be affected by power line maintenance activities or road maintenance for power line access. In the past, vegetation management projects have been designed to account for the presence of this species.

Whitebark pine (candidate)

Status: Whitebark pine is known to occur in the western mountains of the United States and Canada. In California, it occurs in the Klamath Ranges, High Cascade Range, Warner Mountains, and the Sierra Nevada. It is a slow-growing, long-lived conifer that tolerates poor soils, steep slopes, and windy exposures and is found at treeline and subalpine elevations throughout its range.

The plan areas host approximately 7 percent of the extent of whitebark pine in California known to exist or thought to exist based on habitat modeling as shown in Table 66 (Slaton et al. 2014). Across the two forests, approximately 99 percent of whitebark pine occurs in designated wilderness. In the Sierra National Forest, most of the small amount of whitebark pine located outside of designated wilderness areas is in adjacent inventoried roadless areas, including 27 acres located in the Kings River Special Management Area. The extent of whitebark pine in the Sierra National Forest is next to the large central distribution in the Inyo National Forest, which contains about one-third of the statewide total.

Table 66. Distribution of mapped and potential whitebark pine in the plan area and California

Region	Acres in Wilderness	Acres outside Wilderness	Total Acres
Sequoia National Forest	2,188	0	2,188
Sierra National Forest	22,960	214	23,174
Inyo National Forest	106,046	17,363	123,409
Adjacent National Parks	74,155	122	74,277
Total in California	304,930	67,083	372,013

Whitebark pine is not identified on the U.S. Fish and Wildlife Service species list for the Sequoia National Forest, and field botanists and ecologists have not documented them in the plan area. However, some potential whitebark pine habitat has been mapped in the Golden Trout Wilderness with smaller amounts in the Monarch and Jennie Lakes Wilderness. Because field botanists and ecologists have not detected this species, it is not evaluated for the Sequoia National Forest.

Whitebark pine serves a number of important ecological functions, including snow retention, runoff regulation, soil temperature moderation, early colonization of disturbed sites, and forage and habitat for birds and mammals (Meyer 2013b).

Threats: There are several major threats to whitebark pine, including the introduced pathogen white pine blister rust, attack by native bark beetles, fire suppression, and climate change (United States Department of the Interior 2011a, 2016c). Current information suggests that white pine blister rust disease is not a prevalent risk in the Sierra National Forest to the degree it is in other parts of the Sierra Nevada (Maloney 2011). Similarly, a small amount of mortality from mountain pine beetle has been observed in the Sierra National Forest, but not at significant levels (Maloney 2011). While there has been a trend of changing stand structure in some whitebark pine stands, there has been no clear evidence of range retraction or expansion. Historically, mountain pine beetle mortality in stands of whitebark pine may have functioned to release saplings that were seed cached by Clark's nutcrackers where saplings were suppressed by the overstory trees; however, the interactions may be different with the combination of climate change and white pine blister rust (Meyer et al. 2016). Where mortality has occurred in other areas, some stands showed signs of increased growth following release (MacKenzie 2014, Perkins 2015).

Whitebark pine of all age classes are adversely affected by high-intensity fire, but severely burned areas also provide a mineral soil seedbed and are used by Clark's nutcrackers as seed cache sites and can serve as regeneration sites. Climate-related threats are impacts on individuals from snow avalanches, which will be influenced by climate change to the extent that patterns of snowfall and conditions that trigger avalanches change over time. Although each threat individually is problematic, the combined impacts pose a significant threat to species viability.

Environmental Consequences

Effects Common to All Alternatives

All site-specific projects would be evaluated for effects on federally listed species in compliance with the Endangered Species Act and Section 7 consultation would occur as determined necessary. In project-level biological opinions, additional terms and conditions on top of plan direction may be required to avoid jeopardy to the species from project activities and to contribute to the persistence of federally listed species.

California Condor

If condors increase foraging or establish nest or roost sites in the plan area, the primary programs that may affect condors within the authority of the Forest Service are vegetation and fuels management, recreation, and infrastructure programs.

Consequences Common to All Alternatives

Condors could be affected at foraging locations. Because they are opportunistic foragers on carrion, condors could be attracted to dead animals, especially along roadsides. They could be at some risk of injury by passing vehicles along major roads, although they are regularly found along Highway 1 and other major roads along the coast of California with limited conflicts. If condors began to regularly forage in these forests, plan direction would encourage coordination with state and county road agencies to develop strategies to manage road killed large mammals along heavily traveled roads as determined necessary. Condors are more likely to be disturbed by people observing them where they roost or forage. All alternatives include direction that would encourage public education to lessen the impacts of recreation disturbance to wildlife.

Increasingly, a variety of herbicides and pesticides, including organochlorines, have been used by illegal marijuana growers in the national forests. This can result in poisoning wildlife, creating a risk of secondary poisoning by scavengers such as condors. Under all alternatives, when illegal marijuana growing sites are found, hazardous materials are cleaned up whenever possible. However, animals contaminated by chemicals prior to cleanup are likely to remain in the environment and chemicals could continue to bioaccumulate.

As condors increase foraging and use of the national forests, there could be some risk of collision with power lines and other infrastructure from existing facilities. The specific risk is currently unknown as it depends on site location, flight paths, and feature designs. Any future project proposals for power lines or wind energy development within the condor range would consider the risks to condors.

The administrative site for the Springville Work Center is within the boundary of the very large Tulare County Rangelands critical habitat unit that is in the foothills north of Porterville and west of the Sequoia National Forest boundary. Administrative activities and uses of the Springville Work Center would continue under all alternatives. The location of the work site in the town of Springville and along State Route 190, with adjacent residential and commercial building, reduces the likelihood of use of this area by condors, minimizing the risk of adverse effects from disturbance.

Consequences Specific to the Action Alternatives

Condors historically have nested in giant sequoia trees in the Sequoia National Forest in the Giant Sequoia National Monument (United States Department of Agriculture 2012d). Management in the Giant Sequoia National Monument would continue to be guided by the 2012 management plan and is outside the plan area for this revision. Two groves of giant sequoia occur in the Sierra National Forest; however, they are not expected to provide nesting sites due to their generally small size. Management direction for these groves under alternative A is provided by the presidential proclamation establishing the Giant Sequoia National Monument and regional guidance for giant sequoia groves.

Under the action alternatives, a specific management area is delineated for the McKinley and Nelder Giant Sequoia Groves. The management area for each grove provides plan direction focused on the ecological restoration and maintenance of the giant sequoia groves, emphasizing the resilience of large and old trees. This may result in slightly better management of the groves due to the specific emphasis, although management under alternative A would be very similar. As opposed to the larger groves in the Giant Sequoia National Monument, these groves are relatively small and disjunct, and it is unlikely that they would provide nesting areas for condors.

The action alternatives emphasize vegetation and fuels management to support restoring fire as an ecosystem function in the plan areas. While this can, and does occur to some extent under alternative A, it would be more likely to occur under the action alternatives due to the emphasis placed on it. To the extent that fire is restored to landscapes that have become overgrown due to fire suppression, it may improve the forage quality for deer and other large animals, leading to improved populations and greater potential of dead animals providing foraging opportunities for condors. This opportunity may be greater in the action alternatives than alternative A, although opportunities to restore fire in the foothill zone, where the benefits may be the greatest for deer, may not differ much between alternatives.

If condors establish nest or roost sites in the plan areas, all action alternatives include plan components that would provide guidance to evaluate the effects of recreation and other activities on condors and consider mitigations, including restrictions on activities that could disturb condors. The specific plan guidance in the action alternatives may make it easier to provide a suite of management actions to protect condors from disturbance than under alternative A which would primarily rely on the Endangered Species Act to determine potential actions.

Least Bell's Vireo, Southwestern Willow Flycatcher, and Western Yellow-billed Cuckoo

These three species share similar habitat and occur in the riparian vegetation and riparian forests along the Kern River Valley from the lakebed of Lake Isabella through the South Fork Wildlife Area in the plan area and outside the national forest through the many conservation lands such as the Audubon Kern River Preserve and California Department of Fish and Wildlife Canebrake Wildlife Area and others in the Kern River Valley. Since they share common habitat locations, depending on riparian vegetation (willows and cottonwoods), and face similar threats, they are analyzed here together.

The primary program areas that may affect these species under the authority of the Forest Service are the fire, range, and recreation programs, which are discussed below.

Consequences Common to All Alternatives

The Lake Isabella livestock grazing allotment is west of the South Fork Wildlife Area and permits livestock grazing by cattle through an allotment management plan. Consultation with the U.S. Fish and Wildlife Service on the project-level action has established terms and conditions that guide livestock grazing, consistent with the Endangered Species Act, primarily for the southwestern willow flycatcher. When the water level in Lake Isabella is drawn down for extended periods, riparian vegetation can grow which has the potential to provide ephemeral habitat for these species. When this condition exists, livestock grazing could affect habitat or potentially disturb individuals. The current timing and intensity of grazing minimizes impact on mature riparian forest.

This area is generally considered unsuitable habitat which does not often contribute to successful reproduction because nests are often inundated as water levels rise due to snowmelt and water storage operations (Del Nevo et al. 1998). Since the plan direction for livestock grazing does not substantively change between alternatives, there are no expected additional effects from the range program area to these species. Additionally, livestock grazing that could affect these species and their habitat is provided by terms and conditions under a biological opinion that appear to be consistent with the revised plan direction under all alternatives.

The South Fork Wildlife Area is managed primarily for wildlife habitat protection while providing some recreation opportunities, particularly nature viewing, fishing, and hiking. Use varies seasonally, mostly dependent on the water levels in Lake Isabella, which occasionally inundates the area. All alternatives include plan components that provide guidance to evaluate the effects of recreation and other activities on wildlife and consider mitigations, including restrictions on activities in breeding areas. Any actions that restrict public access or uses would require site-specific analysis and project level decisions including compliance with requirements of the Endangered Species Act.

Consequences Specific to Alternatives B, C, D, and E

The Kern River Valley has a limited history of large fires, primarily due to the lower flammability of riparian forest habitats. However there have been three recorded fires that have burned portions of the South Fork Wildlife Area, the largest being the Cove Fire in 2011, which burned the southern portion of the Wildlife Area resulting in loss of the mature trees. The risk of fire is greater during periods of prolonged reservoir drawdown due to drought or reservoir operations, such as the repairs. Fires could threaten the loss of the large cottonwood trees that provide important habitat for the western yellow-billed cuckoo.

Under alternative A, fire management would largely continue to emphasize fire suppression, although some prescribed burning could occur. Although there are different approaches to managing vegetation and fuels between the action alternatives, there would likely be limited differences in potential management and restoration because direction for riparian conservation areas relevant to the areas occupied by these species is similar across alternatives. There would continue to be an emphasis on suppression of fires that could adversely affect critical habitat. Alternatives B and D would emphasize fuels reduction and managing the risk of large high-severity fires at a landscape scale, which could reduce the potential for large fires starting elsewhere and threatening the South Fork Wildlife Area, although the benefit is limited given the non-forest vegetation types surrounding the wildlife area.

Sierra Nevada Bighorn Sheep

The primary program areas that may affect bighorn sheep under the authority of the Forest Service are the fire and recreation programs.

Consequences Common to All Alternatives

Although there is currently no species-specific plan direction for Sierra Nevada bighorn sheep under alternative A and species-specific plan direction is provided in the action alternatives, all project activity and decisionmaking under all alternatives would still be guided by project-level requirements to comply with the Endangered Species Act.

Range management plan direction would not vary across the action alternatives and there is no livestock grazing by domestic sheep or goats in allotments in the Sequoia or Sierra National Forest. Therefore, there is no risk of disease transmission to Sierra Nevada bighorn sheep from the permitted livestock grazing program under all alternatives.

Consequences Specific to Alternative B, C, D, and E

These alternatives include species specific plan direction and plan content for bighorn sheep that describe bighorn sheep habitat, provide guidance to reduce the risk of disease transmission from domestic sheep and goats, and provide guidance to manage disturbance from recreation.

As Sierra Nevada bighorn sheep recover, the alternatives express the intent to manage population expansion areas occupied by bighorn sheep outside of current herd units in order to improve population distribution. The alternatives clarify the desired condition for bighorn sheep habitat to better describe the different seasonal habitat needs and need to provide for movement between the herds. This contributes to a recovery plan task to maintain and enhance integrity of bighorn sheep habitat (United States Department of the Interior 2007).

All of the Sierra Nevada bighorn sheep critical habitat on both forests is located in the wildfire maintenance zone. In this strategic fire management zone, fires from natural sources such as lightning, would be evaluated to determine if they could be managed with less than a full fire suppression response, considering safety to firefighters and the public and potential positive and negative effects from expected fire behavior to various resources. Fires in the bighorn sheep range are expected to occur infrequently, and are expected to mostly be small to moderate in size with mixed severity fire effects given the sparse fuel conditions.

Fire intensity is also expected to be highly variable in the subalpine zone with large higher-severity fire patches usually limited in size due to the matrix of clumpy forest and forested meadows. Fire management may have short-term effects but is expected to have minimal long-term adverse effects on suitable habitat considering the rugged rocky terrain favored by bighorn sheep. In the wildfire maintenance zone, the alternatives encourage restoring fire to the landscape by emphasizing managing naturally-ignited wildfires when it safe to do so instead of promptly suppressing them. In designated wilderness, the alternatives include direction to use minimum impact strategies and tactics unless more direct action is needed for safety and to protect property. The intent is to use spatial support tools, wildfire risk assessments, and decision support systems to determine the appropriate wildfire management strategy. Since the location of designated critical habitat is included in these decision-support systems, the risk of adverse impacts on Sierra Nevada bighorn sheep and critical habitat from wildfire and fire management actions would be lessened.

The use of managed wildland fire may have some ephemeral adverse effects such as disturbance and displacement or short-term reduction in forage, but the desired condition is to restore fire as a natural ecosystem process for the long-term benefit of this species. Restoring expected fire regimes in the species range would help to protect or restore vegetation structure and composition that would sustain or improve the ecological conditions needed by the species in critical habitat and improve the condition of forage and cover outside of critical habitats.

Overall, increasing the amount of fire in the bighorn sheep range would generally be beneficial where it restores more open conditions and increases visibility and reduces hiding cover for predators. Implementing these fire management approaches is expected to increase the likelihood of restoring fire to areas occupied by Sierra Nevada bighorn sheep, which would contribute to a recovery plan task to maintain or enhance the integrity of bighorn sheep habitat.

Although there is no goat grazing in authorized livestock grazing allotments, recreational pack goat use is currently allowed, though actual use in areas potentially occupied by bighorn sheep is believed to be very low. Pack goats could transmit disease to bighorn sheep because they can carry some of the same diseases; however, the risk is thought to be lower than for grazing goats due to better husbandry and handling practices that minimize the risk of contact.

Under alternative A, there is no specific direction to avoid or minimize contact between domestic goats or sheep and bighorn sheep. Plan direction in the action alternatives directs that domestic sheep or goat grazing and pack goat use is not allowed in areas where there is a high risk of contact unless the risks of disease spread can be adequately mitigated. Plan direction includes the intent to coordinate with the California Department of Fish and Wildlife and the U.S. Fish and Wildlife Service to conduct a risk assessment of pack goat use and develop mitigation strategies to manage the risk of disease transmission, if needed. If on completion of the risk assessment, risk mitigation actions are needed, plan direction would require that pack goat use not be allowed unless the risks can be mitigated in any areas having high risk of disease transmission. This more clearly contributes to a recovery plan task to prevent contact between bighorn sheep and domestic sheep or goats.

Although not currently known to be a substantial concern, specific direction requires evaluating areas and taking action when needed where recreation or other disturbance is causing Sierra Nevada bighorn sheep to avoid important habitat areas. This more clearly contributes toward a recovery plan task to investigate and analyze human use patterns relative to habitat use patterns of bighorn sheep and another recovery plan task to manage human use locally where research finds human use is causing bighorn sheep to avoid important habitat, which may compromise survivorship or reproductive success. Although alternative A does not specifically address this concern, the consequences are likely not substantially different since direction in the current plan is to contribute to the recovery of federally listed species and would likely address the concern in a similar manner.

Compared with alternative A, all plan revision alternatives strengthen the cooperative relationship with the California Department of Fish and Wildlife to manage Sierra Nevada bighorn sheep populations by containing a goal to work with State agencies to restore and maintain essential habitat for at-risk species and implement other recovery actions according to species recovery plans. This would facilitate cooperation and support if those activities occur on National Forest System lands to support the desired condition that activities are designed to maintain or enhance self-sustaining populations of at-risk species in the inherent capabilities of the plan area by considering the relationship of threats (including site-specific threats) and activities to species survival and reproduction. Supporting these activities would contribute to a recovery plan task to temporarily protect Sierra Nevada bighorn sheep herds from predation losses where needed.

Fisher (Proposed)

The primary programs within the authority of the Forest Service that may affect the fisher are the fire, vegetation and fuels, recreation, and roads and infrastructure programs.

Alternatives B, C, D, and E include plan direction that considers the findings and recommendations of the Southern Sierra Nevada Fisher Conservation Strategy (Spencer et al. 2016). In determining how to best incorporate the findings and recommendations, we considered that the strategy authors recognize the uncertainty of fisher ecology and response to management actions given the widespread tree mortality in the southern Sierra Nevada (Spencer et al. 2017). Very little is known about how fisher would react to the changed environment caused by the widespread tree mortality, both in the short term and in the long term. Regardless, fisher scientists and land managers are in the process of evaluating the current fisher conservation strategy in light of the widespread tree mortality and changed conditions in the southern Sierra Nevada to determine how findings and recommendations should be updated.

Consequences Common to All Alternatives

Past fire suppression has led to losses in landscape-level ecosystem heterogeneity. The Sierra Nevada Adaptive Management Project[32] conducted an intensive investigation into fisher use of habitat and response to management disturbance, largely in the Bass Lake Ranger District of the Sierra National Forest. They assessed fisher occupancy in relation to fire history, elevation and canopy cover and evaluated the response of fishers to fuel reduction activities.

Fishers used areas with higher canopy cover and occupancy was lower in areas with recent fire histories (both natural and prescribed). Persistence was lower in areas with more fuels reduction activities, though it is speculated that fishers would resume the use of treated areas within a few years (Sweitzer et al. 2016a). Occupancy modeling suggests that fuels treatments would have

[32] http://snamp.cnr.berkeley.edu/

little effect on fishers, either positively or negatively, at the regional scale (Spencer et al. 2016). However, if fires become larger and more severe in the future, modeling suggest that carefully planned and implemented fuels treatments may reduce overall fire risks and help to sustain fisher habitat and populations (Spencer et al. 2016).

Modeling has suggested that large, high-severity fires can have significant, negative impacts on fisher habitat quality and population size (Scheller et al. 2011, Thompson et al. 2011). However, restoration is proceeding at a pace and scale that is inadequate to address the problem in a timely way. The limited pace and scale of restoration and lack of active management is a stressor.

Recommendations regarding spreading out treatments both spatially and temporally can be in direct contradiction with creating effective fuels treatments that alter fire behavior on the landscape. However, the dilemma is that short-term negative localized effects on fisher from active vegetation management designed to reduce high-severity wildfire in and near suitable habitat might outweigh the positive long-term effects of protecting suitable fisher habitat (Spencer et al. 2008).

Research and planning related to the Dinkey Landscape Restoration Project in the Sierra National Forest has focused on designing and evaluating suitable vegetation management practices that can reduce the threat of habitat loss from uncharacteristic wildfire while retaining suitable habitat conditions. Recent research highlights the importance of fine scale and landscape scale heterogeneity and the role that understory cover plays in fisher use of den sites across their home range.

Recent studies have documented a significant threat to fisher from rodenticide poisons commonly used in illegal marijuana plantations, with males being more affected than females (Gabriel et al. 2012, Gabriel et al. 2015). A large proportion of fisher carcasses recovered in the southern Sierra research sites showed evidence of exposure to one or more rodenticides (Thompson et al. 2013a). More than 300 illegal marijuana sites have been located in these research areas since 2002 and this is a likely risk factor for fisher in the plan areas.

There are several state highways in the plan areas that are moderately or heavily traveled at moderate to high speeds which poses a risk of fisher being struck and injured or killed by vehicles. In addition, the forests have hundreds of miles of double lane paved roads which receive low to moderate volumes of traffic traveling at mostly low to moderate speeds. Fisher have been killed along roads by vehicles primarily on Highway 41 where it extends across the Sierra National Forest and Yosemite National Park. Some attempts to reduce this risk have included placing signs and reducing speed limits, as well as identifying high priority travel corridors and developing culvert passageways under roads. These efforts to identify locations and design actions to reduce fisher deaths would continue to be evaluated and implemented when feasible, under all alternatives.

The two national forests moved away from even-aged reforestation management in the early 1990’s to a program focused on understory fuels reduction and stand thinning intended to control density and improve growth and resilience of stands. This was done to reduce the threat of future wildfires but also for habitat maintenance of mature forest stands. Thinning reduces the number of trees on a site, allowing remaining trees to increase crown and photosynthetic production. It also increases growth rates on the remaining trees which grow larger and faster than those in untreated stands.

For restoration purposes, in several vegetation types, especially mixed conifer, reforestation implemented in a group selection can increase stand heterogeneity and improve landscape level resiliency and wildlife habitat diversity. It can also create opportunities to restore shade intolerant conifers such as pines, and facilitate management for mature hardwoods that provide resting and denning cavities for fisher. These group selection treatments create early seral stage patches of shrub and younger age-class trees. Increasing early seral stages would address the restoration of vegetative characteristics, such as hiding cover, by providing patches with more diverse understory cover.

All alternatives could allow group selection treatments as a part of restoration activities but the amount would vary by alternative, with the least occurring under alternatives C and E and the most occurring under alternative D.

Consequences Specific to Alternative A

Alternative A provides direction for the Southern Sierra Fisher Conservation Area that encompasses the known occupied range of the fisher in the Sierra Nevada when it was established in 2001. This area is managed to support fisher habitat consistent with the protections for the California spotted owl since they share many of the same important habitat attributes (United States Department of Agriculture 2004b). The Southern Sierra Fisher Conservation area covers approximately 600,000 acres in the Sierra National Forest and 530,000 acres in the Sequoia National Forest.

Alternative A continues to take a species-specific approach to habitat protection, in which treatments are limited in the Southern Sierra Fisher Conservation Area and near fisher den sites, including in the wildland-urban interface. Specific requirements and limitations on management actions for protecting fisher are intended to provide short-term species protection against disturbance to the species or high quality habitat. However, these short-term protections decrease the ability to restore or move habitats toward the natural range of variation that would better allow for long-term species persistence. Habitat quantity is not expected to change much under this alternative as a result of direct management actions, but it could be at a risk of loss from large, high-severity fires. Such fires are predicted to increase the most under this alternative.

Alternative A has the fewest acres treated with prescribed burning and the estimated area restored to low and moderate severity fire mosaics would be the lowest compared with the action alternatives . Alternative A has slightly higher amounts of mechanical thinning compared with alternatives C and E. However, these treatments are focused in the wildland-urban intermix defense zone and threat zone, and generally in areas with a high-level risk from wildfire. Mechanical thinning would not be primarily focused on wildlife habitat restoration. Fishers and other species that depend on mature forests with diverse stand structures would have minimal direct habitat improvement from treatments under alternative A, other than the potential reduction of future habitat losses from wildfire and tree mortality related to droughts.

Since high-severity fires and widespread tree mortality are emerging as the primary threat to forest dependent species, restoring fire mosaics over larger forest areas is needed to provide for long-term species persistence. Under alternative A, only 12,400 acres in the Sierra National Forest are estimated to be restored to low or moderate fire mosaics; 8,500 acres of prescribed burning would be combined with an estimated 3,800 acres of wildfire managed for resources. This is less habitat by a factor of 4 to 7 that is resilient to large-scale fires, compared with the other alternatives. For the Sequoia National Forest, only 27,500 acres are estimated to be restored to low or moderate fire mosaics; 1,500 acres of prescribed burning would be combined with an estimated 26,000 acres of wildfire managed for resources.

Salvaging dead trees in areas prone to wildfire could be beneficial to reduce the reoccurrence of high-severity fires and aid in the regeneration of forest habitats. With the increase in widespread tree mortality, snags and down logs are more prevalent than when the current plan was created to protect these fairly limited resources. Given limited access and the overwhelming extent of tree mortality, most areas away from roads and infrastructure would remain untreated and fuel conditions that can contribute to fire spread would continue to worsen. Therefore, wildlife dependent on mature forests are at a greater risk of complete habitat loss due to frequent wildfires or from individual tree deaths due to lowered resilience to drought, insects, or diseases than from losing habitat from individual dead trees.

Consequences Specific to Alternative B

The action alternatives share many of the same desired conditions and similar guidelines for the fisher. However, alternative B allows exceptions in community buffers surrounding structures and infrastructure. For example, in order to distribute mechanical treatments out in space and time to reduce the risk of fisher abandoning territories, mechanical thinning is allowed in up to 30 percent of fisher hexagon grid areas over a 5-year period. However, mechanical thinning in community buffers does not count toward these percentages. Since the community buffers are narrow strips immediately adjacent to structures and infrastructure, while there is a potential for short-term, localized impacts on fisher, it is likely to be extremely limited.

In the Sierra National Forest, 84 percent of fisher core habitat and 95 percent of fisher linkages fall outside the CWPZ and would have plan direction to provide for habitat needs and species protection from disturbance due to management activities. Fourteen percent of fisher core habitat and 4 percent of linkages are in the CWPZ and wildlife habitat management area overlap area. In these areas, fishers would receive moderate protection, and treatments would be subject to limited operating periods and active den avoidance.

In the Sequoia National Forest, 90 percent of fisher core habitat and 99 percent of fisher linkages fall outside the CWPZ and would have high species protection from forest management. Less than 1 percent of fisher linkages are in the CWPZ and wildlife habitat management area overlap area, where fishers would receive moderate protection. Forest management under alternative B would have minor-intensity adverse effects on fisher habitat and connectivity at the landscape scale. Restoration to reduce high-severity wildfires, increase forest heterogeneity and diversity, and retain such special habitat features as snags, down logs, and tree cavities would move fisher habitat toward better ecosystem resilience in wildlife habitat management area. It also would provide for continued persistence on National Forest System lands over the long term.

Alternative B provides exceptions for the type and extent of vegetation management and fuels reduction treatments that can occur in fisher habitat in community buffers areas and the CWPZ. Alternative B also provides an exception for applying limited operating periods for fishers to reduce disturbance during the breeding season in these areas. The intent is to facilitate action to reduce risks to human safety and protect property. However, most quality habitat for mature forest-dependent species is captured in the wildlife habitat management area, which would still implement species-specific protection.

Consequences Specific to Alternative C and E

Only a very small amount of fisher core habitat occurs in the wildland urban-intermix defense zone, about 5 percent in the Sierra National Forest and 2 percent in the Sequoia National forest. Even less of the fisher linkages are in the defense zone: about 1 percent in the Sierra National Forest and none in the Sequoia National Forest. In the defense zone, more intensive treatments, including the use of mechanical thinning and prescribed burning, could occur to treat vegetation and fuels to reduce the risk of wildfires to communities.

Mechanical treatments would be limited to no more than 13 percent of a fisher hexagon grid area over a 5-year period to distribute disturbance over time and have less potential to affect fisher use of territories. These types of activities could disturb fishers during the breeding season or lower habitat quality by reducing canopy cover or removing or moving snags or down logs that could serve as resting or denning sites. Outside of the defense zone, alternatives C and E include greater emphasis on the use of prescribed burning and more limitations on the use of mechanical thinning to reduce disturbance during the breeding season and to reduce short-term impacts on existing high quality habitat.

Under alternative C, of the mapped fisher core areas, approximately 15 percent of the total in the Sierra National Forest and approximately 21 percent of the total in the Sequoia National Forest would be managed as recommended wilderness areas. Of the mapped fisher linkage areas, recommended wilderness management would apply to approximately 66 percent of the total in the Sierra National Forest and 33 percent in the Sequoia National Forest.

Under alternative E, of the mapped fisher core areas, approximately 11 percent of the total in the Sierra National Forest and approximately 20 percent of the total in the Sequoia National Forest would be managed as recommended wilderness areas. Of the mapped fisher linkage areas, recommended wilderness management would apply to approximately 66 percent of the total in the Sierra National Forest and 39 percent in the Sequoia National Forest.

Under both alternatives C and E, the effect on fishers from these areas being managed as recommended wilderness is the potential reduction of disturbance from people using mechanized and motorized equipment. However, because of these limitations on mechanized and motorized uses, opportunities to conduct vegetation management and prescribed burning to lessen the risk of uncharacteristic high-severity fire and to restore fire to the ecosystem would be more limited than other alternatives. This could leave more areas of the forests at risk of uncharacteristic high-severity wildfire and continued risk of drought related tree mortality. However, in those areas that were already inventoried roadless areas or do not have existing road or trail access or where lands are steep or existing vegetation or fuels is not in need of treatment, the difference in positive or negative effects would not be substantially different than the other alternatives.

Under alternatives C and E, plan direction to reduce short-term impacts on habitat and minimize the risk of disturbance during the breeding season would also apply to other species of conservation concern that use mature forests, such as the California spotted owl, northern goshawk, and Sierra marten. The combined effect would be fewer acres likely to have mechanical treatments occurring during the breeding season across the forest and in potential fisher habitat outside of the fisher core areas and fisher linkage areas. Where existing fuels are heavy or vegetation conditions would make prescribed burning difficult, these areas may be left untreated in these alternatives, compared with alternatives A, B or D. This would limit short-term impacts on fisher and fisher habitat, but may result in greater long-term impacts on habitat quality or quantity if areas are affected by uncharacteristic high-severity wildfire.

Consequences Specific to Alternative D

Most of the vegetation and fuels reduction treatments would be concentrated in the focus landscape areas in the Montane Zone, because the emphasis is on restoring resilience in old forest habitat that supports fishers and several species of conservation concern (California spotted owls, Sierra martens, great gray owls, and northern goshawks). Overall, ecological resilience to large, high-intensity wildfire would move from low resilience under alternative A to moderate resilience under alternative D in the focus landscapes and other areas where larger landscapes are restored (see "Fire Trends"). This improved resilience to drought, high-severity wildfire, insects, and disease would have long-term positive benefits for the habitat condition and quantity for fisher and other at-risk terrestrial wildlife species associated with mature forest habitat.

Alternative D's management approach allows greater potential for short-term impacts on fishers and fisher habitat in order to have a greater reduction in risk of loss of mature trees and to restore more areas toward desired conditions and ultimately to achieve improved habitat condition in the long term. It would do this by providing more exceptions and flexibility to conduct treatments in fisher habitats and by reducing tree diameter removal restrictions in community buffers, CWPZ, and focus landscapes.

Where fisher core habitat overlaps the CWPZ (approximately 16 percent in the Sierra National Forest and 10 percent in the Sequoia National Forest), there are few restrictions on conducting vegetation and fuels reduction treatments to reduce the threat or impact of wildfire to communities or infrastructure. This could impact fishers that use or would have used this habitat to the extent that treatments occur and modify or remove habitat elements used by fisher such as snags and down logs that may provide resting or denning sites.

Alternative D allows up to 50 percent of a fisher hexagon grid area to be treated over a 5-year period, to allow more treatment in the CWPZ and to allow complete fuelbreak systems in the focus landscapes to be designed and implemented within a shorter time frame and to allow additional treatments in fuelbreak system areas to allow larger landscape prescribed burns to be implemented. To the extent treatments occur, some benefit may occur to fisher habitat outside of the CWPZ if vegetation and fuels treatments help limit the number of fires that start in or near communities and burn onto the national forest.

A smaller number of mapped fisher linkage areas overlap the CWPZ (approximately 5 percent in the Sierra National Forest and less than 0.1 percent in the Sequoia National Forest) and would have the same effects as described for the fisher core areas. This intensity of treatment in a shorter time frame may affect fisher occupancy of territories in the short term, compared with the unknown short-term and long-term effect on fisher occupancy if the area were left untreated or incompletely treated and burned in a future high-severity fire.

Where fisher habitat exists in the focus landscapes outside of the CWPZ (approx. 40 percent of the fisher core habitat and 51 percent of the linkage areas in the Sierra National Forest and 21 percent of the fisher core habitat and no acres of fisher linkage areas in the Sequoia National Forest), some plan direction would provide for reducing project disturbance effects on potential fisher denning sites. They require retaining some habitat elements like snags and down logs that may provide resting and denning sites but with less restrictions than outside of the focus landscapes. This additional flexibility that could result in greater short-term effects was needed to better ensure that projects would be more likely to be designed to be both operationally and economically feasible.

The management approach in the focus landscapes is to implement a system of fuelbreaks along major ridges, roads, and other logical features to help confine, contain, or moderate the spread of fire across broad landscapes. Additionally, a system of fuelbreaks would make it easier to conduct larger landscape scale prescribed burns or to make decisions to manage wildfires where they could meet resource objectives. These actions (prescribed burning and managing naturally ignited wildfires) would benefit fishers in the long term by improving the resilience of mature forest stands and lessening the risk of habitat loss from uncharacteristic high-severity wildfire.

To complement the system of fuelbreaks, additional vegetation and fuels reduction treatments would occur in the watersheds to increase the resilience of mature and old forest stands. Treatments, including mechanical thinning, fuels reduction, and prescribed burning, could occur and result in short-term disturbance of fisher and a reduction of habitat quality by lowering canopy cover and removing or rearranging fuels, including moving or reducing down logs. In addition, in focus landscapes, small group selection harvests could occur to restore landscape heterogeneity, and in particular to support the restoration of shade intolerant pine or to facilitate management of oaks.

These same types of vegetation and fuels management could occur outside of the focus landscapes but would have more constraints on management activities to reduce short-term impacts on fisher or fisher habitat.

Sierra Nevada Yellow-Legged Frog and Mountain Yellow-Legged Frog

The primary programs in the authority of the Forest Service that may affect the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog are fire, recreation, and restoration programs. Since the Sierra Nevada yellow-legged frog occupies areas lower in elevation and outside of designated wilderness, it may also be affected by the vegetation and fuels, range, and roads and infrastructure programs.

Consequences Common to All Alternatives

All of the designated critical habitat for the mountain yellow-legged frog in the Sequoia National Forest is in designated wilderness. Some of the designated critical habitat for Sierra Nevada yellow-legged frog in the Sierra National Forest plan area is in designated wilderness areas. In designated wilderness, active ground-disturbing management, such as direct vegetation management, prescribed burning, and habitat restoration, generally would not occur.

In designated wilderness, since direct restoration of habitat involving ground-disturbing action would be limited, the primary means of restoring aquatic habitats would be passive managing actions or small-scale restoration such as moving trails away from breeding habitat. Outside of wilderness, habitat restoration specifically designed for these species may occur and could occur using the same methods and in the same areas under all alternatives. Breeding habitat restoration could entail a variety of methods, including hand or machinery treatments to improve stream and meadow conditions.

Authorized livestock grazing occurs in areas currently occupied by Sierra Nevada yellow-legged frog in the Sierra National Forest, located in wilderness and non-wilderness areas : Iron Creek, Beasore, Soquel, Chiquito, Mono, Dinkey, Markwood, Patterson Mountain, Collins, and Blasingame Allotments. Six of the allotments have only one known small population in meadow or stream habitat. Meadows with occupied habitat in the Iron Creek, Beasore, Markwood and Dinkey Allotments are at least partially on non-Federal land, with portions of the occupied meadow that overlap National Forest System lands. The remaining four allotments have up to three occupied meadow or stream habitats within the boundary. The Collins, Blasingame, and Mono Allotments have at least half of the allotment acres in wilderness.

Occupied meadows in the Soquel and Chiquito Allotments are partially fenced to protect breeding habitat for the Sierra Nevada yellow-legged frog, minimizing the risk of impacts on individuals. There is current livestock grazing in designated critical habitat in the Mono Allotment in the Sierra National Forest. Livestock grazing has the potential to cause injury or death to individuals from trampling or entrapment in deep hoof prints.

Livestock grazing could also lead to changes in meadow and stream hydrology affecting suitable habitat by altering water flow, water depth, and surface characteristics important for burrows and basking. None of the alternatives directly change the status or use on individual allotments, nor do they substantively change current direction for livestock grazing. Some plan components were clarified to specifically address management around fens due to their sensitivity. Implementing these guidelines should continue to protect habitat for both yellow-legged frog species under all alternatives.

Current livestock grazing is managed under a programmatic biological opinion by the U.S. Fish and Wildlife Service (United States Department of the Interior 2015b) and would not be expected to substantially change as a result of adopting any of the alternatives[33] due to the similarity to current plan direction.

Since there is no authorized livestock grazing that overlaps occupied habitats for the mountain yellow-legged frog in the Sequoia National Forest, there are no effects from livestock grazing.

Other than fire management, habitat in critical habitat areas, largely in wilderness, would remain essentially undisturbed by management activity, but meadows and streams used by these species may be exposed to periodic, low-level, recreation use by individuals, small groups of hikers and recreational pack stock. Under all alternatives, in designated wilderness, if the level of recreation use were found to be adversely impacting these species, the forest plan provides guidance to mitigate the effects.

Approximately 41 acres of the Mono Creek critical habitat unit for Sierra Nevada yellow-legged frog is outside of the John Muir Wilderness at the very northern end of Lake Thomas Edison. In this small area, recreation activities are expected to continue with trail access through the area. There are no known conflicts with recreation at these sites. Under all alternatives, if recreation uses are found to affect this species, plan direction provides guidance to reduce or eliminate the impact though education or alteration of uses and activities at the project level.

There are no effects from roads and other infrastructure that would affect the northern DPS of the mountain yellow-legged frog because all occupied habitats and critical habitats are located in designated wilderness. There are currently 10 known occurrence sites for the Sierra yellow-legged frog located outside of designated wilderness and inventoried roadless areas. Some of these have roads and other infrastructure near occupied habitats. Road maintenance would occur as needed along the existing roads but additional direction to protect riparian conservation areas would also apply to many road related activities that might be proposed reducing potential impacts on the species or occupied habitat.

[33] On adopting a new forest plan, the Forest Service would re-initiate consultation on the project-level programmatic biological opinion to consider the updates to the relevant plan direction for these two national forests.

Consequences Specific to Alternative A

Alternative A does not define specific forest plan direction regarding fire management strategies outside of the wildland-urban intermix that address at-risk species. However, national forest staff can evaluate naturally ignited wildfires on a case-by-case basis to determine if they could be managed to meet resource objectives. Because the emphasis is not on restoring landscape-scale natural fire regimes to benefit habitat, alternative A is the least likely to return natural fire to the landscape in yellow-legged frog habitat, and long-term effects of fire suppression would likely continue, including increased risk of uncharacteristically large fires and subsequent increase in sediment input into habitat.

Consequences Common to Alternative B, C, D, and E

In designated wilderness, the desired condition for the two yellow-legged frog species would primarily be attained through managing wildfires by considering the expected fire effects on habitats and striving to maintain and restore fire as an ecological process. While managing wildfires to meet resource objectives is also allowed under alternative A, resource objectives in the forest plan would be more clearly defined under alternatives B, C, D, and E, thus making it simpler to evaluate and manage selected wildfires that are appropriate for this strategy. Effects on yellow-legged frog species would be considered when determining whether to manage wildfires for resource protection to improve overall watershed resilience to stochastic events, therefore improving the long-term habitat condition for the frogs.

Only a small portion of critical habitat for the Sierra Nevada yellow-legged frog occurs outside of the John Muir Wilderness on the Mono Creek critical habitat unit at the very northern tip of Lake Thomas Edison. This area has mostly sparse conifers, and would not likely have mechanical vegetation treatment. Other areas near occupied sites with Sierra Nevada yellow-legged frog could have mechanical vegetation treatments nearby. As with alternative A, direction for riparian conservation areas would apply to the portion of this area near the lake and inflow stream which would minimize the potential for effects from ground-disturbing mechanical treatments, although there are no known occurrences in this area.

There are approximately 10 known occurrences of Sierra Nevada yellow-legged frogs outside of designated wilderness and inventoried roadless areas that have the potential for more mechanical treatments and prescribed fire under alternatives B and D and more prescribed fire under alternatives C and E. However, any proposed treatment units that may affect this species would be designed to avoid or minimize effects. If affects could not be avoided, consultation with the U.S. Fish and Wildlife Service would be required to ensure specific actions did not jeopardize the species. Therefore, though there could be differences in the amount of mechanical treatment and prescribed burning in some alternatives compared with alternative A, it is unlikely to lead to a difference in effects on either yellow-legged frog species between the plan revision alternatives.

Yosemite Toad

The primary programs under the authority of the Forest Service that may affect the Yosemite toad are the fire, vegetation and fuels, range, recreation, restoration activities, and roads and infrastructure programs.

Consequences Common to All Alternatives

Approximately two-thirds of the designated critical habitat for the Yosemite toad in the Sierra National Forest is in designated wilderness areas. In designated wilderness, the desired conditions for Yosemite toad would be attained primarily through guiding decisions related to managing wildfires by considering the expected fire effects on habitats. This management is designed to benefit resources and to maintain and restore fire as an ecological process. While this primary approach is common across the alternatives, there are some differences in the plan direction for how and where fires are managed and this would be evaluated more specifically by alternative.

Other than fire management, habitat in wilderness areas would remain essentially undisturbed by management activity, but meadows and streams used by these species may be exposed to periodic, low-level, dispersed wilderness travel, by individuals and small groups of hikers primarily on trails. Recreationists are often attracted to meadows and viewing and photographing wildlife is a substantial attraction. If recreation disturbances were found to be causing an adverse effect, under all alternatives, the Sierra National Forest staff would work with the California Department of Fish and Wildlife and the U.S. Fish and Wildlife Service to determine what mitigations might be needed to address site-specific effects.

Recreation pack stock use could impact individuals or habitats if it occurs in breeding and rearing habitat before frogs metamorphose.[34] Current pack stock use levels is low to moderate and has decreased over past historic levels. Commercial pack stock use is prohibited by a court order that restricts pack-stock grazing in occupied Yosemite toad breeding and rearing habitat through the time of toad metamorphosis. This is not expected to change, and if there were changes, there would be required subsequent environmental analysis and they would not vary by plan alternative. These restrictions are consistent with the forestwide plan direction to consider project timing for projects that may affect occupied habitats for at-risk species.

The risk of adverse effects on critical habitat occurs primarily in the one-third of critical habitat located outside of designated wilderness in the Iron Creek, Dinkey Creek, Wishon, and Jackass Meadows areas. Proactive suppression of wildfires might continue to occur to protect life and property where infrastructure or heavy public use occurs, and this is unlikely to vary by alternative.

Fire suppression could result in some risk of adverse effects from ground disturbing activities, but most activities near streams and meadows have existing minimization practices for fire operations. For extended fire management, resource advisors are typically used to identify and minimize adverse effects. Emergency fire operations are subject to emergency consultation procedures. Similarly, there could be a need for vegetation and fuels management to reduce fire risks and to provide for public safety given the heavy recreation use that occurs in some of these areas; however, this would not be likely to adversely affect critical habitat as direction adopted under all of the alternatives provides for riparian conservation areas that would apply to meadows.

Restoring fire to the ecosystem would benefit critical habitat by reducing the risk of post-fire sediment affecting aquatic habitats. If restoration or other project activities are proposed around meadows and ponds occupied by Yosemite toads, they would be guided by direction for riparian conservation areas to maintain or improve the ecological conditions that contribute to the recovery of threatened and endangered species and there would be design features, mitigation, and project timing considerations that would avoid, minimize, or mitigate effects on occupied habitats.

[34] The process of transformation from an immature form to an adult form.

The use of pesticides in critical habitat and occupied habitat would continue to be limited for treatment of invasive plant species, and with campgrounds for vector control of disease from rodents. In all cases, plan direction requires that any pesticide application within 500 feet of known occupied Yosemite toad sites would avoid adverse effects on individuals or their habitats. While pesticides are rarely or never used in designated critical habitat for Yosemite toads, due to remoteness and lack of need, they could be used if an invasive weed species was thought to have potential for ecosystem impacts.

Outside of designated wilderness there are some existing roads near Yosemite toad populations that have been known to cause mortality when toads cross roads. As mentioned in the Affected Environment, the Sierra National Forest has been working with researchers to test and evaluate methods to reduce road-related mortality and would continue to coordinate and cooperate under all alternatives.

Consequences Specific to Alternative A

Alternative A does not define specific forest plan direction regarding fire management strategies outside of the wildland-urban intermix that address at-risk species. For the Sierra National Forest, the Forest Service would evaluate naturally ignited wildfires on a case-by-case basis to determine if they could be managed to meet resource objectives. This would occur in the majority of occupied habitats and critical habitat located in designated wilderness. To the extent that fire is restored to these higher elevation landscapes, it would reduce the likelihood of future wildfires burning outside of the natural range of variation, which would reduce the potential for post-fire sediment impacts.

The portion of Iron Creek and Dinkey critical habitat units outside of designated wilderness contains some wildland-urban intermix defense and threat zone where fuels treatments and fire suppression are expected to protect human assets. However, because of the high recreation values of this area, the extent and locations of fuel treatments would likely be mitigated by the need to provide the scenic values expected by the recreating public. This could lessen the risk of impacts on habitat but may result in less effective fuels treatments compared with the other alternatives that emphasize the need for effective strategic treatments resulting in more risk of adverse effects on habitat.

Consequences Specific to Alternative B

Alternative B replaces the distance-based wildland-urban intermix defense and threat zones of alternative A with strategic fire management zones. Ninety-six percent of the critical habitat for Yosemite toad is in the wildfire maintenance zone and wildfire restoration zone, which have desired conditions to be resilient to the range of fire effects and where wildland fire has predominantly positive benefits. In these two strategic fire management zones, fires from lightning would be evaluated to determine if they could be managed with less than a full fire suppression response considering safety to firefighters and the public and potential positive and negative effects from expected fire behavior to various resources. To aid in determining the appropriate wildfire management strategy, spatial support tools are used to identify the locations of special habitats and key habitat areas, including critical habitat areas, so they can be considered. The direction would increase the likelihood that more wildfires would be managed in the future to restore the ecological role of fire and to improve ecosystem integrity and lessen future adverse effects of wildfires. Therefore, there would be a long-term improvement in Yosemite Toad habitat, relative to alternative A.

Vegetation and fuels management could occur in the portion of critical habitat unit outside of wilderness. Fuels and vegetation treatments would be focused in the community and general wildfire protection zones and in the wildlife habitat management areas as shown in Table 67. Fuels treatments could use hand treatments, mechanical treatments, or prescribed burning or some combination of those methods. Mechanical treatments would be limited in existing inventoried roadless areas which are approximately one-third of the non-wilderness critical habitat acres. In the riparian conservation areas surrounding occupied habitats, plan direction would limit the ground disturbing impacts to protect Yosemite toad habitat.

Table 67. Approximate National Forest Service acres of wildlife habitat management areas in critical habitat units

Critical Habitat Unit Name	Wildlife Habitat Management Area Number	National Forest Service Acres
Iron Mountain	8	10,800
Kaiser/Dusy	8	63,800
Round Corral Meadow	8	4.200

Plan direction would also guide the design of treatments to meet the scenery needs of recreation in heavily used areas, potentially lessening the amount vegetation removed. Treatments that improve the resilience of the vegetation near occupied sites and fuels reduction treatments are expected to lessen the risk of high-severity wildfire outside the natural range of variation which would benefit the Yosemite toad by providing more stability to the habitat conditions of occupied sites.

Consequences Specific to Alternatives C and E

Although some of the strategic fire management zones under alternative C and E are different than those in the other alternatives, the fire management effects on Yosemite toad are expected to be similar to those described for alternative B. The wet meadow and riparian areas important to Yosemite toad would generally be avoided by fire management activities based more on the wet site conditions rather than the fire management zone. Critical habitat areas and occupied habitats are identified on pre-suppression decision-support tools and reflected in aerial retardant avoidance maps. Like all other alternatives, for wildfires managed to meet resource benefits, the location of critical habitat would be considered in planning strategies and tactics to avoid or minimize impacts from operations and fire effects on habitats.

Under alternatives C and E, there could be vegetation and fuels treatments planned in the wildland-urban intermix defense zone around Huntington Lake, but the emphasis would be on hand treatments and the use of prescribed burning instead of on the use of mechanical equipment. There would likely be minimal difference in effect on Yosemite toads and their habitat; however, because mechanical treatments in Yosemite toad habitat would be designed to protect the species and its habitat, including use of hand treatments instead of mechanical treatments to avoid adversely impacting individuals.

There could be fewer short-term effects on habitat because there would be less mechanical treatment near habitat compared with alternatives B and D, but there could be greater potential negative effects from uncharacteristically large wildfires because alternatives C and E would not be able to treat as many acres of fuels in upland areas near Yosemite toad habitat as alternatives B and D.

Consequences Specific to Alternative D

The strategic fire management zones would be the same as alternative B and the effects from fire management activities to Yosemite toad would be expected to be similar.

Since alternative D would have the highest amount of vegetation and fuels treatments of all alternatives, there is a higher potential for fuels treatments to occur in or surrounding the community and general wildfire protection zones around Huntington Lake in the Kaiser/Dusy critical habitat unit and the portions of critical habitat in focus landscapes shown in Table 68. Work in the focus landscapes would be concentrated on strategic fuelbreaks with some restoration thinning treatments in the forested portions of the subwatersheds to increase forest resilience. Most of the upland treatments would not affect Yosemite toads or their habitat.

Table 68. Approximate National Forest Service acres of focus landscape units in critical habitat units

Critical Habitat Unit Name	Focus Landscape Number	National Forest Service Acres
Iron Mountain	1	6,200
Kaiser/Dusy	2	22,500
Kaiser/Dusy	4	11,500

To the extent a system of strategic fuelbreaks is implemented and fuels are reduced in upland areas, it would reduce the risk of future wildfires burning with a higher severity than the natural range of variation lessening the risk of sediment that could affect the habitat used by Yosemite toads. Implementing strategic fuelbreaks in watersheds containing Yosemite toad or suitable habitat would make it easier to conduct prescribed fires and to manage wildfires to meet resource objectives which would restore vegetation and ecological functions toward the natural range of variation and better provide for resilience of meadow and forest ecosystems.

Lahontan Cutthroat Trout and Paiute Cutthroat Trout

Since these two species occupy similar habitats and have similar threats and consequences, they are analyzed together here. When discussion applies to both species, the generic term cutthroat trout is used. The primary programs that may affect both species that are under the authority of the Forest Service are the fire, range, and recreation programs. Since the Lahontan cutthroat trout occupies areas outside of designated wilderness, it may also be affected by the vegetation and fuels, restoration, and roads and infrastructure programs.

Consequences Common to All Alternatives

As described in “Aquatic and Riparian Ecosystems,” all plan revision alternatives include an aquatic and riparian conservation strategy that provides a comprehensive and multi-scale management framework for watershed, riparian and stream conservation. The aquatic and riparian conservation strategy is similar to alternative A, retaining the essential elements of the existing management direction for riparian conservation areas. There are many specific desired conditions for watersheds forestwide and for riparian conservation areas that would shape the purpose and need and project design outcomes of future projects. Desired conditions for the riparian conservation areas and watersheds provide beneficial functions such as cold, clean water; stream shading; aquatic/riparian habitat; and nutrients.

There are also many specific standards and guidelines that avoid, mitigate, or minimize certain types of activities or intensities or magnitudes of effects in riparian conservation areas and to riparian resources. These plan components collectively help ensure stream and riparian habitats are conserved and restored for long-term sustainability and resilience of the ecological conditions that contribute to species recovery. The plan revision alternatives vary in management of critical aquatic refuges or conservation watersheds, which will be discussed for each alternative below.

Although the different alternatives take slightly different approaches to prioritize watershed restoration and slightly different approaches to identifying areas of particular importance to these species as shown in Table 69, there is functionally little difference, in part because projects requiring consultation would tend to have similar project designs to minimize or avoid adverse effects. All action alternatives include forestwide direction for animal and plant species coupled with forestwide direction for watersheds. This provides desired conditions and guidance in project design to maintain, improve, or protect ecological conditions needed to contribute to the recovery of federally listed species and to consider the desired conditions of riparian vegetation when proposing treatments in the upland portions of watersheds.

Table 69. Aquatic conservation strategy management areas for Lahontan cutthroat trout and Paiute cutthroat trout by alternative

Alternative	Critical Aquatic Refuges	Conservation Watersheds
A	Cow Creek (Lahontan cutthroat trout) W. Fork Portuguese Creek (Lahontan cutthroat trout) Stairway Creek (Paiute cutthroat trout) Sharktooth Creek (Paiute cutthroat trout)	None
B	None	Kings (Lahontan cutthroat trout) San Joaquin (Lahontan cutthroat trout)
C	Cow Creek (Lahontan cutthroat trout) W. Fork Portuguese Creek (Lahontan cutthroat trout) Stairway Creek (Paiute cutthroat trout) Sharktooth Creek (Paiute cutthroat trout)	Kings (Lahontan cutthroat trout) San Joaquin (Lahontan cutthroat trout)
D	None	None
E	Cow Creek (Lahontan cutthroat trout) W. Fork Portuguese Creek (Lahontan cutthroat trout)	Kings (Lahontan cutthroat trout) San Joaquin (Lahontan cutthroat trout)

Under alternative A, projects proposed in the Cow Creek, West Fork of Portuguese Creek, Stairway Creek, or Sharktooth Creek critical aquatic refuges would be guided by direction to provide habitat for the respective cutthroat trout species and to restrict or minimize activities that would impact riparian habitats or stream conditions. The removal of specific direction for these critical aquatic refuges under alternative B and the identification of the Kings and San Joaquin conservation watersheds under alternatives B, C, and E would likely cause no difference in the management of cutthroat trout habitat because protections would still exist under the riparian conservation area direction, Endangered Species Act, and general watershed protections. Having identified areas that include these species could result in slightly higher prioritization for restoration, particularly where partner funding is solicited, compared with alternative D; however, funding for endangered species habitat restoration is often a priority factor by itself.

Three of the four occupied habitat areas for cutthroat trout are located in active livestock grazing allotments. For Lahontan cutthroat trout, livestock grazing and operations in the areas of occupied habitat along Cow Creek in the Dinkey Allotment and the West Fork of Portuguese Creek in the

Mugler Allotment have been adjusted based on a prior U.S. Fish and Wildlife Service consultation and biological opinion, including fencing nursery areas along Cow Creek (United States Department of the Interior 1994b, 1995c).

Any future proposals to discontinue the fencing or to consider additional fencing would be guided by the plan direction to manage essential habitat for the species according to the recovery plan and to limit streambank disturbance and would be considered in consultation with the U.S. Fish and Wildlife Service. For the Paiute cutthroat trout, only the occupied habitat along Sharktooth Creek is in an active allotment, the Cassidy Allotment; however, livestock grazing effects are limited because the occupied habitat area is generally inaccessible to livestock (United States Department of the Interior 1995c). The Stairway Creek population is not in an active allotment.

All alternatives would continue plan direction to protect a 200-foot zone around occupied stream reaches containing Lahontan cutthroat trout. This direction requires falling trees away from the stream and disposing of slash in ways that avoid adverse effects on the stream. All alternatives would continue plan direction to limit stream bank disturbance from livestock to 10 percent of the occupied or essential habitat stream reach and take corrective action if this is exceeded.

Roads exist in and near both of these occupied sites for Lahontan cutthroat trout. Under all alternatives, the Forest Service would implement best management practices for road maintenance, including the use of dust abatement chemicals. It would design projects so as to avoid, minimize, or mitigate potential impacts on occupied habitat. We would require consultation with the U.S. Fish and Wildlife Service if the projects may affect the species. The populations for Paiute cutthroat trout are in designated wilderness and are unaffected by roads and road maintenance.

Roads provide access for recreation, both for fishing and dispersed camping. Except for Cow Creek, it is legal to fish for cutthroat trout; the impacts of fishing is considered by the California Department of Fish and Wildlife, which regulates the harvest. This is outside of the authority of the Forest Service, although access to the streams and impacts of anglers and other recreationists on the stream habitats is within its authority to manage.

Stairway Creek, Cabin Creek, and Sharktooth Creek are all relatively inaccessible and lightly used, and therefore are managed as wild trout fisheries without special protective regulations (United States Department of the Interior 1995c). Currently there are no identified priorities for habitat restoration identified by the recovery plan (United States Department of the Interior 1995c) or in coordination with the California Department of Fish and Wildlife relevant to the Sierra National Forest plan area.

In wilderness, fire suppression would include minimum impact suppression techniques wherever feasible under all alternatives. The occupied habitat for Lahontan cutthroat trout and Paiute cutthroat trout is identified as terrestrial aerial retardant avoidance areas on maps used when suppressing wildfires (United States Department of Agriculture 2011e). Use of aerial retardants is minimized in designated wilderness areas unless needed to protect life or property. When needed, water drops from helicopters is preferred to minimize impacts on wilderness character and if needed near occupied habitat, to limit the risk of adverse fire effects on federally listed species. The effect of these actions would minimize the risks of direct impacts from chemicals and on-the-ground fire suppression related ground disturbance to occupied habitats. However, reduced use of retardants could also result in wildfires burning at higher intensities or across larger areas, which could carry higher risks of post-fire sedimentation. Given the generally sparse vegetation in the occupied habitat areas, the risks of substantial high-severity fire effects and associated sedimentation to occupied stream segments would likely be low to moderate.

Although the occupied habitat areas for Lahontan cutthroat trout have a slightly different recreation strategy across the alternatives, the effects are likely to be similar because these occupied habitat areas would not be expected to have a change in recreational development or level of recreation use. This is true even under alternatives B, C, and D, which would designate a corridor along Beasore Road as Destination Recreation Management Area across the top of the West Fork of Portuguese Creek including the occupied habitat for Lahontan cutthroat trout. Given the location and site conditions, additional recreational developments would not be expected along the occupied areas of this creek. If additional recreational developments resulted in increased use of the existing roads, maintenance and management would be as described above and would not adversely affect the creek. The Paiute cutthroat trout occupied habitats are in designated wilderness, and management direction would not change across alternatives.

If additional restoration activities are needed, such as restoration after wildfires burn in the watershed, the Sierra National Forest would coordinate with California Department of Fish and Wildlife and U.S. Fish and Wildlife Service to ensure protection of habitat. While this would occur under alternative A without specific plan direction, it is addressed as a plan goal under alternatives B, C, D, and E to express the Forest Service's intent in the Sierra National Forest to improve conditions for federally listed species. It is likely that little restoration would occur for the Paiute cutthroat trout occupied habitat areas in designated wilderness.

Consequences Specific to Alternatives B, C, D, and E

For the Paiute cutthroat trout, the occupied habitat in Stairway Creek and Sharktooth Creek were evaluated and have been found to meet the eligibility requirements to be considered for inclusion in the National Wild and Scenic Rivers System. The assigned preliminary classification is wild river for both segments. Eligible wild and scenic rivers are managed by applying interim protection measures that protect them sufficiently to maintain free flow and outstandingly remarkable values.

Because of the presence of Lahontan cutthroat trout, fisheries are identified as one of the outstandingly remarkable values. Future in-stream habitat restoration projects, such as construction of structures and vegetation management to protect and enhance wildlife and fish habitat, can occur in wild rivers, as long as they harmonize with the area's essentially primitive character and fully protect identified river values and do not affect the river's free-flowing character. Vegetation and fuels management projects would generally be limited in the eligible wild river corridor.

Additional plan direction further limits the potential for impacts on riparian resources when prescribed fires are planned. When water drafting is needed on projects, screening devices are required to minimize removal of aquatic species from aquatic habitats, including juvenile fish, amphibian egg masses and tadpoles. However, prior to determining if water drafting would be suitable for occupied habitats, the proposed sites would be evaluated for effects on Lahontan cutthroat trout and in some cases, water drafting may be prohibited. Efforts to manage the impacts of wildfires and implement vegetation and fuels management to lessen the risk of habitat loss or the potential for sediment from adjacent burned areas from impacting occupied habitats would contribute toward recovery of this species by better protecting this out-of-basin population.

Since both populations of Paiute cutthroat trout occur in designated wilderness, they are unlikely to be affected by prescribed burning or active management activities.

With regard to wildfire management, although the occupied habitat areas would be managed slightly differently across the alternatives (see Table 70), the overall effects would likely be similar across alternatives.

Table 70. Fire management strategy for occupied habitats of Lahontan cutthroat trout and Paiute cutthroat trout

Alternative	Cow Creek (Lahontan cutthroat trout)	W. Fork Portuguese Creek (Lahontan cutthroat trout)	Stairway and Sharktooth Creeks (Paiute cutthroat trout)
A	No specific direction	No specific direction	No specific direction
B and D	Wildfire maintenance zone	North portion, wildfire restoration zone south portion, general wildfire protection zone	Wildfire maintenance zone
C and E	Wildfire maintenance zone	General fire zone	Wildfire maintenance zone

There is no specific direction for fire management in these areas under alternative A because they are not within the defense zone or threat zone. Naturally ignited wildfires could be managed to meet resource objectives when it is safe to do so, which is also the approach in the action alternatives. Alternatives C and E do not differentiate between the general wildfire protection zone and wildfire restoration zone like alternatives B and D, instead categorizing the area around the west fork of Portuguese Creek as the GFZ.

Regardless, the direction for managing fire would be similar by having guidance to manage wildfires to meet resources objectives when it is safe to do so and manage and mitigate the impacts of fire suppression activities to the extent possible. Thus, even though the mapped fire zones would be different between the alternatives in the areas that could affect cutthroat trout, the consequences would be similar because fire management decisions would be guided by protection of life and property and managing wildfires to meet resource objectives, which would restore fire as an ecological process, when it is safe to do so.

Since the populations of Paiute cutthroat trout are all in designated wilderness, they would not be affected by vegetation or fuels management activities. The populations of Lahontan cutthroat trout are in areas where they could be affected by vegetation and fuels management activities as described in the sections below.

Consequences Specific to Alternatives B and D

Alternative B and D would encourage an increase in the pace and scale of ecological restoration and fuels reduction activities aimed at reducing the risk and effects of large high-severity wildfires compared with the other alternatives. The two occupied habitats for Lahontan cutthroat trout are in the wildlife habitat management area under alternative B and outside of focus landscape areas under alternative D. To the extent that treatments occur in areas near the occupied habitats, it could lessen the risk of large high-severity wildfires affecting the watershed or it could result in lessened or more variable fire severity. This might lessen the risk of sediment affecting occupied habitat. This would only affect the watershed areas occupied by Lahontan cutthroat trout outside of designated wilderness as all occupied habitat areas of Paiute cutthroat trout are in designated wilderness.

Consequences Specific to Alternatives C and E

Compared with alternatives A, B, and D, alternatives C and E would have more restrictions on the use of mechanical treatments to restore vegetation or treat fuels. This would limit the amount of fuels reduction and prescribed burning that could occur, which would reduce the increased fuels from widespread tree mortality in the landscapes surrounding these occupied sites. In the short term, this would reduce the potential for mechanized equipment causing ground disturbance. Other plan direction would limit the potential for projects to adversely alter ecological conditions or contribute adverse levels of sediment to the occupied streams. In the long term, this could result in more areas burning at higher fire severity or with higher intensity, which could adversely affect conditions adjacent to Cow Creek and Portuguese Creek and generate higher levels of sediment from burned uplands which could affect breeding habitat or breeding success.

There would be little difference between alternatives for the Paiute cutthroat trout because they occur in designated wilderness and active management to treat fuels would not be expected to occur and wildfire risk modeling determined these areas are most amenable for restoring fire as an ecological process which would benefit habitat sustainability over the long-term.

Little Kern Golden Trout

The primary programs that may affect this species that are under the authority of the Forest Service are the fire, range, recreation, and restoration activities programs.

Consequences Common to All Alternatives

All of the critical habitat in the plan area occurs in the designated Golden Trout Wilderness. In designated wilderness fire suppression activities would employ minimum impact suppression techniques wherever feasible. The critical habitat is identified as a terrestrial aerial retardant avoidance area on maps used when suppressing wildfires (United States Department of Agriculture 2011e). Use of aerial retardants is minimized in designated wilderness areas unless needed to protect life or property. When needed, water drops from helicopters is preferred to minimize impacts on wilderness character and if needed near occupied habitat, to limit the risk of adverse fire effects on federally listed species. The effect of these actions would minimize the risks of direct impacts from fire suppression activities and fire-related sediment to occupied habitats.

Although direction under alternatives B, C, D, and E for addressing recreation impacts on wildlife in wilderness has been clarified from the current direction under alternative A, direction for avoiding or mitigating impacts on federally listed species has not fundamentally changed. Thus, if recreation activities are found to be adversely affecting occupied habitat, there would be little difference between alternatives in actions or activities to address the impacts.

The State of California regulates the harvest of this species and it is currently open to recreational fishing. Direction to mitigate the impacts from livestock grazing has been addressed at the project-level in an existing biological opinion (United States Department of the Interior 1994d) and this direction would continue in all alternatives.

The portion of the critical habitat outside of designated wilderness is in the Giant Sequoia National Monument, which is not affected by this plan revision.

Consequences Common to Alternatives B, C, D, and E

Much of the critical habitat is in the natural range of variation due to wildfires that have burned in the last 15 years. High levels of sedimentation from high-severity wildfire could impacts the occupied stream segment but given the generally sparse vegetation in this area and recent fire history in the landscape, the risks of substantial high-severity fire effects over a broad area would likely be low. Restoring fire as an ecological process would better ensure levels of sedimentation in the natural range of variation to maintain spawning habitat.

Bakersfield Cactus

The primary programs under the authority of the Forest Service that may affect Bakersfield cactus are the fire, recreation, and roads and infrastructure programs.

Consequences Common to All Alternatives

The potential population of Bakersfield cactus is unlikely to be affected by most program activities given the isolated location of the population.

Although the location is in different Sustainable RMAs based on the alternatives (no RMAs under alternative A; DRAs under alternatives B and C, no RMAs under alternative D, and GRA under alternative E), it is not expected to result in a difference in effects between alternatives. This is due to the location being on a rocky slope where recreation development is not likely and substantial changes in recreation uses is not expected. Some dispersed recreation use could occur that might affect the potential population but there is no existing or anticipated development that would encourage users to encroach on the population site. In all alternatives, if recreation impacts were found to be occurring, projects could be considered to mitigate the impacts on natural resources from recreation.

Road management could affect this potential population; however, management of the State Route 178 is governed by the California Department of Transportation and not the Forest Service.

Fire management activities and the impacts of fire are a potential concern however the rocky location of the potential population would limit impacts of future fires and have limited opportunities for active fuels management in all alternatives. The area is in the Wildfire Restoration Zone under alternatives B and D and the GFZ under alternatives C and E; however, the generally sparse vegetation minimize fire risks to this location.

Mariposa Pussypaws

The primary programs under the authority of the Forest Service that may affect this species are the fire, vegetation and fuels, range, and roads and infrastructure programs.

Consequences Common to All Alternatives

The effects on the known populations of Mariposa pussypaws from the range management and recreation programs have been mitigated by past and ongoing management decisions. The areas surrounding the populations have been fenced to exclude livestock. One population has an access road nearby that is used to service the transmission lines that is seasonally open to the public but is maintained to a level suitable only for high clearance vehicles. Motorized travel by the public off the designated route is prohibited by Forest Order thus impacts from unauthorized off-highway vehicle use is unlikely. There are no designated routes near the second population.

Although the location of these two populations is in different Sustainable RMAs based on the alternatives (no RMAs under alternative A; GRA under alternatives B, C, D, and E), it is not expected to result in a difference in effects between alternatives. This is due to the location being in a remote generally open area where recreation development is not likely and substantial changes in recreation uses is not expected. Some dispersed recreation use could occur in the area near the transmission line that might affect the potential population but there is no existing or anticipated development that would encourage users to encroach on the population site. In all alternatives, if recreation impacts were found to be occurring, projects could be considered to mitigate the impacts on natural resources from recreation.

While the two populations occur in different fire management zones across the alternatives, the effects are likely to be similar because the generally sparse vegetation would likely have minimal fuels or vegetation management opportunities other than potentially prescribed burning. Since the locations are in the lower elevation areas characterized by the threat zone under alternative A, community and general wildfire protection zones in alternatives B and D and GFZ under alternatives C and E, it is likely management would tend toward fire suppression due to risks to highly valued resources and assets. The locations of federally listed species would be considered in wildfire decision support systems to aid in minimizing direct impacts during fire suppression actions and if fires are managed to meet resource objectives.

Whitebark Pine (Candidate)

The primary programs under the authority of the Forest Service that may affect whitebark pine are the fire and recreation programs.

Consequences Common to All Alternatives

Whitebark pine are periodically monitored by the Forest Service Regional Ecology Program and are recognized as a species highly susceptible to climate change (United States Department of the Interior 2016c). Whitebark pine would continue to be periodically evaluated by the Forest Health Protection program and by forest pathologists for tree mortality and susceptibility to bark beetle attack and to monitor for white pine blister rust.

Since almost all of the extent of whitebark pine in these two forests is in designated wilderness or in adjacent inventoried roadless areas, little management would occur in areas with whitebark pine except for activities associated with recreation management and managing wildfires to restore ecological processes. The extent of impacts of recreation management on whitebark pine is not known, but they occur in and near trails. Whitebark pine can be affected by collection and use of whitebark pine branches and downed wood for campfires by recreationists. However, the Sierra National Forest has implemented elevation-based campfire restrictions in wilderness areas in part to reduce the impacts of depletion of downed wood and ground litter in the elevations where whitebark pine occurs.

The Forest Service does not expect that recreation uses for firewood is significantly affecting whitebark pine. Trail maintenance could also affect whitebark pine through potential limbing of branches or impacts on root systems from adjacent trails and recreation uses or by affecting seedlings or saplings. All alternatives include forestwide direction to evaluate and mitigate effects on at-risk species (sensitive species under alternative A); specifically, these are to assess and, where needed, mitigate the site-specific impacts on whitebark pine during project-level planning.

Consequences Specific to Alternative A

Alternative A has general direction to protect the diversity of plant communities and seral stages, but has no direction specific to whitebark pine. Projects and activities would be guided by agency direction for managing candidate species and direction to manage Regional Forester's sensitive species. As a sensitive species, project proposals would be evaluated at the project level to ensure they do not lead to a trend toward Federal listing. Short-term effects would be minimal to whitebark pine, because small-scale restoration projects and species monitoring would continue to occur under this alternative and projects that could affect whitebark pine would be evaluated to ensure it would contribute to the conservation of the species.

The current forest plan defines fire management zones only around communities. No specific forest plan direction exists to guide fire management related to whitebark pine in the majority of the areas where whitebark pine occurs, which is primarily in designated wilderness and remote alpine and subalpine habitats. When fires occur in these areas away from communities, fire management decisions are guided by agency policies and procedures where naturally ignited wildfires are considered for management to meet resource objectives on a case-by-case basis.

Since forest plan resource objectives for wildfire management are only general in nature, many wildfires continue to be suppressed, slowing the restoration of fire as an ecosystem function to many forest landscapes. Continuing to suppress wildfires allows vegetation to continue to become denser which can increase competition by encroaching trees and shrubs and increase water stress to whitebark pine. Burned areas that create exposed mineral soil are also important for seed caching by animals, particularly the Clark’s nutcracker, which is an important mechanism for whitebark pine regeneration.

Because alternative A lacks an emphasis on whitebark pine conservation and many wildfires that burn in whitebark pine habitats would likely continue to be suppressed, it would protect and restore the least amount of whitebark pine habitats. However, alternative A would still provide the ecological conditions necessary to conserve candidate species and would maintain or restore their habitats in the plan area to contribute to preventing them from being federally listed.

Consequences Common to Alternatives B, C, D, and E

Desired conditions for the alpine and subalpine zone, including a desired condition focused on whitebark pine, provide for healthy whitebark pine, including resilience to moisture stress, drought, and bark beetles, and resistance to white pine blister rust. The desired condition for the alpine and subalpine vegetation zone provides for protection and conservation of genetic diversity through the maintenance of mature cone-bearing trees. This is important to ensure sufficient seeds for caching by Clark’s nutcrackers to aid in natural regeneration and to maintain genetic diversity.

Since most of the whitebark pine occurs in designated wilderness, no direct active management other than restoring fire as an ecosystem process would likely occur, which would move toward the vegetation desired conditions that would benefit whitebark pine. Almost all of the whitebark pine occurs in the wildfire maintenance zone in the action alternatives except for a very few stands mapped near Mount Givens east of Kaiser Pass. Compared with alternative A, the plan revision alternatives would better reduce the threat of high-intensity fire, and to some degree other threats, because of the emphasis on ecosystem restoration through the use of prescribed fire and wildfire managed to meet resource objectives. The latter is especially beneficial for whitebark pine because this is the primary restoration treatment in designated wilderness areas, where much of the whitebark pine occurs. As a result, there would be a positive effect on whitebark pine habitat quality and population trend to the extent that fire is restored in the natural range of variation.

The forest plan includes a goal to collaboratively support the development of a regional whitebark pine conservation and restoration strategy. This strategy is envisioned as a regional approach to the rangewide restoration strategy developed in 2012 (Keane et al. 2012) and would cover whitebark pine across its range in California. It would likely identify habitat management objectives or habitat goals and tactical practices that could be implemented to conserve whitebark pine. If such habitat management objectives or habitat goals were developed, they would be considered in the design of projects as appropriate. Any tactical practices could be considered and implemented in future projects unless they are inconsistent with an existing standard or guideline, in which case an amendment to the forest plan may be considered. This would provide additional assurances that whitebark pine are conserved in the plan areas.

Although the need to develop a regional conservation strategy is currently recognized, there is no specific plan direction under alternative A and it may be less likely to occur without the added recognition and emphasis in the forest plan. Therefore, under alternatives B, C, D, and E, greater acreage of wildfire managed to meet resource objectives may potentially result in improved resilience and regeneration of whitebark pine. This factor is expected to result in a moderate, but site-specific upward trend in whitebark pine vigor and reproduction. As a result, these alternatives would have some positive short- and long-term effects on whitebark pine habitat extent and condition.

Cumulative Effects

The Endangered Species Act defines cumulative effects to federally listed species as non-Federal actions that are reasonably certain to occur in the plan area. Federal actions are excluded from the cumulative effects analysis because past and present actions would have undergone consultation and future actions are subject to consultation.

There are other reasonably foreseeable non-Federal activities that may occur in the plan area that may affect federally listed species. For many federally listed species, cooperative actions are taken by the California Department of Fish and Wildlife, in coordination with the Forest Service and the U.S. Fish and Wildlife Service to conduct surveys of species and habitats, and to directly manipulate individuals and populations through translocations or research.

For example, the California Department of Fish and Wildlife helps restore the Sierra Nevada bighorn sheep population throughout its range, guided by the 2007 recovery plan (United States Department of the Interior 2007). The Forest Service expects the California Department of Fish and Wildlife to continue to conduct population surveys, evaluate and monitor mortality in bighorn sheep, and evaluate and implement translocation to meet recovery plan distribution and population criteria. We expect that they will also continue to work with the USDA Wildlife Services to evaluate and oversee the management of mountain lions that are affecting species recovery. These actions would improve the size and distribution of populations to meet recovery goals.

For some fish and amphibian species, the State of California has in the past, and is expected to continue to conduct control of nonnative species that threaten federally listed species. Collectively, these activities are primarily intended to address survival and reproduction of individuals and to improve the persistence of populations.

Activities that directly affect habitat, such as fuels treatments or habitat restoration projects, typically involve Federal actions and are not considered cumulative effects under the Endangered Species Act. Similarly, other non-Federal activities that may affect the primary populations of some species, particularly the two herbaceous plants (Bakersfield cactus and Mariposa pussypaws), occur outside of the plan area and are also not considered cumulative effects for this project under the Endangered Species Act. For the purposes of the Endangered Species Act, there are no other foreseeable cumulative actions identified for federally listed or candidate species as well as critical habitat at this time in the plan area.

Although not considered cumulative effects under the Endangered Species Act, several other factors could cumulatively influence effects to species or habitats they use, particularly aquatic species. In addition to the species-specific primary stressors identified for federally listed species, several other risk factors fall outside the authority of the Forest Service but have the potential to impact populations on a regional or global scale. These are acid deposition, airborne contaminants such as pesticides, climate change, disease, and ultraviolet-B radiation. The Forest Service has few options to reduce the risk some of these factors pose to federally listed species and their habitat.

Ecological consequences of climate change likely poses the most risk to aquatic species given the potential to change the quantity and seasonal pattern of water storage and flow through aquatic systems. However, restoration of meadows, which store water in watersheds with at-risk species can buffer against changing climate. Reduced snowpacks may result in less available surface water, which could affect breeding sites and may lead to less successful reproduction especially for smaller headwater streams. Changes in seasonal patterns of precipitation types and amounts, along with changes in temperature such as early snowmelt and warmer temperatures, may affect species behavior, the timing of reproduction, and other phenological events resulting in lowering survivorship. Improving ecosystem integrity in meadows and uplands in critical habitat areas may ameliorate local risk factors by improving the resiliency of watersheds to annual fluctuations in weather conditions and water flow through aquatic systems.

The ecological consequences of climate change on terrestrial federally listed species, such as the fisher, is more complex and uncertain. As discussed in “Agents of Change: Climate, Fire, Insects, and Pathogens,” the combination of changes in the amount and patterns of precipitation with warming temperatures is projected to extend fire seasons and increase total area burned and the amount of area burned at high-severity. This could result in direct removal of habitat and cumulative loss of mature forest habitats over time. While the effects of climate change may have negative effects on the risks to old forests from increasing wildfire potential and increasing risks of tree mortality related to droughts, there may also be some potential benefits to fisher if there is an increase in habitat availability from the predicted reduction in snow pack (Zielinski et al. 2017).

Analytical Conclusions

Alternatives B and D are more likely to reduce the risks from wildfires and tree mortality from insects and disease that could negatively affect the quantity and condition of habitats that contribute to the recovery of threatened and endangered species and the conservation of proposed species, compared with alternatives A, C, and E. Alternatives A, C, and E have the most limited ability to mitigate the continuing increase in large, high-intensity wildfires and build adaptive capacity of ecosystems to climate change, although alternatives C and E are slightly better than alternative A at addressing climate change. Large wildfires with expansive areas of high-severity impacts are a major threat to many federally listed species because they completely remove important habitat elements from a large portion of the landscape, for example, large living trees, dense canopy cover, down woody debris, riparian vegetation, and structural complexity. In addition, wildfires can influence sedimentation and water quality and water quantity in aquatic systems. Climate change is influencing all species and their habitats in more complex ways, many of which are still unknown.

Although alternatives B, C, D, and E all focus on moving the vegetation types toward desired conditions, alternatives B and D are better positioned to achieve these desired conditions in a shorter time frame because they focus on restoring resilience at a large landscape scale using a variety of tools that effectively decrease the expected amount of crown fire and large patches of high-severity fire effects toward the levels expected in the natural range of variation. The Forest Service assumes that the treatment pace and scale under alternative B would move the landscape to a moderate fire resilience within the first 10 years of plan adoption. It expects the pace and scale of restoration proposed under alternative D to surpass alternative B in its ability to move the landscape to a more resilient position. These alternatives are also slightly better than alternative A and much better than alternatives C and E in building adaptive capacity of the ecosystems to climate change.

Alternative B represents a balance between alternative A, C, and E in that it proposes to restore ecosystems toward their natural range of variation faster than alternative A because of the landscape level approach and more acres proposed for treatment. Alternative B proposes to restore ecosystems toward their natural range of variation more effectively than alternatives C and E by allowing a wider variety of restoration tools, substantially increasing the likelihood that treatments would actually occur. Alternative B provides a more cautious approach than alternative D by tempering the pace of restoration and implementing more species-specific plan components, including requiring more pre-project surveys and applying more stringent limited operating periods to protect potentially reproducing individuals and reducing short-term impacts on habitat for terrestrial wildlife species of conservation concern. Ultimately though, this slower pace of treatments would continue to leave habitat for federally listed species at risk of loss or degradation due to large, high-intensity wildfires.

Alternative D would more quickly achieve resilience of the landscape to large-scale disturbances such as insect outbreaks, high-severity wildfire effects, and drought-related tree mortality, thereby providing a greater long-term benefit to terrestrial wildlife habitat quantity and condition. However, the management approach has greater potential for short-term impacts on achieving improved habitat condition by prioritizing restoration efforts into focus landscapes where residual old forest is most at risk of loss. The evaluation of such a tradeoff for both alternatives would be assessed over time by the plan monitoring program and informed by knowledge gained from the broader-scale monitoring strategy.

Because the forest plan is a framework programmatic document, it cannot ensure future projects might not affect federally listed species. Therefore it is possible that projects developed consistent with the forest plan may still affect individuals, occupied habitats, or key components of critical habitats. Thus, we determined that adopting any of the proposed alternatives may affect and could be likely to adversely affect listed species or critical habitats. However, we believe that because of the conservation measures of the alternatives, the U.S. Fish and Wildlife Service would determine that adopting any of the alternatives would not jeopardize the continued existence of these species when they issue a biological opinion.

Similarly, we determined that although all alternatives are designed to conserve critical habitat, some actions may have adverse effects to critical habitat, even if short term. Due to the conservation approach of the alternatives, we believe that the U.S. Fish and Wildlife Service would determine that, at the programmatic level, all of the alternatives are not likely to result in destruction or adverse modification of critical habitat.

Federally Listed Species Determinations

Table 71. Summary of determinations for federally listed species and critical habitats

Species	National Forest	Determination
California condor	Sequoia and Sierra	May affect, likely to adversely affect
California condor critical habitat	Sequoia	May affect, likely to destroy or adversely modify critical habitat
Least Bell's vireo	Sequoia	May affect, likely to adversely affect
Southwestern willow flycatcher	Sequoia	May affect, likely to adversely affect
Southwestern willow flycatcher critical Habitat	Sequoia	May affect, likely to destroy or adversely modify critical habitat
Yellow-billed cuckoo, western DPS	Sequoia	May affect, likely to adversely affect
Yellow-billed cuckoo, western DPS proposed critical habitat	Sequoia	May affect, likely to destroy or adversely modify critical habitat
Sierra Nevada bighorn sheep	Sequoia and Sierra	May affect, likely to adversely affect
Sierra Nevada bighorn sheep critical habitat	Sequoia and Sierra	May affect, likely to destroy or adversely modify critical habitat
Fisher (proposed)	Sequoia and Sierra	May affect, likely to adversely affect
Mountain yellow-legged frog, northern DPS	Sequoia and Sierra	May affect, likely to adversely affect
Mountain yellow-legged frog critical habitat	Sequoia	May affect, likely to destroy or adversely modify critical habitat
Sierra Nevada yellow-legged frog	Sequoia and Sierra	May affect, likely to adversely affect
Sierra Nevada yellow-legged frog critical habitat	Sequoia and Sierra	May affect, likely to destroy or adversely modify critical habitat
Yosemite toad	Sequoia and Sierra	May affect, likely to adversely affect
Yosemite toad critical habitat	Sierra	May affect, likely to destroy or adversely modify critical habitat
Lahontan cutthroat trout	Sierra	May affect, likely to adversely affect
Paiute cutthroat trout	Sierra	May affect, likely to adversely affect
Little Kern golden trout	Sequoia	May affect, likely to adversely affect
Little Kern golden trout critical habitat	Sequoia	May affect, likely to destroy or adversely modify critical habitat
Bakersfield cactus	Sequoia	May affect, likely to adversely affect
Mariposa pussypaws	Sierra	May affect, likely to adversely affect
Whitebark pine (Candidate)	Sierra	May affect individuals, not likely to jeopardize the continued existence

California condor and Critical Habitat

- The forest plans include direction to manage foothill vegetation to move toward desired conditions which would generally improve conditions for large mammals such as deer, which could improve foraging conditions.
- The forest plans include direction to manage recreation impacts and consider managing recreation uses if they adversely affect at-risk species.
- Lead poisoning remains a substantial threat that is outside of the authority of the Forest Service but is being addressed by the State of California and is expected to be lessened in the future.

We determined that despite plan direction that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb individuals or habitat used by condors. Condors could be affected by vegetation and fuels, recreation, and roads and infrastructure management or activities. Since the forest plan is at a programmatic level, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely affect* the California condor in the Sequoia and Sierra National Forests.

We determined that given the small area of the forest plan revision area in designated critical habitat near the Springville Work Center, plan components and plan content would serve to avoid, mitigate, or minimize effects to critical habitat given the low likelihood of condor use given the developed nature of the Work Center. Since the forest plan is at a programmatic level, while it is expected but cannot be ensured that projects developed under it would have no effect or that all actions would be discountable, insignificant or beneficial. Therefore, we determine that adoption of the revised forest plan under all alternatives *may affect critical habitat, and is likely to destroy or adversely modify critical habitat* of the California condor in the Sequoia National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and species-specific) to provide for ecological conditions that would contribute to the recovery of California condor in the plan area as determined important by the U.S. Fish and Wildlife Service.

Least Bell’s vireo, southwestern willow flycatcher and critical habitat, and western yellow-billed cuckoo and proposed critical habitat

- Essential habitat for these species is provided in the South Fork Wildlife Area that is managed primarily to provide for the riparian vegetation and riparian forest habitat required by these species.
- Some transitory habitat develops below the high water line of Lake Isabella during extended periods of drought or prolonged reservoir drawdown that may be affected by livestock grazing and by recreation activities.
- All alternatives include plan components to mitigate the impacts of recreation on at-risk species if recreation impacts were found to be negatively affecting these species.
- The riparian forest habitat is at some risk of damage from wildfire as evidenced by the Cove Fire in 2011. All alternatives manage the area as an area with an emphasis on reducing the risks and effects of wildfire due to the structures in the area, which would provide indirect benefit to the riparian forest habitats.

- Wildfires and the management of fire, including prescribed burning, may affect habitat required by these species.

We determined that despite plan direction that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat through fire, range, or recreation management activities. Since the forest plan is at a programmatic level, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely affect* the least Bell's vireo, southwestern willow flycatcher, or western yellow-billed cuckoo in the Sequoia National Forest.

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some elements of critical habitat may be affected by fire management, range management, and recreation management. Since the forest plan is at a programmatic level, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect critical habitat, and is likely to destroy or adversely modify critical habitat* of the southwestern willow flycatcher and *may affect proposed critical habitat, and is likely to destroy or adversely modify proposed critical habitat* for the western yellow-billed cuckoo in the Sequoia National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem and species-specific) to provide for ecological conditions that would contribute to the recovery of these species in the plan area as determined important by the U.S. Fish and Wildlife Service.

Sierra Nevada bighorn sheep and critical habitat

- The forest plan includes direction to avoid, mitigate, or minimize the risk of disease spread from recreational pack goats.
- The forest plan includes direction to evaluate areas where recreation uses may be adversely affecting Sierra Nevada bighorn sheep. Nonetheless, individual animals are likely to be affected by short-term disturbance and displacement by human activities.
- Critical habitat in wilderness areas would remain essentially undisturbed by management activity and may be benefited by restoring the ecological role of fire. There could be disturbance during fire management activities, and the duration of disturbance could be greater when fires are managed to meet resource benefits instead of quickly suppressed. This could have short-term effects on individuals leading to long-term benefits to habitat, especially if vegetation is more open reducing predator hiding cover.

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat could be affected by fire management or recreation activities. Since the forest plan is at a programmatic level, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely effect* of the Sierra Nevada bighorn sheep in the Sequoia and Sierra National Forests.

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some elements of critical habitat may be affected by fire management and range management. Since the forest plan is at a programmatic level, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect critical habitat, likely to destroy or adversely modify critical habitat* of the Sierra Nevada bighorn sheep in the Sequoia and Sierra National Forests.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and species-specific) to provide for ecological conditions that would contribute to the recovery of Sierra Nevada bighorn sheep in the plan area as determined important by the U.S. Fish and Wildlife Service.

Fisher (Proposed)

- Great uncertainty exists around the ecological response of the fisher to the recent widespread tree mortality in the plan area.
- Alternatives B, C, D, and E incorporate the findings and recommendations of the Southern Sierra Fisher Conservation Strategy to varying degrees given the conflicting interests of reducing short-term impacts on fisher and fisher habitats with reducing the threats of loss of habitats and key ecological conditions.
- Alternatives B and D intend to improve the resilience of mature forest stands by thinning trees, reducing fuels, and restoring fire as an ecological process in strategic locations to also reduce the risk of uncharacteristic high-severity fire effects of large wildfires. Alternatives B and D use different approaches to identify the emphasis and priority areas for treatments and the treatment intensity and pace and scale of treatment across the forest. A variety of methods including mechanical treatments, prescribed burning, and managing wildfires to meet resource objectives would be used. There is more certainty that this would occur on enough area or in strategic locations, especially under alternative D, but there is also more certainty that it would have short-term effects on fisher and fisher habitat, but would also lead to improved habitat conditions in the future.
- Alternatives C and E intend to improve the resilience of mature forest stands by reducing fuels and restoring fire as an ecological process primarily by using prescribed fire and managing wildfires to meet resource objectives. There is less certainty that this would occur on enough area or in strategic locations to reduce the risk of habitat loss from large uncharacteristic high-severity fire in the future.
- All alternatives recognize the impacts of rodenticides on fisher, although exposure from illegal uses on or near National Forest System lands is outside the control of the agency.

We determined that despite plan direction that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat via fire management, vegetation and fuels management, recreation activities, and roads and infrastructure programs. Since the forest plan is at a programmatic level, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely affect* the fisher in the Sequoia and Sierra National Forests.

Mountain yellow-legged frog and Sierra Nevada yellow-legged frog and critical habitats

- All alternatives retain similar riparian conservation area direction that minimizes aquatic and riparian vegetation impacts in a buffer around streams and meadows.
- All alternatives intend to restore fire as an ecological function where possible, especially in the designated wilderness areas where most of the occupied habitat and critical habitat occurs.
- The State of California manages stocking of trout and evaluates and coordinates removal of nonnative fish where they affect native species. This would continue under all alternatives.
- Livestock grazing occurs in several allotments containing occupied habitats of the Sierra Nevada yellow-legged frog in the Sierra National Forest. No livestock grazing occurs in occupied habitats of the mountain yellow-legged frog in the Sequoia National Forest. The livestock grazing program is evaluated and managed under the project-level programmatic biological opinion, which would be updated following plan revision.
- In the CNDDB there are no records of the mountain yellow-legged frog in the Sierra National Forest and no records of the Sierra Nevada yellow-legged frog in the Sequoia National Forest.
- Critical habitat in wilderness areas would remain essentially undisturbed by management activity and may be benefited by restoring the ecological role of fire. There could be disturbance during fire management activities, and the duration of disturbance could be greater when fires are managed to meet resource benefits instead of quickly suppressed. This could have short-term effects on individuals leading to long-term benefits to habitat, especially if riparian and upland vegetation is more resilient and within the natural range of variation.

We determined that despite plan direction that would serve to avoid, mitigate, or minimize effects to these species, some actions and activities may disturb or affect individuals or habitat through fire, recreation management, and restoration activities. In addition, the Sierra Nevada yellow-legged frog could be affected by vegetation and fuels, range, or roads and infrastructure management or activities. Since the forest plan is a framework programmatic action under the Endangered Species Act, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely affect* the mountain yellow-legged frog and the Sierra Nevada yellow-legged frog in the Sequoia and Sierra National Forests.

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some elements of critical habitat may be affected by fire management and range management. Since the forest plan is at a programmatic level, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect critical habitat, and is likely to destroy or adversely modify critical habitat* of the mountain yellow-legged frog in the Sequoia National Forest and the Sierra Nevada yellow-legged frog in the Sequoia and Sierra National Forests.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem and species-specific) to provide for ecological conditions that would contribute to the recovery of both the mountain yellow-legged frog and the

Sierra Nevada yellow-legged frog in the plan area as determined important by the U.S. Fish and Wildlife Service.

Yosemite toad and Critical Habitat

- All alternatives retain similar riparian conservation area direction for meadows.
- Critical habitat in wilderness areas would remain essentially undisturbed by management activity and may be benefited by restoring the ecological role of fire. There could be disturbance during fire management activities, and the duration of disturbance could be greater when fires are managed to meet resource benefits instead of quickly suppressed. This could have short-term effects on individuals leading to long-term benefits to habitat, especially if riparian and upland vegetation is more resilient and within the natural range of variation.
- The State of California manages stocking of trout and evaluates and coordinates removal of nonnative fish where they affect native species. This would continue under all alternatives.
- Existing livestock management practices would continue, including evaluating the impacts of livestock on occupied habitats and adjusting livestock grazing practices where needed.
- In the CNDDB there are no records of the Yosemite toad in the Sequoia National Forest.

We determined that despite plan direction that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat through fire, vegetation and fuels, range, recreation, or roads and infrastructure management, or restoration activities. Since the forest plan is at a programmatic level, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely affect* the Yosemite toad in the Sequoia and Sierra National Forest.

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some elements of critical habitat may be affected by fire management and range management. Since the forest plan is a framework programmatic action under the Endangered Species Act, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect critical habitat, and is likely to destroy or adversely modify critical habitat* of the Yosemite toad in the Sierra National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem and species-specific) to provide for ecological conditions that would contribute to the recovery of the Yosemite toad in the plan area as determined important by the U.S. Fish and Wildlife Service.

Lahontan cutthroat trout and Paiute cutthroat trout

- Three occurrences occur in livestock grazing allotments; however, current livestock grazing practices are mitigated through terms and conditions established in prior allotment level consultations or livestock grazing does not affect occupied habitats. Those practices would not change as a result of adopting any of the alternatives.
- All alternatives retain existing direction to protect a zone around occupied reaches with Lahontan cutthroat trout.

- All alternatives retain existing direction to protect streambanks from disturbance from livestock.
- Plan components provide for the maintenance of barriers to avoid interbreeding with nonnative salmonids

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat for both species could be affected by fire, range, or recreation management. In addition, the Lahontan cutthroat trout could be affected by vegetation and fuels, or roads and infrastructure management, or restoration activities. Since the forest plan is a framework programmatic action under the Endangered Species Act, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely affect* the Lahontan cutthroat trout and Paiute cutthroat trout in the Sierra National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and species-specific) to provide for ecological conditions that would contribute to the recovery of the Yosemite toad in the plan area as determined important by the U.S. Fish and Wildlife Service.

Little Kern golden trout and critical habitat

- Portions of the critical habitat are in the Little Kern Allotment. Livestock grazing practices have been addressed in a prior consultation for this allotment; those practices would not change as a result of adopting any of the alternatives.
- All alternatives retain existing direction to protect streambanks from disturbance from livestock.
- Plan components provide for the maintenance of barriers to avoid interbreeding with nonnative salmonids

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat could be affected by fire, range, or recreation management, or restoration activities. Since the forest plan is a framework programmatic action under the Endangered Species Act, it cannot ensure that projects or activities developed or authorized under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, and is likely to adversely affect* the Little Kern golden trout in the Sequoia National Forest.

We determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some elements of critical habitat may be affected by fire management, range management, recreation management, and restoration activities. Since the forest plan is at a programmatic level, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect critical habitat, and is likely to destroy or adversely modify critical habitat* of the Little Kern golden trout in the Sierra National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and species-specific) to provide for ecological conditions that would contribute to the recovery of the Little Kern golden trout in the plan area, as determined important by the U.S. Fish and Wildlife Service.

Bakersfield Cactus

The one possible population location is unlikely to be altered under any alternative due to its location on a roadcut near an existing highway.

For Bakersfield cactus, we determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat could be affected by fire, recreation, or roads and infrastructure management. Since the forest plan is a framework programmatic action under the Endangered Species Act, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, but is not likely to jeopardize the continued existence* of the Bakersfield cactus in the Sequoia National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and species-specific) to provide for ecological conditions that would contribute to the recovery of Bakersfield cactus in the plan area as determined important by the U.S. Fish and Wildlife Service.

Mariposa Pussypaws

- Both populations have been fenced to avoid impacts from livestock grazing.
- Off-highway vehicle use is restricted to designated motorized routes, which limits the threat of disturbance to the populations.

For Mariposa pussypaws, we determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals or habitat could be affected by fire, range, or roads and infrastructure management, or recreation activities. Since the forest plan is a framework programmatic action under the Endangered Species Act, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. Therefore, we determined that adoption of the revised forest plan under all alternatives *may affect individuals, but is not likely to jeopardize the continued existence* of the Mariposa pussypaws in the Sierra National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and species-specific) to provide for ecological conditions that would contribute to the recovery of Mariposa pussypaws in the plan area as determined important by the U.S. Fish and Wildlife Service.

Whitebark pine (candidate)

- All alternatives recognize the need to develop a regional whitebark pine conservation and restoration strategy relevant to whitebark pine in California national forests, which could identify additional actions to better conserve the species in the plan area.
- Over 99 percent of the known or suspected whitebark pine occurrences in the plan area are in designated wilderness where few management activities other than fire management and recreation would potentially affect the species. Most of the approximately 200 acres of

mapped potential occurrences are located in inventoried roadless areas where few management activities would be planned.

For whitebark pine, we determined that despite plan components and plan content that would serve to avoid, mitigate, or minimize effects, some actions and activities may disturb or affect individuals and whitebark pine stands or habitat could be affected by fire or recreation management. Since the forest plan is a framework programmatic action under the Endangered Species Act, it cannot ensure that projects developed under it would have no effect or that all actions would be discountable, insignificant, or beneficial. However, due to the very small amount of whitebark pine located outside of designated wilderness we determined that adoption of the revised forest plan under all alternatives *may affect individuals, but is not likely to jeopardize the continued existence* of the whitebark pine in the Sierra National Forest.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and species-specific) to provide for ecological conditions that contribute to the conservation of whitebark pine in the plan area.

Species of Conservation Concern

Background

Species of conservation concern is a new category developed under the 2012 Planning Rule. It is defined as “a species, other than federally recognized threatened, endangered, proposed, or candidate species that is known to occur in the plan area and for which the Regional Forester has determined that the best available scientific information indicates substantial concern about the species’ capability to persist over the long-term in the plan area” (36 CFR 219.9(c).

In coordination with the Sequoia and Sierra National Forests and the Forest Service’s responsibilities and authority under the 2012 Planning Rule (36 CFR 219.7(c)(3)), the Regional Forester determined the terrestrial wildlife, aquatic wildlife, and plant species of conservation concern for the Sequoia and Sierra National Forests, with a separate list for each forest (Moore 2019). Designating these species is not a forest plan decision. The Regional Forester has the authority to change species on the list of species of conservation concern to reflect new information. The Forest Service sensitive species concept is not carried forward as part of the 2012 Planning Rule, and the relationship of the two is discussed in the next section.

Table 72 summarizes the total number of species of conservation concern for each national forest by taxonomic grouping. The actual species of conservation concern are presented in the Regional Forester’s letter (Moore 2019) and in the following sections for terrestrial wildlife, aquatic wildlife, and plant species of conservation concern.

Table 72. Number of Regional Forester’s species of conservation concern occurring in the forest plan revision plan areas

Forest	Mammals	Birds	Amphibians	Fish	Terrestrial Invertebrates	Aquatic Invertebrates	Plants	Total
Sequoia	3	8	6	4	4	1	49	75
Sierra	3	6	5	3	2	1	45	65

Columns should not be totaled because some species are shared between the two forests.

The 2012 Planning Rule requires that plan components provide ecological conditions necessary to maintain "a viable population" of each species of conservation concern and defines (Sec. 219.19) a viable population as one "*that continues to persist over the long term with sufficient distribution to be resilient and adaptable to stressors and likely future environments.*" The concept of ecological conditions as defined in the 2012 Planning Rule includes more than vegetation composition and structure; it is designed to encompass those factors as well as others, including stressors that are relevant to species and ecological integrity. Examples of ecological conditions are the abundance and distribution of aquatic and terrestrial habitats, connectivity, roads and other structural developments, human uses, and invasive species.

As required by Section 219.8(a), plan components were developed that provide ecological conditions that promote species persistence with 'sufficient distribution to be resilient and adaptable to stressors and likely future environments' in the plan area, in the capability of the area. The plan area is defined as national forest service lands covered by a plan (36 CFR 219.19). Plan components include broader coarse-filter standards and guidelines that maintain or restore the structure, function, composition, and connectivity of ecosystems. In some cases, where ecosystem level plan components could not adequately address species persistence, species-specific plan components were also developed.

The extent and condition of habitat are the indicators used to determine if such ecological conditions are present to conserve species of conservation concern and to contribute to preventing species from becoming listed. The Rule also requires the analysis consider the authority of the Forest Service and the inherent capability of the plan area to provide for each species of conservation concern.

We considered the range of potential plan components (desired conditions, objectives, goals, suitability of areas, standards, and guidelines), beginning with approaches that emphasize management of ecosystem properties and evaluated the characteristics of the alternatives to verify that the necessary ecological conditions were provided for at-risk species (Hayward et al. 2016). To do this, for each species of conservation concern in the plan area, we assessed whether the alternative addresses known threats to the species' persistence with one of four possible outcomes or determinations, as follows:

1. The ecosystem plan components should provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area. No additional species-specific plan components are warranted.
2. The ecosystem plan components should provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area. Nonetheless, additional species-specific plan components have been provided for added clarity or measures of protection.
3. The ecosystem plan components may not provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area. Therefore, additional species-specific plan components have been provided. The combination of ecosystem and species-specific plan components should provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area.
4. It is beyond the authority of the Forest Service or not in the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population of the [SPECIES NAME] in the plan area. Nonetheless, the plan components should maintain

or restore ecological conditions in the plan area to contribute to maintaining a viable population of the species in its range.

This part of the assessment is termed a persistence analysis. The persistence analysis is detailed in Appendix D of Volume 2, and a summary of results of the persistence analysis is included in the analytical outcome section for terrestrial wildlife, aquatic wildlife, and plant species of conservation concern. In the case of outcomes 3 and 4 where species viability is currently uncertain, proposed plan components are designed to maintain or restore habitat toward a condition that would contribute to maintaining a viable population of the species in its range.

Relationship between Regional Forester sensitive species and species of conservation concern

Under the current forest plan, rare wildlife and plant species are managed according to the agency direction for sensitive species. Sensitive species are identified by the regional forester as plant and animal species for which population viability is a concern, where there is a significant current or predicted downward trend in population numbers or density or in habitat capability that would reduce a species' existing distribution. Sensitive species identified for the Sequoia and Sierra National Forests were designated by the Regional Forester following direction in FSH 2609.26, Chapter 30: "the Regional Forester . . . must consider those species that are known, reported, or suspected to occur on, or in the immediate vicinity of National Forest System lands in the Region" (United States Department of Agriculture 2013g).

The 2012 Planning Rule directs that the species of conservation concern lists are specific to each national forest, and species must be known to occur in the plan area.

During the evaluation of species of conservation concern, approximately 100 terrestrial and aquatic wildlife species, and over 150 plant species, were considered for recommendation, including consideration of all species on the Region 5 Regional Forester's sensitive species list for the Sequoia and Sierra National Forests. The Regional Forester's sensitive species list of wildlife, fish, and invertebrate animals and the list of plant sensitive species in these national forests are based on the September 9, 2013, versions of the USDA Forest Service Pacific Southwest Region Sensitive Animal and Plant Species by Forest (United States Department of Agriculture 2013g).

Of the 25 wildlife sensitive species in the Sequoia National Forest, 17 are carried forward as species of conservation concern; and of the 19 wildlife sensitive species in the Sierra National Forest, 13 are carried forward as species of conservation concern.

Overall, there are 101 Regional Forester designated plant sensitive species between the two forests and 68 species met the criteria for species of conservation concern on one or both forests. For the Sequoia National Forest, 39 of the 75 plant sensitive plant species are carried forward as species of conservation concern. For the Sierra National Forest, 42 of the 57 sensitive plant species are carried forward as species of conservation concern.

In general, sensitive species were determined not to meet the established criteria as a species of conservation concern for one or more of the following reasons:

- It is a federally recognized threatened, endangered, proposed, or candidate species under the Endangered Species Act and is considered under the other category of at-risk species (for example, Sierra Nevada yellow-legged frog).

- The species does not occur on the national forest plan area, for example, species that have occurrences in the Giant Sequoia National Monument but not in the Sequoia National Forest plan area.
- Previous occurrence records were determined to be incorrect identifications of the species or could not be relocated.
- Recent surveys indicated the species is more common than originally thought.
- NatureServe, California Natural Diversity Database, California Native Plant Society Rare plant inventory, or other best available scientific information or data sources indicate threats to the species were not substantial.
- There was no information about threats to the species. This was a relatively uncommon circumstance, because information about threats could be inferred from threats to the ecosystems on which the species depend. Lack of information generally only limited species inclusion on the list if the species had not been observed for decades or more, leading to uncertainty about the condition of its specific habitat.

The specific reasons a sensitive species was determined to meet or not meet the established criteria as a species of conservation concern are provided in the species rationales found in the animal or plant rationale documents for the Sequoia and Sierra National Forests (United States Department of Agriculture 2019d, a, b, c). For the sensitive species that did not meet the established criteria, we provide a brief summary of our findings in Table 73 and Table 74.

Table 73. Summary of the rationale that a Regional Forester's animal sensitive species did not meet the established criteria as a species of conservation concern

Common Name and Scientific Name	Rationale for not Meeting Criteria (Relevant National Forest)
Pallid bat (*Antrozous pallidus*)	The greatest threats to the persistence of pallid bats are those most closely associated with the Central Valley and urban areas, not National Forest System lands. Since they use a wide diversity of roosting structures, threats to tree roosting sites are not considered a limiting factor in the Sierra National Forest plan area. There are no records for pallid bat in the Natural Resources Information System (NRIS) database or CNDDB located in the Sequoia National Forest plan area (sensitive for both and not an species of conservation concern (SCC) for both Sequoia and Sierra National Forests).
North American wolverine (*Gulo gulo*)	Federally listed as a proposed threatened species. No contemporary verified or documented occurrences in the plan area (sensitive for both and not an SCC for both Sequoia and Sierra National Forests).
Fisher (*Pekania pennanti*)	Federally listed as a proposed threatened species (sensitive for both and not an SCC for both Sequoia and Sierra National Forests).
Western pond turtle (*Emys marmorata*)	There are over 1,400 NRIS records for western pond turtle in the Sierra National Forest and 15 CNDDB records. Many NRIS records are of the same location, just at a different times, and data suggests a stable trend in populations (Sierra National Forest). The Sequoia National Forest plan area does not have a lot of western pond turtle's preferred habitat of Sierra Nevada foothill ecosystem types with aquatic habitat. There are two NRIS records in the Sequoia National Forest plan area that are just south of the boundary with the Sierra National Forest. No trend information to indicate substantial concern (Sequoia National Forest).

Common Name and Scientific Name	Rationale for not Meeting Criteria (Relevant National Forest)
Yosemite toad (*Anaxyrus canorus*)	Federally listed as threatened; analyzed as listed species (Sierra National Forest).
Mountain yellow-legged frog (*Rana muscosa*)	Federally listed as endangered; analyzed as listed species (Sequoia National Forest).
Sierra Nevada yellow-legged frog (*R. sierrae*)	Federally listed as endangered; analyzed as a listed species (Sierra National Forest).
Northern California legless lizard (*Anniella pulchra*)	No known occurrence in plan area (Sequoia National Forest).

Table 74. Summary of the rationale that a Regional Forester's plant sensitive species did not meet the established criteria as a species of conservation concern

Species	Rationale for not Meeting Criteria (Relevant National Forest)
Boechera shevockii	No known occurrence in plan area (Sequoia National Forest).
Botrychium lunaria	No known occurrence in plan area (Sierra National Forest).
B. minganense	No known occurrence in plan area (Sequoia National Forest).
B. montanum	No known occurrence in plan area (Sequoia National Forest).
B. paradoxum	No known occurrence in plan area (Sierra National Forest).
B. tunux	No known occurrence in plan area (Sierra National Forest).
B. yaaxudakeit	No known occurrence in plan area (Sierra National Forest).
Brodiaea insignis	No known occurrence in plan area (Sequoia National Forest).
Bruchia bolanderi	No known occurrence in plan area (Sequoia National Forest).
Calochortus palmeri var. *palmeri*	Inventories have expanded the occurrences and populations of this species and monitoring has indicated a stable trend (Sequoia National Forest).
Canbya candida	The species is widely distributed in its range. Insufficient information to conclude there is a substantial threat to persistence (Sequoia National Forest).
Cinna bolanderi	No known occurrence in plan area (Sequoia National Forest).
Cryptantha incana	Numerous collections from the plan area indicate this species is much more common than previously thought, and that several occurrences could be added to CNDDB. Insufficient information to conclude there is a substantial threat to persistence (Sequoia National Forest).
Delphinium inopinum	Monitoring indicates a stable trend for the species. There is insufficient information on which to base a substantial concern about the species' capability to persist over the long term in the plan area (Sequoia National Forest).
Diplacus pulchellus (*Mimulus pulchellus*)	No known occurrence in plan area (Sierra National Forest).
Draba cruciata	No known occurrence in plan area (Sequoia National Forest).
Dudleya cymosa ssp. *costatifolia*	No known occurrence in plan area (Sequoia National Forest).
Erigeron aequifolius	Populations are relatively stable due to steep, rugged nature of the habitat, making them inaccessible, with no known threats from vegetation treatment activities, grazing, and recreation (Sierra National Forest only).
Eriogonum nudum var. *regirivum*	No known occurrence in plan area (Sequoia National Forest).
E. twisselmannii	No known occurrence in plan area (Sequoia National Forest).

Species	Rationale for not Meeting Criteria (Relevant National Forest)
Erythranthe discolor	No longer recognized as a unique taxon but included with *E. montioides*, which is considered common (Sequoia National Forest).
E. filicaulis	No known occurrence in plan area (Sierra National Forest).
E.e gracilipes	No known occurrence in plan area (Sequoia National Forest only).
E. norrisii	No known occurrence in plan area (Sequoia National Forest only).
E. shevockii	No known occurrence in plan area (Sequoia National Forest).
Erythronium pusaterii	No known occurrence in plan area (Sequoia National Forest).
Fritillaria striata	No known occurrence in plan area (Sequoia National Forest).
Glyceria grandis	No known occurrence in plan area (Sierra National Forest).
Greeneocharis circumscissa var. *rosulata* (*Cryptantha circumscissa* var. *rosulata*)	No known occurrence in plan area (Sequoia National Forest).
Helodium blandowi	No known occurrence in plan area (Sierra National Forest only).
Heterotheca monarchensis	No known occurrence in plan area (Sierra National Forest only).
Hulsea vestita ssp. *pygmaea*	Two occurrences in plan area, from 1897 and 1969, have not been relocated; insufficient information to conclude there is a substantial threat to persistence in the plan area (Sequoia National Forest).
Iris munzii	No known occurrence in plan area (Sequoia National Forest)
Leptosiphon serrulatus	A 1923 occurrence has not been relocated; there is insufficient information to conclude there is a substantial threat to persistence in the plan area (Sequoia National Forest).
Lewisia congdonii	No known occurrence in plan area (Sequoia National Forest).
Lupinus lepidus var. *culbertsonii*	No known occurrence in either plan area. Species occurs in Giant Sequoia National Monument, and no collections could be verified to be this species in the plan area (Sequoia National Forest and Sierra National Forest).
Mielichhoferia elongata	Greater abundance of occurrences and populations than previously thought (Sequoia National Forest and Sierra National Forest).
Monardella beneolens	No known occurrence in plan area (Sequoia National Forest).
M. linoides ssp. *oblonga*	Greater abundance of occurrences and populations than previously thought (Sequoia National Forest).
Navarretia setiloba	No known occurrence in plan area (Sequoia National Forest).
Peltigera gowardii	Greater abundance of occurrences and populations than previously thought (Sierra National Forest). No known occurrence in plan area (Sequoia National Forest).
Petrophyton acuminatum (*P. caespitosum* ssp. *acuminatum*)	No known occurrence in plan area (Sequoia National Forest and Sierra National Forest).
Pinus albicaulis	Fish and Wildlife Service candidate species (Sequoia National Forest and Sierra National Forest).
Saltugilia latimeri	No known occurrence in plan area (Sequoia National Forest).
Sidotheca caryophylloides	Insufficient information to conclude there is a substantial threat to persistence; rank does not indicate concern and threats in the plan area have not been identified (Sequoia National Forest).
Stylocline masonii	No known occurrence in plan area (Sequoia National Forest).

For sensitive species that are not a species of conservation concern, not a federally listed or candidate species, but do have an occurrence in the plan area, analysis of these species are included in the appropriate sections by examining occurrence and habitat information for each sensitive species, and identifying the potential effects of the revised forest plan to ecosystem types (habitat) in which species occur. For plant species, threats to species or groups of species or to habitats and habitat conditions were identified as indicators because they are measures to maintain viable populations.

While some sensitive species are not carried forward as species of conservation concern, forest plan direction is written broadly enough to provide ecological conditions that support ecosystem integrity and ecosystem diversity that should support their persistence in the plan area. For some species the action alternatives provide direction to manage for special habitats that surround the individual species occurrence locations in order to provide the necessary ecological conditions that allow for their persistence. This might benefit some sensitive species that occur in association with other species of conservation concern. For example, for bat species that are not species of conservation concern, plan guidance provides protection for bat hibernacula and maternity colonies that may be adversely affected by recreational, management, or other activities. The Forest Service would consider either installing bat gates at the entrances of caves and mines or restricting access by other means. In addition, a forestwide desired condition applies to habitats and the ecological conditions and processes that would guide all projects to provide for sustainable populations of native species.

Adaptive procedures under the 2012 Planning Rule provide for continued consideration of species included on the species of conservation concern list, including revisions of the list to add or remove species if necessary. Under the action alternatives, if new information indicates that an additional species meets the criteria for being added as a species of conservation concern, the responsible official for the national forest where the species occurs may recommend the addition to the Regional Forester for the Pacific Southwest Region of the Forest Service. If the Regional Forester approves the change, the responsible official then determines if a change in forest plan direction is needed.

Likewise, new scientific information regarding an existing species of conservation concern may lead to their removal from the list if there is no longer a substantial concern for its persistence in the plan area; or new information may lead to a need to change the forest plan to add, remove, or change plan components. Since the process of identifying and managing species of conservation concern is adaptive and can be changed, longer term environmental consequences to former sensitive species is not expected. If ecological conditions change, new scientific information about species becomes available, or new or emerging threats are recognized, former sensitive species can be reevaluated to determine if they should become species of conservation concern.

Terrestrial Species of Conservation Concern

Background

The Regional Forester identified 24 terrestrial wildlife species (Moore 2019). The rationale for animal species considered for species of conservation concern are detailed in reports for each national forest (United States Department of Agriculture 2019a, b). In accordance with the 2012 Planning Rule, the forest plan must include plan components to “contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area.” This section evaluates and discloses the potential environmental consequences of the forest plan alternatives on terrestrial wildlife species of conservation concern and evaluates the effectiveness of the alternatives to provide direction to create the ecological conditions to contribute to maintaining a viable population of species of conservation concern in the plan areas (each national forest).

The need for plan revisions is guided by three primary topics: ensure ecological integrity, which addresses the need to restore the resilience of vegetation and aquatic and riparian ecosystems to fire, drought, and climate impacts; restore wildlife and plant habitat and diversity; and reduce the risk of wildfire impacts on species and wildlife habitat. An issue related to terrestrial wildlife includes the concern that the perceived accelerated pace and scale of potential management activities to restore resilience may not provide adequate habitat for wildlife species that use forests with large trees and dense canopy cover.

Conversely, a second issue is that overemphasizing wildlife habitat needs overshadows the resilience and sustainability need of the forest itself. There is a concern that wildfires that could be managed to meet resource objectives would continue to be suppressed instead. There is also a concern that aquatic and riparian systems that provide habitat for many terrestrial wildlife species are under increasing stress and in need of restoration to increase their resilience due to climate change and drought. The alternatives present a range of approaches that address the revision topics and issues, including these issues related to at-risk terrestrial wildlife species and habitat.

Comprehensive information for each species of conservation concern that covers the biology, current distribution, ecological conditions in the plan areas, and key threats to persistence, is in the rationales for animal species considered for species of conservation concern (United States Department of Agriculture 2019a, b). An in-depth analyses for the persistence of species of conservation concern on both forests, which includes forest plan components addressing threats, and determination outcomes of the Forest Service's ability to maintain viable species populations, is detailed in Appendix D in Volume 2 and summarized in the analytical conclusions section below. In the analysis here, we summarize some pertinent information and focus the analyses of environmental consequences for wildlife species and their habitats by alternative at the planning level. We encourage the reader to review the rationales and Appendix D for detailed individual species evaluations, threats to species, and how forest plan components address persistence at the comprehensive species level.

Analysis and Methods

We evaluated at a programmatic level the management directions that may lessen or worsen threats to habitat. Our forest plan does not authorize site-specific projects or activities; therefore, there are no direct effects from adopting it. We will analyze the direct and indirect site-specific effects as needed when future projects are proposed. Although we may describe the potential short-term consequences of implementing the programmatic approach where needed, this evaluation focuses on longer term indirect and cumulative effects that may occur over the 15-year life of the forest plan.

Where possible, we quantified impacts on wildlife by determining the acreage of wildlife habitat types potentially altered based on desired conditions, objectives, standards and guidelines, and other management direction. The amount of each habitat type that would be affected is determined by comparing habitat size data on existing conditions to the anticipated conditions under the action alternatives when plan revision components are carried out. Where quantities of acreage information could not be determined, we analyzed potential effects on wildlife and their habitats qualitatively, relying substantially on our professional judgment and on scientific literature about a species, their habitat, and effects of management. We used this information to reach reasonable conclusions as to the context, intensity, duration, and type of a potential impact as explained further below.

Context. The context of the impact considers whether the impact would be local, forestwide, or regional. Local impacts would be those that occur in a specific area, forestwide impacts are those that would affect the forest as a whole, and regional impacts are those that extend to the larger Sierra Nevada. Context suggests that certain impacts depend on the setting of the proposed action. For example, management actions that restore watersheds will usually have regional effects for native species.

Intensity. The intensity of the impact considers the effects of an action on the size and integrity of native habitats, diversity, and species populations. These designations are used to describe both beneficial and adverse impacts. Negligible impacts would have no measurable or perceptible changes on wildlife habitat or populations. Minor impacts would be local in a relatively small area and would be short term, and they would not be expected to have an overall effect on species persistence. Moderate impacts would be clearly detectable on wildlife habitat and populations and would be sufficient to cause a change in the abundance, distribution, quantity, or integrity of a species, the community diversity (such as the numbers of different kinds of species present), or natural processes (such as hydrology). Major impacts would be substantial and highly noticeable, with the potential for permanent landscape-scale changes in the distribution, diversity, or dynamics of species populations, community diversity, and natural processes.

Duration. A short-term impact would have an immediate effect on native habitat, diversity, and native populations but would not cause declines or increases in populations or diversity over time. Short-term impacts are normally associated with such activities as prescribed burning, hazard tree removal, and mechanical vegetation treatments. Long-term impacts would lead to a loss or gain of native habitat, diversity, and species populations, as exhibited by a decline or increase in species abundance, viability, and survival.

Type of impact. The type of impact is a consideration of whether the impact would be beneficial or adverse. Impacts are considered beneficial if an action causes no detrimental effect, results in an increase in the size or integrity of species populations or habitat components, reduces disturbance to native ecosystem processes, increases native species richness/diversity, or otherwise increases native habitat quantity and quality. Impacts are considered adverse if they reduce the size, integrity, or diversity of native habitat.

The analysis of habitat is based largely on that described in “Terrestrial Ecosystems” and “Aquatic and Riparian Ecosystems.” The evaluation of environmental consequences on habitat that supports species persistence is an assessment of the alternative’s effectiveness. However, there is a level of uncertainty about the possible effects of forest management and activities on habitat that supports species persistence; this is because of gaps in knowledge about the complex interaction between species and their habitats (Holthausen 2002) and how some species respond to varying degrees of habitat alteration.

The analysis area is the Sequoia and Sierra National Forests plan areas. In some cases, the best available scientific information for at-risk species’ ecological relationships originated outside the analysis area. However, we used indicator measures and threat information from in the analysis area in making our conclusions.

Indicators and Measures

The key indicators for the terrestrial species analysis are landscape-scale changes in habitat quantity and condition, and changes in wildlife populations and distribution. Habitat quantity is evaluated by the amount and distribution of habitat types in the plan areas over the next 15 years. We used the California wildlife habitat relationship system classes (Mayer and Laudenslayer 1988) to represent the number of habitat acres for species of conservation concern. We evaluated the wildlife habitat condition by the potential trend in resiliency and ability of habitats to be adaptable to large-scale disturbances, such as wildfire, insect outbreaks, and drought; and by vegetation composition, structure, and percent within the natural range of variation (see "Terrestrial Ecosystems").

Changes in wildlife populations and distribution as a result of management populations cannot be effectively predicted to compare alternative management approaches, but such changes can be used to assess future management effectiveness.

We selected the following indicators because they provide a reasonable assessment of ecological conditions needed to support the persistence of species of conservation concern, and because we could readily compare the relative differences among alternatives:

- Condition and amount of available species of conservation concern habitat
- Wildlife habitat open to potential disturbance from forest plan management approaches
- Wildlife habitat resilient to large-scale disturbance as a result of forest plan vegetation treatments and fire management
- Wildlife habitat connectivity with adjacent lands of other ownership
- Amount of contiguous, unfragmented wildlife habitat
- The effectiveness of plan components to protect, mitigate, and enhance key ecological conditions for species of conservation concern, such as canopy closure, large snags, dens, nest and roost sites, large trees, and protected activity centers

The amount of habitat provides a relative measure of habitat condition and extent to maintain species persistence and is also an appropriate measure for analysis. We used the condition of habitat as an indicator only when we could estimate it adequately at the programmatic level, such as when assessing not only the amount of impact from wildfire but also the type of fire and the resulting effects on habitat quality; see "Terrestrial Ecosystems" and "Aquatic and Riparian Ecosystems."

Vegetation types described by California Wildlife Habitat Relationships classifications are useful in comparing the proportion of the landscape in forested versus non-forested areas and general wildlife habitat associations. However, many wildlife species use multiple habitat types or only portions of habitats with specific characteristics. The California Wildlife Habitat Relationships classification does not reflect aspects of structure that are important to many at-risk species, such as large trees and snags (North 2012). Despite the shortcomings of classification, it has been applied for multiple decades. It is still used in part to characterize wildlife habitat suitability for some of the species of conservation concern that we analyzed in this plan.

Assumptions

- We based much of the analysis on the premise that the natural range of variation provides important background information for evaluating ecological integrity and sustainability

(Wiens et al. 2012). We assumed that high ecological integrity and resilience condition landscapes are greater than 60 percent within the natural range of variation, moderate at 30 to 60 percent, low at 15 to 30 percent, and very low at less than 15 percent, within the natural range of variation.

- The farther a habitat has departed from desired conditions, the greater the risk to the viability of its species; conversely, the closer a habitat is to desired conditions, the lower the risk to the viability of its species. Therefore, comparing how the alternatives achieve the desired conditions provides a comparison of each alternative's effectiveness.
- Coarse-filter plan components that largely center on desired conditions within the natural range of variation are expected to provide for the conditions to maintain the persistence or contribute to the recovery of native species in the plan area, including species of conservation concern, over the long term. The coarse filter approach assumes that wildlife diversity broadly depends on the integrity of the function, composition, and structure of the forest's terrestrial, riparian, and aquatic ecosystems.
- For this analysis, we assumed that plan components would be implemented as described and that objectives would be realized over the life of the plan. The Forest Service may be able to achieve more than what is defined in an objective depending on funding availability, improvements in methods, and support through partnerships.
- The greater the size of a habitat community and the stronger its links to neighboring communities, the more it can support viable species populations and be resilient to such landscape-level events as wildfire, drought, and climate change.
- Restoration and vegetation treatments would involve some short-term adverse impacts, such as smoke from prescribed burning, vegetation removal, or vegetation composition modification, that over time could successfully replicate natural processes and move habitats toward desired conditions.
- The alternatives' differences in priority and methods would achieve desired conditions at different paces and scales. Species-specific components may limit the effectiveness of management approaches to reach desired conditions.
- The fundamental premise is that forest plan components for ecosystem integrity and diversity would provide the ecological conditions to maintain the diversity of plant and animal communities and to support the persistence of most native species in a plan areas.

Species evaluated

There are 24 terrestrial wildlife species of conservation concern across the Sequoia and Sierra National Forests (Table 75); several species are on the list for both national forests.

Table 75. Terrestrial animal species of conservation concern in the Sierra and Sequoia National Forests

Common Name ***Scientific Name***	**Primary Ecological Zones or Ecosystem Types**	**Special Habitat Needs and Key Ecological Conditions**	**National Forest**
Fringed myotis *Myotis thysanodes*	Montane mixed conifer	Large trees and snags and abandoned mines and caves provide critical roosting habitat and hibernacula.	Sequoia/Sierra

Common Name ***Scientific Name***	**Primary Ecological Zones or Ecosystem Types**	**Special Habitat Needs and Key Ecological Conditions**	**National Forest**
Sierra marten *Martes caurina sierra*	Mixed conifer, riparian areas; meadows, upper montane forests, subalpine, and alpine vegetation	High elevation in late-successional, mature red fir and lodgepole pine forests in areas with abundant snowpack. Needs structurally diverse mature conifer forests, abundant snags and down logs for denning and resting, heterogeneous habitat for cover and prey species, and high canopy cover.	Sequoia/Sierra
Townsend's big-eared bat *Corynorhinus townsendii*	Montane mixed conifer	Found in all habitat types, at low to moderate elevations. Not found in high elevation subalpine and alpine habitats. Requires caves, mines, or buildings for breeding and hibernacula.[35] Prefers mesic[36] habitats, where it gleans from brush or trees along habitat edges.	Sequoia/Sierra
Bald eagle *Haliaeetus leucocephalus*	Large bodies of water (lakes or reservoirs) or free flowing large rivers; montane forest	Nests in tall trees, usually over 100 feet high, or on cliffs, usually near water. Favors lakes and rivers with abundant prey, mostly fish.	Sequoia/Sierra
California spotted owl *Strix occidentalis occidentalis*	Upper montane and mixed conifer (red fir, Jeffrey and lodgepole pine)	Strongly associated with areas of mature and old forests, with thick dense canopy closures that contain many dense, old, live trees and snags and fallen logs.	Sequoia/Sierra
Great gray owl *S. nebulosa*	Mixed conifer and upper montane forest (red fir, Jeffrey pine, lodgepole pine); meadows	Breeds in mixed conifer/red fir forests bordering meadows. Winters in mixed conifer, down to blue oak woodlands.	Sequoia/Sierra
American peregrine falcon *Falco peregrinus anatum*	Montane mixed conifer	Nests on vertical cliff habitat, with large potholes or ledges, that is inaccessible to land predators. Hunts in a wide variety of habitats, including meadows, woodlands, marshes, and mudflats.	Sierra
Kern red-winged blackbird *Agelaius phoeniceus aciculatus*	Foothill riparian habitat dominated by cottonwood and willow	Resident of wetland habitats. Nests and roosts in fresh and saline emergent wetlands of cattails and tules or in moist, open habitats with thickets of sedges, willows, dense forbs, and grasses. Forages mostly in cropland, grassland, and wet meadow habitats.	Sequoia
Mount Pinos sooty grouse *Dendragapus fuliginosus howardi*	Subalpine forest, mixed conifer	Permanent resident at middle to high elevations. Occurs in open, medium-aged to mature stands of fir, Douglas-fir, and other conifer habitats, interspersed with medium to large openings, and available water.	Sequoia

[35] A shelter occupied during the winter by a dormant animal
[36] Containing a moderate amount of moisture

Common Name ***Scientific Name***	**Primary Ecological Zones or Ecosystem Types**	**Special Habitat Needs and Key Ecological Conditions**	**National Forest**
Northern goshawk *Accipiter gentilis*	Mixed conifer to lodgepole pine and deciduous forests	Favors moderately dense coniferous forests broken by meadows and other openings, between 5,000 and 9,000 feet in elevation. Typically nests in mature conifer stands near streams. Forages in mature and old-growth forests that have relatively dense canopies and open understories, but also hunts among a variety of vegetation, including meadow edges.	Sequoia/Sierra
Tricolored blackbird *Agelaius tricolor*	Foothill riparian habitat with tules and cattails	Breeds near fresh water, preferably in emergent wetlands with tall, dense cattails or tules, but also in thickets of willow, blackberry, wild rose, and tall herbs. Feeds in grassland and cropland habitats.	Sequoia
Willow flycatcher *Empidonax traillii brewsteri* and *E. t. adastus*	Riparian meadow and riparian meadow non ecosystem assessment types.	Breeds in moist, shrubby areas, often with standing or running water. Winters in shrubby clearings and early successional growth. Deciduous trees and shrubs interspersed with open areas enhances the quality of foraging habitat.	Sequoia/Sierra
Fairview slender salamander *Batrachoseps bramei*	Oak woodlands, chaparral habitat, riparian corridors	Yearlong resident in the western slope of the southern Sierra Nevada. Prefers streams and moist wooded canyons in valley foothill riparian habitats, blue oak woodlands, and Sierra mixed conifer woodlands	Sequoia
Gregarious slender salamander *Batrachoseps gregarius*	Foothill oak woodlands and riparian corridors	Microhabitat may include surface cover, such as down wood (in or under logs, under bark or boards), rocks, and litter.	Sierra
Hell Hollow slender salamander *B. diabolicus*	Pine-oak woodlands and chaparral habitat, along riparian zones in proximity to large rivers and streams	Prefers north-facing slopes, and individuals are usually found beneath rock talus and large stones and other surface cover shaded by oak trees that dominate the region.	Sierra
Kings River slender salamander *B. regius*	Interior live oak, blue oak foothill pine, moist coniferous forest	Streams and moist canyons, in valley foothill riparian habitat, blue oak woodland and mixed conifer woodland. Also, well-shaded, mixed chaparral on north-facing slopes.	Sierra
Limestone salamander *Hydromantes brunus*	Foothill pines, oaks, buckeye and chaparral	Found in association with limestone but can also be found under slate slabs, irregularly shaped limestone pieces, moss-covered and barren talus, and in rock crevices. Caves and abandoned mines can also provide these ecological conditions.	Sierra

Common Name ***Scientific Name***	**Primary Ecological Zones or Ecosystem Types**	**Special Habitat Needs and Key Ecological Conditions**	**National Forest**
Yellow-blotched salamander *Ensatina eschscholtzii croceater*	Canyon live oak, woodlands and riparian areas	Coniferous forest, deciduous forest, oak woodland, coastal sage scrub, and chaparral. Microsites under logs, bark, moss, leaf litter, and talus or in animal burrows, often near streams and creeks.	Sequoia
Behr's metalmark *Apodemia virgulti davenporti*	Shrub, chaparral, woodlands, and mixed forest	Several kinds of arid habitats occupied by stands of suitable caterpillar host plants, primarily fasciculate buckwheat (*Eriogonum fasciculatum*), but also Wrights buckwheat (*E. wrightii*), in open mixed deciduous conifer forest.	Sequoia
Evius blue *Plebejus icarioides evius*	Montane	Montane areas at intermediate elevations and closely associated with a lupine foodplant. Forest clearings, meadows, stream margins, and edges with buckwheat and lupines.	Sequoia
Greenish blue *P. saepiolus aehaja*	Montane	Wet meadows and riparian streambed habitats in montane ecosystems. Caterpillars and adults feed on clovers of the genus *Trifolium*.	Sequoia
Indian Yosemite snail *Monadenia yosemitensis*	Foothill zone	Found only in Mariposa County, at the boundary of Yosemite National Park and Sierra National Forest, along the Merced River near the south fork confluence. Mossy limestone crevices and talus, typically on steep slopes, where moisture and high humidity are retained. Caves and abandoned mines may also provide these conditions.	Sierra
Merced Canyon shoulderband *Helminthoglypta allynsmithi*	Foothill zone	Merced Canyon area, just south of Portal; talus deposits and outcrops, typically on steep slopes where moisture and high humidity are retained. Other ecological conditions are rocks, logs, vegetation, leaf litter, and woody debris in forest habitats.	Sierra
Tehachapi fritillary *Speyeria egleis tehachapina*	Montane	Montane meadows, forest openings, and rocky outcrops where host plant species of *Viola* occur.	Sequoia

Affected Environment

Terrestrial Wildlife Habitat

The following is a summary of the main ecological zones and vegetation types associated with species of conservation concern in the plan areas. "Terrestrial Ecosystems" provides more detailed analysis on ecological zones and vegetation classes (Table 18). Vegetation types are based on the California Wildlife Habitat Relationships classification system.

Foothill Zone (Blue Oak Woodlands, Chaparral/Live Oak)

The foothill ecological zone occurs at the lowest elevations on the western slopes of the Sierra Nevada. A mosaic of chaparral, blue oak savannahs, live oak woodlands and forests, narrow riparian stringers along rivers and streams, seeps, and scattered pine support species of conservation concern, such as several at-risk salamanders and butterflies. At the higher reaches of the foothill zone, patches of ponderosa pine and black oak occur and gradually transition into ponderosa pine forests in the montane zone above.

Montane Zone (Dry Mixed Conifer Forests, Jeffrey Pine Forests, Red Fir Forests, and Lodgepole Pine Forests)

The mixed conifer forests in this zone support a variety of wildlife species: Sierra marten, fringed myotis, Townsend's big-eared bat, California spotted owl, great gray owl, northern goshawk, and Mount Pinos sooty grouse.

Current vegetation composition, structure, and resilience are highly dissimilar to desired conditions, except in the Kern Plateau and Kern River drainage. Overall, vegetation and fire regimes of this zone are outside the natural range of variation. Fire exclusion and past timber harvest strategies resulted in higher forest densities, increased and more uniform tree canopy cover, greater small and medium tree density, and lower large tree density than desired (see "Terrestrial Ecosystems") (Stevens et al. 2016). There is less diversity, which reduces habitat diversity and quality.

Trees are stressed by a variety of factors, such as drought, wildfires, insects, diseases, competition, and climate change. The resilience of these forests to drought, large and severe wildfires, and other stressors has decreased considerably under current conditions.

Upper Montane Zone (Red Fir, Jeffrey Pine, Moist Lodgepole Pine, Dry Lodgepole Pine, and Montane Chaparral)

These vegetation types and others, such as wet meadows and riparian areas, occur in a patchy mosaic across the upper montane landscape, depending on changes in elevation, topography, soils, climate, and prior disturbance from such factors as fire and insects. Associated wildlife species are similar to those in the montane zone.

Subalpine and Alpine Vegetation Zone (Subalpine Woodlands and Forests and Alpine Vegetation)

The upper montane zone includes the subalpine and alpine zones. The subalpine landscapes consist of a mosaic of subalpine forests and woodlands, extensive rock outcrops, scrub vegetation, meadows, and riparian corridors (Fites-Kaufman et al. 2007). Since alpine environments are found at the extreme end of the temperature gradient in the Sierra Nevada, the life forms that are narrowly adapted to those conditions essentially have nowhere to go when their environment changes; this puts them among the species most vulnerable to climate change (Sydoriak et al. 2013). Coniferous forests in the subalpine zone in California typically support fewer species of birds and mammals than any other major forest type in the state (Verner and Purcell 1988). Sierra Nevada bighorn sheep use the upper montane, alpine, and subalpine habitats of the plan area, particularly rugged rocky areas. Sierra marten and Mount Pinos sooty grouse use some portions of the subalpine zone, where dense patches of forest are interspersed with meadows and riparian areas.

Arid Shrublands and Woodlands (Pinyon-Juniper, Sagebrush, and Mountain Mahogany)

Arid shrublands and woodlands dominate the lower elevation southeastern portion of the Sequoia National Forest and very little of the Sierra National Forest. The primary vegetation types are pinyon-juniper and sagebrush. These vegetation types in the Sequoia National Forest occur between two biogeographic provinces—Sierra Nevada and Mojave Desert—and as a result have high plant diversity and some unusual plant combinations. Changes in climate, fire, and grazing regimes in the late nineteenth and twentieth centuries have particularly influenced the structure, function, and distribution of arid shrublands and woodlands in this area (Slaton 2015). Some terrestrial invertebrate species of conservation concern are supported by these habitats, such as various at-risk butterflies that forage in sagebrush habitats.

Old Growth Forest

There are old growth forests across various elevations and ecosystems. Although they tend to contain old and usually large trees, tree size varies, based on species and site productivity (see "Special Habitats" under "Terrestrial Ecosystem Processes and Functions"). The density, size, and arrangement of individual trees also varies by ecosystem type, with higher elevations having a more open and scattered arrangement. Old growth forests at lower elevations tend to contain larger trees in a wide variety of densities and canopy covers. Old growth forests often contain large snags and logs in addition to large live trees.

The densities of all of these old forest components varied widely in the past. Much of the montane mixed conifer and pine forests that contain large, old trees are more uniformly dense, with high tree cover, than they were in the past (Safford 2013, Stephens et al. 2015, Collins et al. 2015). There are increased rates of old growth trees dying from competition with younger trees for water, climate change that influences carbon balances and growth reserves, bark beetle related mortality, and increased high-intensity fire. California spotted owl and Sierra marten are strongly associated with dense, older forest conditions. Bald eagles, fringed myotis, and great gray owl use individual old growth forest components, such as large snags and trees.

Wetlands, Marshes, Wet meadows, Seeps

Meadows, seeps, and springs in the drier southern Sierra Nevada provide important and diverse habitat for plants and animals. Meadows in the Sierra National Forest range from extremely large to tiny meadows around springs. These wetter habitats are important to numerous wildlife species and provide habitat for species of conservation concern, such as salamanders, butterflies, and Sierra marten. Butterflies are associated with meadows and vegetation around lakes and ponds. Sierra martens use riparian corridors in mature forests. Marshes with tules and cattails provide nesting habitat for Kern red-winged blackbird and tricolored blackbird.

Riparian Communities

Riparian forests and woodlands occur throughout the two national forests and have an exceptionally high value for many wildlife species; they often support a higher concentration of species diversity than most terrestrial ecosystems. Riparian forests and woodlands provide habitat for at-risk salamanders, willow flycatchers, and greenish blues, as well as a number of other native species. Riparian corridors are important for movement, habitat, and foraging and as water sources for numerous species. Townsend's big-eared bats, foraging generalists, are known to use riparian corridors and other bodies of water to capture prey. The limited distribution of riparian communities and their proportionally higher value to terrestrial wildlife makes protection and maintenance of these areas critical to species persistence.

Open Water (in Relation to Terrestrial Species)

Many terrestrial wildlife species depend on habitat surrounding lakes, ponds, and associated habitats, such as marshes, to support one or more life history requirements, particularly breeding or foraging. For example, bald eagles forage in lakes and other large bodies of water; the peregrine falcon breeds near open waters, such as lakes, ponds, rivers, or wetlands; and a variety of bat species forage in or near waterbodies, such as the fringed myotis bat, which uses open habitat or dry forest next to an open water source. Butterflies often use aquatic habitats. In the Sequoia National Forest, the area surrounding Lake Isabella, the Kern River corridor, and South Fork Wildlife Area are hotspots for many terrestrial wildlife species, particularly migratory birds. Riverine and open water habitats are approximately 15,300 acres in the Sierra National Forest and 11,500 acres in the Sequoia National Forest.

Complex Early Seral Habitat

Complex, early seral habitat is the stage of forest development that follows significant deaths in a mature forest (see “Special Habitats” under “Terrestrial Ecosystem Processes and Functions”). The complex early seral habitat is often characterized by high densities of snags, the development of shrub cover and other native vegetation, downed wood, and natural conifer regeneration. Complex early seral habitat provides an important habitat type to several mature forest-associated species. Specifically, it can provide cavities for roosting, nesting, and denning, an increased prey base for a variety of species, and a diverse edge habitat that can benefit some species. This transitional seral stage provides important habitat for a variety of birds and small mammals that are prey for such species as California spotted owls and Sierra martens. This habitat can also be important for woodpeckers and cavity-nesting birds that benefit from the increase in snag habitat and food resources associated with dead and dying trees.

With the change of vegetation conditions that are outside the natural range of variation, the size and distribution of complex, early seral habitat in both location and timing has changed, with large fires creating very large blocks of dead trees on both national forests.

Caves, Cave-Like Habitat, and Cliffs

Large cliffs provide habitat for a variety of raptors, including peregrine falcon, osprey, bald eagle, and golden eagle. Peregrine falcons currently nest in cliff habitat in the Giant Sequoia National Monument; adjacent to the Sierra and Sequoia National Forests; they have been sighted throughout both national forests (eBird 2018). Caves and cave surrogates, such as mines, cave openings, and structures, can provide habitat for many bat species, including Townsend’s big-eared bat and the fringed myotis bat. Natural caverns and large, abandoned mine shafts exist in the national forest plan areas.

Key Threats to Terrestrial Species of Conservation Concern

This section summarizes information on the primary stressors or threats for terrestrial wildlife species of conservation concern (Table 76). Detailed threat analyses and how forest plan components address threats to species of conservation concern are provided in Appendix D.

Table 76. Summary table of terrestrial species of conservation concern, ecological zones or types, key ecological conditions, and primary stressors or threats to persistence

Species	National Forest	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
American peregrine falcon	Sierra	Unmanaged recreation	Falcon collection permits; pesticides/chemicals use outside national forest system
Bald eagle	Sequoia and Sierra	Forest management activities	Changes in timing and flow of water and water availability resulting from climate change or hydroelectric power; wildfire

Species	National Forest	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
California spotted owl	Sequoia and Sierra	Vegetation/fuels management, high-severity wildfire, insect outbreaks, noise disturbance/recreation	Genetic introgression from barred owls; drought stress/climate change
Great gray owl	Sequoia and Sierra	Declining/drying meadow conditions, conifer encroachment, Veg/fuels management, Recreation, forest fragmentation/loss of connectivity from roads, trails, and structures that modify hydrologic flows in the meadows	High-severity wildfire, insect outbreaks, roads, vehicle collisions, predation from great horned owl, drought stress
Kern red-winged blackbird	Sequoia	Altered aquatic/riparian systems, invasive species	Hydroelectric plants, climate change and drought, urban water use, increasing temperatures
Mount Pinos sooty grouse	Sequoia	Declining/drying meadow conditions	High-severity wildfire, climate change and loss of snow pack; high endemism (relict species), hunting
Northern goshawk	Sequoia and Sierra	High-severity wildfire, insect outbreaks	Climate change, high-severity wildfire, tree mortality
Tricolored blackbird	Sequoia	Invasive species	Water use from urban areas, changes in water levels, climate change/drought
Willow flycatcher	Sequoia and Sierra	Loss in connectivity between habitat patches; declining/drying meadow conditions; forest management activities (fire, veg); invasive species; livestock grazing	Changes in timing and flow of water and water availability resulting from climate change (drought) or hydroelectric power; increasing demands for water by humans; nest parasitism from brown headed cowbirds/residential bird feeders
Fringed myotis bat	Sequoia and Sierra	Fuels reduction and vegetation management, recreation, high-severity fire, insect outbreaks; loss of connectivity/movement corridors; improper cave closures	Drought stress/climate change; white-nose syndrome
Sierra marten	Sequoia and Sierra	Fuels reduction and vegetation management, recreation, high-severity fire, insect outbreaks; loss of connectivity/movement corridors	Insecticide and pesticide use (illegal marijuana growing); climate change and drought; ski resort development; roads
Townsend's big-eared bat	Sequoia and Sierra	Fuels reduction and vegetation management, recreation, high-severity fire, insect outbreaks; loss of connectivity/movement corridors	Drought stress/climate change; white-nose syndrome
Fairview slender salamander	Sequoia	Ground disturbance to microsite conditions, degradation or loss of habitat due to ground disturbance for timber removal, fire suppression equipment and road maintenance; fire	Climate change related impacts such as drought; changing snow-rain interface; tree mortality; fire

Species	National Forest	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
Gregarious salamander	Sierra	Ground disturbance that alters or removes ground cover, including woody debris and forest litter can directly impact this species, decadence of black oak, fire	Drought, changing snow-rain interface; tree mortality
Hell Hollow slender salamander	Sierra	Ground disturbance to microsite conditions, degradation or loss of habitat due to ground disturbance, fire	Drought
Kings River slender salamander	Sierra	Ground disturbance to microsite conditions, degradation or loss of habitat due to ground disturbance or fire	Climate change, prolonged drought
Limestone salamander	Sierra	Disturbance, degradation or loss of habitat to microsite conditions due to recreation or mining activities. Loss of habitat due to fire	Climate change, prolonged drought
Yellow-blotched salamander	Sequoia	Degradation or loss of habitat from ground disturbing activities, fire suppression activities and changes in moisture levels that may impact riparian micro-site conditions	Climate change and associated changes in rainfall and temperature
Behr's metalmark	Sequoia	Cheatgrass, water withdrawal, grazing, conifer encroachment, loss of habitat from fires	Drought, climate change; urban development at lower elevations
Evius blue	Sequoia	Fire suppression and encroachment of conifers; invasive annual grasses	Climate changes such as warmer temperatures, less snowpack, earlier snowpack melting, and drought
Greenish blue	Sequoia	Fire suppression and encroachment of conifers; invasive annual grasses	Climate changes such as warmer temperatures, less snowpack, earlier snowpack melting, and drought
Tehachapi fritillary	Sequoia	Fire suppression and conifer encroachment; invasive annual grasses; grazing; loss of habitat from fires	Climate changes such as warmer temperatures, less snowpack, earlier snowpack melting, and drought
Indian Yosemite snail	Sierra	Habitat alteration such as development for mining, road widening or construction	Climate changes such as warmer temperatures and drought
Merced Canyon shoulderband	Sierra	Disturbance, degradation or loss of habitat to high-intensity fire, recreation, or mining	Climate changes such as warmer temperatures and drought

Key threats for terrestrial species of conservation concern are generally summarized as follows:

- Habitat loss due to widespread tree mortality from drought, insects, pathogens, and high-severity fires
- Reduction in habitat quality from homogenous (similar in kind) forest structure and composition

- Loss of key ecological elements, such as large trees, snags, downed logs, tree cavities, dense canopy cover, willow thickets, marsh tules, undisturbed caves, and host plants
- Human-caused disturbance and displacement
- Loss of water associated wildlife habitats (riparian, wet meadows, seeps, streams, and marshes) due to drought, conifer encroachment, sedimentation, erosion, water quality degradation, and water diversion
- Climate change-related effects on vegetation, snowpack, drought, and altered fire regimes
- Population collapse as a result of limited distribution, small population size, hybridization, or localized catastrophic event, or a combination thereof

Fringed Myotis Bat
National Forest: Sequoia and Sierra National Forests

Status: The fringed myotis bat appears to be in serious decline as historic maternity colonies have disappeared and those remaining are significantly reduced in size (Pierson 1998). The Western Bat Working Group considers the fringed myotis bat to be imperiled or at high risk of imperilment in the majority of the national forests in California (Weller 2005). The fringed myotis bat occurs throughout the Sierra Nevada Range; however, the species is patchily distributed showing irregular patterns of abundance (Bradley et al. 2006, Weller 2005).

The fringed myotis bat is known to migrate, but little is known about the distance traveled or location of winter habitats (O'Farrell and Studier 1973). The CNDDB has recorded occurrences of the fringed myotis bat from the Sequoia and Sierra National Forests. In the Sequoia National Forest, fringed myotis were recorded at Miracle and Democrat Hot Springs in Kern County. One male was collected in 1998 and a post-lactating adult was captured and released in 1992 (at a mine), both in the Kern River Ranger District. One male was collected in 1999 south of Delonegha Hot Springs, along highway 178 and the Kern River.

According to the NRIS database there are 30 observations of fringed myotis in the Sierra National Forest, all recorded in the last ten years. Surveys have detected fringed myotis at several sites including Huntington Lake, Markwood Meadow, Buck Meadow and the Sweetwater Mine. NRIS records show that six fringed myotis bats have been captured in mist-netting surveys in the forest (USDA 2015).

Threats: Disturbance at roost sites is considered a major threat to this species. The major threats for fringed myotis bat are identified as loss or modification of roosting habitat due to closure or renewed activity at abandoned mines; recreational caving and mine exploration; loss of current and future large, decadent trees; and replacement of buildings and bridges with non-bat friendly structures (Bradley et al. 2006). Management activities that reduce the number of snags or potential creation of snags may reduce available roost sites. If hibernating bats are disturbed, arousal from hibernation increases the possibility that the bat's stored fat will be insufficient to survive the winter (USDA FS 2005). Pesticides may affect fringed myotis bats by accumulating in the fatty tissues of bats and by reducing the quantity of prey that can be consumed (McCracken 1986). Pesticides in fatty tissues are released during hibernation, migration, or periods of stress and may be passed to nursing young. The emergence and spread of the pathogenic white-nose syndrome fungus (*Pseudogymnoascus destructans*) that infects hibernating bats and is prevalent along the eastern one-third of the U.S. has the potential to spread to California. Fringed myotis bats may be at risk in the future from white-nose syndrome.

Sierra Marten
National Forest: Sierra and Sequoia

Status: In addition to harvest of old forest, martens were trapped for fur until 1954 and it is thought that these actions contributed to declining numbers of Sierra marten (Zielinski 2014). In the southern and central Sierra Nevada the marten is considered well distributed but not in the northern Sierra Nevada (Kurcera et al. 1996, Zielinski et al. 2005). Sierra martens are ranked by NatureServe as a G4G5 (apparently secure/secure) but S3 (vulnerable) in California. Sierra martens are listed as a species of special concern by California Department of Fish and Wildlife and were designated a species of greatest conservation need in the 2015 California State Wildlife Action Plan (California Department of Fish and Wildlife 2015a). Marten occur in forested areas that receive considerable snowfall (Zielinski 2014). The upper montane forests serve as this subspecies primary habitat, which is considered within the range of natural variation (Meyer 2013a) on these forests.

Threats: Key risk factors to Sierra marten are climate and climate-driven changes including decreased snowpack and altered fire regimes. The capacity of the marten to adapt to climate change is limited by its reliance on deep snow for access to prey in winter through under snow, foraging and caching of food (Hauptfeld and Kershner 2014b). The other key risk factor is fragmentation (primarily due to roads) and, at lower montane or foothills elevations, past timber harvest. In the future, the forested habitat the marten relies on may be further fragmented by changes in macro and micro forest conditions or reduced by increasing wildfires associated with climate warming (Zielinski 2014, Hauptfeld and Kershner 2014b). A vulnerability assessment by (Hauptfeld and Kershner 2014b) ranked overall vulnerability of the marten as moderate/high, due to its moderate/high sensitivity to climate and non-climate stressors, moderate adaptive capacity, and moderate/high exposure. Pacific martens are also listed as climate vulnerable in the 2015 California State Wildlife Action Plan (California Department of Fish and Wildlife 2015a).

The southern extreme of the range for martens is in the two national forests plan area and generally populations at the edges of their range are more at risk than those in the center. Martens are extremely sensitive to the loss and fragmentation of mature forest habitat (Zielinski 2014). (Lawler et al. 2012) predicted that the range of marten in California will contract to the north and become less common and more fragmented. High-intensity fires have been increasing in upper montane red fir forests and this trend is expected to increase with climate change (Schwartz et al. 2015). Changes could include a loss of red fir (Lenihan et al. 2003) and lodgepole pine habitat (replacement by white fir or loss by high-intensity wildfire) and increased competition from other carnivores (like Fisher) no longer constrained by snow levels. Also, because of the marten’s aversion to crossing large openings, large fires may fragment marten habitat and isolate populations leading to localized extinction. The increase in large trees killed by bark beetles will create new snags at the expense of living trees used for resting and denning. Finally, increased drying conditions would lead to further deterioration of montane meadows. Drier meadows would likely reduce the prey populations on which martens depend.

Townsend’s big-eared bat
National Forest: Sequoia and Sierra

Status: Nearly 20 years ago, Townsend’s big-eared bat was reported to have shown marked population declines over a 40 to 60 year period (Pierson and Rainey 1998); with a 39 percent loss in the number of maternity colonies, a 55 percent decline in the total number of individuals, and a

32 percent decrease in the average size of remaining colonies. The most notable declines occurred in the central Sierra Nevada. This species occurs on both the Sierra and Sequoia National Forests.

Threats: According to the Western Bat Working Group, this species now ranks as a high risk species due to habitat loss, habitat fragility, trend, and abundance (Piaggio 2005). High risk means that threats are well documented, are current and ongoing, and have a high probability of substantially impacting the species by reducing habitat over a widespread area. The Townsend's big-eared bat is highly susceptible to human disturbance and colonies are known to abandon roost sites after human visitation. The species is particularly vulnerable during the maternity season when females are aggregated and rearing defenseless young (Pierson and Rainey 1998). Pesticides may affect bats by reducing the quantity of prey or be consumed and accumulated in the fatty tissues of bats (McCracken 1986). Pesticides in fatty tissues are released during hibernation, migration, or periods of stress and may be passed to nursing young. The emergence and spread of the pathogenic white-nose syndrome fungus (*Pseudogymnoascus destructans*) that infects hibernating bats has the potential to spread to California. Townsend's big-eared bats may be at risk in the future from white-nose syndrome, which has been verified as occurring in Washington State, and this is far west of previous eastern occurrences.

American Peregrine Falcon
National Forest: Sierra

Status: In general, American peregrine falcons are uncommon on California national forests, including in the Sierra National Forest. This species was de-listed under both the Endangered Species Act and the California Endangered Species Act in 1999. The American peregrine falcon is a resident breeding and wintering subspecies in the southern Sierra Nevada (White et al. 2002). Breeding Bird Survey data indicate significantly increasing population sizes of peregrine falcons in California during 1966 to 2007 at 12.8 percent per year, with the greatest increase occurring between 1999 and 2007 at 20.4 percent per year (Sauer et al. 2008).

In the Sierra National Forest, peregrine falcons use many areas for hunting and numerous cliffs are confirmed or suspected nesting sites. Approximately 29 nesting attempts were recorded in the Sierra National Forest from 1993-1997 at 6 different sites: Balloon Dome, Fuller Buttes, Tollhouse Rock, Sunset Point, Shuteye Peak, and Garlic Falls. A total of 7 nests successfully fledged 16 young according to California Department of Fish and Wildlife nest records. Current population trends or occupancy rates for the species in the Sierra National Forest are unknown.

Threats: Recreation activities that might affect peregrine falcon are development of rock climbing routes at newly discovered crags, dispersed camping in sensitive riparian ecosystems, and hikers on trails in peregrine nesting habitat. Some key recreation sites or areas in the Sierra National Forest where nesting peregrines have been observed in the past are Shaver Lake and vicinity, and Tollhouse Rock, which is popular among rock climbers on the forest's western boundary. Disturbance of nests from rock-climbing activities has been documented (White et al. 2002). Other potential threats are over collecting of chicks by falconers and illegal pesticides in marijuana grow sites that continues to threaten egg shell development of peregrine falcon. There are no windfarms in close proximity to the forest and no mortalities resulting from collisions have been reported or observed. The forest has no transmission corridors, and there are no existing or planned transmission corridors as identified.

Bald Eagle
National Forest: Sequoia and Sierra

Status: In 2007, the U.S. Fish and Wildlife Service delisted the threatened bald eagle in the contiguous 48 states due to population recovery. This species is still protected under the Bald and Golden Eagle Protection Act of 1940. The U.S. Fish and Wildlife Service continues to monitor the status of the bald eagle at 5-year intervals (United States Department of the Interior 2009a) and the data indicate highly significant increases in California during the period from 1966 to 2007 (14 percent per year) and 1980 to 2007 (12 percent per year) (Sauer et al. 2008). The bald eagle population in the southern Sierras is believed to be stable or slightly increasing. This species is still listed as endangered under the California Endangered Species Act.

Bald eagles can be found as a migrant or wintering bird throughout the Sierras, especially near reservoirs, lakes and large rivers. A wintering population is prominent at the South Fork Wildlife Area at Lake Isabella in the Sequoia National Forest. Nesting has been documented at reservoirs in the Sierra National Forest (Southern California Edison Company 2011).

Threats: For both forests, there are potential threats to bald eagle due to habitat loss resulting from high-intensity fires, limited availability of a large live tree component due to recent widespread bark beetle related tree mortality, and disturbance from recreationists.

Composition, structure, and fire regimes are largely outside the natural range of variability in many areas (Van de Water and Safford 2011); after over a century of fire suppression and timber harvesting, forest density is greater, tree canopy is denser, and small and medium trees are more dominant in the forests, while in stand variation in tree size and density has decreased. Pines and oaks have decreased substantially and shade tolerant species, such as cedar and fir, have increased. Drought recently triggered high-severity fires and bark beetle related tree mortality in all forest types. Statewide trends in 2017 indicate mortality at higher elevations in the white and red fir, compared with previous years where extensive mortality occurred in lower elevation pine and mixed conifer forests.

Disturbance from recreational activities such as boating, jet-skiing, fishing, and low flying aircraft can cause disturbances to nesting birds, but this species also shows some tolerance for the presence of humans (Buehler 2000). Timber harvest that removes potential nest or roost trees pose a risk. Climate change could reduce reservoir levels and prey availability. Collisions with objects, including wind turbines, have also been documented as a threat to bald eagles (Pagel et al. 2013). Use of illegal pesticide, such in marijuana grow sites continues to threaten bald eagles.

Disturbance from high recreationist use around Lake Isabella and development along the shores is likely the biggest risk factor affecting bald eagles in the Sequoia National Forest, since it is an important wintering area for bald eagle.

California Spotted Owl
National Forest: Sequoia and Sierra

Status: California spotted owls were believed to be distributed relatively continuously and uniformly throughout their range in the Sierra Nevada (Verner et al. 1992, Noon and McKelvey 1996, Gutiérrez et al. 2017), with concern for fragmentation effects at finer scales due to habitat changes (Gutiérrez and Harrison 1996, Gutiérrez et al. 2017). Over the past 20 years, gradual and steady population declines of California spotted owl have been observed across the Sierra Nevada (Keane 2014). Population trends from four demographic study areas in the Sierra Nevada suggest that the populations may be declining on National Forest System lands in the Eldorado, Lassen, and Sierra National Forests, and may be stable or increasing in the Sequoia Kings Canyon study area (Conner et al. 2013, Keane 2014, Tempel and Gutierrez 2013). (Conner et al. 2013) used a Bayesian approach for estimating the probability of different levels of population decline using realized population change and reported a 78 percent probability that a decline was occurring in the Sierra National Forest and an 8 percent probability of a stable or increasing population in the Sequoia and Kings Canyon National Parks. The factors driving these population trends likely involve a complex interaction of multiple current and past factors. The majority of owls occur in the mid-elevation, mixed-conifer forests on the west slope of the Sierra Nevada. Some owls also occur at lower elevations in the oak woodlands of the western foothills in the southern Sierra Nevada, at higher elevations in red-fir forests, and in conifer forests on the eastern slope of the mountains (Verner et al. 1992, Gutiérrez et al. 2017).

There are 66 protected activity centers in the Sequoia National Forest, excluding the Giant Sequoia National Monument. California spotted owl habitat in the Sequoia National Forest plan area is varied, approximately 32 percent of the protected activity center acreage is in the mixed conifer vegetation type and 23 percent is in montane hardwood and montane hardwood conifer vegetation types. The majority of nest and roost sites occur in mid slope regions between 4,000 and 7,500 feet in Sierran mixed conifer and montane hardwood conifer vegetation types, with flying squirrels as the main prey source. At the lowest elevations in the oak woodland belt, owls can be found along canyon ravines in stringers of canyon live oak and most commonly consume woodrats.

The southernmost area in the Sequoia National Forest is a transition zone between the southern Sierra Nevada and isolated mountains. Spotted owls in this transition zone nest from low elevation pockets of live oak at 1,000 feet up to successful nests at over 9,000 feet in elevation, with the majority of known owl territories in the black oak-conifer transition at 4,500 feet up to the mixed conifer- red fir transition near 8,500 feet. There are a number of mountain ranges with unique characteristics, such as the Greenhorns, Breckenridge, and Piute Mountains, and the Kern Plateau.

The Greenhorn Mountains are an extension of the west side Sierra Nevada mixed conifer habitats. They are primarily dense, second-growth fir and cedar that resulted from pre-1900 timber harvest and fire exclusion. These habitats appear to support a spotted owl population that is connected to the rest of the Sierra Nevada spotted owl population.

Breckenridge Mountain and the Piute Mountains are isolated from the Greenhorn populations by gaps of several miles of unsuitable habitat. Both Breckenridge and the Piute Mountains are further isolated by loss of habitat due to large, stand replacing fires. These areas also have lower quality habitat that is closer to east-side Sierran pine due to poor site quality and lower mean annual precipitation. The owl territories on these mountains are few and widely separated due to habitat limitations.

There are 240 designated protected activity centers and the same number of home range core areas (HRCA) in the Sierra National Forest, with heavy concentrations south of Shaver Lake. Approximately 50 percent of the overall protected activity centers acreage is in the mixed conifer vegetation type. Tree species typically are ponderosa pine, sugar pine, incense cedar, and white fir, and some Douglas-fir. Black oak is an important component of many mixed conifer stands, particularly at the lower elevations and on drier aspects (south and west).

Threats: Starting in the early 1900s, fires were actively suppressed with the intention of protecting forests. Years of fire suppression resulted in increased vegetation density and uniformity, an increase of less fire tolerant trees, and understory fuel loads resulting in increased fire potential (van Wagtendonk and Fites-Kaufman 2006, Stephens 2005, Stephens and Moghaddas 2005, North et al. 2009b).

High-severity fire and widespread loss of habitat is perhaps the biggest threat to spotted owls. Following the King Fire of 2014 spotted owl occupancy declined markedly at severely burned sites 1-year post fire, and the large patch of severely burned forest was strongly avoided for foraging (Jones et al. 2016, Gutiérrez et al. 2017).

Logging in the mid-1900s focused on selective harvest of larger trees and on regenerating areas in the 1980s (Verner et al. 1992), which affected habitat of old forest species. On both national forests, harvest of large trees was essentially eliminated in 1990s, and the emphasis shifted to stand maintenance thinning harvests intended to control density and growth of stands, generally for habitat maintenance. Recently, there is an emphasis on post-fire salvage logging.

Vegetation management around nests or den sites for the California spotted owl, goshawk, fisher, and marten has been heavily restricted. At the same time, a growing concern for the cumulative effects of past management and fire suppression increased the focus on restoring fire and reducing forest densities and surface fuel accumulations. Currently, most of the landscape is not resilient to large, high-intensity fire, and is susceptible to drought and insect/pathogen outbreaks. Recent bark beetle outbreaks in all ecosystem types have further reduced the large tree component. Restoration is proceeding at a pace and scale that is inadequate to address the problem in a timely way. The limited pace and scale of restoration and lack of active management is a stressor. In the Sequoia National Forest, there are over 20,000 acres of plantations with high fuel loading and inter-tree competition, and low species diversity.

Current research suggests strategically placed landscape treatments (mechanical treatments and managed fire) can reduce fire severity and spread (Gutiérrez et al. 2017) and reduce impacts on spotted owl habitat (Ganey et al. 2017), and that by combining fuel treatments with prescribed and managed fire can effectively reduce the extent of high-intensity fires in the Sierra Nevada under most conditions (Jones et al. 2016, Gutiérrez et al. 2017).

Barred owl is known to hybridize with the California spotted owl, jeopardizing its genetic integrity (Keane 2014). It has been observed in the northern portion of the Sierra National Forest. It is unknown how many barred owls there are or how fast they are progressing south. Barred owls are not currently considered common in the Southern Sierras (Jones et al. 2016, Gutiérrez et al. 2017), but their populations are expanding their range into the Sierra Nevada and are considered an increasing threat to California spotted owls (Keane 2014).

There has been no evidence to indicate that West Nile virus has affected California spotted owl populations. Hull et al. (Hull et al. 2010b) screened samples for West Nile virus antibodies from 209 California spotted owls collected from the southern (Sierra National Forest, Sequoia and Kings Canyon National Parks) or northern (Plumas and Lassen National Forests) Sierra Nevada from 2004 to 2008 and results were negative for all sampled California spotted owls (Gutiérrez et al. 2017).

Terrestrial ecosystems of the Sequoia and Sierra National Forests are expected to experience dramatic changes in climate in the coming decades (Safford et al. 2012a, Meyer 2013a).

Consequently, the future range of variation in climate exposure for these ecosystems will almost certainly exceed the natural range of variation.(Schwartz et al. 2013a) evaluated future climate exposure to vegetation using downscaled climate projections for the southern Sierra Nevada, including for the Sequoia and Sierra National Forests. Their results indicate a high proportion of all terrestrial ecosystems will be moderately, highly, or extremely vulnerable to future climate by the end of the century.

Great Gray Owl
National Forest: Sequoia and Sierra

Status: Great gray owls are listed as endangered by the State of California. In the central Sierra Nevada this species is primarily found in Yosemite National Park and the adjacent Sierra and Sequoia National Forests, but breeding has been documented as far north as Plumas County and south to Tulare County (Hull et al. 2014, Wu et al. 2015). There is a gap in nest records from Calaveras and Amador Counties and between El Dorado and Plumas Counties (Wu et al. 2015). About 100 to 200 individuals have been estimated in California since 1980 (Hull et al. 2010a), and only 80 were estimated in 2006 (Maurer 2006). Yosemite National Park estimates that it has 65 percent of the nesting owls in California in what is described as the Sierra Nevada population. Recent surveys and genetic sampling of the Sierra Nevada great gray owl population indicate that it is s geographically-isolated population of a few hundred individuals in the central Sierra Nevada (Hull et al. 2014).

In the Sequoia National Forest plan area, there are no known nest sites; there is one 1986 CNDDB record for great gray owl, located a little over a mile north of Fish Creek Campground on the Kern Plateau. There are no NRIS database occurrence records in the plan area, no sightings reported in eBird, and there have been no detections of great gray owl recorded as part of the Sierra Nevada Avian Monitoring Information Network surveys in the plan area. One the Sierra National Forest, there are currently 14 great gray owl protected activity centers.

A landscape habitat suitability model used in Yosemite National Park highlights that high suitability great gray owl areas are rare in the park with only 0.8 percent of the landscape rated in the highest 20 percent suitability class (Keane et al. 2011). However, a recent comparison of 47 great gray owl nest sites with paired reference sites throughout the Sierra Nevada indicates that this species may persist and nest in lower elevations than previously thought, with 21 percent of nests below 3,281 feet, which corresponds to the lower conifer zone/foothill zone (Wu et al. 2015). Additionally, this once perceived conifer forest specialist had 30 percent of all total nests surveyed in large oak trees (Wu et al. 2015). There are three active great gray owl sites in the Giant Sequoia National Monument, Hume Lake Ranger District, and all are located in what had been considered atypical habitat; lower elevation areas of open pine stands, generally lacking large trees but with a large black oak component.

Threats: Past suppression policies have led to conditions that can result in large areas of high-severity fire that may be detrimental to old forest species. Fire suppression and uncharacteristic wildfire can alter the structure and composition of the forest interface near meadows. Decreasing trends in early seral and complex early seral habitat, which can provide foraging opportunities, are most likely due to past fire suppression and salvage logging efforts. (see above for additional information). These past management practices can put forest edge habitat adjacent to meadows at particular risk.

Inappropriate grazing practices can greatly reduce plant cover, which may affect habitat for prey species like voles and pocket gophers. The relationship between herbaceous height, species abundance, and vulnerability to predation by great gray owls is not well understood for the various species. Deleterious effects to one prey species may be beneficial to another prey species. Voles may be negatively correlated with grazing intensity (Winter 1986, Johnson and Horn 2008, Kalinowski et al. 2014, Rickart 2013), whereas pocket gopher density may increase or decrease with grazing (Dull 1999, Powers et al. 2011).

Current trends in the number of livestock grazing show a decrease in livestock numbers since the 1960s, as summarized in the forest assessments (United States Department of Agriculture 2013b, c). For example, current livestock numbers in the Sequoia National Forest are approximately 60 percent of those permitted in the 1960s. Conditions in meadows and riparian areas have generally been improving and most measures of rangeland condition indicate an upward trend. Lingering effects of past meadow impacts remain in some areas where water tables have lowered. Some meadows have had active restoration projects.

Great gray owl has a moderate to high climate vulnerability rating. Many climate models project significant range contractions in some species distributions, especially those with high climate sensitivity and low adaptive capacity. Species with low adaptive capacity are those that have small and isolated populations, low genetic variation, and limited ability to move widely and low reproductive rates. (Gardali et al. 2012) note that great gray owl are among the bird species considered vulnerable to climate change in California. Increasing temperatures combined with a change from a snow-dominated to a rain-dominated system will impact meadows due to changes in the hydrologic regime. Total meadow area may decline and wet meadows may shift to dry meadows, especially small irregularly shaped meadows at low to mid elevations (Gross and Coppoletta 2013b). This drying would decrease herbaceous biomass, which could in turn affect rodent populations for the owl.

Population growth in many of the counties is expected to increase demand for recreation opportunities in the Sequoia and Sierra National Forests and may increase user conflict. According to 2010 census data, over 1 million people live within 1 hour of the forests and population of the cities and towns near the forests are increasing. Recreation and activity related disturbance can cause nest failure during the breeding season. Incidental mortalities can occur. Vehicle collisions along primary roads can cause direct mortality (van Riper et al. 2013). Collisions with vehicles on roads around occupied meadows are substantial threats, in part because the population is so small (Bull and Duncan 1993, Maurer 2006, Bunn et al. 2007, Steel et al. 2011). West Nile virus infection has also been listed as a cause for concern in the owl population (Hull et al. 2010b).

Kern Red-Winged Blackbird
National Forest: Sequoia National Forest

Status: The Kern red-winged blackbird is known from Walker Basin, in east central Kern County, and the South Fork of the Kern River (Mailliard 1915b, Mailliard 1915a). The breeding population in the South Fork Kern River Valley was previously estimated to number as many as 500 individuals. A survey in the Walker Basin in 2001 found approximately 50 red-winged blackbirds believed to be this subspecies (Gallion 2008); it is unknown if the subspecies continues to persist in the Walker Basin.

Important nesting areas on the South Fork of the Kern River are protected and are the Kern River Preserve, managed by the National Audubon Society; Canebrake Ecological Reserve, managed by California Department of Fish and Wildlife; and the South Fork Wildlife Area, managed by the Sequoia National Forest. This blackbird is a species of special concern for the California Department of Fish and Wildlife.

Threats: Kern red-winged blackbird and its associated habitat are at risk due to water use from expanding population pressures and human demands, events related to climate change (for example, increasing temperatures, temporal changes in precipitation, and runoff) and habitat loss caused by invasive species. Any loss of wetland habitat through climate change or human water uses would likely adversely affect this subspecies. Tamarisk and other invasive plants moving into wetlands along the South Fork Kern River may threaten the foraging and nesting habitat of the Kern red-winged blackbird (Gallion 2008). Regulating water levels at Lake Isabella is outside the authority of the Forest Service.

Mount Pinos sooty grouse
National Forest: Sequoia National Forest

Status: The Mount Pinos sooty grouse, *Dendragapus fuliginosus howardi*, is considered one of three subspecies of sooty grouse in California. The Mount Pinos sooty grouse is believed to extirpated from much of its historic range that occurred from Kings Canyon south and west to the Mount Pinos region of Kern and Ventura Counties (Zeiner et al. 1990, Bland 2013). The CNDDB database contains two records for the subspecies: four birds found on the Los Padres National Forest in 1931; and six birds on Sequoia National Forest in May 2004.

Recent unpublished studies by G. Barrowclough of the mtDNA control region (cited in Natureserve) of old specimens of grouse from Mount Pinos, suggest that those grouse are distinct, may be restricted to a smaller area, and represent an extinct species; and the morphologically distinct *D. f. howardi* is not genetically distinct from *D. f. sierrae*. Despite the genetic outcome, Bland (Bland 2017) emphasizes the importance of the contraction of *D. f. howardi* from Kern County and the southern part of Tulare County, with only rare reports from south of the Tulare-Kern County line (Bland 2008). (Bland 2008) suggests that sooty grouse observed south of Tulare County in recent decades may have been birds dispersing from a Sierra Nevada source, rather than members of a resident breeding population. Currently, the southernmost known breeding locations are at Sunday Peak in south-central Tulare County and Sherman Peak in southeastern Tulare County .

Threats: In the Sequoia National Forest, hunting is allowed in Fresno and Tulare County, where grouse populations are believed to be stable. Hunting is not allowed in Kern County, where Mount Pinos sooty grouse is believed to be absent.

Sooty grouse are associated with upper elevation conifer forests that may be affected by high-severity wildfire and climate change. In early spring, sooty grouse congregate in open mature stands of conifers near the crests of ridges (Bland 2013). These “hooting sites,” or “spring activity centers” are traditional, and are returned to year after year, generation after generation. Loss of large trees from these areas are detrimental to grouse (Bland 2013). In late spring and summer through fall, females and their young are associated with meadows and other mesic areas. Degradation of meadow and mesic areas can negatively effect brood production. In winter, sooty grouse seek dense conifer stands at high elevations where they subsist almost entirely on fir needles and buds. Forest heterogeneity is important to maintain for grouse. Groups or clumps of conifers, especially in fir stands provide important food and thermal and hiding cover for grouse.

Northern Goshawk
National Forest: Sequoia and Sierra National Forests

Status: In the Sequoia National Forest plan area, there are 13 protected activity centers, with the number of current active territories unknown. In the Sierra National Forest, there are 66 protected activity centers documented, with the number of current active territories unknown.

Northern goshawks tend to nest in forested habitat across their range, across all elevations, leading some to characterize them as habitat generalists at the landscape scale (Squires and Reynolds 1997). In California, goshawks typically nest in areas of high canopy cover, with large trees and old forest characteristics. Suitable stands occur in a broad range of conifer and conifer-hardwood types, including ponderosa, Jeffrey, and lodgepole pine, mixed conifer, white and red fir, Douglas-fir, and mixed redwood–Douglas-fir–hardwood; less common in quaking aspen and in pinyon-juniper (Gaines 1992). Nest stands are often on moderate slopes or benches, and have open understories.

Threats: Logging in the mid-1900s focused on selective harvest of larger trees and on regenerating areas in the 1980s (Verner et al. 1992), which affected habitat of old forest species. On both national forests, harvest of large trees was essentially eliminated in 1990s, and the emphasis shifted to stand maintenance thinning harvests intended to control density and growth of stands, generally for habitat maintenance. Vegetation management around nests or den sites for the California spotted owl, goshawk, fisher, and marten have been heavily restricted.

In the Sequoia and Sierra National Forests, cumulative effects of past management and fire suppression lead to increased forest densities and surface fuel accumulations. The landscape is not resilient to large, high-intensity fire, and is susceptible to drought and insect/pathogen outbreaks and recently much of the suitable nesting habitat in closed canopy forests has been substantially impacted from large high-severity fires and landscape scale tree mortality related to drought and bark beetle outbreaks.

Habitat occupancy rates for northern goshawk are known to decrease in areas of tree cover loss. For example, in the Rim Fire in the Stanislaus National Forest, the amount of high-severity fire in a territory negatively affected occupancy and nesting of goshawk and prevalence declined overtime from 70 percent the year following fire to 54 percent 3 years post-fire (Kalinowski et al. 2017). These results indicate that high-severity fire and associated loss of tree cover reduces the quantity and quality of goshawk habitat and is a conservation concern in the increasingly fire-prone and bark beetle outbreak-prone forests of California (Kalinowski et al. 2017). In addition, current and future warming and drying climate trends increase vulnerability to high-intensity fires and further fragmentation of old forest habitat.

Tricolored Blackbird
National Forest: Sequoia

Status: The geographic range of this species is restricted to California's Central Valley and surrounding foothills, a few coastal areas, and other scattered sites (Meese et al. 2014). Statewide, the population of tricolored blackbirds declined 35 percent, from approximately 395,000 to 258,000 birds between 2008 and 2011 (Kyle and Kelsey 2011). From 2011 to 2014 the number of tricolored blackbirds dropped another 44 percent, from 258,000 to 145,000 birds (Meese et al.

2014). The blackbird's historic breeding range in California included the San Joaquin Valley and the foothills of the Sierra Nevada south to Kern County, and up to 3,400 feet in Walker Basin (Grinnell and Miller 1944). In the Sequoia National Forest, breeding colonies have been recorded only in marshes around Lake Isabella and the Kern River. The tricolored blackbird is a threatened species under California Endangered Species Act, with many of the concerns focused on grain fields and nesting colonies in areas of agricultural production.

Threats: The greatest effects to this species are related to habitat loss and alteration with virtually all suitable habitats being converted by agriculture and urbanization (Meese et al. 2014). In the limited habitat for this species in the Sequoia National Forest, loss of tules or cattails to invasive species like tamarisk is a major threat. Changes in water levels at Lake Isabella may also be a threat, but regulating those levels is outside the authority of the Forest Service.

Willow Flycatcher
National Forest: Sequoia and Sierra National Forests

Status: The willow flycatcher is a polytypic species, with three subspecies breeding in California: *E. t. brewsteri* in isolated patches in northern California and along the western slope of the Sierra Nevada; *E. t. adastus* along the eastern slope of the Sierra Nevada; and *E. t. extimus* (southwestern willow flycatcher) breeding in riparian areas of southern California, including near Lake Isabella (Grinnell and Miller 1944, Unitt 1987, Browning 1993). *E. t. extimus* is a federally endangered species and was described in the federally listed species section above. The boundary between *E. t. brewsteri* and *E. t. adastus* in the Sierra Nevada and elsewhere is unclear (Sedgwick 2001), these subspecies are discussed collectively below. The willow flycatcher (*E. traillii*) is listed as endangered under the California Endangered Species Act; both subspecies *E. t. brewsteri* and *E. t. extimus* are listed as endangered.

Once common throughout the western United States, the willow flycatcher is gone from much of its range. Information from the Sierra Nevada indicates a substantial decline of subspecies *E. t. brewsteri* and *adastus* during the past 40 years, resulting in the absence or near-absence from multiple areas that were historically inhabited (Gaines 1992, DeSante and George 1994, Craig and Williams 1998, Bombay et al. 2003, Green et al. 2003, Siegel et al. 2008). There were six sites considered "occupied" on Sequoia National Forest under the 2004 Sierra Nevada Forest Plan Amendment (USDA 2004). Five of those sites are in Giant Sequoia National Monument and one is in the Sequoia National Forest Plan area. Although willow flycatcher was detected during monitoring in the Monument in 2009, the last detection during monitoring in the plan area was in 2001, despite repeated surveys. Flycatcher surveys are conducted using standardized protocol (Bombay et al. 2003). The willow flycatcher site in the plan area, Troy Meadow, has not been occupied since 1997.

There were eight known occupied flycatcher sites reported in the Sierra National Forest in 2004 (USDA 2004). However, the Sierra National Forest has no currently occupied sites based on consistent survey and reporting for historically occupied sites. Flycatcher surveys are conducted using standardized protocol (Bombay et al. 2003). Two sites, Markwood Meadow and Long Meadow, were occupied, on two occasions each between 2000 and 2008, but these two sites have not been occupied since 2008. Follow-up visits for detections at other sites listed as occupied in the 2004 Framework have been negative, with no evidence of birds persisting through the breeding season.

The status of *E. t. brewsteri* and *E. t. adastus* in the Sequoia National Forest is not well understood because these willow flycatcher subspecies are difficult to differentiate from the federally listed southwestern willow flycatcher in the field. Willow flycatchers have been detected outside of the South Fork Wildlife Area and are presumed to be *E. t. brewsteri* but identity has not been confirmed. These include multiple sightings in eBird.

Threats: Throughout the Sierra Nevada, loss and degradation of riparian and meadow habitats due to human influences (Siegel and DeSante 1999, Green et al. 2003) is a contributing factor to population declines of breeding willow flycatchers. Degradation could include the following (Green et al. 2003):

- Changes in hydrological patterns leading to meadow drying
- Destruction of shrub vegetation resulting in loss of nesting sites and cover for predator avoidance
- Increased predator access to meadow interior
- Loss of foraging substrate and decreased insect abundance
- Potentially increased contact with brown-headed cowbirds

Recent population declines of *E. t. brewsteri* observed in relatively pristine and seemingly unaffected habitats in Yosemite National Park suggest other reasons for these declines, including effects on the wintering grounds or migration routes, and climate change (Siegel et al. 2008). These factors, as they affect this species in both national forests, are outside of the authority of the Forest Service to address.

Since there are currently no occupied willow flycatcher sites in the Sequoia and Sierra National Forest plan areas, no sites overlap with livestock grazing. Efforts to improve riparian areas have occurred in both forests, primarily springs and relatively small portions of streams in annual grass systems are the result of positive mitigations resulting from ongoing allotment analyses in the forest. As a result of analyzing range condition through the NEPA process in the Sequoia National Forest, eight allotments required riparian area fence protection totaling 24 specific riparian areas. All of the sites required fencing to reduce livestock impacts and move the area to an acceptable standard. Sixteen of the sites have been constructed and the remaining seven are pending (NEPA completed in September 2011 for 8 sites, one of which was completed in 2012). Four additional riparian exclosures were constructed on Greenhorn Mountain to rectify resource concerns. All of the sites fenced thus far have shown improvement and upward trends in the riparian component of the sites.

Terrestrial Salamanders

National Forest: See Table 77

Status: The rare salamanders share many common attributes with rare plants in that many are narrowly endemic. All of the species require moisture to survive and because of this, at lower, drier elevations they are increasingly restricted to seasonal springs and seeps in otherwise arid environments. Habitat suitability appears to depend on microsite conditions such as north-facing talus and rocky slopes or under rocks and woody debris in forested habitats (Stebbins 1985). Many of these species occur in the foothills of these forests' drier vegetation types and elevations that contain oak woodland, coastal sage scrub, and chaparral. Several of these species occur in the

Table 77. Summary table of terrestrial salamander species of conservation concern, ecological zones or types, key ecological conditions, and primary stressors or threats to persistence

Species (Forest)	Primary Ecological Zones or Ecosystem Types	Special Habitat Needs/Key Ecological Conditions	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
Fairview slender salamander (Sequoia)	Oak woodlands, chaparral habitat, riparian corridors	Talus slopes, under rocks, forest litter, rocks, down logs, woody debris. Uplifted ridges of metamorphic rocks paralleling the Kern River (Jockusch et al. 2012)	Ground disturbance to microsite conditions, degradation or loss of habitat due to ground disturbance, fire suppression equipment and road maintenance.	Climate change related impacts such as drought
Hell Hollow slender salamander (Sierra)	Pine-oak woodlands and chaparral habitat, along riparian zones in close proximity to large rivers and streams.	North-facing slopes are preferred, and individuals are usually found beneath rock talus and large stones and other surface cover shaded by oak trees	Ground disturbance to microsite conditions, degradation or loss of habitat due to ground disturbance, fire	Drought
Kings River slender salamander (Sierra)	Interior live oak, blue oak foothill pine, moist coniferous forest	Logs or rocks with tree overstory (shade) and talus slopes	Ground disturbance to microsite conditions, degradation or loss of habitat due to ground disturbance or fire	Climate change
Limestone salamander (Sierra)	Foothill pines, oaks, buckeye and chaparral	Cliffs, crevices, ledges, and talus, frequently of limestone substrate	Disturbance, degradation or loss of habitat to microsite conditions due to recreation or mining activities. Loss of habitat due to fire	Climate change
Yellow-blotched salamander (Sequoia)	Canyon live oak, Woodlands and riparian areas	Down logs and litter	degradation or loss of habitat from ground-disturbing activities, fire suppression activities and changes in moisture levels that may impact riparian microsite conditions	Climate change and associated changes in rainfall and temperature.

relatively moist conditions found in montane forests (red fir), often occurring in forest litter in the shade of trees or rock crevices, ravines, creeks, and often on north-facing or shaded areas depending on the availability and constancy of moist conditions. None of the salamanders that are species of conservation concern are located in the harsh subalpine or alpine conditions of these forests.

Salamanders are found under logs, woody debris, bark, moss, leaf litter and talus, crevices, or in animal burrows (Stebbins 1985, (Lannoo 2005). The limestone salamander is dependent on a limestone substrate (Lannoo 2005). Generally, there are many subspecies of salamanders because their dispersal capability is often limited by features on the landscape and habitat requirements; however, a few species do have local seasonal migrations (Jockusch et al. 1998). Eggs are deposited in terrestrial sites, probably in moist sites along springs, seepages, or creek margins (Lannoo 2005), and there is no aquatic larval stage. Food is not a limiting factor and consists of invertebrates including snails, crickets, earthworms, and a large variety of insects.

All localities for Kings River slender salamanders occur on public lands administered by the Forest Service or National Park Service (Lannoo 2005). In other cases, a substantial portion of these salamanders' range is known to occur on public lands, though they can be an artifact of where they are more easily studied or the management of these lands has provided refugia from development and agricultural pressures on private lands.

Threats: There are no specific known limiting factors on the three national forests for salamander survival. Similar to many rare plants as well as invertebrates, these species are inherently limited in their geographic range resulting in limited occurrences and distribution. Several of these species have difficulty naturally dispersing or crossing human-made features such as highways, which can serve as barriers. For all of these species, population status is uncertain. The principal threats in the literature is habitat degradation or loss with concerns across all of these species for increasingly drier conditions resulting from climate change (Lannoo 2005). Potential losses of individuals could occur through fire suppression (compaction or deep soil disturbance from equipment), grazing that affects hydrology, logging, firewood collecting, mining and more consequential losses from impoundments, and hydro development.

Climate change may eliminate or reduce the suitability of some of the existing habitat. Subterranean habitat may limit effect of wildfire on this species and habitat may be maintained with restoration of periodic fire. High-intensity fire is assumed to be a threat when individuals are above ground and at risk and likely impacts habitat in all respects and results in some direct mortality. However, the yellow-blotched salamander survived large fires in both the Breckenridge and Piute Mountains in forested habitats with large-scale, stand-replacing fire effects (S. Anderson, personal communication with J. Friedlander, April 7, 2016).

While salamanders can survive and demonstrate resilience over time to extreme fire conditions; other ground disturbing activities during fire suppression could disturb habitat. Drier or highly variable, conditions could influence habitat. Climate analyses indicate little or no effects on habitat for most of these species (Wright et al. 2013). The Fairview slender salamander.is predicted to have a 50 percent decline in occupancy of habitat (Wright et al. 2013) .

Table 77 lists the status and threats for the terrestrial salamander species of conservation concern. Note that several species of primarily aquatic amphibians are addressed in "Aquatic At-risk Species."

Terrestrial Invertebrates

This section includes the butterflies, Indian Yosemite snail, and Merced Canyon shoulderband, and the information for each species is summarized in Table 78.

Table 78. Summary table of terrestrial invertebrate species of conservation concern, ecological zones or types, key ecological conditions, and primary stressors or threats to persistence*

Species	Primary Ecological Zones or Ecosystem Types	Special Habitat Needs/Key Ecological Conditions	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
Behr's metalmark	Shrub, chaparral, woodland and mixed forest	Suitable caterpillar host plants, primarily fasciculate buckwheat (*Eriogonum fasciculatum*), but also Wright's Buckwheat (*Eriogonum wrightii*), in open mixed deciduous conifer forest. Adult's feed nectar from flowers of Eriogonum and other plants.	Cheatgrass, water withdrawal, grazing, conifer encroachment, loss of habitat from fire events	Drought, climate change; urban development at lower elevations
Evius blue	Montane	Forest clearings, meadows, stream margins, and edges with buckwheat and lupines present. *Lupinus excubitus* is considered the primary foodplant, but the variety is not known.	Fire suppression and encroachment of conifers; invasive annual grasses	Climate changes such as warmer temperatures, less snowpack, earlier snowpack melting, and drought
Greenish blue	Montane	Bogs, roadsides, stream edges, open fields, meadows, and open forests. Caterpillars and adults feed on clovers of the genus *Trifolium*.	Fire suppression and encroachment of conifers; invasive annual grasses	Climate changes such as warmer temperatures, less snowpack, earlier snowpack melting, and drought
Tehachapi fritillary	Montane	Meadows, forest openings and rocky outcrops where host plant species of Viola occur.	Fire suppression and conifer encroachment; invasive annual grasses; grazing; loss of habitat from fire events	Climate changes such as warmer temperatures, less snowpack, earlier snowpack melting, and drought
Indian Yosemite snail	Foothill Zone	Mossy limestone crevices and talus, typically on steep slopes where moisture and high humidity are retained. Caves and abandoned mines may also provide these ecological conditions.	Habitat alteration such as development for mining, road widening or construction	Climate changes such as warmer temperatures and drought
Merced Canyon shoulderband	Foothill Zone	Talus deposits, outcrops logs and woody debris; typically on steep slopes where moisture and high humidity are retained	Disturbance, degradation or loss of habitat to high-intensity fire, recreation, or mining	Climate changes, such as warmer temperatures and drought

*Primary stressors not under Forest Service are not necessarily discussed further.

Butterflies
National Forest: Sequoia

Status: Behr's metalmark, evius blue, greenish blue, and Tehachapi fritillary butterflies occur mostly at mid to high elevations between 4,000 to 8,500 feet in the Sequoia National Forest, with ranges in the southern Sierra Nevada. Occurrences of these species of conservation concern are associated with habitats during peak flowering times, including dry and wet meadows, scree slopes, lakes, and stream banks. Butterflies inhabit virtually every part of an ecosystem largely determined by their dispersal ability, feeding and reproductive habits. Habitat suitability for many species depends on microsite conditions that can vary with each life stage. Having both host and nectar plants available are typically critical requirements, which may limit populations to the boundary of such habitats. For some, the majority of their life stages are limited to one or a few plants for larval, juvenile or pupa, and adult stages.

Threats: Many of the populations are highly isolated from one another and cover a small area often less than an acre in size. The small area occupied by populations make them very susceptible to subtle habitat changes, in addition to wildfire that may result in habitat type conversion. Host plants are the plants that the female butterflies lay they their eggs and larvae feed. Most species of butterflies have evolved to be very selective and will lay their eggs only on one or two specific species of plants, which also serve as a primary food source. Host plants can be susceptible to ground disturbance and threatened by effects of climate change. Changes in temperature extremes and precipitation could affect host plant availability. Fires that burn with low to moderate severity can regenerate flowering plants in fire-adapted ecosystems important for butterflies. Application of pesticides that are used to control nuisance insects, other pests, or to kill target plants are threats to many butterflies if they are not selective or if they affect larval plants or habitat. Certain species of ants prevent wasps from parasitizing butterfly larvae, so the absence and limited abundance of certain ant species can be a limiting factor that limits geographic range and occupied sites. Hobby collecting of butterflies can impact populations and more information needs to be gathered with respect to this potential threat.

Indian Yosemite Snail
National Forest: Sierra

Status: Indian Yosemite Snail is found only in Mariposa County, at the boundary of Yosemite National Park and Sierra National Forest, along the Merced River near the South Fork confluence. In the Sierra National Forest, it occurs along the Merced River about a mile from the confluence with the South Fork of the Merced River, and along the South Fork of the Merced River about a quarter mile from Hite Cove. The main requirements for land snails are moisture, food, shelter and a source of calcium for shell building and physiological processes (Burch and Pearce 1990).

Threats: Connectivity of habitat is important because this species has limited movement capability and is restricted to limited times of the year for movement. Burch and Pearce (Burch and Pearce 1990) suggest refuges may be the most important factor limiting terrestrial snail abundance, which require the right assemblage of habitat components including access to a substrate of calcareous carbonate (often cliffs habitats or talus slopes), sufficient moisture (even in arid environments), and food consisting of herbaceous materials such as decaying leaf litter. Moisture is required for respiration and often hatching of eggs and lack of moisture can serve as a barrier to dispersal; therefore, lack of precipitation due to climate change can be a threat.

Seasonal deep refugia include talus deposits and outcrops, which contain stable interstitial spaces large enough for snails to enter. These seasonal refugia also provide protection from fire and predation during inactive periods (Duncan 2005). As fire severity and intervals increase, degradation, connectivity and loss of habitat for this species will also increase. Since land snails have limited mobility, poor active dispersal ability, and are very sensitive to desiccation, they are highly vulnerable to fire itself and to subsequent habitat destruction (Burke 1999). Intense fires can result in the persistence of only a small fraction of mollusk fauna for many years (possibly a century or more). Less severe fires leaving numerous large, minimally charred logs in the stand result in a greater portion of mollusk survival (Burke 1999).

Warming temperatures and longer droughts associated with climate change is expected. This change will intensify trends in fire, insect and pathogen outbreaks, and drought-related tree mortality. As a result, microsite conditions on rocky steep slopes that include high humidity and moisture would be impacted.

Merced Canyon Shoulderband
National Forest: Sierra

Status: This species is found in the Sierra National Forest in the Merced Canyon area, just south of Portal. There are four small known populations due to terrestrial snails tending to be sedentary. Baker (Baker 1958) claimed "long-distance dispersal of terrestrial gastropods is undoubtedly passive" although short distance dispersal is active involving slow, short-distance migration under favorable conditions. Passive migration of snails via wind, rafting on floating objects, or birds may occur over longer distances and may occur across barriers.

Threats: Connectivity of habitat is important because this species has limited movement capability and is restricted to limited times of the year for movement. Seasonal refugia provide protection from fire and predation during inactive periods (Duncan 2005). As fire severity and intervals increase, degradation, connectivity and loss of habitat for this species will also increase. Since land snails have limited mobility, poor active dispersal ability, and are very sensitive to desiccation, they are highly vulnerable to fire itself and to subsequent habitat destruction (Burke 1999). Intense fire events can result in the persistence of only a small fraction of mollusk fauna for many years (possibly a century or more). Less severe fires leaving numerous large, minimally charred logs in the stand result in a greater portion of mollusk survival (Burke 1999). Warming temperatures and longer droughts associated with climate change is expected. This change will intensify trends in fire, insect and pathogen outbreaks, and drought-related tree mortality.

Environmental Consequences for Terrestrial Species of Conservation Concern

The proposed management actions under each alternative are evaluated in terms of the context, intensity, and duration of the impacts and whether they are considered beneficial or adverse to the natural environment. Evaluating the proposed magnitude of change in the management approach by alternative and potential consequences from the management approaches are described at the planning level by major ecological zones, vegetation types, and species habitat associations.

Consequences Common to All Alternatives

Managing Wildfire

Low and moderate fire mosaics are an important ecological process to maintain and restore wildlife habitats. Due to a history of fire suppression, drought, widespread tree mortality, and climate change, high-intensity, stand-replacing fires have become one of the greatest threats for many forest species of conservation concern.

From 2010 to 2017, U.S. Forest Service aerial detection surveys found that over 52 million trees had died across the Sierra and Sequoia National Forests (United States Department of Agriculture 2017f), with the majority of tree mortality related to drought and bark beetle interactions (Figure 8 and Figure 9). The Forest Service recognizes the need to modify forests and restore fire to the landscape to make habitats more resilient to such large-scale events as high-intensity fire, drought, and insect outbreaks. Using prescribed burning and managing wildfires for resource objectives can directly affect wildlife species if it results in habitat loss or degradation, injury or death, and disturbance or displacement. The context, duration, and intensity of fire treatment effects on wildlife depends on the specific action. Generally, prescribed burning is controlled in a specific area and is of low intensity and short duration. This makes the effects on wildlife short term, with minor impacts on species persistence.

Managed wildfires would depend on local conditions, including the season, weather, place of ignition, accessibility for firefighters, and fire fuel loads. These factors can cause a range of context, intensity, and duration, which may increase direct impacts on wildlife. However, the intent of wildfire management would be to replicate natural processes and to move habitats toward desired conditions and the natural range of variation. With preparation and proper planning, managed wildfires can move wildlife habitat conditions to high ecological integrity and resilience.

There are trade-offs between mitigating short-term impacts through species-specific protection and restricting treatments, and providing long-term habitat resilience through effective, wide-reaching, and fast-paced treatments. The alternatives differ in fire management methods and number of acres to be restored or managed, and they are discussed below.

As with prescribed fire and managed wildfire, mechanical treatments can have short-term direct impacts on wildlife species when implemented at the project level. Access road construction, vegetation removal, soil compaction and erosion, and mechanized equipment use can cause habitat loss or degradation and can harm, injure, disturb, or displace species. Mechanical treatments are primarily intended as a pretreatment for prescribed burning or fire breaks. This is to allow the controlled use of fire to move habitats toward desired conditions or to protect humans or properties. Without mechanical pretreatment to reduce fuel loads and tree density, much of the forest conditions are prone to high-severity fires, which imperil species persistence over the long term. The alternatives differ in the number of acres to be mechanically treated and the guidance to help projects be designed to avoid, minimize, or mitigate site-specific impacts on species of conservation concern.

Vegetation and Fuels Treatments

For all alternatives, vegetation and fuels treatments would generally remove trees for ecological restoration or fuels reduction purposes, and not for timber production as the primary or secondary purpose. The amount of trees cut would vary by alternative, but the types of impacts from vegetation and fuels treatments on wildlife are similar across alternatives. Removing trees and other vegetation and reducing fuels could affect species of conservation concern and other native wildlife through loss and degradation of habitat, disturbance and displacement, and injury and death. All alternatives strive to maintain key ecological features, such as snags and large down logs, and favor retention of trees that are substantially larger and older than most of the trees on the landscape. These larger trees provide greater wildlife habitat for old forest dependent species, although tree variety is important to prey availability.

Changes in forest structure and seral stage can modify wildlife habitat occupancy and use. Depending on the scale and timing of vegetation and fuels treatments, the intensity of impacts can range from minor to moderate on species of conservation concern. Loss or disturbance of nest trees for California spotted owl, northern goshawk, great gray owl, and loss or disturbance to dens for marten could cause reduced reproduction success or direct mortality if timber harvest were to occur during breeding seasons. All alternatives would have direction to protect nest trees for California spotted owl, great gray owl, and northern goshawk, and protect known marten dens.

Wilderness

The alternatives differ in the amount of recommended wilderness and are addressed below. However, the management and effects of designated wilderness would be similar across all alternatives and would be implemented according to existing wilderness management plans. Managing designated and recommended wilderness can benefit species. This would come about by preventing certain ground-disturbing management activities that might reduce habitat quality. Limiting mechanized and motorized activities, such as mountain biking and off-highway vehicle use, could avoid disturbance of individual wildlife during sensitive times of the year, such as breeding periods. However, some disturbance to wildlife will continue, such as high use along very popular trails such as the PCT and John Muir Trail, or high use impacts where popular campsites are located close to meadows, lakes and riparian areas.

Due to limited uses, adverse impacts on species of conservation concern and their habitat are expected to be of minor intensity in designated or recommended wilderness from forest management activities. However, the threat of stand replacing wildfire, insect outbreaks, drought, and other random events that cause widespread tree mortality and loss of quality wildlife habitat would continue at a greater risk than forest areas treated for forest resilience.

In the Sierra National Forest, approximately 5,490 acres (7 percent) of California spotted owl and 370 acres (3 percent) of northern goshawk protected activity centers are in designated wilderness. In the Sequoia National Forest, 4,900 acres (21 percent) of spotted owl and 300 acres (14 percent) of goshawk protected activity centers are in designated wilderness managed by the Forest Service. Protected activity centers for great gray owls are not documented in designated wilderness on either national forest, but comprehensive surveys have not been conducted in many areas. Protected activity centers are current at the time of preparation of this revised draft environmental impact statement and may modify or add protected activity centers with new information.

Most subalpine and alpine, arid shrublands and woodlands, and montane riparian habitats are in wilderness areas. Associated species of conservation concern are Sierra martens and at-risk butterflies. In addition, in the Sierra National Forest, 90 percent of wet meadows are in designated wilderness and contribute to the persistence of many species.

All alternatives encourage managing wildfires to meet resource objectives when it is safe to do so to restore fire as a key ecosystem process, and is the primary strategy in designated and recommended wilderness. This can substantially improve habitat condition, diversity, structure, and vegetation species composition. It uses minimum impact suppression tactics, to the extent possible. It reduces the human impact on wilderness character, which tends to minimize impacts on wildlife habitats. However, the action alternatives provide a clearer plan direction than under alternative A. This should result in more wildfires being managed and more acres having fire restored over time, especially in designated and recommended wilderness areas. Over time this is expected to improve the resilience of habitat by lessening the risk of uncharacteristic changes in habitat from wildfires.

Designated and recommended wilderness management direction can also adversely affect species by preventing or limiting restoration. In areas where vegetation and fuels have been affected by past management, wildfires are becoming increasingly large and often have high-severity impacts on habitats outside the natural range of variation.

Recreation Management

There are differences in the amount and management of recreation by alternative, but the type of impacts from recreation on wildlife are similar for all alternatives (see **Volume 3 Maps**). Hikers, campers, mountain bikers, off-road and over-snow motorized vehicle users, and horseback riders can disturb and displace wildlife (Leung and Marion 2000, Havlick 2002, English et al. 2014). These effects are more pronounced during sensitive times, such as breeding, hibernating, and raising young. Recreation use tends to be highest during spring and summer, which correspond with wildlife breeding and raising young.

Areas such as meadows, cliffs, riparian habitat, lakes and ponds, and rocky outcrops may experience greater impacts than other habitats from increased recreation. This is because these areas tend to receive more intense or frequent use. Human disturbance, including that from various kinds of recreation, such as rock climbing, caving, road and trail use, off-highway or over-the-snow vehicle operation, is a known threat for fringed myotis bats, Townsend's big-eared bats, bald eagles, peregrine falcons, Sierra martens, and great gray owls.

Motorized travel is one of the highest uses on both the Sierra and Sequoia National Forests and can cause death or injury, disturbance, displacement, and habitat fragmentation. The intensity of adverse impacts depends on the type, timing, and location of recreation.

More disturbance by humans to species of conservation concern will occur as recreation use increases with human population growth and continued tree mortality decreases the amount of quality wildlife habitat available. This is more of a concern for those species intolerant of disturbance and with specific habitat requirements, such as Townsend's big-eared bat, or when it occurs in higher value habitats, such as riparian ecosystems.

Range Management

All alternatives maintain the same level of livestock grazing as the current plan under alternative A. Permitted livestock grazing would be managed the same as under current practices unless changed by future project-specific decisions. Range plan direction does not vary across alternatives B, C, D, and E, with range and at-risk species plan direction that is compatible. If negative effects are found, steps to minimize effects of livestock grazing on habitat would be taken.

Consequences Specific to Alternative A (No Action)

Alternative A would continue the current conditions and management. Compared with the action alternatives, current management has limited capabilities to move wildlife habitat toward desired conditions and to address the increasing threat of widespread tree mortality at a landscape scale.

Alternative A continues to take a species-specific approach to habitat protection, in which treatments are limited in California spotted owl, great gray owl, and northern goshawk protected activity centers, and near marten den sites, including in the wildland-urban intermix. Specific requirements and limitations on management actions for protecting at-risk species provide short-term species protection. However, they decrease the Forest Service's ability to restore habitats to the natural range of variation that would allow for long-term species persistence. Habitat quantity is not expected to change under this alternative, but it could be at a risk of loss from large, high-severity fires. Such fires are predicted to increase the most under this alternative.

Vegetation and Fuels Treatments

Treatments to restore vegetation types to within the natural range of variation are generally limited under alternative A. Treatments are focused primarily on reducing fuel volumes and fire risks, rather than on restoring forest condition to the natural range of variation. Treatments would be prioritized, based on the proximity to the wildland-urban intermix where wildlife habitat quality is anticipated to be less due to higher human-disturbance. Most treatments would be in the montane ecological zone, with minor amounts in the upper montane ecological zone, which could disturb species of conservation concern occupying these areas. However, current management direction provides protection for nest trees, dens, and protected activity centers to minimize timber harvest impacts on species of conservation concern.

Since high-severity fires and widespread tree mortality are emerging as the primary threat to forest dependent species, such as California spotted owl, northern goshawk, and Sierra marten, restoring fire mosaics over larger forest areas is needed to provide for long-term species persistence. Under alternative A, only 12,400 acres in the Sierra National Forest are estimated to be restored to low or moderate fire mosaics; 8,500 acres of prescribed burning would be combined with an estimated 3,800 acres of wildfire managed for resources. This is four to seven times less habitat that is resilient to large-scale fires, compared with the other alternatives. For the Sequoia National Forest, only 27,500 acres are estimated to be restored to low or moderate fire mosaics; 1,500 acres of prescribed burning would be combined with an estimated 26,000 acres of wildfire managed for resources.

Alternative A focuses fire management on the wildland-urban intermix zone and addresses specific species protection by setting limitations, such as restricting the removal of trees larger than 30 inches in diameter and limiting the reduction in canopy cover. This would occur in the wildland-urban intermix and would limit vegetation treatments in protected activity centers. These can mitigate short-term impacts and increase protection for sensitive species. However, the imposed restrictions under the current plan have shown to reduce the effectiveness and scale of treatments and to cause more homogenous stand conditions. In the long term, these restrictions reduce the amount of healthy, diverse, resilient habitat and would not provide the structural complexity that many species require for persistence (North et al. 2015).

Under alternative A, 15,000 acres in the Sierra National Forest and 4,500 to 7,500 acres in the Sequoia National Forest are estimated to be treated by mechanical thinning. It would primarily take place in the wildland-urban intermix zone to protect human health and property, with minimal benefit of restoring wildlife habitat. There is species-specific direction pertaining to mechanical treatments that would mitigate short-term effects on sensitive species. Again, these would mostly occur near human communities and would impair the Forest Service's ability to treat more acres for resilience to wildfire, insects, and drought. Under alternative A, mechanical treatments would have limited ability to meet landscape-scale desired conditions for terrestrial ecosystems to address long-term wildlife persistence. Alternatives C and E have fewer acres to be treated mechanically, but prescribed burning to restore habitats, including wildlife habitat, and protect human health and property would be emphasized.

Throughout both national forests the habitat in the montane zone is becoming increasingly dense and homogenized under the current management approach. These conditions are generally the result of decades of fire suppression, relatively slow treatment rates, limited treatment tools, treatments at the patch and stand scale (instead of landscape scale) in the wildland-urban intermix, and requirements to retain all large-diameter trees and dense canopy cover everywhere except in the wildland-urban intermix. These homogenous forest areas do not provide the structural diversity needed to support all aspects of sensitive species survival such as cover for prey species, replacement trees and snags, and openings for foraging.

Because many wildlife species depend on aquatic habitats to varying degrees for survival, it is essential for management to improve these habitats for species persistence beyond current management direction (see Aquatic and Riparian Ecosystems). Without restoration and maintenance, the condition of aquatic habitats would continue to deteriorate from stressors. There could be a loss of structure and species diversity where invasive species or encroaching conifers replace native species that typically support terrestrial wildlife species.

Wilderness

Under the current management plan no new wilderness designations are recommended. Large contiguous habitat blocks are important to support species of conservation concern connectivity, especially those with large home ranges or sensitive to human disturbance. Most of the wilderness areas are in the montane and upper montane ecological zones. They provide quality habitat for mature forest-dependent species, such as California spotted owls, great gray owls, northern goshawks, and Sierra martens. These species would benefit from the added protection designated wilderness provides from disturbances such as mechanized travel (for example, mountain biking), mechanical treatments, road and facility construction, and motorized travel.

Vegetation and restoration management is limited in wilderness areas, which minimizes localized disturbance, but can continue the trend of forest habitat moving away from natural range of variation, with the exception of managed wildfires for resource objectives. Due to the remoteness of wilderness areas and their high vulnerability to fire, wildfires can become uncontrolled, large high-severity fires that completely remove or degrade the quality of large areas of wildlife habitat.

Recreation Management

There is more uncertainty in how new and emerging recreation uses would be adaptively managed under alternative A, compared with the plan revision alternatives, since it would not direct the Sequoia and Sierra National Forests to adequately manage recreation opportunities and settings. For example, there would be uncertainty when and how to respond to changing or emerging unmanaged recreation uses that have potential ecological effects species of conservation concern, since it would likely be addressed on a project-by-project basis through analysis of effects. The plan revision alternatives would have direction for a more adaptive response possible under the action alternatives.

Species-specific Conservation

Management direction under the current plan has intended to protect habitat for California spotted owls and forest carnivores such as marten. However, lack of vegetation treatments or requiring that treatments retain unnaturally dense conditions throughout the landscape makes these species and their habitat more vulnerable to being lost from high-severity wildfire and reduces habitat quality. Recently, large areas of forest carnivore habitat and California spotted owl protected activity centers have been lost to large wildfires. This has resulted in high-intensity, long-term effects that have completely removed forested landscapes, including canopy cover, live trees, and structurally complex understories needed by these species.

Research indicates that areas burned by moderate to high-severity wildfire have an increase in standing snags and shrub vegetation. This, in combination with severe fire weather, promotes reoccurrence of high-severity fires in these areas (Coppoletta et al. 2016). Salvaging deadwood in areas prone to wildfire could be beneficial to reduce the reoccurrence of high-severity fires and aid in the regeneration of forest habitats. With the increase in widespread tree mortality, snags, down logs, and deadwood are more prevalent than when the current plan was created to protect these key ecological conditions. Presently, these features are not as much of a limiting factor for species of conservation concern survivorship as compared with when current management was created.

Following large fires, alternative A provides direction to leave 10 percent of burned areas unsalvaged to provide habitat for species that depend on complex early seral habitats, such as cavity-nesting birds and Sierra martens. Large fire salvage is primarily along roads and near infrastructure related to hazards and public safety, and typically does not exceed 10 to 20 percent of the large burn area. The market value for fire killed trees decreases rapidly with most value lost within 5 years of the fire due to decay. Salvage material is not typically offered until almost half the value is lost. Salvage cannot keep up with the amount of deadwood on the landscapes. Therefore, wildlife is at a greater risk of complete habitat loss due to frequent wildfires or from tree deaths from lowered resilience to drought, insects, or diseases than from losing salvaged deadwood.

Consequences Common to Alternatives B, C, D, and E

Recreation Management

The plan revision alternatives would provide direction to manage recreation through a zoned approach, including the use of direct management techniques in the general recreation area zone to respond when necessary to protect resources like habitat for species of conservation concern. Destination recreation areas have concentrated recreation use, and the plan revision alternatives would include guidance to control capacity limits to protect resources. Direction in the plan revision alternatives would also include managing dispersed recreation activities when evidence of impacts on natural resources emerge; not locate new recreation facilities in at-risk species habitat; and address impacts on at-risk species habitat during project design of recreation developments. Management direction under alternative A would not include managing recreation activities with minimal adverse impacts on sensitive environments and natural resources.

Invasive Species Management

Invasive species management would not differ among action alternatives. The action alternatives would have greater benefit to species of conservation concern, compared with alternative A, which is primarily focused on noxious weeds. The action alternatives’ direction would have expanded direction to recognize threats from all nonnative species, including adverse impacts on species of conservation concern. Alternatives B, C, D, and E would have an objective to treat 300 acres in the Sierra National Forest and 800 acres in the Sequoia National Forests to manage invasive species. This would benefit species of conservation concern and other native wildlife by reducing competition from invasive species and degradation of habitat where invasive species control would be implemented.

Species-Specific Conservation

The development of ecosystem based desired conditions for all species, is that management actions (coarse-filter provisions) that move ecosystem conditions toward the natural range of variation would benefit species persistence. However, for some species this approach may not be adequate, because the historic natural range of variation is not achievable or because of risks not related to habitat. In order to improve conditions for species of conservation concern and to reduce the need for listing new species under the Endangered Species Act, the action alternatives would include specific or fine filter direction. This would improve habitat conditions and refugia for at-risk species and would support self-sustaining populations in the inherent capabilities of the plan area, including minimizing impacts from threats.

Detailed analysis for individual species of conservation concern is found in the “Persistence Analysis for Species of Conservation Concern” in Appendix D. Action alternatives that differ for species-specific components and may cause a difference in impacts on species of conservation concern are addressed under the applicable alternative. However, as determined by the “Species of Conservation Concern Persistence Analysis” no action alternative would alter the species determination outcomes at the population level. However, alternatives C and E have more components to mitigate short-term impacts for individual species protection.

Alternatives B, C, D, and E share the same desired conditions, goals, standards, and potential management approaches for forestwide components for wildlife. These focus on moving wildlife habitats and key ecological conditions to support species of conservation concern persistence throughout the plan areas over alternative A.

Alternatives B, C, D, and E identify vegetation desired conditions designed to provide overall ecological integrity. They include habitat for all associated species and specifically provide the ecological conditions necessary to maintain viable populations of species of conservation concern in the plan areas (see Appendix D). The Forest Service developed a guideline to protect trees that are used for nesting, denning, or roosting by at-risk species. This extends to some adjacent trees that provide necessary shade or other important habitat conditions. In addition, we developed a guideline to consider at-risk species early in the environmental planning process and to consider mitigation and avoidance.

We have developed species-specific plan components for Sierra marten, California spotted owl, great gray owl, and northern goshawk, with some that vary across the alternatives and they are described further under each alternative description. The action alternatives take different approaches to species-specific management with varying levels of exceptions and modifications in different management areas including fire management zones, wildlife habitat management areas, focus landscapes, and recommended wilderness. Depending on where protected species habitat, such as protected activity centers or California spotted owl territories, occur in different management areas determines if the identified species habitat receives low, moderate, high or highest level of protection.

- Low protection would occur in management areas where plan components allow the greatest exceptions or modifications to species-specific protection to prioritize human safety and property.
- Moderate protection would occur in management areas where some exceptions or modifications to species-specific protection would occur to reduce risk to human safety and property, as well as, to implement restoration treatments to achieve desired conditions.
- High protection would occur in management areas where there are minimal or no exceptions or modifications to species-specific plan components to protect species of conservation concern from forest management activities.
- Highest protection would occur in management areas, like in designated or recommended wilderness, where forest management activities are restricted and wildfire is the primary restoration mechanism.

These levels denote protection from short-term localized impacts from forest management activities but do not convey protection from large-scale stochastic events such as climate change, widespread tree mortality, or high-severity wildfire. Areas with high or highest level of species protection may be at greater risk of habitat loss from these stochastic events without forest management restoration.

For some species of conservation concern, we have developed species-specific plan components or have carried them forward from the existing plans; they are the same across alternatives. These species of conservation concern include at-risk bat species, American peregrine, bald eagle, Kern red-winged blackbird, Mount Pinos sooty grouse, tricolored blackbird, willow flycatcher, terrestrial salamanders, and terrestrial invertebrates.

California Spotted Owl, Great Gray Owl, and Northern Goshawk

Although specific plan direction varies, alternatives B, C, D, and E include plan direction to incorporate the findings and recommendations of the Draft Conservation Strategy for the California Spotted Owl (United States Department of Agriculture 2018b). Alternatives B and D allow more project treatment near species than recommended under conservation strategies, but projects are more distributed across the forest and focus on landscape habitat resilience. This would balance potential short-term impacts on individual species of conservation concern with habitat resilience, which is necessary for long-term species persistence.

Sierra Marten

Species-specific plan direction for Sierra martens incorporates recent mapping of combined fisher and marten core habitat and information from the Science Synthesis and Climate Adaptation Strategy for the Sierra Nevada. Much of the marten's core habitat overlaps with wilderness or inventoried roadless areas and would have limited management. Additional desired conditions address management of core habitat to restore and maintain habitat quality and resilience to climate change. Although plan direction related to other species varies by alternative and may also affect marten habitat, alternatives B, C, D, and E include plan direction to maintain and improve Sierra marten core habitat and conserve the key habitat characteristics. All these alternatives contain a guideline to retain overtopping and multi-storied canopy conditions as well as patchy mosaic of shrubs and understory vegetation, but can be modified in management areas.

Fringed Myotis and Townsend's Big-eared Bat

Ecosystem-level plan components provide for key ecological features such as snags and aquatic foraging habitat for at-risk bat species. Plan components to manage recreation opportunities to protect sensitive wildlife would minimize disturbance risk to roosting and hibernating bats. A potential management approach is included in all action alternatives to protect known bat hibernacula or maternity colonies by installing bat gates at mines or caves or restricting access by other means.

American Peregrine

Ecosystem-level recreational goals and guidelines would ensure disturbance to nesting peregrine falcons is minimized through public education, managing recreation activities, such as rock climbing, and planning recreation facilities away from at-risk species breeding habitat.

Bald Eagle

Plan components to improve and maintain aquatic habitats would protect bald eagle foraging habitat to the extent within the Forest Service's ability. Species specific guideline to conserve known nest, roost, or den trees would protect bald eagles nests and breeding.

Kern Red-winged Blackbird and Tricoloured Blackbird

Revised plan direction to control invasive species and maintain or improve aquatic habitats would minimize the loss of quality marsh habitat for blackbirds. Forest plan desired conditions for the South Fork Wildlife Area aim to maintain and improve at-risk species, including Kern red-winged blackbird, conservation.

Mount Pinos Sooty Grouse

Due to limited distribution and population declines throughout the range of Mount Pinos sooty grouse, the Sequoia National Forest may provide important refugia habitat if this subspecies occurs. It is unknown if this subspecies has a viable population in the Sequoia plan area, however, revised plan direction to move terrestrial habitats, especially in the alpine and subalpine ecosystems, toward desired conditions would contribute to sustainable populations where this subspecies occurs.

Willow Flycatcher

Species-specific plan direction for willow flycatcher is similar to existing plan direction that includes survey requirements and livestock grazing direction for occupied sites. Revised plan standards address grazing impacts on willow flycatcher through implementing survey requirements and seasonal limitations on grazing in willow flycatcher occupied sites.

Terrestrial Salamanders

Desired conditions for maintaining adequate habitat features for at-risk species and historic distributions of amphibians would guide forest management activities to conserve at-risk salamanders. Specifically, a forestwide species specific desired condition to provide habitat and refugia for at-risk species with restricted distributions would promote persistence of sensitive terrestrial salamanders.

Terrestrial Invertbrates
Butterflies

Little is known about the current distribution and status of at-risk butterfly species in the forest plan areas. However, revised plan direction to move ecosystems toward desired conditions and control the spread of invasive species would maintain potential habitat and address the primary threats of loss of quality habitat due to invasive plants and climate change stressors. Plan components to create resilience habitats, reduce conifer encroachment to meadows, and protect special habitats for at-risk species would further promote the survivorship of sensitive butterfly species such as Evius blue, Behr's metalmark, and Tehachapi fritillary where they occur.

Indian Yosemite snail and Merced Canyon shoulderband

The primary threats to Indian Yosemite snail and Merced Canyon shoulderband are identified as loss of quality microsite habitat due to recreation and mining, and climate change stressors. Revised plan direction to protect sensitive habitats, such as caves, mines, and talus slopes, and manage recreation opportunities to limit disturbance to sensitive species would provide for the persistence of sensitive snails where found in the Sierra National Forest.

Consequences Specific to Alternative B

Under alternative B, WHMA are established. Management in these areas emphasizes retention and restoration of habitat for old forest-dependent wildlife species in a manner consistent with terrestrial ecosystem desired conditions. The intent is to balance short-term impacts on species of conservation concern with achieving the pace and scale needed for landscape forest resilience. This is done by retaining most California spotted owl, great gray owl, and northern goshawk limited operating periods in the WHMA. The intent is to reduce disturbance risk and short-term impacts on breeding, while allowing more treatments near species than the current plan and distributing treatments across the forest.

Vegetation and Fuels Treatments

Significant portions of important wildlife habitat in WHMAs overlap with the CWPZ. Much of the CWPZ is occupied by species of conservation concern. Conservation of wildlife habitat is needed for species persistence, necessitating a balance between short-term species protection and human safety and property protection. In order to balance the competing objectives of the community wildlife protection zone and WHMA, plan direction is applied differently where these zones overlap. Providing direction in areas that overlap the CWPZ increases restoration and maintenance opportunities, while protecting communities. It also clarifies prioritization of management approaches, when compared with all of the other alternatives, including alternative A.

Under alternative B there would be a slight increase in ecological resilience overall and a moderate increase at sites where restoration occurs in the Foothill, Montane, and Upper Montane Zones (see "Terrestrial Ecosystems"). Improvement from very low or low ecological resilience to moderate resilience can increase the likelihood that wildlife habitats, including those that support species of conservation concern, persist over the long term. In addition, structure and diversity of forest habitats would improve under alternative B. This alternative moves away from creating homogenous habitats, which do not support all aspects of species of conservation concern survival, such as breeding habitat, prey species cover, and forest openings.

Under alternative B, the acres estimated to be restored to low and moderate fire mosaics are 61,000 acres in the Sierra National Forest and 47,000 acres in the Sequoia National Forest. This would improve ecological resilience in treated areas and would reduce the primary threat of wildlife habitat loss due to widespread tree mortality. Alternative B would also mechanically treat 30,000 to 60,000 in the Sierra National Forest and 7,500 to 12,000 in the Sequoia National Forest. This is approximately 2 to 4 times (Sierra) and approximately 1.5 to 2.5 times (Sequoia) higher than under current management. Mechanical treatments would also aim to restore habitat resilience providing long-term wildlife persistence. Timber suitability is limited to outside California spotted owl protected activity centers, conservation watersheds, and riparian conservation areas. These important habitats would be protected from timber harvest impacts and minimize short-term impacts on species associated with these areas.

Under alternative B, 400 acres would be restored for riparian structure and composition, 5 stream miles would be improved for fisheries and other aquatic species, and five meadows would be improved on each forest. Such meadows would support species of conservation concern associated with these habitats by improving the habitat quality. These efforts would have beneficial long-term effects on wildlife and fisheries over current management where there are no similar objectives.

Recommended Wilderness

Alternative B does not recommend any wilderness for the Sierra National Forest and only one addition to existing wilderness in the Sequoia National Forest by adding 4,906 acres to the Monarch Wilderness. These approximately 5,000 acres, mostly in Sierran mixed conifer forests, would be protected from such multiple uses as timber harvesting and motorized recreation. They would be managed with limited treatment and restoration effort, much of the recommended wilderness is already inventoried roadless areas where the risk of management disturbance is already mostly limited.

Species-Specific Conservation

Our detailed analysis for individual species of conservation concern is focused on alternative B plan components. It can be found in “Species of Conservation Concern Persistence Analyses,” in Appendix D.

The action alternatives share many of the same desired condition and similar guidelines for great gray owl, California spotted owl, northern goshawk, and Sierra marten. However, alternative B allows exceptions in community buffers in protected activity centers, territories, or core habitat. The level of protection for species with protected activity centers and core habitat varies by management area. For example, limited operation periods to protect breeding individuals would apply in WHMA where they do not overlap with community buffers. The lowest level of species protection is in the community buffers; this was done to prioritize human safety and control fire. Community buffers have changeable boundaries, based on fire modeling, local conditions, and structure. Therefore, they cannot be mapped. However, all community buffers are in CWPZ and can represent the maximum area of low species protection; in practice, the community buffers would be a smaller area.

Where CWPZ and WHMA management areas overlap there are fewer exceptions to emphasize species protection in identified quality wildlife habitat and the Forest Service expects a moderate level of species protection. This would be done to balance human safety and restoration treatments and to mitigate short-term impacts on species.

California Spotted Owl

As described above different management areas have different levels of species protection from short-term forest management activities. For example, mechanical thinning is allowed in up to 5 to 10 percent in California spotted owl protected activity centers over 10 years. However, mechanical thinning within community buffers does not count toward these percentages. This exception increases the potential for short-term, localized impacts on spotted owls where there is overlap in community buffers. However, in the Sierra National Forest only 7 percent of California spotted owl protected activity center acreage fall in CWPZ and outside WHMA (see Table 79). In the Sequoia National Forest, only 3 percent of California spotted owl protected activity centers are in CWPZ and outside WHMA (see Table 80).

For California spotted owl protected activity centers, 8,940 acres (12 percent) in the Sierra National Forest and 2,430 acres (11 percent) in the Sequoia National Forest are in the CWPZ and WHMA overlap areas with moderate species protection.

Outside the CWPZ, species protection is considered high and has the most documented protected activity centers; the Sierra National Forest has 80 percent of spotted owl and the Sequoia National Forest has 87 percent spotted owl protected activity centers (See Table 79 and Table 80).

Great Gray Owl

In the Sierra National Forest, 3 percent of great gray owl total protected activity center acreage fall in CWPZ and outside WHMA, 790 acres (40 percent) of great gray owl protected activity centers are in the CWPZ and WHMA overlap areas, and 57 percent of great gray owl are outside the CWPZ where species protection is considered high (see Table 79). At the time of forest plan revision and draft environmental impact statement documentation there are no known great gray protected activity centers in Sequoia National Forest.

Northern Goshawk

In the Sierra National Forest, less than 1 percent of northern goshawk total protected activity center acreage fall in CWPZ and outside WHMA. In the Sequoia National Forest, there are no northern goshawk protected activity center acres documented in CWPZ and outside WHMA.

In the Sierra National Forest, 1,130 acres (10 percent) of northern goshawk protected activity centers are in the CWPZ and WHMA overlap areas with low species protections. In the Sequoia National Forest, 740 acres (31 percent) of goshawk protected activity centers are in the overlap area with moderate species protection.

Outside the CWPZ, species protection is considered high and has the most documented protected activity centers for northern goshawk protected activity centers; 89 percent in the Sierra National Forest and 69 percent in the Sequoia National Forest (see Table 79 and Table 80).

Table 79. Sierra Comparison of Species Protection in Different Management Areas by Alternative

Species Protection	Alternative B Inside CWPZ,* Outside WHMA	Alternative B Inside CWPZ* and WHMA	Alternative B Outside CWPZ	Alternatives C and E inside Wildland-Urban Intermix Defense Zones	Alternatives C and E outside Wildland-Urban Intermix Defense Zones	Alternative C Recom-mended Wilderness**	Alterna-tive D Inside CWPZ*	Alternative D Outside CWPZ, Inside Focus Land-scapes	Alternative D Outside CWPZ and Focus Landscapes	Alternative E Recom-mended Wilderness**
PACs level of protection	Low (exceptions in community buffers)	Moderate (some exceptions in community buffers)	High	Moderate	High	Highest	Low (exceptions in community buffers, CWPZ, and Focus Land-scapes)	Moderate (exceptions in Focus Landscapes)	High	Highest
California spotted owl territory protection	Protection limited to PACs	Protection limited to PACs	Protection limited to PACs	Moderate	High	Highest	Protection limited to PACs	Protection limited to PACs	Protection limited to PACs	Highest
California spotted owl PACs (74,376 total)	5,770 acres (7% of total acres)	8,942 acres (12% of total acres)	59,665 acres (80% of total acres)	3,220 acres (4% of total acres)	71,157 acres (96% of total acres)	8,225 acres (11% of total acres)	14,712 acres (20% of total acres)	23,116 acres (31% of total acres)	36,549 acres (49% of total acres)	6,568 acres (9% of total acres)
California spotted owl territories (172,336 total)	N/A	N/A	N/A	7,275 acres (4% of total acres)	165,061 acres (96% of total acres)	23,656 acres (14% of total acres)	N/A	N/A	N/A	16,349 acres (9% of total acres)
Great gray owl PACs (1,945 Total)	56 acres (3% of total acres)	785 acres (40% of total acres)	1,105 acres (57% of total acres)	530 acres (27% of total acres)	1,416 acres (73% of total acres)	6 acres (<1% of total acres)	841 acres (43% of total acres)	350 acres (18% of total acres)	755 acres (39% of total acres)	0
Northern Goshawk PACs (11,598 total)	89 acres (< 1% of total acres)	1,133 acres (10% of total acres)	10,374 acres (89% of total acres)	736 acres (6% of total acres)	10,860 acres (94% of total acres)	1,300 acres (11% of total acres)	1,222 acres (10% of total acres)	4,362 acres (38% of total acres)	6,012 acres (52% of total acres)	1,039 acres (9% of total acres)

*Community buffers are in CWPZ and have the most exceptions for species-specific protection. Community buffers cannot be mapped, due to varying boundaries, based on fire models, structures, and local conditions.

PAC = protected activity center

Table 80. Sequoia Comparison of Species Protection in Different Management Areas by Alternative

Species Protection	Alternative B Inside CWPZ,* Outside WHMA	Alternative B Inside CWPZ* and WHMA	Alt B Outside CWPZ	Alternatives C and E Inside Wildland-Urban Intermix Defense Zone	Alternatives C and E Outside Wildland-Urban Intermix Defense Zone	Alternative C Recommended Wilderness**	Alternative D Inside CWPZ*	Alternative D Outside CWPZ, Inside Focus Landscapes	Alternative D Outside CWPZ and Focus Landscapes	Alternative E Recommended Wilderness**
PACs level of protection	Low (exceptions in community buffers)	Moderate (some exceptions in CWPZ)	High	Moderate	High	Highest	Low (exceptions in community buffers, CWPZ, and Focus Landscapes)	Moderate (exceptions in Focus Landscapes)	High	Highest
California spotted owl territory protection	Protection limited to PACs	Protection limited to PACs	Protection limited to PACs	Moderate	High	Highest	Protection limited to PACs	Protection limited to PACs	Protection limited to PACs	Highest
California spotted owl PACs acres (22,846 total)	586 acres (3% of total acres)	2,427 acres (11% of total acres)	19,835 acres (87% of total acres)	487 acres (2% of total acres)	22,631 acres (99% of total acres)	2,546 acres (11% of total acres)	3,013 acres (13% of total acres)	1,714 acres (8% of total acres)	18,121 acres (79% of total acres)	2,985 acres (13% of total acres)
California spotted owl territories acres (45,548 Total)	N/A	N/A	N/A	1,509 acres (3% of total acres)	44,039 acres (97% of total acres)	5,437 acres (12% of total acres)	N/A	N/A	N/A	6,488 acres (14% of total acres)
Great gray owl PACs (0 total)	0	0	0	0	0	0	0	0	0	0
Northern Goshawk PACs (2,346 total)	0	737 acres (31% of total acres)	1,609 acres (69% of total acres)	212 acres (9% of total acres)	2,134 acres (91% of total acres)	120 acres (5% of total acres)	737 acres (31% of total acres)	133 acres (6% of total acres)	1,476 acres (63% of total acres)	112 acres (5% of total acres)

*Community buffers are in the CWPZ and have the most exceptions for species-specific protection. Community buffers cannot be mapped, due to varying boundaries, based on fire models, structures, and local conditions.

** Recommended wilderness does not include Giant Sequoia National Monument acres.

Note: Protected activity centers, territories, habitat, and linkage acre values are current at time of document preparation and may change over time, based on available information.

PAC = protected activity center

Sierra Marten

Similar to old forest raptors, Sierra marten habitat protections from short-term forest management activities provide exceptions under alternative B. The guideline to retain multi-storied canopy and understory diversity would be exempt in community buffers to prioritize human safety and fire management. All other management areas would implement plan direction to improve marten core habitat.

Consequences Specific to Alternatives C and E

Alternatives C and E share most forest plan direction but differ in recommended wilderness designations. Therefore, the environmental consequences would be the same for most forest management activities; these are combined below. The restoration strategy under alternatives C and E is to use fire as the primary tool to achieve desired conditions. They have fewer short-term impacts on species of conservation concern. However, under alternatives C and E, opportunities to manage prescribed fires and wildfires may be lower. This would be due to a lack of vegetation pretreatment, which narrows the conditions under which fire can safely meet objectives.

Vegetation and Fuels Treatments

Alternatives C and E focus on fewer management and restoration treatments at the landscape scale. These alternatives have the least amount of mechanical thinning; instead, they focus on treatments in the wildland-urban intermix and use patch treatments. This would limit the potential to move wildlife habitat toward desired conditions and toward greater ecological integrity and resilience across the forests compared with alternatives B and D. Alternatives C and E would use more prescribed fire (15,000 to 35,000 acres in the Sierra National Forest and 15,000 to 28,000 acres in the Sequoia National Forest) than under current management of 8,500 acres in the Sierra National Forest and 1,500 acres in the Sequoia National Forest. This would move wildlife habitats toward desired conditions over current management but would restrict mitigation to short-term impacts on species of conservation concern. Under these alternatives, in the Foothill, Montane, and Upper Montane Zones, resilience would continue to be low across most of the landscape. This is because vegetation density would remain high and heterogeneity would remain low. This could result in widespread habitat loss for forest-dependent species (see “Terrestrial Ecosystems”).

Alternatives C and E have the greatest management direction to improve aquatic habitats by restoring riparian structure and composition (4,000 in the Sierra National Forest and 2,000 in the Sequoia National Forest) and improving meadows (15 in both forests), habitat for fisheries and other aquatic species (Sierra 10 river miles, Sequoia 20 river miles), increasing critical aquatic refuges (Sierra 198,600 acres, Sequoia 248,200 acres) and using draft conservation watersheds (Sierra 422,200 acres, Sequoia 381,100 acres). Critical aquatic refuges would increase by 156,200 acres in the Sierra National Forest and 59,400 acres in the Sequoia National Forest, compared with alternative A. These alternatives would limit the types of management activities, such as mechanical thinning and timber harvest, and intensity. Thus, alternatives C and E protect associated species from disturbances and habitat modifications.

Alternatives C and E have the lowest timber harvest objective, and they also designates the fewest acres suitable for timber harvesting. Timber suitability is limited to the areas that are outside California spotted owl territories, which provides a greater area of owl habitat than protected activity centers (see Appendix A). These alternatives would introduce conservation watersheds, expand critical aquatic refuges and retain riparian conservation areas, all of which assist in protecting riparian areas. These highly-productive, yet limited habitats provide greater value for many species of conservation concern, such as great gray owl, willow flycatcher, and Sierra marten.

Recommended Wilderness

Alternative C has the highest amount of recommended wilderness in both forests. It would increase the size of large contiguous habitat blocks in the plan areas and linking areas along the borders, with minimal management and disturbance from forest management activities (see Volume 3: Maps: Alternative C Wilderness Maps). Under alternative C additions to existing wildernesses would connect the Kaiser and Ansel Adams Wildernesses in the Sierra National Forest. It would create a larger contiguous block of mostly montane and upper montane habitats, which could increase habitat connectivity for species associated with these habitat types. Because management activities in wilderness areas would be the most restricted activities and uses, impacts on wildlife, including species of conservation concern, would be minor.

Under alternative C, an additional 8,230 acres (11 percent) in the Sierra National Forest and 2,550 acres (11 percent) in the Sequoia National Forest of California spotted owl; 1,300 acres (11 percent) in Sierra and 120 acres (5 percent) in Sequoia of northern goshawk; and 6 acres (less than 1 percent) in Sierra of great gray owl protected activity centers are in recommended wilderness under Forest Service authority. These values do not include recommended wilderness in the Giant Sequoia National Monument.

Species-Specific Conservation

The action alternatives share the same desired condition and similar guidelines for northern goshawk, great gray owl, and California spotted owl. However, alternatives C and E have a slightly higher level of protection by not allowing waivers and modifications in protected activity centers, territories, and core habitat for species of conservation concern. These include more restrictions on where mechanical thinning can occur and applying limited operation periods with fewer waivers in protected activity centers. Flexibility with fewer restrictions are provided in the wildland-urban intermix defense zones and, to a lesser extent, in the GFZs, but mechanical thinning would still be prohibited within 500-foot radius around nests.

The level of protection for species varies by management area, with exceptions for species protection in the wildland-urban intermix defense zone; this would be to protect human safety and high value resources from fire. However, there are still species-specific plan components to mitigate short-term impacts even in the wildland-urban intermix defense zone, so species protection is considered moderate.

California Spotted Owl

In the Sierra National Forest, 4 percent of spotted owl protected activity center acres are in wildland-urban intermix defense zones. In the Sequoia National Forest, 2 percent of spotted owl protected activity center acres are in these zones. The remaining acres, and vast majority, are outside the wildland-urban intermix defense zones and provide a high level of species protection (see Table 79 and Table 80). High species protection includes few to no exceptions to species-specific standards and guidelines such as limited operating periods, tree diameter thresholds, and canopy retention.

Great Gray Owl

In great gray owl protected activity centers outside the wildland-urban intermix, the Forest Service would allow only low intensity prescribed fire treatments to reduce surface and ladder fuels. In the Sierra National Forest, 27 percent of great gray owl protected activity center acres are in wildland-urban intermix defense zones with the remaining 73 percent outside the wildland-urban intermix defense zones with high level of species protection. There are no currently documented great gray owl protected activity centers in the Sequoia National Forest.

Northern Goshawk

For northern goshawk protected activity center acres, only 6 percent in the Sierra National Forest and 9 percent in the Sequoia National Forest are in wildland-urban intermix defense zones. In goshawk protected activity centers outside the wildland-urban intermix, the Forest Service would allow only low intensity prescribed fire treatments to reduce surface and ladder fuels. Plan components specific to northern goshawk protection under alternative C would reduce short-term impacts but limit the Forest Service's ability for effective restoration treatments and to manage forest areas for desired conditions. For example, mechanical vegetation treatments would not exceed 5 percent per year and 10 percent per decade of the total acres in northern goshawk protected activity centers.

Sierra Marten

Alternative C has the same Sierra marten desired conditions and first guideline, as described under alternative B, but without exceptions. The guideline would apply to areas close to human structures and restrict fire management treatments to prioritize Sierra marten core habitat maintenance. However, since most Sierra marten habitat occurs at high elevation it is unlikely fire management activities would be greatly restricted in areas around human structures. Under alternative C an additional guideline to maintain or increase understory heterogeneity in marten denning habitat and include non-linear edges to decrease potential predation of martens was created for further protect Sierra martens.

Consequences Specific to Alternative D

Alternative D emphasizes restoration in focus landscapes. Treatments in large focus landscapes under alternative D would more rapidly improve the resilience of the greater landscape to wildfire and changing climate conditions than under the other alternatives. Focus landscape treatments not only disrupt the spread of high-intensity wildfires over large landscapes, they also move the vegetation types closer to in the natural range of variation (see "Terrestrial Ecosystems"). This shared emphasis would improve habitat condition for at-risk terrestrial wildlife species over the long-term.

Vegetation and Fuels Treatments

Mechanical treatments and prescribed fire throughout the focus landscapes would restore fire as a process in these areas. Such treatments also would increase the likelihood that, when large wildfires move through these areas, fire severity would be closer to desired conditions and the natural range of variation than in adjacent unrestored areas.

The amount of restoration could be double than under alternative B and more than double what currently occurs under alternative A. Alternative D proposes to restore vegetation at a landscape scale (focus landscapes), which can more effectively improve habitat connectivity for species than alternative A. This also would better enable wildfires to move through the treated landscape in a mosaic pattern, with smaller patches of varying severities of fire effects.

Most of the focus landscape areas would occur in the Montane Zone, because the emphasis is on restoring resilience in old forest habitat that supports California spotted owls, great gray owls, northern goshawks, and Sierra martens. Overall, ecological resilience to large, high-intensity wildfire would move from low resilience under alternative A to moderate resilience under alternative D in the focus landscapes and other areas where larger landscapes are restored (see “Fire Trends”). This improved resilience to drought, high-severity wildfire, insects, and disease would have long-term positive benefits for the habitat condition and quantity of at-risk terrestrial wildlife species associated with mature forest habitat.

Under alternative D most acres are estimated to be restored to low and moderate fire mosaics (90,000 acres for the Sierra National Forest and 102,000 acres for Sequoia). This would improve the ecological resilience in treated areas and would minimize the primary threat of wildlife habitat loss due to widespread tree mortality. Alternative D also has the highest targeted mechanical treatment (45,000 to 90,000 in Sierra National Forest and 9,000 to 18,000 in Sequoia National Forest). This is 3 to 6 times higher in the Sierra National Forest and 2 to 4 times higher in the Sequoia National Forest than under current management. Although short-term impacts on wildlife from mechanical thinning can occur, restoring and treating large landscapes to improve forest resilience and move habitats toward the natural range of variation is critical for forest-dependent species of conservation concern.

Alternative D has the most timber harvest objectives for both forests. To reach these objectives, the Forest Service must open more areas for timber suitability and provide flexibility for species protection.

Under alternative D, conservation watersheds and critical aquatic refuges have been removed, and direction for riparian conservation areas has been changed to allow the riparian conservation areas near ephemeral streams to be included for timber harvesting suitability. This opens approximately 317,000 additional acres in the Sierra National Forest and about 220,000 acres in the Sequoia National Forest in riparian conservation areas as suitable for vegetation treatments using timber harvest. This is compared with existing conditions and other revision alternatives.

These open acres could increase adverse impacts, such as erosion, removal of vegetation, soil compaction, and reduced water quality, on species of conservation concern that use these ephemeral streams. However, Guideline (WTR-RCA-GDL) 09 states “Where at-risk species are present in ephemeral streams, the habitat should be protected by a 25-foot buffer around the habitat,” which would minimize any adverse effects. These impacts would be mostly localized and short term. Timber suitability for harvesting does not include California spotted owl protected activity centers.

Under alternative D, 1,000 acres on each forest would be restored for riparian structure and composition, 5 stream miles would be improved for fisheries and other aquatic species, and five meadows would be improved. These actions would support species of conservation concern associated with these habitats by improving habitat condition and reducing the loss of these limited, yet higher value wildlife habitats. They also would have beneficial long-term effects for wildlife and fisheries over current management, where there are no similar objectives.

Alternative D has the greatest flexibility to remove large-diameter trees, driven by the need to promote the growth and vigor of large or larger trees, to improve resilience, and to increase tree diversity. In addition, although more large trees may be removed in focus landscapes and community buffer fire zones, more large trees could be maintained on the landscape. This would be due to the anticipated decrease in large, high-intensity wildfires and increased vigor of retained trees from lower competition.

Alternative D would have long-term benefits for habitat condition and quantity, with higher short-term and localized impacts on wildlife where treatments occur than other action alternatives. However, the monitoring program would evaluate if adjustments in plan components or the pace or scale of restoration would be needed. These adjustments would ensure that removing large-diameter trees, salvaging trees after a large disturbance, and restoring landscapes at a larger scale and faster pace would provide the ecological conditions that support the persistence of at-risk species.

Recommended Wilderness

Under alternative D, the Forest Service does not recommend any additional areas for wilderness designation and impacts would be the same as described under alternative A.

Species-Specific Conservation

Alternative D prioritizes the increased pace and scale of forest treatments over short-term species protection. It does this by including more waivers for limited operating periods, higher percentages of allowable disturbance in protected activity centers and core habitats, and exceptions in community buffers and focus landscapes.

Limited operating periods to protect breeding individuals where they do not overlap with community buffers and, to some extent, in focus landscapes would provide more flexibility to carry out treatments than under the other action alternatives. This would allow the Forest Service to move more forest areas toward desired conditions and provide long-term species persistence through resilient habitats, but increase potential for short-term disturbance to individual species of conservation concern.

Species protection is lowest in community buffers in the CWPZ; moderate protection occurs outside the CWPZ and in focus landscapes; and high protection occurs outside the CWPZ and outside focus landscapes, where forest treatments do not make exceptions for species protection. Even though alternative D offers the most exceptions to mitigate short-term effects of individual species, most protected activity centers are in high and moderate protection management areas.

California Spotted Owl

In the Sierra National Forest, 20 percent of California spotted owl protected activity centers are in areas with low protection, 31 percent are in areas with moderate protection, and 49 percent are in areas with high protection (see Table 79).

In the Sequoia National Forest, 13 percent of California spotted owl protected activity centers are in areas with low protection, 8 percent are in areas with moderate protection, and the majority of 79 percent are in areas with high protection (see Table 80).

Great Gray Owl

In Sierra National forest 43 percent of great gray owl protected activity centers are in areas with low protection, 18 percent are in areas with moderate protection, and 39 percent are in areas with high protection (see Table 79). No great gray activity centers are documented in the Sequoia National Forest.

Northern Goshawk

In Sierra National Forest 10 percent of northern goshawk protected activity centers are in areas with low protection, 38 percent are in areas with moderate protection, and 52 percent are in areas with high protection (see Table 79).

In Sequoia National Forest 31 percent of northern goshawk protected activity centers are in areas with low protection, 6 percent are in areas with moderate protection, and 63 percent are in areas with high protection (see Table 80).

Sierra Marten

Alternative D has the same Sierra marten specific plan components, including exceptions in community buffers, as alternative B. Therefore, impacts would be the same as described under alternative B.

Consequences Specific to Alternative E

As described in **Chapter 2**, alternative E shares the same plan components and direction as alternative C, except in regard to recommended wilderness. Environmental consequences would, therefore, be the same as under alternative C, except as described below.

Recommended Wilderness

Alternative E is similar to alternative C, except that it includes less recommended wilderness. Recommended wilderness areas would expand the designated wilderness polygons, providing larger contiguous blocks of low disturbance, minimally managed wildlife habitat. However, this would be to a lesser degree than under alternative C. Most of the recommended wilderness areas are in the Montane and Upper Montane Ecological Zones, which provide quality habitat for mature forest-dependent species. Examples are California spotted owl, great gray owl, northern goshawk, and Sierra marten. These species would benefit from the added protection from disturbance uses, such as mechanized travel (mountain biking), timber harvesting, road and facility construction, and motorized travel.

Under alternative E, an additional 6,570 acres (9 percent) in the Sierra National Forest and 3,000 acres (13 percent) in the Sequoia National Forest of California spotted owl and 1,040 acres (9 percent) in the Sierra National Forest and 110 acres (5 percent) in the Sequoia National Forest of northern goshawk protected activity centers are in recommended wilderness under Forest Service authority. These values do not include recommended wilderness in the Giant Sequoia National Monument. There are no additional documented great gray owl protected activity center acres in recommended wilderness under alternative E.

Cumulative Effects

There are several past, present, and reasonably foreseeable future actions of adjacent landowners that can cumulatively affect wildlife persistence through habitat modification over the next 15 years. All past and present actions on National Forest Service lands and surrounding areas have undergone regulatory compliance from Federal, state, and local agencies with an aim to balance multiple land uses with wildlife species protection. It is expected that projects on state and local government managed lands are compatible with wildlife and habitat protection measures, especially with regards wildfire management and adapting ecosystems to climate change.

Most of the lands in the analysis area managed by Federal land management agencies have individual resource management plans or shared, collaborative programs in place. Examples are Inyo National Forest Land Management Plan, Yosemite National Park Management Plans, Sequoia and Kings Canyon National Park Management Plans, and a Strategic Framework for Science in Support of Management in the South Sierra Nevada Ecoregion. These plans are intended to guide the protection of natural resources, particularly for wildfire management, and would provide for terrestrial species persistence. The proposed management approaches under each revised plan alternative are generally consistent with management strategies of other lands in the cumulative analysis area.

Although each plan revision alternative aims to improve ecosystem resilience and move habitats toward the natural range of variation, it is anticipated be more effective in time and scale under some alternatives compared with others. Some alternatives (B and D) prioritize vegetation and fuels treatments over restrictions in sensitive species core habitat and protected activity centers than others (C and E). While alternatives differ in their ability to achieve desired conditions, it is not expected that the management approach under any alternative, combined with actions on other lands, would have an adverse cumulative effects on terrestrial species of conservation concern in the analysis area.

In consideration of changed conditions and widespread tree mortality (see “Agents of Change”) the primary threats to terrestrial species of conservation concern are loss or degradation of habitat and habitat fragmentation due to drought, climate change, insects, disease, and uncharacteristic wildfires. Many agencies in the Southern Sierra Nevada ecoregion are working individually and collaboratively to improve landscape resiliency to climate change stressors and uncharacteristic wildfires.

Alternatives B, C, D, and E emphasize an all-lands-management and shared-stewardship approach to increase the resilience of ecosystems throughout the landscape. Collaborative land management would cumulatively increase the capability of the Sequoia and Sierra National Forests to restore vegetation composition and structure for a greater resilience to environmental stressors. Although alternative C and E have greater emphasis on species protection than alternatives B and D, all revised plan alternatives aim to reduce the potential for large-scale habitat loss through strategic and collaborative management that aligns with state, local, and other Federal regulation to protect species of special concern. For example, the California State Wildlife Action Plan is intended to “help conserve wildlife and vital natural areas before they become more rare and more costly to protect” and has been updated to incorporate climate change impacts and adaptation strategies for state-wide wildlife conservation.

Analytical Conclusion Terrestrial Species of Conservation Concern

Vegetation and Fuels Treatments

In consideration of the increasing trends of widespread tree mortality and vulnerability to high-severity fires, species of conservation concern are at risk of persistence due to habitat loss. Habitat conditions that continue to trend away from the natural range of variation under alternative A and under alternatives C and E, though to a lesser extent, have the lowest adaptive capacity to landscape-scale changes, such as climate change and high-severity fire. Alternatives

A, C, and E emphasize treatments on the patch and stand scale, which does not translate into a greater degree of resiliency that would be achieved with landscape-scale restoration; this is the emphasis under alternatives B and D.

Alternative A would provide a low level of long-term connectivity for forest-dependent species, lower than the other alternatives. This is because it is the least flexible management approach in addressing rapidly changing conditions that could lead to the large-scale loss of contiguous areas of forested habitat. Alternative A increases the potential for forest habitats to deteriorate farther from the natural range of variation. This is due to the relatively slow rate of restoration, the emphasis on treating the wildland-urban intermix rather than strategically treating vegetation across the landscape, and the requirements to retain all large-diameter trees and dense canopy cover everywhere except in the wildland-urban intermix.

Alternative A has the fewest acres treated with prescribed burning, estimated wildfire managed for resources, and restored to low and moderate fire mosaics (see "Revision Topic 1: Fire Management"). Alternative A has slightly higher mechanical thinning projected than alternatives C and E. However, these are focused in the wildland-urban intermix defense zone and not for wildlife habitat restoration (see "Revision Topic 1: Fire Management"). Species, such as Sierra martens and California spotted owls that depend on mature forests with diverse stand structures, would have minimal benefit from treatments under alternative A. The current plan direction cannot provide structurally diverse and resilience wildlife habitat critical for species survival without updated forest management practices.

Compared with alternative A, alternatives C and E have only a slightly higher ability to mitigate the continuing increase in widespread tree mortality and high-intensity wildfires and for ecosystems to build adaptive capacity for climate change. Alternatives C and E are likely to have the least potential for short-term impacts on habitat condition, given the limitations on vegetation restoration and salvage. Under these alternatives, prescribed burning would be emphasized and mechanical treatments would be rare.

Compared with the other action alternatives, C and E are estimated to have significantly less acreage to be restored for forest structure and composition as directed by desired conditions and objectives. Under these alternatives forest treatments to restore forest habitats to desired conditions is minimal. Also, forest management direction is more passive, by setting aside habitats for recommended wilderness (see below), putting limitations on vegetation treatments, and reducing timber harvest volumes. Without forest management to treat landscape habitats, wildlife habitat, especially in the Montane and Upper Montane Zones, would continue to trend away from the natural range of variation and would be prone to continued extensive and widespread tree mortality. Continued habitat loss through high-severity wildfires, drought, insects, and disease would imperil the persistence of all species of conservation concern over the long term.

However, alternatives C and E would have the highest objectives to restore riparian structure and composition (Sierra National Forest 4,000 acres, Sequoia National Forest 2,000 acres), meadows (15 for both forests), habitat for fisheries and other aquatic species (Sierra National Forest 10 river miles, Sequoia National Forest 20 river miles), critical aquatic refuges (Sierra National Forest 198,625 acres, Sequoia National Forest 248,205 acres) and retain existing conservation watersheds (Sierra National Forest 422,180 acres, Sequoia National Forest 381,113 acres). With an emphasis on proportionally higher value, yet limited distribution, wildlife habitats would benefit associated species of conservation concern, such as at-risk salamanders, willow flycatcher, great gray owl, and Sierra marten. It also would benefit numerous species that use riparian corridors for movement and refuge and meadows for hunting and forage. These habitats would still be at risk of degradation from high-severity fires through erosion and runoff, if large high-severity fires were to occur in the watersheds.

Although all action alternatives focus on moving the vegetation types toward desired conditions, alternatives B and D are better positioned to achieve these desired conditions in a shorter time. This is because they take a more active management approach on restoring resilience at a large landscape scale. These alternatives would allow variety of tools that effectively decrease the expected amount of crown and large patches of high-severity fires to the levels expected in the natural range of variation (see Revision Topic 1: Fire Management).

The treatment pace and scale under alternative B would move the landscape to a moderate fire resilience within the first 10 years of plan adoption. The pace and scale of restoration proposed under alternative D would surpass alternative B in moving the landscape to a more resilient position. These alternatives would provide greater long-term species persistence than alternative A and alternatives C and E in building adaptive capacity of the ecosystems to climate change and widespread tree mortality.

Alternative B provides a more cautious approach than alternative D, by tempering the pace of restoration and implementing more fine-filter plan components. This includes more stringent limited operating periods to protect breeding individuals and habitat for at-risk species in the short term (see “Species-Specific Conservation”, below).

Recommended Wilderness

Alternatives A, and D do not include any recommended wilderness and for the Sierra National Forest, alternative B does not include any recommended wilderness. These alternatives would have no beneficial effects for terrestrial wildlife species from recommending wilderness. Under alternative B, one recommended wilderness, the Monarch Wilderness Addition – South (4,906 acres) is included for the Sequoia National Forest.

Alternative C includes the most recommended wilderness. It would provide greater connected habitat blocks and areas of minor human-caused disturbance, compared with all other alternatives. Wilderness areas would, for the most part, be left to natural processes, with minimal active management. Managed wildfires would be the primary method to move ecosystems toward desired conditions. However, as discussed, due to the remoteness of wilderness areas, some wildfires could remove or degrade large areas of wildlife habitat (see “Species-Specific Conservation”, below).

Alternative E includes less recommended wilderness than alternative C, but more than the other alternatives. It would also provide connected habitat blocks and areas of minor human-caused disturbance.

Species-Specific Conservation

Alternatives C and E limit restoration treatments, mainly mechanical thinning, in California spotted owl territories; other action alternatives would limit restoration to protected activity centers only. This would almost double the amount of spotted owl habitat restricted from treatments. These alternatives also have fewer exceptions or flexibility to modify or waive limited operation periods for California spotted owls, great gray owls, and northern goshawks. Most protected activity centers for California spotted owl (96 percent in the Sierra National Forest and 99 percent in the Sequoia National Forest), great gray owl (73 percent in Sierra), and northern goshawk (94 percent in the Sierra National Forest and 91 percent in the Sequoia National Forest) are outside the wildland-urban intermix defense zone. Outside this zone these species would receive a high level of species protection from forest management vegetation and fuels reduction treatments but would still be threatened by habitat loss from wildfire and other stochastic events (see Table 79 and Table 80).

Alternative B provides exceptions for treatment applications in Protected Activity Centers and limited operating periods for California spotted owls, great gray owls, and northern goshawk protections in community buffers areas and CWPZs. The intent is to prioritize human safety. However, most quality habitat for mature forest-dependent species is captured in the WHMA, which would still implement species-specific protection. For example, 75 percent of California spotted owl, 96 percent of great gray owl, and 87 percent of northern goshawk protected activity center acres fall in WHMA in the Sierra National Forest. In the Sequoia National Forest, 64 percent of spotted owl and 86 percent of goshawk protected activity center acres are in WHMA. Under alternative B, there are no documented protected activity centers in the recommended wilderness addition.

Alternative D's management approach has greater potential for short-term impacts on achieving improved habitat condition. It would do this by providing exceptions and flexibility to treatments in protected activity centers and by reducing tree diameter removal restrictions in community buffers, CWPZ, and focus landscapes. Still, 49 percent in the Sierra National Forest and 79 percent in the Sequoia National Forest of California spotted owl, 39 percent in the Sierra National Forest of great gray owl, and 52 percent in the Sierra National Forest and 63 percent in the Sequoia National Forest of northern goshawk protected activity center acres would receive a high level of protection outside the CWPZ and focus landscapes.

Alternative D provides the Forest Service with more adaptive management and flexibility to achieve desired conditions at a greater pace and scale. It does this by relying on the local forester's expertise to implement projects and treatments to balance managing for long-term resilient landscapes and short-term species protection. The evaluation of such a trade-off would best be evaluated over time by a monitoring program and adaptive management techniques.

Species of Conservation Concern Determination Outcomes

The Forest Service must determine whether the plan components required by the 2012 Planning Rule provide the ecological conditions necessary to "contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area."

The Planning Rule sets forth three possible outcomes for the responsible official's analysis of plan components, with respect to species of conservation concern. A fourth outcome may arise when the planning unit staff have developed a set of ecosystem-level plan components that they think would provide for species persistence but also provides supplementary species-specific plan components for greater emphasis and clarity. There are several required components and optional components and content in the plan, such as goals and potential management approaches. These serve as an overall foundation for providing the ecological conditions necessary to support the persistence of species of conservation concern in the plan areas.

Appendix D contains the persistence analysis for species of conservation concern for both forests. It primarily addresses alternative B and analyzes relevant forest plan component effects on each species of conservation concern. It includes a crosswalk table that shows how plan components meet species-specific habitat needs, grouped by the key ecological conditions or habitat elements that species share in common.

Table 81, below, provides a summary of determination outcomes for both forests. If it is unknown whether an existing viable population of a given species is present, then the determination defaulted to being beyond the authority of the Forest Service or not within the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population.

Table 81. Summary of Determination Outcomes for Species of Conservation Concern in Sequoia and Sierra National Forests

Species of Conservation Concern	Forest of Occurrence	Determination Outcome*			
		1	2	3	4
Fringed myotis	Sequoia/Sierra	No	No	No	**Yes**
Sierra Marten	Sequoia	No	No	No	**Yes**
Sierra Marten	Sierra	No	**Yes**	No	No
Townsend's big-eared bat	Sequoia/Sierra	No	No	No	**Yes**
American peregrine falcon	Sierra	No	**Yes**	No	No
Bald eagle	Sequoia/Sierra	No	**Yes**	No	No
California spotted owl	Sequoia/Sierra	No	No	**Yes**	No
Great gray owl	Sequoia	No	No	No	**Yes**
Great gray owl	Sierra	No	No	**Yes**	No
Kern red-winged blackbird	Sequoia	No	No	No	**Yes**
Mount Pinos sooty grouse	Sequoia	No	No	No	**Yes**
Northern goshawk	Sequoia/Sierra	No	**Yes**	No	No
Tricolored blackbird	Sequoia	No	No	No	**Yes**
Willow flycatcher	Sequoia/Sierra	No	No	No	**Yes**
Fairview slender salamander	Sequoia	No	**Yes**	No	No
Gregarious slender salamander	Sierra	No	**Yes**	No	No
Hell Hollow slender salamander	Sierra	No	No	No	**Yes**
Kings River slender salamander	Sierra	No	**Yes**	No	No
Limestone salamander	Sierra	No	No	No	**Yes**
Yellow-blotched salamander	Sequoia	No	No	No	**Yes**
Behr's metalmark	Sequoia	No	No	No	**Yes**
Evius Blue	Sequoia	No	No	No	**Yes**
Greenish blue	Sequoia	No	No	No	**Yes**
Indian Yosemite snail	Sierra	No	No	No	**Yes**
Merced Canyon shoulderband	Sierra	No	No	No	**Yes**
Tehachapi fritillary	Sequoia	No	No	No	**Yes**

*Determination outcomes
1: The ecosystem plan components should provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area. No additional species-specific plan components are warranted.
2. The ecosystem plan components should provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area. Nonetheless, additional species-specific plan components have been provided for added clarity or measures of protection.
3. The ecosystem plan components may not provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area. Therefore, additional species-specific plan components have been provided. The combination of ecosystem and species-specific plan components should provide the ecological conditions necessary to maintain a viable population of the [SPECIES NAME] in the plan area.
4. It is beyond the authority of the Forest Service or not within the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population of the [SPECIES NAME] in the plan area. Nonetheless, the plan components should maintain or restore ecological conditions in the plan area to contribute to maintaining a viable population of the species in its range.

Aquatic Species of Conservation Concern

Background

This section summarizes current conditions of aquatic and semiaquatic animal species of conservation concern in the Sequoia and Sierra National Forests, and the consequences of implementing the alternatives. Similar to other species of conservation concern sections, we evaluate and disclose the potential environmental consequences of the forest plan alternatives on these aquatic species and habitat; evaluating the effectiveness of the alternatives to provide direction to create the ecological conditions to maintain viable populations of species of conservation concern in the plan area. The sections above on "Aquatic and Riparian Ecosystems" and "Terrestrial Vegetation Ecology" cover the general ecological integrity of the ecosystems on which aquatic species of conservation concern depend, while this analysis focuses on effects to individual species.

This evaluation was completed by examining conditions of and threats to individual aquatic species of conservation concern, and also by examining the collective distribution patterns of aquatic species of conservation concern in the plan area, by watershed and by ecosystem. This approach assisted in understanding the broad relationship between a programmatic land management plan and the desired conditions identified for the aquatic species of conservation concern and western pond turtle in the plan area. Desired conditions for aquatic species of conservation concern emphasize habitat that supports self-sustaining populations, precluding the need for listing, and improving conditions for these species

Analysis and Methods

This analysis uses the same ecosystem plan component and species specific plan component approach as the "Terrestrial Species of Conservation Concern" analysis to assess the alternatives' potential for providing the habitat characteristics to support wildlife diversity and the persistence of native species in the plan area. The ecosystem plan component approach (coarse filter) assumes that diversity is broadly dependent on the integrity of the function, composition, and structure of the forest's terrestrial, riparian, and aquatic ecosystems to provide the ecological conditions that support the abundance, distribution, and long-term persistence of native species.

This analysis compares the current abundance and condition of various habitats with ecological reference conditions (natural range of variability) based on the dynamic nature of ecosystems, recognizing they are not static (Landres et al. 1999). It recognizes that disturbances or processes like fire, flooding, insects, and disease, and ecosystem responses to those disturbances, are part of the natural processes. However, integrity of whole ecosystems may not necessarily address all species' needs, so additional analyses were conducted to determine how well species specific (fine filter) plan components provided for the ecological conditions in the forest to address key threats to species persistence.

The analysis area includes all National Forest System lands in the Sequoia and Sierra National Forests' plan areas (as described in Chapter 1). In some cases, the best available scientific information for aquatic species of conservation concern ecological relationships originated outside the analysis area. However, indicator measures and threat information from in the analysis area were used in making conclusions.

Indicators and Measures

For aquatic species of conservation concern, we evaluate the extent and condition of habitat as indicators because they provide a reasonable estimate of ecological conditions needed to support the persistence of species of conservation concern and because relative differences among alternatives could be readily compared.

To evaluate extent and condition of habitat, we relied on findings for environmental consequences from "Aquatic and Riparian Ecosystems," "Terrestrial Vegetation Ecology," and "Fire Trends." The extent and condition of each ecosystem or special habitat type served as the habitat indicator for individual species and for assemblages of aquatic species of conservation concern. However, the ecosystem types outlined in "Aquatic and Riparian Ecosystems" are roughly, but not exactly aligned with watershed characteristics to which aquatic species of conservation concern populations are often associated. Therefore, for some species, we also discuss the extent and condition of watershed characteristics if they better reflect the ecological conditions needed by a species.

Assumptions

- If a species is associated with a particular habitat, then the condition, amount, and distribution of those habitat elements available to the species on the landscape help to predict its distribution and abundance in that habitat.
- Habitat abundance and distribution similar to that which supported associated species during conditions as a consequence of evolutionary time, will likely contribute to their maintenance in the future (Haufler 1999). Therefore, habitat abundance, distribution, and condition similar to that within the natural range of variation for the habitats will likely contribute to species persistence in the future (See also "Aquatic and Riparian Ecosystems").
- The planning time frame for the effects analysis is 10 to 15 years; other time frames may be specifically analyzed depending on the resource and potential consequences.
- In general, the further a habitat is departed from desired conditions (natural range of variation), the greater the risk to viability of associated species. Conversely, the closer a habitat is to desired conditions, the lower the risk to viability of associated species. Therefore, comparing the degree to which the alternatives trend conditions toward desired conditions provides a comparison of each alternative's viability effectiveness.
- For the purposes of analysis, we are assuming the plan components will be implemented as described and objectives will be realized over the life of the plan.

Species Evaluated

For the coarse-filter approach, we grouped species by coarse-scale ecosystems described in the "Aquatic and Riparian Ecosystems." The environmental consequence findings of that section also compared existing and foreseeable future conditions of ecosystems to desired conditions, and this comparison was used as the basis of the coarse-filter evaluation. This coarse-filter approach assumes that viability of species of conservation concern is broadly dependent on the integrity of the ecosystems where they currently occur. However, because integrity of whole ecosystems does not necessarily ensure persistence of all species of conservation concern, particularly those with very limited distribution, we conducted additional fine-filter evaluations (species-specific and by special habitat) to ensure persistence is provided for all aquatic species of conservation concern.

The fine-filter evaluation was conducted by analyzing (1) special habitats that support suites of some species of conservation concern in the national forests, and (2) known threats to each individual species of conservation concern. We grouped species by fine-scale habitats where possible, to enable a fine filter look at ecological conditions that affect populations. We also discussed documented threats that influence species trends in distribution and viability.

There are 12 aquatic species of conservation concern across the Sequoia and Sierra National Forests with some species occurring on both national forests. Table 82 lists aquatic amphibian species, Table 83 lists fish species, and Table 84 lists aquatic invertebrate species. Note that terrestrial amphibian and invertebrate species are discussed in “Terrestrial Species of Conservation Concern.”

Table 82. Aquatic amphibian species of conservation concern

Common Name	Scientific Name	Applicable National Forest
Foothill yellow-legged Frog	*Rana boylii*	Sequoia, Sierra
Kern Canyon slender salamander	*Batrachoseps simatus*	Sequoia
Kern Plateau slender salamander	*B. robustus*	Sequoia
Relictual slender salamander	*B. relictus*	Sequoia

Table 83. Fish species of conservation concern

Common Name	Scientific Name	Applicable National Forest
California golden trout	*Oncorhynchus mykiss aguabonita*	Sequoia
Kern River rainbow trout	*O. m. gilberti*	Sequoia
Central Valley hitch	*Lavinia exilicauda exilicauda*	Sequoia, Sierra
Hardhead	*Mylopharodon conocephalus*	Sequoia, Sierra
Kern Brook lamprey	*Lampetra hubbsi*	Sierra

Table 84. Aquatic invertebrate species of conservation concern

Common Name	Scientific Name	Applicable National Forest
an isopod	*Calasellus longus*	Sierra
Western pearlshell mussel	*Margaritifera falcata*	Sequoia

Affected Environment

Aquatic ecosystems are lakes, ponds, tarns, rivers, streams, meadows, seeps, springs, and riparian areas, which are common throughout the plan areas on both forests. While the El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation are major drivers of climate in California, the ENSO pattern has increased in variability.

When temperature, snowpack, drought, and runoff timing are examined for the Sierra Nevada several concerns have been raised. The elevations considered most vulnerable to climate change in Sierra Nevada are 5,000 to 8,000 feet, due to a loss of snow reflectivity that can amplify warming and snowmelt (Hall et al. 2018). The variability in flows from year to year makes it difficult to detect whether the quantity of water flowing from the two forests is outside the natural range of variation. In the past, the snowpack stored part of the winter precipitation into the drier summer months. A well-documented shift toward earlier runoff in recent decades has been attributed to a decreasing trend in snow precipitation and earlier snowmelt (Hunsaker et al. 2014).

The following sections describe the major types of aquatic habitat environments, as well as the other factors that influence aquatic ecosystems and habitats. It is useful to evaluate the coarse filter approach by grouping species by aquatic habitat types they are most commonly associated with. All aquatic species of conservation concern occur in at least one of the aquatic habitat types and many occur in two or more and some species do not have a strict affinity to a particular habitat type but are identified to the most commonly associated type.

Aquatic Habitats

Sequoia National Forest

In the Sequoia National Forest, on the South Fork, North Fork and mainstem Kern; seven native fishes were found below natural barriers. Native fishes in the Kern River are golden trout, Kern River golden trout, Little Kern golden trout, hardhead minnow, riffle sculpin, Sacramento sucker, Sacramento Pikeminnow, and Central Valley hitch. Elevations less than 2,500 feet are generally part of the pikeminnow-hardhead-sucker assemblage that occurred in Sierra Nevada foothill streams (Moyle 2002). Water temperatures in this transitional area may exceed 70 degrees Fahrenheit during the summer, especially during “dry and critically dry” water years. At higher elevations, when riparian vegetation is intact (Matthews 2016) temperatures are within the range for native trout.

The Sequoia National Forest has only five natural lakes and all of them are in wilderness. These are Maggie Lakes, Weaver Lake, Silver Lake, Bullfrog Lakes and Coyote Lake. Some lakes, such as Bullfrog Lake, have remained with no introduced fish. This lake provides a last refuge for the mountain yellow-legged frog. In previously fishless lakes, the effects of introduced fish caused the loss of frogs from the area (Knapp et al. 2007). Lake Isabella provides reservoir fisheries; these nonnative fish can move upstream without a barrier in place.

Meadows, seeps, and springs in the drier areas of the forests provide important habitat diversity and habitat for plants and animals. There are an estimated 556 meadows in the Sequoia National Forest. Currently, biodiversity indicators such as fish and amphibians indicate some meadows are not in good condition and would benefit from restoration (Frissell et al. 2012, Moyle and Randall 1998, Purdy et al. 2012, United States Department of the Interior 2015a, Viers and Rheinheimer 2011, Vredenburg et al. 2007). Fens are a subset of these meadows where soils rich in organic material form. Springs are plentiful across the forest and are fed by groundwater (Sada and Pohlmann 2002). No systematic study has been made of the springs or their water supplies. Their water temperature is relatively constant and provides the only water over vast areas. Because of this, they are usually biodiversity hotspots, supporting many species that only occur there.

Sierra National Forest

The water that originates in the Sierra National Forest drains to the San Joaquin River system via the Merced, Chowchilla, Fresno and Kings Rivers, along with the mainstem San Joaquin River. Dams are on all major river systems blocking passage from the ocean onto the forest. There are 155 miles of stream in the Sierra National Forest subject to minimum in-stream flows downstream of hydroelectric dams, which can impair habitat for aquatic species. There are 11 large reservoirs (greater than 150 acres), The Sierra National Forest aquatic systems provide habitat for 31 species of fish, many of which are nonnative.

The forest has 21,550 acres of lakes providing a variety of angling opportunities. The Sierra provides reservoir fisheries, high mountain lake fisheries, and both warm and cold-water fisheries. Lakes above approximately 4,000 feet elevation are generally considered “cold-water” fisheries (water temperatures less than 70 degrees Fahrenheit), where anglers may catch rainbow trout, brown trout, or eastern brook trout.

Reservoir fisheries exist where dams established as part of hydroelectric power development or flood control have created lakes. Kokanee salmon are popular to fish for at several large reservoirs above this elevation. However, both Bass and Shaver Lakes develop temperature thermoclines over the course of the summer, which provide temperatures suitable for species from the bass/sunfish (centrarchid) and catfish families.

The historic introduction of trout into lakes and streams throughout the southern Sierra Nevada has had the effect of eliminating the Sierra yellow-legged frog from over 95 percent of its historic range (Knapp et al. 2007).

Meadows, seeps, and springs in the drier southern Sierra Nevada provide important habitat diversity and habitat for plants and animals. Meadows in the Sierra National Forest range from extremely large to tiny meadows around springs. Large, diverse meadow complexes are found in both wetter areas and drier portions of the national forest, because of persistent snowpack and extensive shallow groundwater systems. There are an estimated 15,750 acres of meadow in the Sierra National Forest (United States Department of Agriculture 2001c, 2004b). Wet meadows and fens are important for Yosemite Toads. Springs are fed by groundwater (Sada and Pohlmann 2002), and may be habitat for Sierra yellow-legged frogs especially where they flow into perennial fishless streams. Their water temperature is relatively constant and provides the only water over vast areas. Because of this, they are usually biodiversity hotspots, supporting many species that only occur there.

Status and Threats for Aquatic Species of Conservation Concern

The key ecological conditions and key risk factors for these potential species of conservation concern center around aquatic or riparian habitats, even for the species that have some terrestrial life stages (Table 85). To assist with a broad qualitative analysis, coarse filter approach, species are grouped by the aquatic habitat types they are most commonly associated. All aquatic Species of Conservation Concern occur in aquatic habitats that were discussed above.

For the two species of golden trout, the key risk factor is related to sufficient water quantity and quality in occupied streams, riparian shading, and bank conditions. For Kern Brook lamprey, hardhead minnow, and Central Valley hitch, the key risk factor is related to sufficient water quantity and quality, and is often governed by hydropower. For foothill yellow-legged frogs, the key risk factor is sufficient water quantity and quality. The key risk factor for the western pearlshell mussel is related to clean hard substrates and the presence of salmonids. The risk for the isopod found near Shaver Lake is the ground water fed springs being dried due to diversion nearby or drought. The key risk factors for slender salamanders are drought, loss of snow, ground-based disturbance from a variety of sources could directly impact individuals on the surface or under rocks, logs or forest litter. Large scale changes in habitat may occur by warming and drying conditions associated with climate change. Changes can also occur at the local scale such as streambank impacts from livestock, recreation activities, roads, or trails, which can be important for species with limited populations, occurrence, or limited habitat.

Table 85. Aquatic species of conservation concern, ecological conditions, and primary stressors/threats to persistence*

Species (National Forest)	Primary Ecosystem Assessment or Habitat Types	Special Habitat Needs/Key Ecological Conditions	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
Foothill yellow-legged frog (Sequoia and Sierra)	Rivers and streams in blue oak woodland, chaparral/live oak, black oak/ponderosa pine, montane and meadows	Flowing water, partially shaded rocky streams	Ground disturbance that alters stream morphology and changes in stream temperature; pesticides	Dams and reservoirs, drought, climate change, nonnative amphibians and fishes, pesticides, predation, and parasites
Kern Canyon slender salamander (Sequoia)	Narrow canyons shaded with willows and cottonwoods and hillsides with oak and pine woodlands.	North-facing small wet creek margins, seeps, riparian zones rocky areas in narrow canyons	Habitat impacts and road developments affecting the Kern River canyon. Road and motorized trail construction, user created trails, cattle grazing	Multiyear droughts, county or private lands road construction
Kern Plateau slender salamander (Sequoia)	Seeps, springs, riparian areas, perennial streams, and wet meadows in upper montane and subalpine forests; red fir/lodgepole pine, between 4,690 to 9,190 feet	Perennially wet and moist habitat (riparian conservation areas); associated with rocky outcrops or rock substrate	Ground disturbance that degrades habitat through capping of springs or alterations of spring water like unauthorized OHV travel, road construction, surface mining, vegetation treatments, and fire, predation and disease	Disturbance of permanent seeps/springs associated with stochastic events (drought/flash floods) and climate change; high levels of endemism and naturally limited dispersal ability; Municipal water diversions and alteration of hydrological flow
Relictual slender salamander (Sequoia)	Seeps and springs in black oak/ponderosa pine riparian: mostly of oaks, along with scattered pines, buckeyes and sycamores in creek bottoms	Rocky areas with sparse tree cover; rarely found far from surface water	Ground disturbance that alters stream morphology like unauthorized OHV travel. Fire suppression may increase conifer density and decreasing riparian hardwood and herbaceous vegetation.	Disturbance of permanent seeps/springs associated with random events (drought/flash floods) and climate change

Species (National Forest)	Primary Ecosystem Assessment or Habitat Types	Special Habitat Needs/Key Ecological Conditions	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
California golden trout (Sequoia)	Rivers and streams in montane, upper montane, and subalpine forests	Cold clean water with pooling habitat, undercut banks, and emergent vegetation. Golden Trout Wilderness (South Fork of Kern River and Golden Trout Creek)	Any activities that alter water flow and hydrologic regime (grazing and water impoundments).	Restricted distribution, genetic introgression and competition from nonnative fish species, endemism/localized extinctions, and stochastic events and drying conditions. Climate change (increased water temperatures and susceptibility to wildlife/sedimentation, reduced snow melt/precipitation).
Kern River rainbow trout (Sequoia)	Rivers and streams in montane and upper montane ecosystems	Cold water less than 24 degrees C, with pooling habitat, undercut banks, and emergent vegetation	Degradation of habitat by livestock over grazing and heavy recreation use, including angling	Genetic introgression and competition from nonnative fish species; climate change
Central valley hitch (Sequoia and Sierra)	Rivers and streams, lakes, ponds	Warm lowland, waters, clear streams, turbid sloughs, lakes and reservoirs	Ground disturbance or activities that alter stream flow including recreation, fire suppression, fire, and vegetation treatments; recreation induced water pollution	Dams and diversions contributing to aquatic habitat alteration by blocking aquatic species movement or migration; fragmented distribution; climate change; nonnative species; predation
Hardhead (Sequoia and Sierra)	Rivers and streams, lakes, and ponds in foothill and montane ecosystems	Clear deep streams with a slow but present flow; occasionally clean cool lakes or reservoirs; and gravel and rocky substrate for spawning	Ground disturbance or activities that alter stream flow including recreation, fire suppression, fire, and vegetation treatments; recreation induced water pollution	Dams and diversions contributing to aquatic habitat alteration by blocking aquatic species movement or migration and consequent temperature changes; nonnative species displacement and predation; climate change
Kern brook lamprey (Sierra)	Rivers and streams	Cool lowland waters, clear streams and silty backwaters of large rivers;	Ground disturbance that alters stream morphology like unauthorized OHV travel, road construction, surface mining; road construction	Dams and diversions block aquatic species movement or migration and consequent temperature changes; nonnative species displacement and predation; chemical spills

Species (National Forest)	Primary Ecosystem Assessment or Habitat Types	Special Habitat Needs/Key Ecological Conditions	Primary Stressors under Forest Service Control	Primary Stressors not under Forest Service Control
An isopod (Sierra)	Seeps and springs in upper montane	Cold water conditions from seeps, springs and lakes	Ground disturbance or activities that alter stream flow including recreation, fire suppression, fire, and vegetation treatments; recreation induced water pollution	Disturbance of permanent seeps/springs including climate change and drought /flash floods; nonnative aquatic organism displacement and parasites
Western Pearl shell (Sequoia)	Rivers and Streams	Cold, clean water where salmonids persist. Substrates usually clean cobbles or boulders. Low velocity pools with low sheer stress	Activities such as grazing, water impoundments, dredging, and road construction that affect in stream flow hydrology and increase sedimentation.	Climate change. Water diversions and related actions that reduce/alter hydrologic regimes, including mining operations and suction dredge activities that increase water temperatures.

*The information in this table provides a general summary. Specific information for the species is provided below and are specific to the species and the national forest it occurs.

Foothill yellow-legged frog
National Forest: Sierra and Sequoia National Forest

Status: The foothill yellow-legged frog (*Rana boylii*) is a stream-breeding amphibian that has experienced significant population declines over a large portion of its historical range. The species is absent from many historic locations on both the Sequoia and Sierra National Forests; however, a couple of positive detections were made after 2000 on both forests (Hayes et al. 2016). This species is found in partially shaded rocky streams in a variety of habitats, including blue oak woodland, chaparral/live oak, black oak/ponderosa pine, montane and wet meadows and appear to be highly dependent on clean flowing water for all life stages.

In the Sequoia National Forest, there have been few sightings of foothill yellow-legged frogs since 1980. Although the species was found to be absent from many historic locations in the forest during surveys occurring from 1990 through 2000, positive detections were made after 2000 (see review in (Hayes et al. 2016). The two most recently occupied localities in the Sequoia National Forest consist of unnamed tributaries of the North Fork Kern River, given the names Ash and Jywood Creeks (Hayes et al. 2016). However, foothill yellow-legged frogs may have been extirpated from Ash Creek (Lind et al. 2003). In Jywood Creek, at least two adult foothill yellow-legged frogs were observed during every survey between 1998 and September 2002 (Lind et al. 2003).

The known foothill yellow-legged frogs in the Sequoia National Forest appear to be very few and limited in distribution, and may be near extirpation in the region. In the Sierra National Forest, the foothill yellow-legged frog has not been relocated in six historical localities, however, (Lind et al. 2003) confirmed foothill yellow-legged frogs in the Sierra National Forest in Jose Creek, which is a tributary of the San Joaquin River that is isolated by the presence of upper Redinger Lake at its mouth. Surveys of Jose Creek have been conducted with varying degrees of intensity since the confirmed population there in 1994. Surveys between 1994 and 2003 detected some adults, juveniles or tadpoles every year; the maximum number of adults found was 19 in 1994, with numbers of adults since not exceeding seven. Surveys of historical sites downstream of Sierra Forest Service lands since 1995 have failed to detect foothill yellow-legged frogs (see Hayes et al. 2016).

Foothill yellow-legged frogs in the Sierra National Forest appear to be rare and limited in distribution, and may be near extirpation in the region. Currently, this species is listed as California Species of Special Concern (Thomson et al. 2016).

Threats: Threats are similar on both the Sequoia and Sierra National Forests. Water development and diversions are a primary cause of population declines and a prominent risk factor because they result in hydrological changes that chronically affect the species' life history (Hayes et al. 2016). Changes in stream temperatures or unusual flow patterns can cause high mortality during the egg and larval life stages. The main causes of mortality in eggs are desiccation or scour (Kupferberg et al. 2012). Other primary risk factors are introduced species, climate change, pesticides, parasites, and habitat loss.

Kern Canyon slender salamander
National Forest: Sequoia National Forest

Status: Kern Canyon slender salamander is endemic to the Sequoia National Forest and has a restricted range. The Kern Canyon Slender Salamander is largely restricted to Breckenridge Mountain. This species occurs in seeps and a road to service a timber sale was put through the seep on Breckinridge Mountain over 25 years ago. The population slowly recovered over 20 years. The entire known distribution for *Batrachoseps simatus* is along the lower Kern River and four another locations in Piute Mountain (Jockusch et al. 2012). Currently, this species is listed as California State threatened; and is under review for Federal listing (07/2015 80 FR 37568 37579).

Threats: This species is rarely found far from surface water and changes in precipitation or stream flows could impact micro-site conditions. This species is most threatened by ground disturbance such as widening of roads, temporary road construction, skid trails, new motorized trail construction, that alters grade and the flow of seeps and springs, as well as litter. Previous road widening along the Kern River apparently eliminated habitat for the species.

Additional threats to this species are impacts from climate change, such as decreased snow pack that may alter seeps and streams (Thomson et al. 2016) and multi-year drought (Lannoo 2005). Large scale fire can directly eliminate individuals and localized populations if the severity is high enough to alter seeps and springs, burn soils, or burn large logs. Seasonal timing of managed and prescribed fire also effects the degree of potential effects. Impacts of chytridiomycosis disease on this species is unknown.

Kern Plateau slender salamander
National Forest: Sequoia National Forest

Status: The Kern Plateau slender salamander is endemic to the Sequoia National Forest where it is largely restricted to the Kern Plateau and isolated populations around Sherman Peak and the Scodie Mountains (Wake et al. 2002). This species occurs in perennially wet and moist habitat, usually associated with rocky outcrops or rock substrate. In the drier portions of its range, the spring and riparian habitats it occupies are fragile and vulnerable to damage. Currently, this species is listed as California Special Animal; and is under review for Federal listing (09/2015 80 FR 56423 56432).

Threats: The biggest threats to this species in the Sequoia National Forest are ground disturbing activities that degrades habitat through capping of springs or alterations of spring water, such as unauthorized OHV travel, road construction, surface mining, vegetation treatments, and fire. These factors combined with direct mortality due to predation, disease and increased stochastic fire events of high-intensity, along with climate change, put the Kern Plateau slender salamander at significant risk. Habitat in the Sequoia National Forest may be naturally limited and increased wildland fire events coupled with subsequent flash-floods that scour habitat are also potential risk factors.

The Kern Plateau slender salamander is largely restricted to the Kern Plateau. Habitat in the Sequoia National Forest may be naturally limited and increased wildland fire events may destroy logs and other components of these species habitat. Tree mortality may have changed habitat for these species. Shade from mixed pine and hardwoods would decline making the habitats warmer. Persistence of the salamander populations may be closely tied to climate variations that affect their habitat, warmer temperatures coming earlier can alter the timing of emergence and activity for this species.

Relictual slender salamander
National Forest: Sequoia National Forest

Status: Relictual slender salamander is endemic to the Sequoia National Forest and has the most restrictive range of all slender salamanders. The entire known distribution for *Batrachoseps relictus* is along the lower Kern River and two other locations in Breckenridge Mountain (Jockusch et al. 2012). All currently known populations of relictual slender salamander are above 1,700 meters in elevation, including two along Lucas Creek and one in the vicinity of Squirrel Meadow (Jockusch et al. 2012). On Breckenridge Mountain, the dominant vegetation is pine-fir forest and embedded seeps in upland areas or along streams is where these salamanders were found (Jockusch et al. 2012). The Relictual slender salamander is a California State Special Animal (04/2018). Currently, this species is listed as California Species of Special Concern (Thomson et al. 2016).

Threats: This species is rarely found far from surface water and changes in stream morphology could impact micro-site conditions. This species is most threatened by ground disturbance that alters grade and the flow of seeps and springs, as well as litter. Previous road construction on Breckenridge Mountain apparently eliminated a portion of the suitable microhabitat at Squirrel Meadow (Jennings and Hayes 1994) Jockusch et al. 2012). When the road was built the seep where *B. relictus* had been found was graded over destroying the original site and altering the flow of the seep by filling it with road fill.

Additional threats to this species are impacts from climate change, such as decreased snow pack that may alter seeps and streams (Thomson et al. 2016). Large-scale fire can directly eliminate individuals and localized populations if the severity is high enough to alter seeps and springs. Impacts of chytridiomycosis disease on this species is unknown.

California golden trout
National Forest: Sequoia National Forest

Status: The California golden trout is endemic to Golden Trout Creek and the South Fork Kern River in the upper Kern River basin (Moyle 2002). The distribution of California golden trout in the Sequoia National Forest is restricted to the South Fork Kern River system. Overall numbers may be as low as 5 percent of the original population size (California Department of Fish and Wildlife 2015b). Because the range of the trout has been severely reduced and is limited to two watersheds, this distribution makes the California golden trout vulnerable to stochastic events that can lead to localized extirpations or further reductions in population size. Smaller populations are subsequently vulnerable to inbreeding, which can influence long-term adaptability to changing environmental conditions. Currently, this species is listed as California Special Animal.

Threats: The primary threats to California golden trout are hybridization with rainbow trout and competition and predation by brown trout (Moyle 2002, Stephens et al. 2004). Hybridization undermines the unique genetic integrity of the golden trout, which may result in a loss of locally adapted genes to the species (Stephens et al. 2004). Brown trout compete and prey on the golden trout, even to the point of local extirpations.

The California Department of Fish and Wildlife and the Forest Service have worked cooperatively to improve conditions for golden trout including removal of obviously hybrid fish, the establishment of barriers to prevent the upstream movement of fish other than golden trout, and the planting of sterile rainbow trout in popular recreational fisheries in close proximity to occupied golden trout waters (Stephens et al. 2004). Overgrazing may cause impacts on riparian and bank structure, thereby affecting the instream habitats the trout rely on. Climate change has the potential to further reduce the range of the California golden trout, primarily through increased water temperatures. The impact of recreation on the California golden trout is relatively minor; however, human activities can result in impacts on stream and riparian features and result in the reintroduction of undesirable fish species into occupied golden trout waters.

Kern River rainbow trout
National Forest: Sequoia National Forest

Status: The Kern River rainbow trout is endemic to the North Fork Kern River and tributaries that do not have fish barriers (Moyle et al. 2015). Most populations in the section of the North Fork Kern River, from Johnsondale to the confluence of the North Fork Kern with the Little Kern River, are of mixed genetic origin. A number of populations in the upper Kern River basin still largely represent the native genotype, and these are in Sequoia National Park (Erickson 2013). An effort is underway to reintroduce this native trout to the Upper North Fork Kern River within its historic range. Currently, this species is listed as California Species of Special Concern (Moyle et al. 2015).

Threats: The primary threats to the remaining populations of Kern River rainbow trout are past and continued hybridization with hatchery rainbow trout (*O. mykiss*), and further introductions of hatchery rainbow, brown, or brook trout by anglers into small isolated streams. In addition, continued grazing in riparian areas and heavy recreation use of the basin, including angling, can degrade the Kern River rainbow trout's fragile habitat. Random natural events, such as floods, drought, and fire, can also exacerbate these problems (California Trout 2013), especially in combination with rain-on-snow flooding associated with climate change (Herbst and Cooper 2010).

Central Valley hitch
National Forest: Sierra and Sequoia National Forests

Status: Hitch were once found throughout the Sacramento and San Joaquin valleys in low elevation streams and rivers, as well as in the Delta. Today they are absent from the San Joaquin River and the lower reaches of its tributaries from Friant Dam down to the Merced River (Brown 2000). Habitat requirements for this species are warm, lowland, waters, clear streams, turbid sloughs, lakes and reservoirs. This species is listed as a California Species of Special Concern (Moyle et al. 2015).

In the Sequoia National Forest Plan area, *Lavinia exilicauda exilicauda* occurs in the lower Kern River near Lake Isabella. Population numbers and trend are not known. However, they were found during monitoring in the lower Kern River over the last 15 years.

In the Sierra National Forest, *Lavinia exilicauda exilicauda* occurs from Bass Lake to Millerton Reservoir, however, population numbers and full range extent are not known.

Threats: The biggest threats to this species on both forests are the loss of water quality and quantity due to water management, hydroelectric use, and climate change; fragmentation of habitat, and predation by nonnative species.

In the Sequoia National Forest, the forest manages the lands around Lake Isabella. Four hydroelectric projects are located on the Kern River. These hydroelectric projects are run of the river and influence flows. A weir with an old fish ladder takes water to one of the lower Kern River facilities. This is a downstream barrier for this fish species.

Lake Isabella is a reservoir that was created by the Isabella Dam, which alters connectivity of habitat for native warm water species like the Central Valley hitch, alters timing and temperature of flows in the river, and is a point of introduction for nonnatives into the river systems (United States Department of Agriculture 2013c). Predation by nonnative, introduced fishes found in reservoirs is also a major threat to this species.

In the Sierra National Forest, stream morphology and temperatures may be affected by hydroelectric use. There are 50 dams and diversions in the Sierra National Forest that affect flow over approximately 220 miles of streams. Dams and diversions contribute to aquatic habitat alteration by blocking aquatic species movement or migration, and contributing to genetic isolation (Moyle et al. 2015). There are approximately 155 stream miles in the forest that are subject to flow regulation under licenses from the FERC. Streams under FERC licenses have conditions for providing minimum in-stream flows. However, genetic bottlenecks can occur with lack of connectivity. Water temperatures downstream of dams are affected by volume of flow and temperature of the upstream reservoir. Warming temperatures can further limit distributions of native fishes and other aquatic dependent species (United States Department of Agriculture 2013c).

Hardhead
National Forest: Sierra and Sequoia National Forests

Status: Hardhead were historically regarded as widespread and locally abundant. This species is a California Species of Special Concern (Moyle et al. 2015).

In the Sequoia National Forest, hardhead occurs in the lower Kings River and lower Kern River (Moyle et al. 2015). The abundance and distribution of the hardhead is relatively well documented, and evidence suggests that they are much less abundant than they were historically. Their distribution is also fragmented, with largely isolated populations found in the lower Kern and Kings Rivers, which are isolated from the rest of the range for this species.

In the Sierra National Forest, hardhead occurs on the San Joaquin River, Willow Creek, and Kings River, with the only stable population located in a stream reach between two dams that provide stable aquatic conditions and protections from nonnative fish predators, including sunfish and bass.

Threats: Distribution is scattered, the widespread alteration of these downstream habitats has resulted in localized and fragmented populations that are more vulnerable to localized extinctions (Moyle 2002). The biggest threats to this species on both forests are the loss of water quality and quantity due to dams and other hydroelectric systems.

In the Sequoia National Forest, watersheds containing this species are "functioning at risk" (United States Department of Agriculture 2013c), with habitat fragmentation, flow alteration, nonnative species, road density, and road proximity to water the most common stressors affecting watersheds that are not properly functioning (United States Department of Agriculture 2013c).

In the Sierra National Forest, water quantity and quality, including stream morphology and temperatures, are affected by hydroelectric use, which is expected to increase. Limited dispersal ability of this species and fragmented populations due to dams put it at risk for localized extinctions. Predation by nonnative, introduced fishes is also a major threat to this species; smallmouth bass (*Micropterus dolomieu*) may readily consume juvenile hardhead minnow (Moyle et al. 2015). Recreation activities on and along the San Joaquin River and other areas may be at risk as recreation use increases (United States Department of Agriculture 2013c).

Kern brook lamprey
National Forest: Sierra National Forest

Status: The Kern brook lamprey is endemic to the east side of the San Joaquin Valley, California, with only six known populations that are isolated from one another; five are in short reaches below dams, so their persistence depends on dam operations and maintenance of suitable habitats for ammocoetes.[37] The Kern brook lamprey occurs in the Kings, Merced and San Joaquin River systems in the Sierra National Forest, in extremely isolated population segments. Currently, this species is listed as a California Species of Special Concern.

Threats: The biggest threats to this species in the Sierra National Forest are the loss of connectivity and water quality and quantity due to hydroelectric use. There are 50 dams and diversions in the Sierra National Forest, which affect flow over approximately 220 miles of streams. Dams and diversions may contribute to aquatic habitat alteration by blocking aquatic species movement or migration, and may contribute to species isolation. Other threats are direct mortality due to chemical spills; competition and predation from invasive species; altered flow, temperature changes, or habitat loss due to vegetation treatments, recreation, agriculture; and mining activities and stochastic events including high-severity wildfire and climate change.

[37] The larva of various lampreys

An isopod
National Forest: Sierra National Forest

Status: *Calasellus longus* is an endemic species to the Shaver Lake area, located in the Sierra National Forest. Shaver Lake is not a natural body of water, but a reservoir for water power formed by the Shaver Lake dam. Having evolved long before 1927, *C. longus* is native to the aquifer that supplies the spring from which the isopods were found (Bowman 1981). Currently, this species is listed as a California Special Animal.

Threats: Due to limited distribution, this species is highly susceptible to stochastic events that may increase temperature and result in drying conditions. Activities that divert water flow from springs further isolate populations, putting it at risk for localized extinctions. Predation by nonnative, introduced fishes and frogs is also a major threat to this species. Recreation use in the Sierra National Forest may also pose a risk to *Calasellus longus* and its habitat.

Western pearlshell mussel
National Forest: Sequoia National Forest

Status: The western pearlshell mussel has a broad distribution but is in decline in most of its range and has been extirpated from many known localities. The causes for these declines, although not completely clear, are associated with anthropogenic changes to habitats that either influence physical habitat or the intermediate fish hosts that the mussels rely on for successful reproduction. Western pearlshell has limited localities in the Sequoia National Forest.

Database records in the Sequoia National Forest plan area include two CNDDB records along the South Fork Kern River near Monache Meadows and NRIS record locations along the Little Kern River and the lower Kern River. Favorable ecological conditions can be found in all these rivers because native and introduced trout occur in these systems and are the intermediate host for this mussel. Little information exists on population trends or density the Kern River and its tributaries. Many western pearlshell populations are no longer recruiting new individuals or the recruitment levels are very low and, in some cases, die offs have been observed (Howard and Cuffey 2006, Hastie and Toy 2008, Howard 2008, Jepsen et al. 2012). Currently, this species is listed as a California Special Animal.

Threats: River or stream impoundments probably have had the greatest impact on western pearlshell populations because hydropeaking water releases interrupt streamflow patterns (including timing, volume, and temperature), channel morphology, and influence the presence and density of host fish species. Many types of channel alteration can affect the stability of the streambed where mussels occur including suction dredge mining, gravel extraction, and channel dredging. If these activities occur in or in close proximity to pearlshell beds, the streambed may become unstable and detrimental changes to the channel can occur with effects to water velocity, water depth, and protection from increased shear stress.

Because clear, cold water is a key habitat element required by the pearlshell, climatological changes that result in reduced streamflow, increased water temperatures, or both, may result in a further reduction in suitable habitat for the mussel or appropriate fish hosts. (Vannote and Minshall 1982) and Howard and Cuffey (2006) attributed increased sediment with declines in *M. falcata*, implicating in-channel dredging, logging, and livestock use in the affected watersheds.

Western pond turtle

The western pond turtle is a Regional Forester's sensitive species with several known occurrences in the Sierra National Forest plan revision area and two records in the Sequoia National Forest plan area. This species did not meet the criteria for a species of conservation concern. This species is included in this analysis along with known or potential threats.

Status: The western pond turtle has lost most of its habitat in the Central Valley of California to agricultural activities, flood control, and urbanization. Although most habitat is altered by humans, the Sierra National Forest provides western pond turtle one of its preferred habitats, Sierra Nevada foothill ecosystem type with aquatic habitat. There are over 1,400 NRIS records for western pond turtle in the Sierra National Forest and there are 15 CNDDB records. Many NRIS records are of the same location with repeated sightings. Thompson et al (2016) classified this northern subspecies as Priority 3 (clearly at risk but likely not experiencing substantial and immediate threat of extirpation) and suggest population sizes are stable in several remaining populations in the southern part of the range, and in some areas, declines may have slowed or stopped.

The Sequoia National Forest plan area does not have a lot of western pond turtle's preferred habitat, Sierra Nevada foothill ecosystems with aquatic habitat. There are two NRIS records in the Sequoia National Forest plan area that are from 1998 and located just south of the boundary with the Sierra National Forest. There are no CNDDB or biodiversity information serving our nation (BISON) records in the plan area.

Threats: The western pond turtle is most sensitive to climatic changes and disturbances that fragment or degrade its habitat, which may affect reproduction and survivorship (EcoAdapt 2017). Drought has the ability to affect the persistence of western pond turtles (Purcell et al. 2017). Increased frequency and severity of droughts can affect the resiliency of small, isolated western pond turtle populations (Purcell et al. 2017). These small populations are essential to the long-term survival of the species because of the fragmented distribution of the species. The effects of consecutive years of drought are cumulative over time for this species. Climate change can exacerbate the habitat fragmentation and is likely to have a severe effect on the ability of the western pond turtle to persist in the area.

Environmental Consequences to Aquatic Species of Conservation Concern

Consequences Common to all Alternatives

All alternatives would retain riparian conservation areas with direction that protects permanent and intermittent aquatic habitats by providing guidance for protecting aquatic and riparian species during ground-disturbing management activities in riparian areas. Other than known sites for these species, the risk is high of increased sedimentation of streams across the landscape. All alternatives would promote priority watershed restoration focused on maintaining or improving watershed conditions using the national program for Watershed Condition Framework as funding permits.

Through partnerships, hand thinning of riparian areas could be done along with meadow, and other watershed restoration work. These partnerships and restoration of riparian areas, meadows and streams could benefit riparian species in the short and long term.

Operations of dams, water diversions and groundwater extraction would continue under all alternatives, and there would be no difference in management of these water uses by alternatives.

Therefore, effects to aquatic species of conservation concern would not vary by alternative. Under all alternatives, the forests would continue to work with partners such as the FERC and water users to minimize effects of these activities on species. However, many of these effects are largely outside the control of the Forest Service, and therefore dams and diversions would continue to have major effects to aquatic habitat and species in the forests, through affecting stream flow.

Consequences Specific to Alternative A

The aquatic management strategy would continue to be used to manage riparian habitats according to the riparian conservation objectives to maintain the ecology of riparian areas to buffer sediment from entering aquatic habitats. The number of critical aquatic refuges would remain unchanged, so some watersheds containing refugia or concentrations of rare species would remain outside of a CAR. Because RCAs include most primary habitat for these species, their habitat has the same protections as CARs, but over a smaller area. Without addressing climate change stressors and the influence of various adjacent ecosystems on a larger landscape scale, this alternative makes it more difficult for projects to strategically protect and improve the condition of riparian habitat than the other alternatives.

The effect on aquatic species from livestock grazing should not vary among alternatives B, C, D, and E, because the alternatives have the same livestock management approach, forestwide protections for watersheds, riparian areas and other plan direction to protect species of conservation concern (SCC). The direction to protect aquatic habitat for SCC would allow the forests to manage grazing annually and protect habitat for aquatic species of conservation concern.

Sensitive aquatic species currently on the Regional Forester’s sensitive species list

Western pond turtle is a sensitive species with known occurrence in the Sequoia and Sierra National Forest plan areas, but are not identified as species of conservation concern or a listed, proposed or candidate species under the Endangered Species Act. This species occupies aquatic/riparian habitat. The protections provided by ecosystem plan direction for riparian conservation areas such as limiting soil disturbance and limiting and treating invasive species, would also help protect this species. The low risk of impact for aquatic ecosystem habitat in perennial streams would be expected due to desired conditions, and supporting standards and guidelines that would provide for resilient, diverse and sustainable habitat; maintain water quality, physical integrity and flow of streams; and aquatic ecosystems.

Consequences Specific to Alternative B

Under alternative B, conservation watersheds are introduced as a management area to protect water quality and species habitat. In the Sierra, several of the critical aquatic refugia were not covered by conservation watersheds. Improving water quality for the reservoirs and water users is an important ecosystem service. Forestwide components addressing watersheds, riparian areas, and protections for at-risk species would maintain more specific protection of these species of conservation concern relative to alternative A.

Conservation watersheds are associated with several populations of at-risk species and areas that are priorities for aquatic and riparian restoration. The effects should be a more widespread improvement to habitat conditions, allowing for greater species dispersal and more areas providing refugia to these species. When coupled to forestwide watershed, RCA and aquatic plan components, each operating at different scales, it is expected that the overall approach would have positive effects on species viability and persistence compared with A. Through partnerships, hand thinning of riparian areas could be done along with meadow, and other watershed restoration work. This alternative could benefit ground dwelling species, such as the slender salamanders in the short and long term.

Consequences Specific to Alternative C

Alternative C proposes to designate additional critical aquatic refuges and Conservation Watersheds for both forests (see "Aquatic and Riparian Ecosystem"). Therefore, there would be protection of more aquatic habitat in these designated areas than under alternatives A, B and D for the Sierra National Forest. Additional wilderness or backcountry areas under alternatives C or E further protect water quality and thus aquatic habitat. Overall this is viewed as a positive improvement for aquatic habitats over alternatives A, B and D.

Through partnerships, hand thinning of riparian areas could be done along with meadow, and other watershed restoration work. This alternative could benefit ground dwelling species in the short term. For species associated with seeps and ephemeral streams avoiding the use of fire except when the species are not active in the late fall would benefit these species.

Consequences Specific to Alternative D

Alternative D allows protections on headwater streams only if at-risk species are present. Under this alternative, the reliance on watershed plan direction and the lowered protections on ephemeral streams can degrade aquatic habitat. The lack of riparian protections for ephemeral streams would increase the amount of sediment moving downstream in to aquatic habitats. More treatment in watersheds across the landscape should reduce the acreage that wildfire burns at high severity, and make the landscape more resilient to climate change. By treating more acres of riparian areas the risk of degrading habitat for species that live in these areas is increased. Alternative D may significantly reduce sediment from high or moderate severity fire but these fires are episodic, and temporally spaced by decades on a certain piece of land. For slow moving species that cannot move among habitats easily, destruction of their habitat through crushing or other ground disturbances is long term.

An increase in ecosystem restoration could have short-term and long-term negative consequences to aquatic species, particularly where mechanized treatments are used to restore riparian vegetation. Slender salamanders when their habitat is disturbed by skid trails or temporary roads may not recover or can take up to 25 years to recover. The needs of these species of conservation concern must be balanced against the need to improve resilience through mechanical treatments.

Consequences Specific to Alternative E

Alternative E proposes to designate the same critical aquatic refuges and Conservation Watersheds as alternative C for both forests (see "Aquatic and Riparian Ecosystem"). Therefore, there would be protection of more aquatic habitat in these designated areas than under alternatives A for the Sierra National Forest. All CARs are nested in Conservation Watersheds in the Sequoia National Forest. Additional wilderness areas further protect water quality and thus aquatic habitat. Back country areas where little development occurs would also protect aquatic and riparian habitat. Overall this is viewed as a positive improvement for aquatic habitats over alternatives A, B and D. Through partnerships, hand thinning of riparian areas could be done along with meadow, and other watershed restoration work. This alternative could benefit ground dwelling species in the short and long term.

Species Specific Consequences

Amphibians: (Foothil Yellow-legged Frog, Kern Canyon Slender Salamander, Kern Plateau Slender Salamander, Relictual slender salamander)

These three species have been grouped here based on aquatic and riparian ecosystems they depend on and the similarities in the consequences from the alternatives. The Kern Canyon slender salamander occurs exclusively in the seeps and stream margins around Breckinridge Mountain. The Kern Plateau slender salamander occurs in perennially wet and moist habitat, usually in rocky outcrops or rock substrate. In the forest, these conditions can be found largely on the Kern Plateau. Foothill yellow-legged frogs is an aquatic species restricted to streams and rivers. Important habitat elements are short plant cover, which provides shaded/cooler environments and unobstructed access to still or slowly flowing water; rodent burrows in winter; and shallow marsh and pond waters for breeding.

Alternatives B, C, D, and E propose all three species as species of conservation concern. See Chapter 2 under “Features Common to alternatives B, C, D and E. Species of Conservation Concern.” By doing so, forestwide watershed and aquatic species of conservation concern direction would be strengthened.

Under current plan direction (alternative A), there are no critical aquatic refuges designated for either of the slender salamanders in the Sequoia National Forest. A critical aquatic refuge, Rincon, does exist for Foothill yellow-legged frogs. However, this covers a very small area, compared with their historic range in the Sequoia National Forest. The same CARs found under alternative A, are proposed under alternatives C, and E. Alternative B proposes Conservation Watersheds (CWs). The three species occur in the proposed CWs under B, C and E. The effects on species habitat would improve with CWs under alternative B, C and E.

Direction to protect species of conservation concern, was included under alternative D and would enable species habitat to be protected. The slender salamanders occur in intermittent and ephemeral stream margins as well as seeps and other moist areas, and are difficult to find. Since the RCAs protecting ephemeral habitats are part of timber suitability under alternative D, the negative effects on the slender salamanders would be higher under this alternative for these species. In addition, the possibility of more sediment mobilizing into perennial channels is higher under alternative D. Since foothill yellow-legged frogs are very sensitive to sediment in their habitats, the negative effect could be higher in this alternative than B, C, and E.

Increased vegetation management under alternative D could inadvertently destroy seep or spring habitats through temporary road opening or skid trails. Under alternative B these areas are in conservation watersheds, and these habitats would be protected from temporary road reopening. Springs and seeps are sensitive water features due to their relative rarity, their small area, and their ecological importance relative to their size. Any activities that disrupt water flow puts spring and seep ecosystems at risk. In addition, persistence of the salamander populations may be closely tied to climate variations that affect their habitat, especially if they experience extreme drying trends, or stochastic events such as flash floods. Given their endemism, restricted range and susceptibility to these environmental events, there is substantial concern for these species ability to persist on the planning unit.

Under alternatives B, C, D, and E, several of the creeks that are home to these amphibian species are proposed as eligible wild and scenic rivers (WSRs). The Forest would therefore be required to maintain free flowing condition and the values that make these streams eligible as a WSR. This would provide another layer of protection for these species, as it would prevent activities that would cause major changes to the streams. To ensure persistence, core habitat areas for the slender salamanders could be buffered from active management actions that may have adverse effects (for example, ground disturbing activities). Road widening on county roads or major forest service roads would necessitate the Forest Service evaluating risks to spring or seep habitats and connectivity to minimize effects on these species.

California Golden Trout and Kern River rainbow trout

Potential threats to Golden Trout are addressed by the "Conservation Assessment and Strategy for the California Golden Trout" (Stephens et al. 2004), which the Forest Service would continue to follow under all alternatives. Kern River rainbow trout are being managed in cooperation with the State, U.S. Fish and Wildlife Service, Sequoia - Kings Canyon National Park, the Kern Community Foundation, and stakeholders. Additionally, a Comprehensive Management Plan for the North Fork and South Forks of the Kern Wild and Scenic River (United States Department of Agriculture 1994) provides overall management direction for the Wild and Scenic River. The WSR designation currently designated for the North and South Forks of the Kern River would continue under all alternatives. Under all alternatives the Fish Creek and Trout Creek watersheds (tributaries of the South Fork Kern) are protected areas for South Fork Golden Trout. No CARs or Conservation Watersheds would protect Kern River rainbow trout under alternatives A, or D.

Alternative A would continue to provide direction (for riparian habitat and sensitive species) through its forest plan components to guide management for the continued conservation of both golden trout species. California golden trout and Kern River rainbow trout are Region 5 Sensitive Species. Any projects that may impact these species would be required to complete a biological evaluation and ensure the continued viability of the species in the Forest.

Alternatives B, C, D and E propose golden trout and Kern River rainbow trout as Species of Conservation Concern. This designation would ensure that the forest implements management actions to improve persistence of these species. This is likely to lead to change in effects on the California golden trout, because the forest can restore the watersheds and streams containing these species through partnerships with the State of California and others. Cooperating with the California Fish and Wildlife to reintroduce Kern River rainbow Trout to their historic range should improve the resilience of the species.

Under alternatives B, C, D, and E; Bitter, Fish, and Trout Creeks, home to golden trout, are proposed as eligible WSR. Under alternatives B, C, D, and E; Bone, Brush, Dry Meadow, Freeman, and Nobe Young Creeks, home to Kern River rainbow trout, are proposed as eligible WSR. The forest would therefore be required to maintain free flowing condition and the values that make these streams eligible as a WSR. This would provide another layer of protection for both species of golden trout, as it would prevent activities that would cause major changes to the streams.

Livestock grazing overlaps with golden and Kern River rainbow trout habitat, and would continue under the same management direction under all alternatives. Grazing has been reduced over time, and many legacy impacts on streams in the Kern Plateau have improved and continue to improve. Under all alternatives, it would be expected that potential negative effects from grazing such as bank trampling, stream widening, consumption of willows and other riparian vegetation on stream habitat would continue to improve under plan direction.

Hardhead, Kern brook lamprey and Central Valley hitch

Potential threats from hydropower management to hardhead minnows, Kern Brook lamprey, and Central Valley hitch are partially addressed by alternatives B, C, D, and E. However, since hydropower is not within the authority of the Forest Service, the effects of hydropower management and dams that block connectivity cannot be mitigated for these three species. Protecting riparian conservation areas around perennial streams would provide protections for water quality for these species in the sections of rivers in which they occur.

Alternative A would continue to provide direction (for riparian habitat and sensitive species) through its forest plan components to guide management for the continued conservation of both species. Hardhead minnows and Kern Brook lamprey are Region 5 Sensitive Species; Central Valley hitch is not. Any projects that may impact hardhead would be required to complete a biological evaluation and ensure the continued viability of the species in the Forest. In the Sequoia National Forest, no critical aquatic refuges would protect any of these species under alternatives A. In the Sierra National Forest the Lower San Joaquin CAR could protect these species, but none of the other river systems that connect to the San Joaquin have CARs under alternatives A.

Alternatives B, C, D and E propose hardhead minnows, Kern brook lamprey, and Central Valley hitch as species of conservation concern. This designation would ensure that the forest implements management actions to improve persistence of these species when possible, including working during FERC relicensing to change the management to improve habitat for these species.

Conservation watersheds proposed by the Sequoia National Forest protect watersheds for hardhead and Central Valley hitch under alternatives B, C, and E. The conservation watersheds in the Sierra National Forest may indirectly improve water quality downstream but as several dams occur in the area, the benefit would be unlikely to reach these species. Additional protection for hardhead and Central Valley hitch is provided by the Sequoia National Forest WSR eligibility of the lower Kern River.

However, the biggest threats to these species on both forests are water management, hydroelectric use, dams, and climate change, all of which make it difficult to maintain these species in the plan area.

Aquatic Invertebrates: Western Pearlshell, *Calasellus longus*

These species were grouped due to their dependence on specialized aquatic habitat.

Neither the western pearlshell nor the isopod, *Calasellus longus* was identified on the Region 5 Sensitive Species list. The current forest plan provides standards and guidelines that generally limit disturbance and impacts in riparian conservation areas for the protection of springs, streams and rivers. Since neither species is currently a Region 5 sensitive species, neither species would be specifically considered in project planning under alternative A.

Both species are proposed species of conservation concern in the action alternatives (see Chapter 2, under "Features Common to alternatives B, C, D, and E. Species of Conservation Concern."). This designation would ensure that the Forest implements management actions to improve persistence of the species. Since western pearlshell and *Calasellus longus* have no special status under alternative A, this designation could improve habitat for both species under the action alternatives. It would be specifically analyzed and management actions would specifically consider effects on this species. One population of western pearlshell is found in existing wilderness, the Golden Trout Wilderness, which confers a protection on the watershed. The lower known population on the lower Kern River would be protected by the WSR eligibility of this section of river. An additional protection of a Conservation Watershed is provided under alternatives B, C, and E for both populations of western pearlshell in the Sequoia National Forest.

Calasellus longus has a severely restricted range in the springs near Shaver Lake and should be protected from cattle and vegetation management. This species may need fine scale species-specific plan components to protect it.

The National Forest has a number of ecosystem level and species specific plan components in place to mitigate risks within its management authority, but cannot mitigate all threats for persistence. Based on this evaluation, the final set of ecosystem plan components and the additional species-specific plan components, when carried out, would provide the necessary ecological conditions to maintain viable populations of Western Pearlshell and the isopod, *Calasellus longus* in their range.

Cumulative Effects

The analysis area is part of the greater southern Sierra Nevada ecosystem and is the vast majority of lands are administered or owned by the several Federal agencies, the State of California, water and power utilities, several Native American tribes, and private landowners. The present and foreseeable actions of these public land management agencies and private landowners would determine the cumulative consequences to aquatic habitat conditions.

Most land in the analysis area that is managed by Federal land management agencies have individual resource management plans or shared, collaborative programs in place to guide the protection of natural resources, particularly in the management of wildfires. The focus of the 2012 Planning Rule on ecosystem integrity, resilience, and diversity is in close alignment with new direction for the National Park Service, which is to build ecosystem resilience for coping with changing climates. The “Strategic Framework for Science in Support of Management in the South Sierra Nevada Ecoregion” was developed collaboratively by Federal land managers in the Southern Sierra Nevada ecoregion (including the Sierra and Sequoia National Forests and Giant Sequoia National Monument) to help mitigate impacts from, and adapt to, climate change (Nydick and Sydoriak 2011a, b).

The operators of the various dams associated with rivers in the analysis area adapt their operations to meet Federal Energy Regulatory Commission relicensing requirements and to address effects of climate change on runoff and base flows. Alternatives B, C, D, and E require working collaboratively with the Federal Energy Regulatory Commission and the power companies to minimize the effects of stream diversions or other flow modifications on aquatic species of conservation concern. These collaborations would help maximize improvement to species of conservation concern habitat, within the constraints of existing infrastructure. Continued hydroelectric dam operation would continue to fragment habitat; causing isolation of populations and susceptibility to stochastic events. These cumulative effects would continue under all alternatives. Potential threats from hydropower management to hardhead minnows, Kern Brook lamprey, and Central Valley hitch are partially addressed by alternatives B, C, D, and E. However, since hydropower is not within the authority of the Forest Service, the effects of hydropower management and dams that block connectivity cannot be mitigated for these three species.

Analytical Conclusion

The alternatives considered in detail outline different approaches to achieving the overall set of desired conditions for maintaining and enhancing aquatic habitats and persistence of aquatic species. This section summarizes how well these alternatives are expected to achieve these desired conditions expressed in terms of the quality and quantity of aquatic habitats.

For most species, plan components describe broad desired conditions that would provide for the ecosystem fabric to support a sufficient distribution of individuals of species of conservation concern and their habitat so that species are resilient to stressors and are likely to persist into the future. Plan components aim to maintain or restore the diversity and connectivity of ecosystems and habitat types throughout the plan area. Connectivity of habitat across the landscape, which drives species distribution, is supported by the plans. For species that are endemic and have a limited area, fine-filter (special habitat-specific) plan components complement large scale direction to maintain these rare species. Finally, when necessary, project-level protections are an option. As a result, each threat in each ecosystem for each species of conservation concern identified has been addressed or mitigated in at least one plan component in each alternative, so that the persistence of each species is provided for.

If, during the life of a plan, it is found that plan components are not sufficient to ensure the persistence of species of conservation concern, the monitoring program developed for the plan should detect this and changes to the plan components would be considered to address the issue.

Aquatic Species of Conservation Concern Outcomes

The persistence determinations for aquatic species of conservation concern is summarized below from the persistence analysis for animal species of conservation concern in Appendix D in Volume 2. The conclusions of the persistence analysis is based on the ability of plan component direction to protect water flows, manage invasive species, improve ecosystem resilience to climate change and other events outside the control of the Forest Service, and to collaborate with other agencies and organizations to restore and maintain at-risk species and their habitat.

The persistence analysis found that for Kern Canyon slender salamander, Kern Plateau Slender salamander, and hardhead: The ecosystem plan components should provide the ecological conditions necessary to maintain a viable population of these species of conservation concern in the plan area. Nonetheless, additional species-specific plan components have been provided for added clarity or measures of protection or both. It is within the inherent capability of the plan areas to maintain or restore the ecological conditions to maintain a viable population of these species in the plan area over the duration of the forest plan.

For foothill yellow-legged frog, relictual slender salamander, California golden trout, Central Valley hitch, Kern Brook lamprey, Kern River rainbow trout, western pearlshell, and the isopod: It is beyond the authority of the Forest Service or not within the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population of these species of conservation concern in the plan area. Nonetheless, the plan components should maintain or restore ecological conditions in the plan area to contribute to maintaining a viable population of the species within its range.

The detailed analysis for each species of conservation concern is in Appendix D. Implementing the emerging plan components, which are similar under the plan revision alternatives, would provide the necessary ecological conditions to maintain viable populations of these species. Forestwide ecosystem plan components support natural ecological processes, functions, and biodiversity, and promote ecological conditions that are resilient to climate change and other stressors. Additional ecosystem plan components provide area-specific desired conditions and management direction, and are tailored to specific ecosystem types or management areas, including providing ecological conditions that support persistence of species in aquatic and riparian areas. Disturbance processes (such as fire) and management activities (such as grazing and recreation) are addressed by ecosystem and other plan components.

Species-specific plan components provide additional direction to mitigate risk to persistence from land management activities, particularly to protect habitat from impacts of livestock grazing or vegetation treatments.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and at-risk species-specific) to provide for ecological conditions that contribute to the persistence of aquatic species of conservation concern in the plan area, or, where it is beyond the authority of the Forest Service or not within the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population of these species in the plan area, contribute to maintaining a viable population of the species within its range.

Plant Species of Conservation Concern

Background

This section summarizes current conditions of plant species of conservation concern in the Sequoia and Sierra National Forests, and the consequences to at-risk plants of implementing the draft forest plans or the alternatives. Similar to other at-risk species sections, we evaluate and disclose the potential environmental consequences of the forest plan alternatives on plant species of conservation concern and habitat; evaluating the effectiveness of the alternatives to provide direction to create the ecological conditions to maintain a viable population of species of conservation concern in the plan area. As previously discussed, the need for plan revisions is guided by three primary topics: ensure ecological integrity, which addresses the need to restore the resilience of vegetation and aquatic and riparian ecosystems to fire, drought, and climate impacts; restore plant habitat and diversity; and reduce the risk of wildfire impacts on species habitat. The alternatives present a range of approaches that address the revision topics and issues, including the issues related to plant species of conservation concern and habitat.

"Terrestrial Ecosystems" and "Aquatic and Riparian Ecosystems" cover the ecological integrity of the ecosystems on which plant species of conservation concern depend and evaluate the consequences of implementing the alternatives on various taxa[38] by integrating an analysis of wildlife, aquatic, invertebrate, and plant species. In this section, the evaluation was completed by examining conditions of and threats to individual plant species of conservation concern, and also by examining the collective distribution patterns of at-risk flora in the plan area, by biogeographic region and by ecosystem. This approach assists in understanding the broad relationship between a programmatic land management plan and the desired conditions identified for at-risk species.

Analysis and Methods

The analysis area includes all National Forest System lands in the Sequoia and Sierra National Forests' plan areas (as described in Chapter 1). In some cases, the best available scientific information for plant species of conservation concern's ecological relationships originated outside

[38] Groups or ranks in a biological classification into which related organisms are classified.

the analysis area. However, we used indicator measures and threat information from in the analysis area in making conclusions.

Indicators and Measures

For all plant species of conservation concern, we identify the extent and condition of habitat as indicators. This is because extent and condition of habitat are direct measures of ecological conditions needed to provide for persistent populations, typically constitute the best available scientific information indicating whether such populations will continue to persist with sufficient distribution in the plan area (36 CFR Sec. 219.19), and because relative differences among alternatives could be readily compared.

Qualitative rather than quantitative comparisons are made because the known distribution of many species is not spatially mapped and the programmatic nature of a forest plan does not direct activities in particular locations. To evaluate extent and condition of habitat, we relied strongly on the findings for environmental consequences in "Terrestrial Ecosystems" and "Aquatic and Riparian Ecosystems." In other words, the extent and condition of each ecosystem or special ecosystem type served as the habitat indicator for individual species, and for assemblages of plant species of conservation concern and overall floristic diversity. However, although the ecosystem types outlined in "Terrestrial Ecosystems" and "Aquatic and Riparian Ecosystems" are roughly aligned with floristic geographic subdivisions (Baldwin et al. 2012), to which at-risk plant populations are often associated, they are not exactly aligned. Therefore, the extent and condition of floristic geographic subdivisions themselves are also discussed to reflect the habitat indicators.

Determinations for each species of conservation concern consist of a persistence analysis, which examines whether plan components provide ecological conditions necessary to provide for the persistence of each species in the plan area. This information is found in "Analytical Conclusions" and Appendix D in Volume 2 of this RDEIS. It is important to note most of the plant species of conservation concern have small occurrence numbers or limited distribution. For these species, associated threats can cause substantial concern for persistence in the plan area. Threats, especially a stochastic event, could affect a substantial proportion of species with low occurrence or limited distribution in a plan area.

As described at the beginning of this section, the primary context for the evaluation of at-risk species, including species of conservation concern, is that forest plan direction for ecological conditions provide for ecosystem integrity and ecosystem diversity. The 2012 Planning Rule requires that forest plan direction be integrated across resources and that the forest plan needs to provide for the ecological conditions that will provide for the persistence of at-risk species within the inherent capabilities of the national forest plan area (36 CFR Sec. 219.5 and 219.8-219.9). The evaluation of forest plan direction that provides for plant species of conservation concern persistence is done first by examining the ecosystem level plan direction, conducted using habitat extent and condition as indicators. Where needed, individual species-specific plan direction is added.

For the ecosystem level approach, species were grouped by ecosystems described in "Terrestrial Ecosystems" and "Aquatic and Riparian Ecosystems" and are discussed in this section. The environmental consequence findings of those sections also compared existing and foreseeable future conditions of ecosystems to desired conditions, and this comparison was used as the basis of the coarse filter evaluation. This ecosystem approach assumes that persistence of species of conservation concern is broadly dependent on the integrity of the ecosystems where they currently occur.

Because integrity of whole ecosystems does not necessarily ensure persistence of all plant species of conservation concern, particularly those with very limited distribution, we conducted additional analyses by special habitat or species-specific direction to ensure that persistence is provided for all plant species of conservation concern. The fine filter evaluation was conducted by analysis of (1) special habitats that support suites of some species of conservation concern, and (2) known threats to each individual species of conservation concern. Species were grouped by fine-scale habitats where possible, to enable a fine filter look at ecological conditions that affect populations. Documented threats that influence species trends in distribution and persistence were also evaluated. The plant rationale documents (United States Department of Agriculture 2019c, d) list each species' ecosystem, NatureServe rank, threats, and the occurrence information. Known threats to species of conservation concern were compared qualitatively by alternative.

For species that were previously listed as Forest Service Pacific Southwest Region sensitive species, but which were not identified as at-risk species under the 2012 Planning Rule, a summarized rationale is provided in Table 74, and a more detailed rationale is found in the rationale documents (United States Department of Agriculture 2019c, d).

Analysis Area

In general, the analysis area for indirect effects includes the portion of the Sequoia National Forest that is undergoing plan revision and all lands managed by the Sierra National Forest; however, for the purposes of this document it may include areas outside the national forest boundaries.

Assumptions

- The fundamental premise is that forest plan components for ecosystem integrity and diversity would provide the ecological conditions to maintain the diversity of plant and animal communities and to support the persistence of most native species in a plan area.
- The farther a habitat has departed from desired conditions, the greater the risk to the viability of its species; conversely, the closer a habitat is to desired conditions, the lower the risk to the viability of its species. Therefore, comparing how the alternatives achieve the desired conditions provides a comparison of each alternative's effectiveness.
- Coarse-filter plan components that largely center on desired conditions within the natural range of variation are expected to provide for the conditions to maintain the persistence or contribute to the recovery of native species in the plan area, including species of conservation concern, over the long term.
- Plan components would be implemented as described and objectives would be realized over the life of the plan. The Forest Service may be able to achieve more than what is defined in an objective depending on funding availability, improvements in methods, and support through partnerships.
- Relevant considerations to the analysis that are common to all alternatives are existing wilderness will continue to be managed as such; there will be a general increase in recreation demand as the human population size increases; weeds and weed seeds will continue to be deposited and spread onto and in the plan area; and climate change trends will continue as projected, with warming temperatures and reduced snowpack.
- Funding will be available to implement restoration measures, including nonnative invasive plant treatments identified as priorities because they pose substantial threats to the persistence of at-risk plant species.

Species Evaluated

There are a total of 80 plant species of conservation concern for the Sequoia and Sierra National Forests, with some species occurring on both forests. The plant species of conservation concern comprise 67 flowering plants; 5 ferns, 7 mosses and 1 conifer (Table 86). Over 150 botanical species were considered for species of conservation status (FSH 1909.12 § 12.52c-d), as documented in the rationale documents for plant species considered for species of conservation concern for the Sequoia and Sierra National Forests (United States Department of Agriculture 2019c, d). Each national forest has their own list of species of conservation concern; the number and types of botanical species for each of the Sequoia and Sierra National Forests is displayed in Table 87 and the list of plant species of conservation concern[39] is presented in Table 89, in "Affected Environment."

Table 86. Numbers of plant species of conservation concern for Sequoia and Sierra National Forests' plan areas combined

Number of Flowering Plants	Number of Ferns	Number of Mosses	Number of Lichens	Number of conifers	Total Number of Plants
67	5	7	0	1	80

Table 87. Numbers of plant species of conservation concern, by national forest and by life form

National Forest	Number of Flowering Plants	Number of Ferns	Number of Mosses	Number of Lichens	Number of Conifers	Total Number of Plants
Sequoia	44	1	3	0	1	49
Sierra	35	5	5	0	0	45

Columns should not be totaled in this table because many species occur on both national forests.

Under the current forest plan, rare plants are provided for according to the direction for Region 5 sensitive species. Of the 101 Region 5 Regional Forester sensitive plant species that occur in the Sequoia and Sierra National Forests plan areas, 68 are carried forward as species of conservation concern. In addition, 12 species not previously categorized as Region 5 Regional Forester sensitive species met the criteria as species of conservation concern.

The species of conservation concern lists are specific to each national forest, and species must be known to occur in the plan area. For that reason, a sensitive species may meet the criteria and identified as a species of conservation concern on one national forest, while not meeting the criteria on the neighboring national forest due to no known occurrence. Thirty-five sensitive plant species had no known occurrence in the Sequoia and Sierra National Forests.

In addition, 11 sensitive plant species did not meet the criteria of a species of conservation concern for the Sequoia and Sierra National Forests. This was due to insufficient information or sufficient information indicating the plant species is abundant and no longer considered threatened or rare. The specific reasons a sensitive species was determined to meet or not meet the established criteria as a species of conservation concern are provided in the plant rationale document for each forest (United States Department of Agriculture 2019c, d).

[39] Pacific Southwest Regional Forester signed lists in 2019.

Affected Environment

Floristic Diversity

The flora of the plan area is notably diverse, reflecting the area's complex geology, topography, and climate. The close juxtaposition of such variable habitats has created opportunities for genetic isolation and subsequent evolution. As a result, the area has a high level of endemic species (unique to a place or region) relative to other regions of the United States (California Native Plant Society 2015). The plan area is situated in the California Floristic Province (Baldwin et al. 2012).

Because many species of conservation concern have a greater affinity for floristic geographic subdivisions (like provinces) than for ecosystems, some detail is provided here on the subdivisions, which assisted in the evaluation of habitat condition and extent. Figure 50 and Table 88 show the floristic geographic subdivisions represented in the plan area (Baldwin et al. 2012). Spatial datasets are used with permission from the Jepson Herbarium (Jepson Flora Project 2015). The Sierra Nevada region occupies the majority of the plan area and is characterized primarily by igneous geology. The Sierra Nevada Foothills subregion borders the Great Central Valley region to the west, and is characterized by blue-oak/foothill-pine woodlands and chaparral. It contains some serpentine areas, but is mainly differentiated from the rest of the Sierra Nevada by its distinct flora, rather than climate or geology (Baldwin et al. 2012). The High Sierra Nevada subregion is topographically complex, spanning nearly 10,000 feet in elevation. Vegetation may be dominated by ponderosa pine, mixed conifer, Jeffrey pine, red fir, lodgepole pine, mountain hemlock, whitebark pine, foxtail pine, or western white pine. Treeless alpine areas, meadows, and riparian areas, are also common.

Plant species of conservation concern occur in all floristic geographic subdivisions and in all ecosystem types. Some hotspots of diversity can be identified in the two national forests. For example, the Merced River Canyon metamorphic soils and subalpine carbonate soils in the Sierra National Forest. The southern High Sierra Nevada subregion also supports some pinyon pine and sagebrush, found in the arid shrublands and woodlands of the lower southeastern portions of the Sequoia National Forest. These vegetation types occur in an area of convergence among three biogeographic provinces: the Sierra Nevada, Great Basin, and Mojave Desert and as a result have high plant diversity and some unusual plant combinations. The effects analysis below includes an integrated look at potential effects on floristic biogeographic subregions and diversity that might be most affected by the alternatives.

Table 88. Floristic geographic subdivisions represented in the plan area (Baldwin et al. 2012)

Province	Region	Subregion*	Number of Plant Species in CNDDB**	Area (Acres)	National Forest
California Floristic Province	Sierra Nevada	High Sierra Nevada (Central or Southern)	92	2,321,711	Sequoia, Sierra
California Floristic Province	Sierra Nevada	Sierra Nevada Foothills (Central or Southern)	45	251,225	Sequoia, Sierra

*Spatial dataset used with permission from the Jepson Herbarium (Jepson Flora Project 2015).

**This number includes all CNDDB species in the plan areas, not just those that are species of conservation concern (CNDDB, 2014).

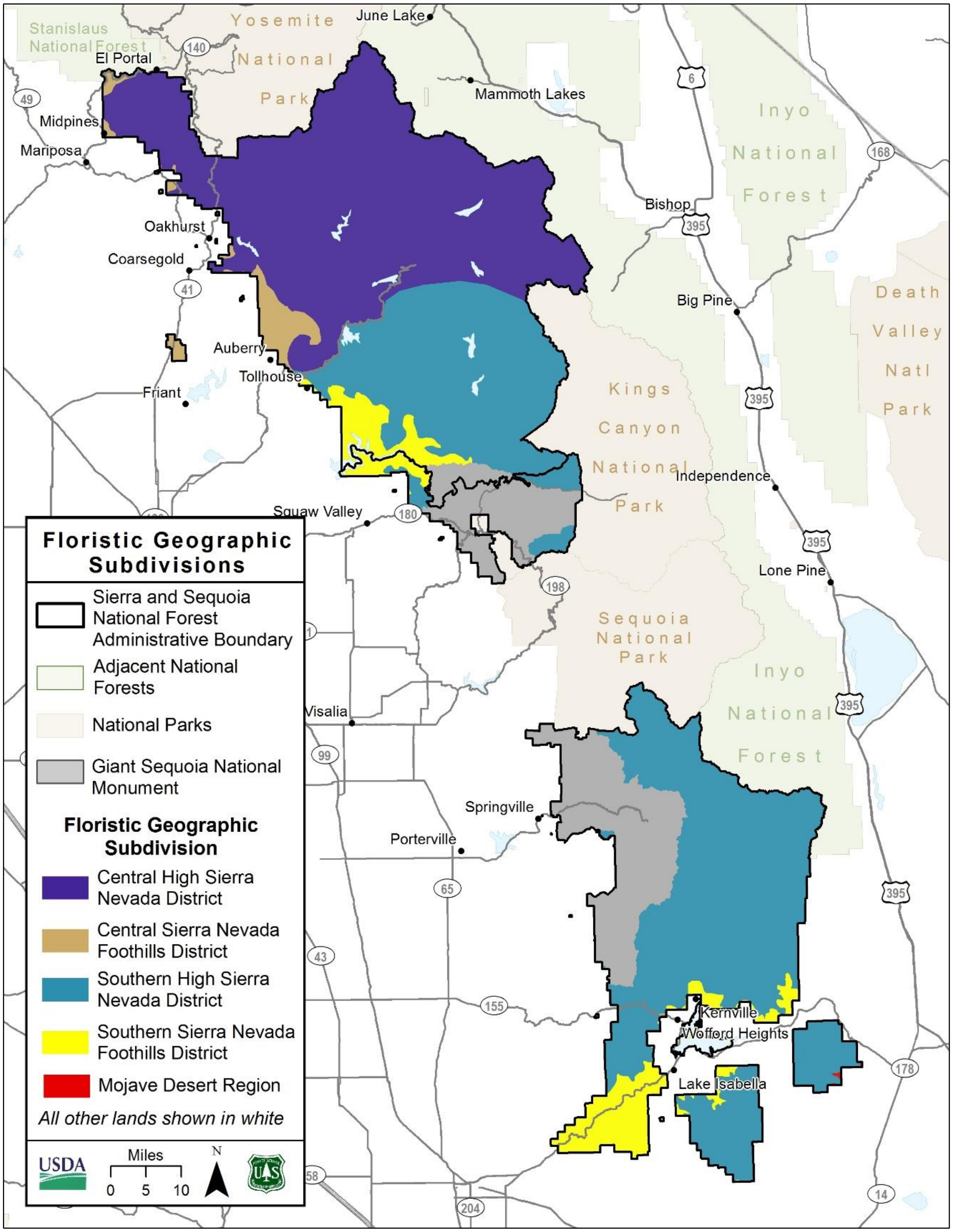

Figure 50. Floristic geographic subdivisions in the plan area

Ecosystem Types

The floristic geographic subdivisions give an overview of the distribution of diversity in the plan area and assist with a broad, qualitative analysis. For further detailed analysis, plant species are aligned with ecosystem types classified in "Terrestrial Ecosystems" and "Aquatic and Riparian Ecosystems." The ecosystem type associated with each plant species of conservation concern is included in Table 89. The ecological habitat types that host particularly high numbers of at-risk plant species are aquatic/riparian areas, meadows, montane, upper montane, subalpine, alpine, pinyon-juniper, and chaparral/live oak habitats. A species often occurs in more than one ecological habitat type.

As discussed in "Terrestrial Ecosystems," special habitats are limited, uncommon habitats that are important in providing unique conditions and may support concentrations of plant species of conservation concern. Special habitats in the Sequoia National Forest and Sierra National Forest are rocky outcrops, talus, and carbonate.

Status and Threats

For each of the 80 botanical species of conservation concern, important information that contributes to the judgement of whether a substantial concern exists for the persistence of a given species includes the occurrences in the plan area, extent of habitat (broad ecosystems or ecosystem types as defined in the forest plan), and known threats. Table 89 displays the list of plant species of conservation concern along with principal ecological habitats in the forests and potential or known threats to persistence. This information is used in the analysis to evaluate how plan components provide for the ecological conditions needed by habitat type and addresses threats associated with those habitats.

All plant species of conservation concern are considered rare to some degree, with limited occurrence numbers or restricted ranges. In the threat column, we include identifying species with extremely small occurrences by the identifier "rarity." No set number was used as a threshold for population size, but rather the context in which each species occurs was considered. Fundamental principles of conservation biology related to minimum population sizes to maintain viable populations and on causes of rarity were considered in these determinations (Rabinowitz 1981, Shaffer 1981, Wiens and Slaton 2012). Species carried forward to the list of species of conservation concern are those for which the identified threats were considered to at least in part affect local population persistence, thus contributing to the substantial concern for species persistence.

Table 89. Plant species of conservation concern for Sequoia and Sierra National Forests

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Potential or Known Threats to Persistence
Allium yosemitense	Yosemite onion	Sierra	Rock outcrop, chaparral/live oak, montane, upper montane	Recreation trampling, invasive species, mining
Astragalus ertterae	Walker Pass milkvetch	Sequoia	Pinyon-juniper	Recreation trampling, grazing, rarity
A. lentiginosus var. *kernensis*	Kern Plateau milkvetch	Sequoia	Subalpine, lodgepole, dry forb, meadow	Recreation trampling, unauthorized OHV travel, road maintenance, grazing

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Potential or Known Threats to Persistence
A. shevockii	Little Kern or Shevock's milkvetch	Sequoia	Upper montane (Jeffrey pine)	Grazing, recreation trampling, fire suppression
A. subvestitus	Kern County milkvetch	Sequoia	Montane, pinyon-juniper	Grazing, livestock trampling, unauthorized OHV travel
Boechera evadens	Hidden rockcress	Sequoia	Rock outcrop, upper montane	Recreation trampling
B. tularensis	Tulare rockcress	Sequoia, Sierra	Rock outcrop, montane, upper montane, subalpine, red fir, meadow	Climate change, unauthorized OHV travel, recreation trampling
Botrychium ascendens	Upswept moonwort	Sierra	Aquatic/riparian, meadow, montane, upper montane, subalpine	Hydrologic alteration, recreation trampling including pack stock, unauthorized OHV travel, severe soil disturbance, grazing, climate change
B. crenulatum	Scalloped moonwort	Sequoia, Sierra	Aquatic/riparian, meadow, upper montane, subalpine	Hydrologic alteration, recreation trampling, unauthorized OHV travel, severe soil disturbance, grazing, livestock trampling, climate change, rarity
B. lineare	Common moonwort	Sierra	Aquatic/riparian, meadow, upper montane, subalpine	Hydrologic alteration, recreation trampling, unauthorized OHV travel, severe soil disturbance, grazing, livestock trampling, climate change, rarity
B. minganense	Mingan moonwort	Sierra	Aquatic/riparian, meadows, upper montane, subalpine	Hydrologic alteration, recreation trampling, unauthorized OHV travel, grazing, climate change, rarity
B. montanum	Western goblin or mountain moonwort	Sierra	Aquatic/riparian, meadows, montane, upper montane, subalpine	Grazing, hydrologic alteration, conifer encroachment, recreation trampling, climate change, rarity
Bruchia bolanderi	Bolander's bruchia	Sierra	Aquatic/riparian, montane, upper montane, subalpine	Grazing, hydrologic alteration, road maintenance, recreation trampling, vegetation treatment activities
Calochortus striatus	Alkali mariposa lily	Sequoia	Aquatic/riparian, meadow, arid shrubland	Livestock trampling, road maintenance, hydrologic alterations, horticultural collecting, invasive species, rarity

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Potential or Known Threats to Persistence
C. westonii	Shirley Meadows star-tulip, mariposa lily	Sequoia	Meadow, mixed conifer, black oak/ponderosa pine	Mechanical vegetation treatment activities, road maintenance
Calyptridium pygmaeum	Pygmy pussypaws	Sequoia, Sierra	Rock outcrop, upper montane, subalpine, alpine	Climate change, recreation, trampling, rarity
Camissonia integrifolia	Kern River evening primrose	Sequoia	Sagebrush	Grazing; unauthorized OHV travel; road maintenance, rarity
C. sierrae ssp. *alticola*	Mono Hot Springs evening-primrose	Sierra	Rock outcrop, montane, upper montane	Invasive species, recreation trampling, road/trail maintenance
Carlquistia muirii	Muir's tarplant	Sequoia, Sierra	Rock outcrop, black oak/ponderosa pine, montane chaparral	Mechanical vegetation and fuels treatment activities, recreation trampling
Carpenteria californica	Tree-anemone	Sierra	Chaparral/live oak, black oak/ponderosa pine, montane	Invasive species, vegetation/fuels treatment activities, altered fire regime, road maintenance, climate change
Cinna bolanderi	Bolander's woodreed	Sierra	Meadow, aquatic/riparian (streams), montane	Grazing and trampling; recreation trampling; soil compaction; hydrologic alteration; mechanical/fuel treatments activities, rarity
Clarkia biloba ssp. *australis*	Mariposa clarkia	Sierra	Chaparral/live oak	Invasive species, road maintenance
C. lingulata	Merced clarkia	Sierra	Chaparral/live oak	Invasive species, road maintenance, rarity
Collomia rawsoniana	Flaming trumpet	Sierra	Aquatic/riparian (rivers and streams), montane, upper montane	Altered fire regime, fuels treatment
Cordylanthus eremicus ssp. *kernensis*	Kern Plateau bird's-beak	Sequoia	Pinyon-juniper, arid shrubland and woodland, upper montane	Recreation trampling, unauthorized OHV travel
Cypripedium montanum	Mountain lady's slipper	Sierra	Montane and upper montane	Altered fire regime, mechanical vegetation/fuels treatment activities, invasive species, climate change, rarity
Deinandra mohavensis	Mojave tarplant	Sequoia	Chaparral, arid shrubland	Grazing, hydrologic alteration, recreation trampling, road maintenance, rarity
Delphinium inopinum	Unexpected larkspur	Sierra	Rock outcrop, montane, upper montane	Invasive species, climate change, rarity

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Potential or Known Threats to Persistence
D. purpusii	Rose-flowered Larkspur	Sequoia	Rock outcrop, cliff, carbonate, pinyon-juniper, chaparral/live oak, montane	Recreation trampling, unauthorized OHV travel, invasive species; altered fire regime
Dicentra nevadensis	Sierra bleeding heart, Tulare County bleeding heart	Sequoia, Sierra	Subalpine, alpine, depressions	Unauthorized OHV travel, invasive species, climate change, High recreation use/trampling, road maintenance, rarity
Diplacus pictus (*Mimulus pictus*)	Calico monkeyflower	Sequoia	Rocky outcrop, blue oak woodland	Grazing, recreation trampling, unauthorized OHV travel, trail maintenance, invasive species
Draba sharsmithii	Mt. Whitney draba	Sierra	Rock outcrop, alpine	Climate change, recreation trampling, rarity
Eriastrum tracyi	Tracy's eriastrum	Sequoia, Sierra	Blue oak woodland, chaparral/live oak	Invasives, unauthorized OHV travel, recreation trampling, road maintenance, road salt, vegetation/fuels treatment activities, rarity
Erigeron aequifolius	Hall's daisy, Hall's fleabane	Sequoia	Rock outcrop, Pinyon-juniper	Recreation trampling, vegetation/fuels treatment activities
E. multiceps	Kern River daisy	Sequoia	Riparian, meadow, upper montane	Altered fire regime, grazing, recreation trampling, unauthorized OHV travel, inappropriate grazing, and mechanical treatments
Eriogonum breedlovei var. *breedlovei*	Breedlove's buckwheat, Piute buckwheat	Sequoia	Rock outcrop, carbonate, mixed conifer, pinyon-juniper	Unauthorized OHV travel
E. nudum var. *regirivum*	King's River buckwheat	Sierra	Rock outcrop, carbonate, chaparral/live oak	Invasive species, recreation trampling, trail construction, rarity
E. ovalifolium var. *monarchense*	Monarch buckwheat	Sequoia, Sierra	Rock outcrop, carbonate, pinyon-juniper	Invasives, climate change, rarity
Eriophyllum congdonii	Congdon's eriophyllum, Congdon's woolly sunflower	Sierra	Rock outcrop, chaparral/live oak, montane	Invasive species, mining, recreation trampling
Erythranthe gracilipes (*Mimulus gracilipes*)	Slender-stalked monkeyflower	Sierra	Rock outcrop, blue oak woodland, chaparral/live oak, montane, complex early seral habitat	Invasives, road maintenance and construction, improperly timed fuels or timber treatments, altered fire regime, unauthorized OHV travel, rarity

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Potential or Known Threats to Persistence
E. norrisii (*Mimulus norrisii*)	Kaweah monkeyflower	Sierra	Rock outcrop, blue oak woodland, chaparral/live oak	Invasive species, rarity
Erythronium pluriflorum	Shuteye Peak fawn lily, manyflower fawnlily	Sierra	Rock outcrop, upper montane, subalpine	Unauthorized OHV travel, invasives, climate change, road maintenance
Fissidens aphelotaxifolius	Fissidens moss	Sierra	Aquatic/riparian, montane, upper montane	hydrologic alteration, rarity
Fritillaria brandegeei	Greenhorn fritillary	Sequoia	Montane, black oak/ponderosa pine	Ungulate browsing, inappropriate mechanical vegetation/fuels treatment activities, recreation trampling
Gilia yorkii	Boyden Cave gilia	Sequoia, Sierra	Rock outcrop, carbonate, pinyon-juniper	Climate change, invasives, rarity
Githopsis tenella	Tube flower bluecup	Sequoia	Montane chaparral	Recreation trampling; grazing; fire suppression activities, rarity
Helodium blandowii	Blandow's bog moss	Sequoia	Subalpine, meadow	Hydrologic alteration, grazing, rarity
Hesperocyparis nevadensis	Piute cypress	Sequoia	Pinyon-juniper, chaparral/live oak	Altered fire regime, recreation trampling, horticultural collection, fire suppression activities
Heterotheca monarchensis	Monarch golden aster	Sequoia	Montane, carbonate	Invasive species, climate change, rarity
H. shevockii	Shevock's golden aster	Sequoia	Blue oak woodland, montane	Road maintenance, recreation trampling
Horkelia parryi	Parry's horkelia	Sierra	Chaparral/live oak	Altered fire regime, invasive species, unauthorized OHV travel, improperly timed mechanical treatments, rarity
H. tularensis	Kern Plateau horkelia	Sequoia	Montane	Recreation trampling, road maintenance, infrastructure maintenance
Hulsea brevifolia	Short-leaved hulsea	Sequoia, Sierra	Mixed conifer, subalpine, upper montane	Altered fire regime, road maintenance, recreation trampling, mechanical vegetation/fuels treatment activities
Ivesia campestris	Field ivesia	Sequoia	Subalpine, meadow	Road maintenance, unauthorized OHV travel
Leptosiphon serrulatus	Madera leptosiphon	Sierra	Blue oak woodland, chaparral/live oak, montane	Invasive species, road maintenance, inappropriate grazing

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Potential or Known Threats to Persistence
Lewisia congdonii	Congdon's lewisia	Sierra	Chaparral/live oak, montane, upper montane	Mining, road maintenance
L. disepala	Yosemite lewisia	Sequoia, Sierra	Rock outcrop, montane, upper montane	Unauthorized OHV travel, fuels treatment, recreation trampling
L. kellogii ssp. *kelloggii*	Kellogg's lewisia	Sierra	Rock outcrop, montane, upper montane	Unauthorized OHV travel
Lupinus citrinus var*. citrinus*	Orange lupine	Sierra	Rock outcrop, blue oak woodland, chaparral/live oak, montane	Unauthorized OHV travel, road maintenance, climate change, invasive species
Meesia uliginosa	Meesia moss	Sequoia, Sierra	Aquatic/riparian, fen, meadows, montane, upper montane	Hydrologic alteration, rarity, climate change
Mielichhoferia shevockii (*Schizymenium shevockii*)	Shevock's copper moss	Sequoia, Sierra	Rock outcrops, blue oak woodland, chaparral/live oak, montane	Road maintenance, rarity
Navarretia peninsularis	Baja navarretia	Sequoia	Meadows, montane, montane chaparral	Road maintenance, unauthorized OHV travel, recreation trampling, rarity
Nemacladus calcaratus	Chimney Creek nemacladus	Sequoia	Pinyon-juniper	Recreation trampling, inappropriate grazing, rarity
N. twisselmannii	Twisselmann's nemacladus	Sequoia	Montane	Grazing, fire suppression activities, fuels treatments
Oreonana purpurascens	Purple mountain-parsley	Sequoia	Rock outcrop, upper montane, subalpine	Grazing, recreation trampling, recreation development, trail maintenance
O. vestita	Woolly mountain-parsley	Sequoia	Rock outcrop, montane, upper montane, subalpine, talus	Grazing, recreation, trampling, rarity
Orthotrichum spjutii	Spjut's bristle moss	Sequoia	Rock outcrops, pinyon-juniper	Recreation trampling, grazing, rarity
Phacelia nashiana	Charlotte's phacelia	Sequoia	Pinyon-juniper, sagebrush	Grazing, mining, unauthorized OHV travel, road maintenance
P. novenmillensis	Nine Mile Canyon phacelia	Sequoia	Pinyon-juniper, montane, live oak	Altered fire regime, recreation trampling; unauthorized OHV travel, mechanical treatments; recreational development; grazing
Platanthera yosemitensis	Yosemite bog orchid	Sierra	Aquatic/riparian, fens, montane, upper montane	Inappropriate grazing, hydrologic alteration, invasive species, rarity

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Potential or Known Threats to Persistence
Pohlia tundrae	Tundra pohlia moss	Sierra	Aquatic/riparian, meadows, upper montane, subalpine	Livestock trampling, hydrologic alteration, rarity
Ribes menziesii var. *ixoderme*	Canyon gooseberry	Sierra	Chaparral/live oak, blue oak woodland	Altered fire regime, fire suppression activities, fuels treatments, invasive plants, unauthorized OHV travel, rarity
Sidalcea multifida	Cut-leaf checkerbloom	Sequoia	Aquatic/riparian, meadows, black oak/ponderosa, pinyon-juniper	Recreation trampling, unauthorized OHV travel
Streptanthus cordatus var. *piutensis*	Piute Mountains jewel-flower	Sequoia	Chaparral, Piute cypress, pinyon-juniper	Road maintenance, unauthorized OHV travel, fire suppression activities
S. fenestratus	Tehipite Valley jewel-flower	Sequoia, Sierra	Rock outcrop, chaparral/live oak, montane, carbonate	Recreation trampling, invasive species, rarity
Symphyotrichum defoliatum	San Bernardino aster	Sequoia	Aquatic/riparian, meadows, chaparral, montane	Invasive species, rarity
Tauschia howellii	Howell's tauschia	Sierra	Rock outcrop, montane, upper montane	Infrastructure maintenance, fire suppression activities, rarity
Trifolium bolanderi	Bolander's clover	Sierra	Aquatic/riparian, meadows, upper montane	Grazing, hydrologic alteration
T. kingii ssp. *dedeckerae* (*T. dedeckerae*)	Dedecker's clover	Sequoia	Rock outcrop, alpine, subalpine, montane	Climate change, rarity
Viburnum ellipticum	Oval-leaved viburnum	Sequoia, Sierra	Chaparral/live oak, black oak/ponderosa	Fuels treatment activities, invasive species, road maintenance, fire suppression activities, climate change, rarity

Table 90 displays the major threat groups and number of species affected. Threats for each plant species of conservation concern are observed threats where known and general potential threats where not specifically known, which makes it difficult to quantify an exact percentage of at-risk plants impacted by a specific threat. For example, grazing may be included as a specific observed threat for one species, and a generalized threat for another based on threats listed in NatureServe(NatureServe 2015). Threats to plant species of conservation concern from recreation activities are trampling, ground disturbance, and plant harvesting, as well as the introduction of weeds by hikers, stock, and unauthorized OHV travel.

Table 90. Known threats to plant species of conservation concern, as documented in best available scientific information*

Threat	Number of Species Documented to be Affected by Threat
Altered fire regime	11
Climate change	20
Erosion/soil degradation	4
Fuel or vegetation treatment	25
Horticultural collection	2
Hydrologic alteration	15
Invasive species	28
Livestock grazing or trampling	31
Mining	4
Rarity**	40
Recreation trampling, trail maintenance	48
Road maintenance	25
Unauthorized OHV travel	28

*Most species of conservation concern are affected by more than one threat.

**All species of conservation concern are considered rare to some degree; occurrence numbers or restricted ranges are considered with various factors that threaten persistence in the plan area.

Developed facilities, such as campgrounds, make areas more accessible and concentrate use that can impact plant habitat. Dispersed camping has similar impacts. Soil disturbance can occur during road maintenance, recreation activities, or during vegetation management treatments and prescribed burning activities. Roads used for vegetation management treatments may also provide an avenue for invasive plant species. Nonnative invasive plant species can displace native plant communities through resource competition, which could result in the loss of native at-risk species habitat, loss of pollinators, decreased plant diversity, and decreased rare plant species viability. Invasive species management activities may include herbicide spraying and mechanical ground disturbance that could impact native species.

In addition to the plant species of conservation concern, there are 11 Regional Forester's plant sensitive species that have known occurrences in one or both plan revision areas, which are not federally listed, proposed, or candidate species under the Endangered Species Act, and did not meet the criteria for a species of conservation concern (see Table 74). These species are included in this analysis, and grouped based on broad similarities in the habitat they occupy as shown in Table 91, along with known or potential threats.

Table 91. Regional Forester plant sensitive species with known occurrences in the plan area and did not meet criteria for species of conservation concern for Sequoia and Sierra National Forests

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Known Threats to Persistence
Calochortus palmeri var. *palmeri*	Palmer's mariposa lily	Sequoia	Meadows, aquatic/riparian, chaparral/live oak, montane, upper montane	Recreation trampling, invasive species

Scientific Name	Common Name	Applicable National Forest	Principal Habitats	Known Threats to Persistence
Canbya candida	White pygmy-poppy	Sequoia	Arid shrubland, pinyon/juniper	Potential threat from recreation trampling, road, trail, and utility maintenance and construction, small scale gold mining.
Cryptantha incana	Tulare cryptantha	Sequoia	Montane, pinyon-juniper, upper montane	Potential for impacts from inappropriate grazing; vegetation management treatments
Delphinium inopinum	Unexpected larkspur	Sequoia	Rock outcrop, montane, upper montane	Potential threat from recreation activities; off-highway vehicle traffic; logging; mining
Erigeron aequifolius	Hall's daisy	Sierra	Rock outcrop, montane, upper montane	No known threats
Hulsea vestita ssp. *pygmaea*	Pygmy hulsea	Sequoia	Subalpine, alpine, rock outcrop, open gravel and talus	Potential for recreation trampling
Leptosiphon serrulatus	Madera leptosiphon	Sequoia	Black oak/ponderosa pine, montane chaparral	None known, not relocated
Mielichhoferia elongata	Elongate copper moss	Sequoia, Sierra	Rock outcrop, black oak/ponderosa, montane, upper montane, subalpine	No threats to this species in the Sequoia National Forest are known at this time.
Monardella linoides ssp. *oblonga*	Tehachapi or Flax-like monardella	Sequoia	Pinyon/juniper, montane and upper montane	Recreation trampling, trail construction, road construction and maintenance
Peltigera gowardii	Western waterfan lichen	Sierra	Aquatic/riparian, upper montane, alpine	Potentially threatened by hydrological alterations, recreation activities, erosion, logging, and vehicles
Sidotheca caryophylloides	Chickweed oxytheca	Sequoia	Black oak/ponderosa	Possibly grazing. No threats in the plan area have been identified

Environmental Consequences to Plant Species of Conservation Concern

Consequences Common to all Alternatives

All alternatives would incorporate at-risk species information from the California Natural Diversity Database, the California Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service.

All alternatives include fuels reduction and vegetation treatments designed to contribute to the restoration of a more resilient landscape. The amount of potential treatment, method of treatment, and priority locations for treatment, varies by alternative as discussed by alternative below. The recent, broad-scale tree mortality event did change fuels conditions and may limit situations that would allow fire to be managed safely.

Travel management and the authorized motorized route system would be the same under all alternatives. If substantial impacts on plant species of conservation concern from use of the authorized motorized route system are discovered, they would be addressed through developing site-specific mitigations and, if needed, through site-specific changes in the authorized motorized route system following procedures of the Travel Management Rule.

Utilization of special forest products and personal-use fuelwood would generally remain similar to current conditions, with minimal increases expected due to population trends. The impacts on plant species of conservation concern are difficult to assess for dispersed personal firewood collection by individuals; this is assessed and managed when planning vegetation and fuels projects that would create piles or collection sites open to public gathering. The potential impacts on plant species of conservation concern would be considered during site-specific planning for those projects with mitigations to minimize or avoid impacts incorporated into project design.

Direction for range management impacts on at-risk plant species would be similar for all alternatives. All alternatives provide for mitigating effects on at-risk plants from grazing and no alternative is expected to change the amount of permitted livestock use.

Broad guidance for the management and control of invasive species is provided by the Forest Service National Strategic Framework for Invasive Species Management FS-1017 2013 (United States Department of Agriculture 2013e). In addition, all alternatives include an approach to controlling invasive species and preventing introduction of new invasive species that is similar to alternative A.

There would be no changes to the current direction for mining. The impacts of authorized mining activities to plant species of conservation concern would be considered and mitigations required as part of decisions to authorize permits for activities and uses.

Special interest areas are those designated for scenic, geologic, botanic, zoologic, paleontological, archaeological/historic, or recreational values, or combinations of these values[40]. Special interest areas designation allows national forests to meet internal and public interest in recognizing special values of certain areas and to tailor land uses to interpret, maintain and enhance those special features. Land uses in a special interest area vary with the type of feature recognized, which is different from wilderness designation and research natural area designation.

Wilderness is designed to provide areas untrammeled by human actions for a wilderness experience, including primitive recreation, solitude, study, and conservation of species. Although a designated special interest area may provide some of these same features, they may also provide other opportunities that wilderness areas do not. For example, a recreation special interest area could have extensive developments to increase visitor access. Special interest areas and their management is similar under all alternatives.

The Sequoia National Forest has five botanical areas: Bald Mountain Botanical Area, Ernest C. Twisselmann Botanical Area, Baker Point Botanical Area, Bodfish Piute Cypress Botanical Area, and Inspiration Point Botanical Area. The Sierra National Forest has three botanical areas: Devils Peak Botanical Area, Carpenteria Botanical Area, and McKinley Grove Botanical Area. Other

[40] Forest Service Manuals 2360 and 2372.

special interest areas, like Nelder Grove Historical Area, also provide habitat for sensitive species or plant species of conservation concern.

Consequences Specific to Alternative A

Under alternative A, the Sequoia and Sierra National Forest would continue to manage a total of 101 Regional Forester's plant sensitive species; there are 75 plant sensitive species for the Sequoia National Forest plan area, and 57 plant sensitive species for the Sierra National Forest plan area. This includes 36 sensitive species with no known occurrence in the Sequoia or Sierra National Forest plan areas. This alternative would consider more rare plants in the project planning process, compared with the 80 plant species of conservation concern considered by the other alternatives. However, since 36 of the Regional Forester's sensitive plant species have no known occurrence in the Sequoia or Sierra plan areas, the plan revision alternatives consider more rare plant species with an actual occurrence in the plan areas.

At the programmatic level, species management guides are developed for Regional Forester's sensitive species with recommendations for management and monitoring. In general, avoidance rather than restoration of habitat of sensitive species at the project level is emphasized. Alternative A requires project level assessment of effects on sensitive species compared with the plan revision alternatives, which rely more strongly on achievement of desired conditions at the ecosystem scale, including in special habitats, to provide for species persistence and apply project-level protections when necessary.

There is more uncertainty in how new and emerging recreation uses would be adaptively managed under alternative A, compared with the plan revision alternatives, since it would not direct the Sequoia and Sierra National Forests to adequately manage recreation opportunities and settings. For example, there would be uncertainty when and how to respond to changing or emerging unmanaged recreation uses that have potential ecological effects, since it would likely be addressed on a project-by-project basis through analysis of effects. The plan revision alternatives would have direction for a more adaptive response possible under the action alternatives.

Alternative A would provide forestwide direction and guidance to address invasive species, or noxious weeds, including those that affect plant species of conservation concern. Forest plan direction requires individual projects to have a noxious weed risk assessment with direction to minimize and mitigate the risk of weed spread and to control new infestations. Treatment efforts for noxious weeds are localized and limited by available funding.

Consequences Common to Alternatives B, C, D, and E

A total of 80 plant species of conservation concern would be identified in the plan areas (Table 86) for all plan revision alternatives; 49 species of conservation concern for the Sequoia National Forest plan area and 45 species for the Sierra National Forest plan area (Table 89). The plant species of conservation concern, primary habitat, and known threats to the persistence is included in Table 89, and a summary of the number of species affected by a known threat is provided in Table 90. The lists of plant species of conservation concern includes many of the 101 Regional Forester's plant sensitive species for the plan areas that are considered under alternative A. The reason sensitive species did not meet the criteria for a species of conservation concern is provided in Table 74.

Plan direction related to plant species of conservation concern would be similar for all the plan revision alternatives and designed to maintain key ecosystem characteristics and ecosystem functions in order to maintain biodiversity of Sequoia and Sierra National Forests, thus providing for habitat needs of diverse native animal and plant species. This ecosystem, or course, filter approach focuses on managing for conditions consistent with the natural range of variation at the landscape scale (Gross and Coppoletta 2013a, Meyer 2015b, Meyer 2015c, Merriam et al. 2013, Safford and Stevens 2017, Sawyer 2013, Slaton and Stone 2015a), with the expectation that the needs and functional capacity of most organisms would be fulfilled.

Terrestrial and aquatic ecosystem direction in combination with direction specific to at-risk species (or fine filter direction), and direction for other resources that affect plant species of conservation concern or their habitats, would be designed to promote resilient intact ecosystems, balance the needs of at-risk species with other resource uses and ecological processes, and mitigate risk to persistence. This would include mitigation from land management activities and other disturbance that cause direct impact on habitat or increase spread of invasive species.

The primary ecosystem and at-risk species-specific plan components for the plan revision alternatives that contribute to providing for the habitat needs and protection of plant species of conservation concern is displayed in Appendix D of Volume 2. Plan direction for these alternatives would provide for ecosystems and habitat conditions resilient to both natural and human caused disturbance, including the interrelated effects of climate change, that would mitigate site specific effects that might occur during projects, like forest management activities, or other allowed activities.

Ecosystem plan direction

For the plan revision alternatives, forestwide direction for plant and animal species, terrestrial ecosystems, and aquatic/riparian ecosystems would be to manage for resilient environments that retain their essential processes and functions, including ecological conditions that support the persistence of plant species of conservation concern. Alternative A would not emphasize forest heterogeneity approaches to promote resilience to the same degree as the plan revision alternatives. Since most of the ecosystem types in the plan areas have diverged from the natural range of variation (see “Terrestrial Ecosystem” and “Aquatic and Riparian Ecosystem”), the plan revision alternatives would provide forestwide terrestrial ecosystem plan direction for all ecosystem types that plant species of conservation concern occur, including direction for the appropriate composition, distribution, structure; fire return interval, and resilience to stressors.

Plan revision alternatives would include objectives to restore forest structure and processes. For many ecosystem types, fire is a key ecological process used to restore and maintain proper conditions, and increase heterogeneity and understory plant vigor. Compared with alternative A, the plan revision alternatives would increase the pace and scale of restoration using fire. This may affect Sierra Nevada montane forests composed of dry mixed conifer, Jeffrey pine, red fir, lodgepole pine, and mountain mahogany vegetation types more strongly than other ecosystems because forests there are more strongly departed from desired conditions (Table 23 and Table 24). These ecosystems occur in the High Sierra Nevada floristic biogeographic subregion, and host over 50 percent of at-risk plant species. Restoration treatment options are low intensity prescribed burning and mechanical thinning to create openings in the canopy and to the understory, and that may create the ecological conditions for regeneration of many rare plant species.

Many plant species of conservation concern benefit from more open conditions that allow reestablishment of a previously existing population or colonization of a new population. For example, a 4-year demographic study of Shirley Meadows star-tulip, *Calochortus westonii* conducted by San Francisco State University, found population expansion was associated with low levels of disturbance that created openings in the forest canopy, and reduced competition for available sunlight, water, and nutrients (Tanner-Sutton 1998).

Some species are heavily reliant on wildfire to provide conditions to regenerate and have been impacted by altered fire regimes. These species would benefit from restoration treatments using fire or mechanical thinning or both. There are at least 11 plant species of conservation concern impacted by altered fire regimes, and along with other species, benefit from restoration of natural processes and forest structure. For example, short-leafed hulsea (*Hulsea brevifolia*) may become abundant after fire or other disturbance that creates openings in the canopy. The plan revision alternatives would support habitat restoration following disturbance, like wildfire, that create large-scale changes in structure or species composition (like from type conversion to cheatgrass), and long-term maintenance in disturbed and adjacent undisturbed landscapes.

For the Sequoia National Forest, direction for projects in arid or xeric shrublands would include design measures to minimize damage to biological soil crusts, with an intent to maintain areas resistant to nonnative plant invasions and assist in native species regeneration. The Mojave tarplant (*Deinandra mohavensis*) is a species of conservation concern as well as a California State Endangered listed species that is found in these habitats, and there are very few known occurrences in the Sequoia National Forest plan area.

For riparian plant species of conservation concern, plan revision alternatives would provide for persistence through forestwide direction for at-risk species and forestwide direction for watersheds. Direction for aquatic and riparian ecosystems would limit impacts on water quality or habitat for aquatic and riparian-dependent species, including from livestock grazing; support stable herbaceous and woody vegetative communities; and ensure natural hydrologic, hydraulic, and geomorphic processes sustain their unique functions and biological diversity. The latter is particularly important to species like *Botrychium crenulatum*, which lives on saturated hard water seeps and stream margins, and the 14 other plant species of conservation concern that may be affected by hydrologic alteration. The resilience of riparian composition and structural heterogeneity to the stressors of climate change and increased risk of wildfires would not be improved under alternative A except on an occasional basis.

The plan revision alternatives would increase the amount of meadow restoration compared with alternative A. Restoration efforts in meadows and other herb-dominated communities and riparian areas, would likely have positive, long-term effects for the many at-risk plant species dependent on these systems, especially those that have been negatively affected by hydrologic changes. For some species, like the alkali mariposa lily (*Calochortus striatus*) that occurs at the border of the Sequoia National Forest and private land, hydrologic changes that threaten habitat originate outside the plan area and mitigation may beyond the authority of the Forest Service.

Climate change is a major threat to plant species of conservation concern, especially those occurring in subalpine and alpine zones with small occurrences. Climate change, along with the potential related drought effects, will likely continue to exert pressure on key ecological conditions that these and other at-risk plant species depend. Climate models project significant range contractions in some species distributions, especially those with high climate sensitivity and low adaptive capacity (Loarie et al. 2008), and many already rare plants are expected to decline (Anacker et al. 2013).

Alpine plants that live at the highest elevations will have few if any other place to go in order to find the colder environments at which they are adapted. These low adaptive capacity species include those that have small and isolated populations, low genetic variation, low reproductive rates, and a limited ability to move widely (Beever et al. 2016), like Tulare County bleeding heart (*Dicentra nevadensis*) that has very few occurrences in high elevations of both plan areas. The plan revision alternatives would focus on increasing ecosystem resilience to climate change, including having fire management and reforestation be responsive and adaptable to rapidly changing conditions; reforestation treatments are emphasized in riparian areas that face the most risk from large-scale events; and interpretation and conservation education would be employed to convey up-to-date and clear messages about natural resources and climate change, and could include information on impacts on plant species of conservation concern.

Alternative A has no direction specific to climate adaptation or resilience, although there is direction for ecological restoration aimed at reducing forest density that is more limited in intensity and extent. Alternative A would include direction through reforestation treatments in riparian areas that face the most risk from large-scale events. The plan revision alternatives would lessen the risks from climate change to species persistence slightly better than alternative A.

Species-specific plan direction

In order to improve conditions for species of conservation concern and preclude the need for listing new species under the Endangered species act, the plan revision alternatives would include specific or fine filter direction to improve habitat conditions and refugia for at-risk species, and to support self-sustaining populations within the inherent capabilities of the plan area, including minimizing impacts from threats. This is particularly important for plant species of conservation concern with restricted occurrences and distributions, like many of the moss and fern species of conservation concern that have only one occurrence in a plan area, or monarch gilia that is known from a single occurrence near Boyden Cave in Kings River Canyon at the border of the Sequoia and Sierra National Forests.

Since fuel and vegetation treatments can threaten rare plants, the plan revision alternatives would include direction that design features, mitigation, and project timing considerations would be incorporated into projects that may affect occupied habitat for at-risk species; that habitat management objectives or goals from approved conservation strategies or agreements would be incorporated, as appropriate, in the design of projects that would occur in at-risk species habitat; and the development of partnerships would be emphasized to provide for the persistence of plant species of conservation concern. Partnering with other agencies and groups would maximize opportunities to improve conditions in the plan area for at-risk species. Partnerships could develop monitoring or management strategies, similar to the management guide for *C. westonii* that was developed internally (Tanner-Sutton 1998).

Alternative A would continue plant sensitive species direction to emphasize the development and implementation of a consistent, systematic, biologically sound program for sensitive plant species and their habitat so that Federal listing does not occur. The direction comes from FSH 2609.26[41] and FSM 2670[42] and includes direction on inventories of project sites, a sensitive plant program management plan for the forest, species management guides, and scientific studies where there are known detrimental effects on sensitive species. Whereas direction for alternative A would

[41] FSH 2609.26 - Botanical Program Management; Chapter 10 - Sensitive Plant Program Management
[42] USDA Forest Service Manual. Chapter 2670, Threatened, Endangered, and Sensitive Plants and Animals. Effective June 23, 1995.

continue to focus on avoidance and limiting affects to individuals, the plan revision alternatives direction would have a broad approach to ecosystems that contribute to species persistence in the plan area.

Regional direction would guide when project-level surveys be used to identify the presence of plant species of conservation concern at a particular project site in order to avoid or minimize adverse impacts; the provisions under §219.9 of the final planning rule are focused on maintaining or restoring the ecological conditions necessary to maintain the diversity of plant and animal communities and support the persistence of native species in the plan area. Because it is not practicable to monitor all plant species across the plan area, the forest plan monitoring program would be designed to assess the status of select ecosystem components. These select ecosystem components are presented in Chapter 4 of the draft plans and are intended to cover a range of habitats where at-risk species occur.

Plan direction and best management practices would reduce the impacts of management actions locally but do not by themselves address the biodiversity, sustainability, or persistence of aquatic and riparian associates. For alternative A, the plan direction is primarily prescriptive and restrictive to limit management activities, which would not restore forest vegetation and improve habitats that support the persistence of all life stages of aquatic or riparian species.

The plan revision alternatives direction would include provisions for persistence of plant species of conservation concern that occur in special habitats, like rock outcrops that support 28 plant species of conservation concern (Table 89). These are especially important for species with extremely limited distributions and facing increasing threats from invasive species, recreation trampling, and climate change. For example, *Eriogonum nudum* var. *regirivum* grows in rock outcrops of chaparral-live oak woodlands and two of the three occurrences are located along the popular Kings River trail.

Plan revision alternative direction would evaluate and incorporate maintenance and enhancement needs for special habitats into project design and implementation, and avoid fire management activities in special habitats. For alternative A, there is no specific direction for special habitats with limited distribution; plant sensitive species occurring in these areas would be included in plan direction for developing species management guides.

Other Direction to Alleviate Threats

The plan revision alternatives would include plan components to alleviate or eliminate threats to species of conservation concern from activities associated with restoration, wildfire management, recreation, and other land management activities. Overall, the plan revision alternatives would have greater potential short-term negative effects on species of conservation concern compared with alternative A, due to the increased pace and scale of restoration, but they also have more potential for long-term positive effects due to restoring resilience to ecosystems.

Ecological restoration is expected to be focused in the montane forests in the High Sierra Nevada region. The potential increased short-term effects are primarily related to the increase in mechanical treatments and potential increased soil erosion, soil compaction, or trampling of plants. These site-specific negative effects on at-risk plant habitat extent and quality would be mitigated through project design features, although mitigations may not eliminate threats altogether. In the long-term, landscape restoration of forested ecosystems, including restoring fire regimes within the natural range of variation, would have positive effects on at-risk plant habitat and quality. For example, short-leaved hulsea (*Hulsea brevifolia*) and flaming trumpet (*Collomia rawsoniana*) appear more abundant after fire or other disturbances that create openings in the canopy. Since there are some differences between alternatives in the amount and methods of achieving restoration, this aspect is further discussed in each alternative's section.

At least 28 plant species of conservation concern are known to be threatened or potentially threatened by invasive species. In particular, blue oak woodlands are heavily dominated by nonnative annual species, with more nonnative than native species present (Keeley et al. 2003, Keeley and Brennan 2012). The increases in forest restoration using mechanical and fire treatments, while beneficial overall to improve ecosystem diversity and ecosystem integrity, creates potential expansion of existing invasive plant populations, like cheatgrass (*Bromus tectorum*) and yellow starthistle (*Centaurea solstitialis*), establishment of new invasive species, and creates challenges to achieve restoration goals (Keeley et al. 2003, Keeley and McGinnis 2007).

Managing vegetation with mechanical treatments is often espoused a bigger risk of invasive plant species establishment and spread, compared with managing vegetation with fire, but most ground-disturbing activities can promote invasive nonnative species disturbance.

Although increased vegetation management activities would likely result in both short-term and long-term increases in invasive plant species, the plan revision alternatives would include similar plan direction compared with alternative A, to guide projects to minimize the risk of invasive species spread associated with project activities, including using an early detection and rapid response strategy. Plan components would direct that invasive species management is considered during project design and implementation, and extra efforts would be taken during fire incident management and in post-fire restoration to reduce the risk of invasive species spread.

Invasive species management for alternative A is primarily guided by existing agency direction, especially the Forest Service National Strategic Framework for Invasive Species Management FS-1017 2013 (United States Department of Agriculture 2013e) and this would continue under all alternatives. Mechanical or managed fire would be applied in a manner that impacts target species more than potential competitors, coupled with active restoration of the native flora is hypothesized to be the only means of eliminating noxious species on a sustainable basis.

Restoring the fire regime to the natural range of variation is generally considered beneficial to plant species of conservation concern, however, the current conditions and resulting fire regime and nonnative invasive plant species infestation presents unknown prospects. Thus, it is unknown if restoring the fire regime under the forest plan revision alternatives, given current conditions would result in less impact on native species from invasive species.

Adaptive management would be essential to ensure that the increased use of fire does not result in negative effects on plant species of conservation concern, including from indirect effects of invasive plant species introduction and spread. Direction for the forest plan revision alternatives would include taking action to control or eradicate invasive species, with the acreage treated varying among alternatives. The amount of invasive species treatment and eradication would be increased by partnering with other agencies and groups to monitor, or with research to evaluate the potential effects of climate change on the spread of invasive and nonnative species.

Nearly 30 species of conservation concern may potentially be impacted by livestock grazing or trampling. The plan revision alternatives would maintain similar levels of livestock grazing as alternative A, but permitted livestock use could decline during the plan period due to warmer temperatures, increased frequency and duration of drought conditions, and more frequent and larger wildfires. The plan revision alternatives would include several updates to the existing management direction for livestock grazing in aquatic and riparian ecosystems, which could benefit riparian plant species of conservation concern like those occurring in fens. The plan revision alternatives would benefit plant species of conservation concern since they encourage livestock management strategies with timely response and adaption to drought, shifts in forage plant communities, loss of herbaceous forest understory vegetation, or creation of post-fire transitory range. Forestwide direction for at-risk species would ensure that the ecological conditions needed for persistence of at-risk species is considered when livestock grazing permits are issued.

Forestwide direction under the plan revision alternatives for sustainable recreation and wilderness includes support for plant species of conservation concern. Dispersed and developed recreation is expected to increase to some degree in the future under all alternatives due to increasing human populations and recreation demand. Some habitats, such as meadows, riparian areas, and rock outcrops, are often places where recreation is more frequent and these habitats may host clusters of plant species of conservation concern.

Intense and increased recreation activities can have direct negative effects on at-risk plant habitat extent or quality, especially from trampling and habitat alterations. Recreation trampling is a known or potential threat for 48 plant species of conservation concern. The plan revision alternatives would provide direction to manage recreation through a zoned approach, including the use of direct management techniques in the general recreation area zone to respond when necessary to protect resources like habitat for plant species of conservation concern. For example, one of two occurrences of slender moonwort (*Botrychium lineare*) is located next to a trail in Piute Canyon (Sierra National Forest) where there is a high potential for impacts from trampling and trail construction. Destination recreation areas have concentrated recreation use, and the plan revision alternatives would include guidance like to control capacity limits to protect resources.

Indirect negative effects in high use recreation areas would be from the introduction or increase of invasive plants. Forest plan direction and guidance under plan revision alternatives would include plan direction to mitigate threats. For example, to avoid fire management activities in riparian conservation areas and meadows except when necessary to protect life and property; avoid activities such as line construction and staging areas and taking extra measures to avoid spread of invasive plants.

In addition, direction in the plan revision alternatives for sustainable recreation would include to manage dispersed recreation activities when evidence of impacts on natural resources emerge; not locate new recreation facilities in at-risk plant species habitat; and address impacts on at-risk species habitat during project design of recreation developments. And for riparian areas, direction would prohibit or mitigate ground disturbing activities where they adversely impact and jeopardize the persistence of plant species in fen ecosystems. Plan direction would guide that projects consider a wide range of management responses to minimize impacts and does not solely require avoidance. Under alternative A, similar efforts and consequences described above are guided by direction focused on Pacific Southwest Region sensitive species.

For the forest plan revision alternatives, direction for sustainable recreation and wilderness would mitigate threats from recreation, fire, and livestock, and ensure watersheds are functioning properly and that impacts on plant species of conservation concern are minimized. Management direction under alternative A would not include managing recreation activities with minimal adverse impacts on sensitive environments and natural resources.

The plan revision alternatives' direction related to Tribes and plant species of conservation concern would include that Native Americans have access to traditional and cultural practices for plant gathering and their traditional ecological knowledge is valued in the process of developing and implementing restoration projects.

Sensitive plant species currently on the Regional Forester's sensitive species list

There are 36 sensitive species with no known occurrence in the Sequoia and Sierra National Forest plan areas. The remaining sensitive species that have a known occurrence in the Sequoia and Sierra National Forest plan areas, but are not identified as species of conservation concern or a listed, proposed or candidate species under the Endangered Species Act, all occupy a habitat group that is also associated with the identified plant species of conservation concern: two species in the rock outcrop special habitat type; two in aquatic/riparian habitat; and the remainder may be found in arid shrubland, pinyon/juniper, black oak/ponderosa, montane, upper montane, or alpine ecosystem habitat (Table 91).

The habitat stressors, and effects of the plan revision alternatives, would be similar to those for the species of conservation concern species in the group. The protections provided by ecosystem plan direction to plant species of conservation concern and their habitats, such as limiting soil disturbance and limiting and treating invasive species, would also help protect sensitive plant species and communities that occupy these types of habitats. For example, to adequately protect plant sensitive species associated with aquatic ecosystem habitat, low risk of impact would be expected due to desired conditions, and supporting standards and guidelines that would provide for resilient, diverse and sustainable aquatic plant and animal communities; maintain water quality, physical integrity and flow of streams; and aquatic ecosystems, that would be free of invasive species. For plants in alpine environments, that are typically in remote areas with limited potential for human disturbance, threats are mainly be associated with factors such as changes in natural fires regimes and resulting changes in natural vegetation conditions.

Consequences Specific to Alternative B

The risk-based fire zone strategy of alternative B would help identify areas that pose fire threats to communities and facilitate and prioritize the design of larger, landscape-scale ecological restoration that would potentially have a larger area treated to reduce fire risks and restore ecosystem conditions, including for plant species of conservation concern.

Alternative B would potentially treat double the area from current levels of alternative A in the Sequoia National Forest, and more than double in the Sierra National Forest. Restoration treatments would benefit fire adapted plant species of conservation concern, like Piute cypress (*Hesperocyparis nevadensis*) and understory species that benefit from open canopy conditions. There is a potential for greater short-term impacts on plant species of conservation concern from the treatment and consequential increase in invasive species.

Applied alone or in combination, mechanical or prescribed fire treatments have a potential to increase the spread and intensification of invasive species like cheatgrass (Keeley and McGinnis 2007, Keeley 2006, Jones et al. 2015, Miller et al. 2014a, Safford and Stevens 2017, Slaton and Stone 2013). Depending on the presence of invasive species prior to restoration treatment, land managers would decide which treatment is best suited for preventing invasive expansion while accomplishing restoration goals.

For riparian plant species of conservation concern, some conservation watersheds occur in designated wilderness areas, and in these areas there may be little additional species specific benefit to having conservation watershed direction. In conservation watershed areas that occur outside of wilderness, it is unknown to what extent conservation watersheds would provide for habitat for plant species of conservation concern.

In all cases, forestwide direction would provide that the primary project level guidance, especially to ensure projects are designed to provide for the persistence of plant species of conservation concern. Therefore, while it is known that several plant species of conservation concern occur in the conservation watersheds and several could also occur in some of the critical aquatic refuges under alternatives A, C, and E, it is not likely there is a substantial difference in risk or benefit to these species between alternatives due to the forestwide direction for at-risk species in all plan revision alternatives, and direction to evaluate project level effects on sensitive species under alternative A.

Sensitive plant species currently on the Regional Forester's sensitive species list

The recommended Monarch Wilderness Addition- South area under alternative B is entirely in the Giant Sequoia National Monument. The recommended wilderness designation may benefit any of the 75 species on the Regional Forester's sensitive species list that occur there by precluding management activities, like mechanical treatments that might allow increases in invasive species, and by limiting mechanized and motorized activities such as mountain biking, and possibly reduce unauthorized off-highway vehicle travel that could cause soil disturbance. There are currently no known occurrences for those species in the boundaries of Monarch Wilderness Addition - South area.

Consequences Specific to Alternative C

Alternative C is similar to E, and would have less area restored through mechanical thinning compared with alternative A and the other plan revision alternatives. Restoration through prescribed and wildland fire would be similar to A and less than alternatives B and D. The restoration strategy under alternative C would be to use fire as the primary tool used to work toward desired conditions and have less short-term impacts on plant species of conservation concern. However, opportunities to manage with fire under alternative C may be lower compared with alternative A due to lack of pretreatment of vegetation, which narrows the conditions under which fire can meet objectives safely.

Although mechanical treatments are often espoused a bigger risk of invasive plant species establishment and spread, most ground-disturbing activities can promote invasive nonnative species disturbance. Applied alone or in combination, mechanical or prescribed fire treatments have a potential to increase the spread and intensification of invasive species, like cheatgrass (Keeley and McGinnis 2007, Keeley 2006, Jones et al. 2015, Miller et al. 2014a, Safford and Stevens 2017, Slaton and Stone 2013) that is the most common invasive species in the plan areas (Slaton and Stone 2015a).

Alternative C would likely have similar short-term negative effects on plant species of conservation concern as alternative B, particularly those dependent on mixed conifer and Jeffrey pine ecosystems. The response of invasive species to restoration treatments using mechanical thinning, fire, or combination of the two, can depend on the type of invasive species present prior to treatment. Land managers can decide which treatment is best suited for preventing invasive expansion while accomplishing goals. To the extent that mechanical ground disturbance increases the risk of invasive species spread, or risk of new invasive plant species infestations and spread, and negative effects on plant species of conservation habitat, alternative C would likely be less than other alternatives. However, since acres treated with fire would be greater, risk of invasive species spread from fire activities would be greater.

Recreation site improvements are likely to be less under alternative C compared with the other plan revision alternatives, although alternative E may be similar. The lack of disturbance would mean fewer potential impacts on habitat and need for mitigation, but also reduced opportunities to improve conditions for plant species of conservation concern.

The greater area of recommended wilderness under alternative C may provide additional benefit to plant species of conservation concern that occupy these areas. For example, the only occurrence of *Erythranthe norrisii* from the Sierra National Forest is located near the confluence of Kings River and Fox Canyon, which is included in the Monarch Wilderness Addition –West area; the only known occurrence of *Helodium blandowii* in the Southern Sierra is located in the Domeland Wilderness Addition – West; and an occurrence of *Hesperocyparis nevadensis* (Piute cypress) is located in the Stormy Canyon area. *Bromus madritensis rubens*, an invasive annual grass, is known to be present in the *Erythranthe norrisii* population. Although treatment options for invasive species management would be more limited in recommended wilderness areas, other management options or tools may be adequate (United States Department of Agriculture 2014b).

Sensitive plant species currently on the Regional Forester's sensitive species list

There are 9 areas of recommended wilderness area under alternative C that are partially or entirely in the Giant Sequoia National Monument. Recommended wilderness direction may offer additional protection for a plant species on the Regional Forester's sensitive species list that occurs in these areas, for example, the only known occurrence of *Boechera shevockii* (Shevock's rockcress) is located on the Needles that lies in the recommended Golden Trout Wilderness Addition – Southwest area and considered potentially threatened by recreation trampling. Direction in recommended wilderness would preclude management activities like mechanical treatments, limit mechanized and motorized activities such as mountain biking, and potentially reduce unauthorized off-highway vehicle travel that could cause soil disturbance.

Consequences Specific to Alternative D

"Consequences Common to alternatives B, C, D, and E," above, provides an overview of potential negative and positive effects of vegetation management to species of conservation concern. Alternative D proposes the most intensive vegetation management, especially in the mixed conifer and Jeffrey pine ecosystems. In general, restoration activities would strive to maintain native species composition and by inference, exclude or control nonnative species. The potential timber harvest activity for alternative D is estimated to be the greatest of all alternatives due to greater flexibility in achieving desired conditions and encouragement of larger, landscape-level projects. These activities disturb soils and remove vegetation cover, resulting in a higher risk for new invasive plant species infestations. However, the absolute level of harvest activities is still low relative to historic levels, and methods and equipment used have less ground-disturbing impact.

The 25 species identified as potentially threatened by vegetation and fuel treatment may have greater short-term negative effects on habitat extent and condition under alternative D compared with alternative A and the other alternatives. The greater acreage of restoration proposed under this alternative would benefit some species, especially the 11 species that are threatened by altered fire regimes, such as short-leaved hulsea, Nine Mile Canyon phacelia, and Parry's horkelia. Project design features would avoid impacts on plant species of conservation concern and minimize invasive plant species introduction and spread. The result of soil disturbance and loss of vegetation cover would be greater under D compared with the other alternatives, because the risk of introductions cannot be eliminated altogether.

Consequences Specific to Alternative E

The "Backcountry Management Areas" under alternative E would lead to a similar outcome as the recommended wilderness designation of alternative C, with overall less development, less concentrated areas of recreation development and less anticipated impacts on at-risk plant species compared with alternative A. Alternative E is similar to alternative C, except the recommended wilderness area under alternative E is less compared with C. For the Sequoia National Forest, alternative E includes the Monarch Wilderness Kings River Addition that includes an occurrence of *Erythranthe* norrisii, in addition to the same recommended areas with occurrences of plant species of conservation concern as alternative C.

Sensitive plant species currently on the Regional Forester's sensitive species list

There are two recommended wilderness areas under alternative E that are partially in the Giant Sequoia National Monument. Although there are presently no known records from the CNDDB of sensitive species in these two areas, recommended wilderness direction would offer additional protection for a plant species on the Regional Forester's sensitive species list that is found to occur in these areas.

Cumulative Effects

A few plant species of conservation concern occur solely within the boundary of the Sequoia or Sierra National Forest plan revision areas. The large majority of plant species of conservation concern have additional occurrences outside the plan revision areas and are affected by management activities that occur both in the plan area, and on adjacent land under Federal, State, local agency, or private management. The consequences of these actions are cumulative across boundaries. There are negative impacts, such as habitat loss, or degradation, that has and is occurring with altered fire regimes, or by the introduction or spread of invasive plant species. Cumulative actions could produce positive results, such as activities that restore fire and the natural range of variation of ecological habitats, or that reduce the risk or extent of invasive species.

Many restoration activities and project design features aimed at protecting plant species of conservation concern are shared by adjacent public land agencies, in particular the National Park Service and the BLM. For example, fire management strategies and approaches are similar across the Federal land management agencies and interagency coordination occurs with Federal, state, and local agencies and Tribes when wildfires cross or threaten adjacent lands. Similar approaches to restore fire to wilderness areas and remote areas are likely to result in more acres where wildfires are managed to meet resource objectives in the future on Federal lands, which would benefit plant species of conservation concern in the long run by restoring fire regimes similar to the natural range of variation.

Similarly, efforts to use weed free and weed seed-free plant material for animal feed or bedding, soil stabilization and land rehabilitation complements similar efforts in the adjacent Yosemite and Sequoia and Kings Canyon National Parks. Combined and coordinated efforts in these areas would improve ecological conditions that provide for the persistence of at-risk species.

Reasonably foreseeable vegetation management activities that may occur on private, State, or other Federal land would be similar in effects on those performed on the national forest—prescribed burning to restore fire disturbance regimes or thinning and removing trees to reduce the risk of high-severity wildfire. These activities would be expected to have similar short-term impacts and long-term benefits similar to those described in the plan revision areas, although activities on private lands would have less emphasis or protection for those species of conservation concern that do not have state endangered species status or state species of concern status.

Road management would continue to occur on Federal, state and county roads and roads would remain as potential sources of invasive plants. Vehicles traveling on roads with invasive species, or that have been used off-road on other lands with invasive species, could spread those invasive species onto the national forest. The plan revision alternatives include direction to work with other partners, including county governments, to address invasive species in order to reduce the extent and risk of invasive species spread and to coordinate treatment that is more effective and efficient. This would benefit plant species of conservation concern overall.

As previously discussed in other sections, the pace of restoration under alternatives B and D in treating both upland and aquatic systems may be more aggressive than those undertaken on other land ownerships in the analysis area but are expected to help more rapidly set the trajectory for a positive trend in ecosystem resilience (especially alternative D). Conversely, under alternatives A and C there is a greater risk of not being able to achieve desired conditions in a timely manner for ecosystem integrity, resiliency, and diversity of upland and aquatic systems because of more limited tools, constraints on habitat modifications related to canopy cover and large trees in upland systems, and the use of mechanical equipment in aquatic systems.

Analytical Conclusions

In general, alternative A would provide the necessary ecological conditions to maintain viable populations of the Regional Forester sensitive species by relying primarily on project-level surveys and mitigations of adverse effects from project activities. There are 12 plant species of conservation concern for the plan revision alternatives that are not included as Regional Forester’s sensitive species. In general these plant species occur in similar habitats and ecological conditions to the Regional Forester’s sensitive species, and are expected to be provided. However, since alternative A would likely result in lower restoration treatment rates than the plan revision alternatives, vegetation would likely remain dissimilar to the desired condition in structure, composition and resilience across many arid landscapes.

Plant Species of Conservation Concern Determinations and Plan Evaluation Outcomes

The Sequoia National Forest has 49 botanical species of conservation concern and the Sierra National Forest has 45 species of conservation concern (Moore 2019). The persistence analysis of plant species of conservation concern for the plan revision alternatives is in Appendix D of Volume 2. Each species of conservation concern was evaluated individually, by plan area, and matched with the appropriate persistence determination.

Many plant species of conservation concern have very low number of occurrences or very limited distribution. The relative rarity of a species is one factor considered to constitute vulnerability. In analyzing persistence of plant species of conservation concern, rarity is considered along with ecological conditions of habitat and the identified threats in the plan area. Since botanical species are non-mobile, identified threats to species with very low numbers of occurrences or very limited distribution need to be managed at sites where they exist in order to improve resilience to stochastic events (such as wildfire, flooding, and climate change) and provide for persistence over the long term.

Here is the summary of results:

- For species that have higher numbers of occurrences and greater distribution of occurrences and individuals in occurrences, such that inadvertent loss of individuals or occurrences would not threaten population persistence and viability, the determination outcome is: The ecosystem plan components should provide the ecological conditions necessary to maintain a viable population of these species of conservation concern in the plan area. Nonetheless, additional species-specific plan components have been provided for added clarity and measures of protection. There are 20 plant species of conservation concern in this group.[43]
- For species that have low to very low numbers of occurrence, limited distribution, and identified threats to persistence in the plan area (although some species are endemic to the plan area, many occur elsewhere but have more than two occurrences in the plan area), the determination outcome is: The ecosystem plan components may not provide the ecological conditions necessary to maintain a viable population of these botanical species of conservation concern in the plan area. Therefore, additional species-specific plan components have been provided. The combination of ecosystem and species-specific plan components should provide the ecological conditions necessary to maintain a viable population of these botanical species in the plan area. There are 11 plant species of conservation concern in this group.
- For species having extremely limited occurrences in the plan area, with identified threats to persistence, and the species also occurs outside the plan area, the determination outcome is: It is beyond the authority of the Forest Service or not within the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population of these botanical species in the plan area. Nonetheless, the plan components should maintain or restore ecological conditions in the plan area to contribute to maintaining a viable population of the species within its range. There are 51 plant species of conservation concern in this group.

Note that the total numbers for the three determination outcomes add up to 82, even though 80 species were analyzed. This is because two plant species of conservation concern that occur on both national forests, *Eriastrum tracyi* and *Hulsea brevifolia*, are counted twice because the determination outcomes were different on each forest. They have differences in number and distribution of occurrences, and there are ecological differences between the plan areas.

All three determination outcomes provide both ecosystem and at-risk species-specific forest plan direction for persistence. The outcome for each plant species of conservation concern is displayed in Appendix D. Implementing the emerging plan components, which are similar under the plan revision alternatives, would provide the necessary ecological conditions to maintain viable populations of plant species of conservation concern. These alternatives include ecosystem coarse filter plan components, which aim at protecting the broad habitats on which these species depend,

[43] Species occurring on both National Forests may have different determination outcomes, so the numbers provided here add up to more than 80 species of conservation concern.

and at-risk species-specific and ecosystem type-specific plan components, including those for special habitats, to ensure species persistence.

To the extent possible, the broad ecosystem desired conditions would provide for the broad ecosystem fabric to support sufficient distribution of a minimum number of reproductive individuals of plant species of conservation concern and their habitat, so that species would remain viable. Species distribution is partially provided for by plan components that aim to maintain or restore the diversity and connectivity of ecosystems and habitat types throughout the plan area (FSH 1909.12.20.13). Forestwide ecosystem plan components support natural ecological processes, functions, and biodiversity, and promote ecological conditions that are resilient to climate change and other stressors.

Additional ecosystem plan components provide area-specific desired conditions and management direction, and are tailored to specific ecosystem types or management areas, including providing ecological conditions that support persistence of species of conservation concern in riparian conservation areas; habitat types that host many botanical species of conservation concern. Forestwide plan direction includes the intent to protect habitats as the ecological fabric to maintain persistence of a large group of at-risk plant species, and it is expected that plan revision alternatives would have minimal short-term negative effects on habitat extent and quality for those at-risk species that depend on them.

Disturbance processes (such as fire) and management activities (such as grazing and recreation) are addressed by ecosystem and other plan components that consider effects on plant communities or species diversity.

At-risk species-specific plan components provide additional forestwide guidance for at-risk species: to promote healthy, resilient ecosystems that support functional plant and animal communities and self-sustaining populations of at-risk species. These plan components are particularly important to botanical species of conservation concern because they address site-specific threats in occupied habitat. Species-specific plan components, including for special habitats, mitigate risk to persistence from land management activities, and provide guidance for addressing existing site-specific threats not related to project activities, while balancing the needs of at-risk species with other resource uses and ecological processes. In addition, at-risk species-specific potential management approaches suggest development of systematic and programmatic approaches to achieve conservation of these botanical species.

When necessary, project-level protections are an option. As a result, each threat in each ecosystem for each species of conservation concern identified has been addressed or mitigated in at least one plan component in the draft forest plan, to support the persistence of each species.

For the purpose of revising the forest plan, we determined that all plan revision alternatives have developed adequate plan components (ecosystem- and at-risk species-specific) to provide for ecological conditions that contribute to the persistence of plant species of conservation concern in the plan area, or, where it is beyond the authority of the Forest Service or not within the inherent capability of the plan area to maintain or restore the ecological conditions to maintain a viable population of these botanical species in the plan area, contribute to maintaining a viable population of the species within its range.

Revision Topic 3: Sustainable Recreation and Designated Areas

The following section provides the analysis for recreation, scenery, wilderness, wild and scenic rivers, the Pacific Crest National Scenic Trail, heritage resources, tribal relations and uses, benefits to people and communities, and other related disclosures. Wilderness and the Pacific Crest National Scenic Trail are discussed with the recreation and scenery resource because of their key roles within the larger context of sustainable recreation. The appendices of the draft forest plans include maps showing the recreation opportunity spectrum, recreation management areas, and scenic integrity objectives.

Sustainable Recreation

The need to provide sustainable recreation was a key topic of interest at public meetings and during public engagement. Sustainable recreation is the set of recreation settings and opportunities on National Forest System lands that are ecologically, economically, and socially sustainable for present and future generations.

Analysis and Methods

Indicators

- Acres of each ROS class
- Access for various types of transportation and activities
- Visitor use patterns and visitor use management
- Recreation facilities and the level of development of recreation sites

Methods

The majority of the sustainable recreation analysis focuses on the areas of the forest that are not congressionally designated wilderness. Recommended wilderness is analyzed only in terms of the effects of recommending wilderness on recreation activities and uses. The "Recommended Wilderness" section below analyzes other wilderness recommendation effects.

This analysis uses the Forest Service's National Visitor Use Monitoring (NVUM) program exit survey data as a baseline for the type and intensity of visitor use in the forests. Both forests have collected data 3 of the past 15 years, at 5-year intervals. NVUM trends are extrapolated in a qualitative way and compared with staff observations.

Forest Service staff provided additional information on where types of use occur in the forests and trends in activities, use conflicts, capacity issues, and more. The Outdoor Alliance also provided geospatial information about recreation. This information was used to provide a general sense of the forests' recreation opportunities and the specific issues related to providing for and managing recreation in the forests.

Assumptions

- Outdoor recreation is projected to grow in the number of participants (Cordell 2012).
- New activity types will continue to emerge, and the relative popularity of activities will continue to change.

- Human populations will continue to increase in areas within and adjacent to the national forests' boundaries, increasing recreation demand in these national forests and increasing the numbers of visitors (English et al. 2014). With increasing use levels, conflicts and crowding may increase. Unmet visitor expectations for recreation experiences may decrease public satisfaction with recreation opportunities within the national forests.
- Deferred maintenance on developed recreation sites and infrastructure will continue to outpace budgets.
- Operational funding for recreation will generally remain constant though management costs will continue to increase, and agency staffing will decline. Forests will leverage funding through external grants, internal competitive project funding, and partnerships.
- Partnerships and volunteerism are required to continue to provide the current quantity and quality of opportunities for public use and recreation, as well as any future increases. Agency capacity constrains increasing the level of engagement with partners and volunteers beyond certain levels.
- Conservation education and interpretive services can foster a greater connection between people and nature and help to create a sense of place and understanding of stewardship responsibilities.
- Climate change will produce warmer temperatures and drier conditions influencing snowpack, drought, and hydrologic flow, as described in the "Agents of Change" section above. The location and timing of activities dependent on snow and snowmelt may change. Warmer temperatures and the timing and magnitude of seasonal changes in temperature and precipitation may cause other recreation patterns to change (Morris and Walls 2009).
- Climate change may increase the frequency of large, high-intensity wildfires or areas with high levels of tree mortality, as described in the "Agents of Change" section. These would change recreation settings and the types and locations of opportunities and use patterns.

Affected Environment

People visit the Sierra and Sequoia National Forests for a wide range of recreation. The forests are adjacent to Yosemite and Sequoia and Kings Canyon National Parks, the Inyo National Forest, and BLM and California State lands. The natural environment draws high levels of visitation to lower elevations in the spring and higher elevations in the summer. Diverse natural settings provide a range of opportunities and experiences in both forests.

Recreation Settings

People choose specific destinations or settings for recreation based on the types of experiences they seek. For example, camping in a large, undeveloped area with few facilities offers a sense of solitude, challenge, and self-reliance. In contrast, camping in an area that is accessible to conventional motorized vehicles and provides developed facilities, such as restrooms and tables, offers more comfort, convenience, security, and opportunities for social interaction. A goal of the Forest Service is to provide opportunities for people to have satisfying recreational experiences by offering a range of choices in terms of the types of settings and activities. Recreation settings and activities range from remote and challenging to easily navigated and supported by tourism services in surrounding communities.

The Forest Service uses a framework called the "Recreation Opportunity Spectrum" (ROS), illustrated in Figure 51, to describe different settings across the landscape and the attributes associated with those settings. The Forest Service defines a recreation opportunity setting as the combination of physical, biological, social, and managerial conditions that give value to a place. Thus, an opportunity includes qualities provided by nature (vegetation, landscape, topography, and scenery), qualities associated with recreational use (levels and types of use), and conditions provided by management (developments, roads, and regulations). The ROS framework is a tool to help managers understand the range of settings and opportunities that exist on a forest. Travel management decisions are separate, site-specific, project-level decisions. The ROS is also aligned with scenery resources.

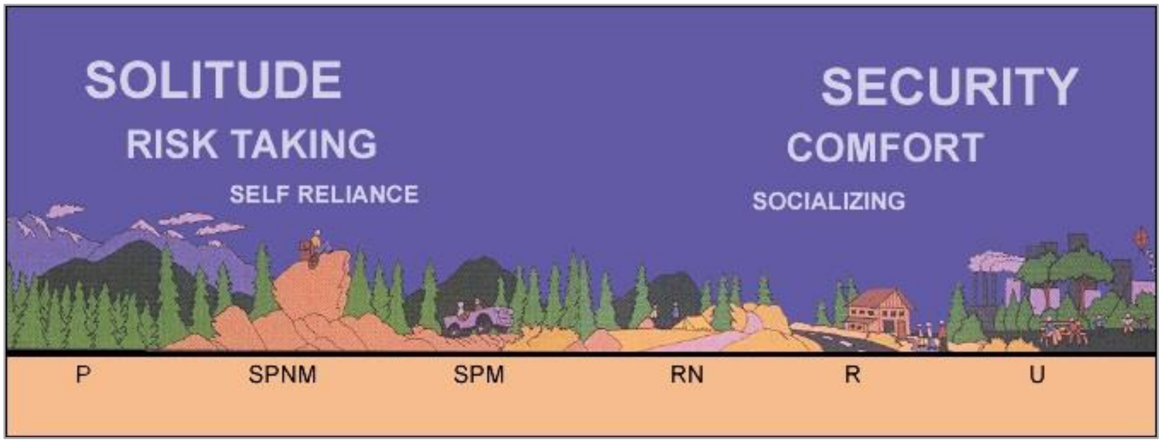

Figure 51. Illustration of the ROS classes along the continuum from primitive to urban

The ROS has six distinct classes along a continuum from primitive and undeveloped to highly modified and developed (Clark and Stankey 1979). The classes are:

- **Primitive** (P) – An unmodified natural environment with a very high probability of experiencing solitude. Motorized use within the area is generally not permitted. There are few, if any, facilities or developments. Most of the primitive settings coincide with designated wilderness boundaries and recommended wilderness areas.
- **Semi-primitive nonmotorized** (SPNM) – A predominantly natural or natural-appearing environment with a high probability of experiencing solitude. Motorized use is generally not permitted. Mechanized transport, such as mountain bikes, is often present. Rustic facilities are present for the primary purpose of protecting the natural resources of the area. These settings offer opportunities for exploration, challenge, and self-reliance.
- **Semi-primitive motorized** (SPM) – A predominantly natural or natural-appearing environment with moderate probability of experiencing solitude. Motorized use on designated routes is generally permitted. Routes are generally designed for off-highway vehicles and other high-clearance vehicles. This setting offers visitors motorized opportunities for exploration, challenge, and self-reliance. Mountain bikes and other mechanized transport are also sometimes present. Rustic facilities are present for the primary purpose of protecting the natural resources of the area or providing portals to adjacent primitive or semi-primitive nonmotorized areas.
- **Roaded natural** (RN) – A predominantly natural-appearing environment with moderate evidence of the sights and sounds of other humans, with nodes and corridors of development that support higher concentrations of use, user comfort, and social interaction.

Motorized use is provided for in construction standards and design of facilities. The road system is generally well defined and can typically accommodate passenger car travel.

- ♦ **Roaded modified** (subclass of roaded natural) – A substantially modified natural environment except for campsites. Motorized use is provided for in construction standards and design of facilities.

- **Rural (R)** – A substantially modified natural environment. Sights and sounds of people are readily evident, and the interaction between users is often moderate to high. Facilities are designed primarily for user comfort and convenience.
- **Urban (U)** – A substantially urbanized environment, although the background may have natural-appearing elements. Sights and sounds of people onsite are predominant. Large numbers of users can be expected, both onsite and in nearby areas.

The ROS is one component of recreation management. It considers access, the built environment to support recreation, and visitor experience, and integrates other resource values, such as areas with wildlife concerns or areas that are at risk of high-severity fire. The function of the ROS system has been to provide a wide range of recreation settings over time, while recognizing that managing recreation uses requires other frameworks and tools in addition to ROS.

The existing ROS map was updated to correct for unintended data errors from data migration and technology improvements over time, and to reflect changes adopted by forest plan amendments that had not been updated in the ROS data system.

Table 92 and Table 93 summarize the total area within each ROS class for the Sequoia National Forest and the Sierra National Forest, respectively, in the existing plans (alternative A) and the plan revision alternatives. For the Sequoia National Forest, primitive, roaded natural, and semi-primitive motorized are currently the predominant ROS classes. For the Sierra National Forest, primitive and roaded natural are currently the predominant ROS classes.

Table 92. Recreation Opportunity Spectrum (ROS) classes by alternative, Sequoia National Forest

ROS Class	Alternative A Acres (Percent of Total Acres)	Alternative B and D Acres (Percent of Total Acres)	Alternative C Acres (Percent of Total Acres)	Alternative E Acres (Percent of Total Acres)
Primitive - Total	300,325 (38%)	300,325 (37%)	453,177 (56%)	437,421 (54%)
Primitive - Designated Wilderness	300,325 (38%)	300,325 (37%)	300,325 (37%)	300,325 (37%)
Primitive - Outside of Wilderness (Designated or Recommended)	0	0	0	0
Primitive - Recommended Wilderness	N/A	0	152,852 (19%)	137,096 (17%)
Semi-primitive Nonmotorized	39,342 (5%)	39,314 (5%)	28,504 (4%)	38,424 (5%)
Semi-primitive Motorized	174,408 (22%)	250,500 (31%)	133,598 (16%)	147,085 (18%)
Roaded Natural	274,344 (34%)	198,403 (24%)	174,310 (22%)	165,721 (20%)

ROS Class	Alternative A Acres (Percent of Total Acres)	Alternative B and D Acres (Percent of Total Acres)	Alternative C Acres (Percent of Total Acres)	Alternative E Acres (Percent of Total Acres)
Rural	7,608 (1%)	21,675 (3%)	20,630 (3%)	21,568 (3%)
Total ROS	796,027	810,219	810,219	810,219

Notes: "Primitive–Total" is the sum of three sub-types of Primitive ROS class: Designated Wilderness, Outside of Wilderness, Recommended Wilderness. These ROS classes are listed subsequently in the table to show that in each alternative, most of the lands in the Primitive ROS class are also designated or recommended wilderness. The larger Primitive–Total under alternatives B, C, D, and E, compared with A, is the result of land that was acquired around Lake Isabella after the release of the Sequoia National Forest plan in 1988. The Forest Service decided to wait until this plan to map ROS for these lands, so the no action alternative does not include these lands in the ROS acreage totals. "Primitive–Designated Wilderness" acreages do not include 13,288 acres of designated wilderness areas in the GSNM. Likewise, "Primitive–Recommended Wilderness" acreages do not include recommended wilderness areas in the GSNM (4,609 acres in alternative B, 82,032 acres under alternative C and 24,405 acres under alternative E). The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision indicating the recommended wilderness process for the GSNM would occur during the forest plan revision. However, ROS numbers in this table do not include lands evaluated for recommended wilderness in the GSNM.

Table 93. ROS classes by alternative, Sierra National Forest

ROS Class	Alternative A Acres (Percent of Total Acres)	Alternative B and D Acres (Percent of Total Acres)	Alternative C Acres (Percent of Total Acres)	Alternative E Acres (Percent of Total Acres)
Primitive—Total	587,286 (45%)	567,481 (44%)	757,392 (59%)	695,446 (54%)
Primitive—Designated Wilderness	552,903 (43%)	552,903 (43%)	552,903 (43%)	552,903 (43%)
Primitive—Outside of Wilderness (Designated or Recommended)	34,383 (3%)	14,578 (1%)	55 (<1%)	806 (<1%)
Primitive—Recommended Wilderness	N/A	0	204,434 (16%)	141,737 (11%)
Semiprimitive Nonmotorized	36,018 (3%)	44,702 (3%)	9,633 (1%)	54,865 (4%)
Semiprimitive Motorized	44,717 (3%)	57,992 (4%)	17,522 (1%)	22,885 (2%)
Roaded Natural	540,664 (42%)	499,734 (39%)	394,325 (31%)	404,325 (31%)
Rural	82,844 (6%)	121,621 (9%)	112,657 (9%)	114,008 (9%)
Total ROS	1,291,529	1,291,529	1,291,529	1,291,529

Notes: "Primitive–Total" is the sum of three sub-types of Primitive ROS class: Designated Wilderness, Outside of Wilderness, Recommended Wilderness. These ROS classes are listed subsequently in the table to show that in each alternative, most of the lands in the Primitive ROS class are also designated or recommended wilderness. "Primitive - Recommended Wilderness" acreages do not include recommended wilderness areas within GSNM (13,213 acres in alternative C, and 22,336 acres in alternative E). The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision indicating the recommended wilderness process for the Monument would occur during the forest plan revision. However, ROS numbers in this table do not include lands evaluated for recommended wilderness within the GSNM.

Access

In addition to ROS, managing recreation also involves understanding and managing public access to recreation activities. Recreation access consists of trails, roads, and other transportation to and within the national forests, provided by state highways, county roads, and a designated system of National Forest System roads and trails. While roads and trails provide access to recreation opportunities, simply traveling on them can also be a recreation activity. Driving for pleasure continues to be one of the most popular activities on both forests. The designation of roads and trails open to motorized vehicles is accomplished through site-specific, project-level planning following the Travel Management Rule (36 CFR 212, 251, 261, and 295).

The national forests provide motorized access through conventional two-wheel-drive roads, four-wheel-drive roads, motorized trails, and motorized snow trails. Motor vehicle use is restricted to designated routes that can include paved highways and roads, gravel or dirt National Forest System roads, and trails designated for motor vehicle travel. Partners, agencies that manage adjoining public lands, and private landowners also provide access to the forests. Forest roads and motorized trails offer scenic views and provide direct access to trailheads, vistas, staging areas, campgrounds, and picnic facilities.

Table 94 summarizes the total mileages of National Forest System roads on each of the forests by maintenance level. On both forests, more roads are maintained at level 2, to accommodate travel by off-highway and high-clearance vehicles, than at levels 3, 4, and 5, for conventional two-wheel-drive vehicles.

Table 94. Summary of total mileages within each road maintenance level, by forest

Maintenance Level	Definition	Sierra National Forest Mileage	Sequoia National Forest Mileage
1	Closed to motorized use, maintained in storage and for future access needs	0	0
2	Managed to accommodate travel by off-highway and high-clearance vehicles	1,949	942
3, 4, and 5	Managed to accommodate passenger cars and other licensed vehicles and closed to unlicensed off-highway vehicles, unless specifically designated	364	440
TOTAL	-	2,313	1,382

Access to the forests also occurs through motorized and nonmotorized trails. Table 95 summarizes the total mileages of designated motorized and nonmotorized trails in each of the forests.

In this analysis, the term “mechanized transport” is defined as transport powered by a living or nonliving power source and includes bicycles and game carts. The term “bicycle” is used to represent mechanized transport in the discussion below. Designated motorized trails and designated nonmotorized trails are open to bicycles, except on any trails within wilderness areas and any trails closed by a Forest Service closure order. The Pacific Crest National Scenic Trail is closed by a regional closure order to mechanized transport. Electric bicycles are considered motorized vehicles and are only allowed on designated motorized routes.

Table 95. Summary of total mileages of designated motorized and nonmotorized trails, by forest

Designation	Sierra National Forest Mileage	Sequoia National Forest Mileage
Motorized	388	370
Nonmotorized, Bicycles Allowed	454	300
Nonmotorized, Bicycles Prohibited	376	387
TOTAL	1,218	1,057
Nonmotorized Snow Trails (subset of total nonmotorized trails)	13	5

The two national forests are open to motorized and nonmotorized winter recreation. Over-snow vehicles are allowed on routes and open areas outside of designated wilderness. Designated winter routes can be groomed, and open areas, which are not groomed, consist of natural snowpack.

The Pacific Crest National Scenic Trail is the only congressionally designated trail in the Sequoia National Forest. The Forest Service has designated five national recreation trails in the Sierra National Forest, including Black Rock, Kings River, Lewis Creek, Rancheria Falls, and Shadow of the Giants.

Visitor Use

Managing recreation also involves understanding user preferences for the locations where different types of activities are most common. Some activities only occur where there are specific resources (for example, rock climbing). NVUM data and reports provide information about visitor use patterns. Sequoia National Forest NVUM data and reports are available for 2006, 2011, and 2016 (United States Department of Agriculture 2006, 2011d, 2016d). Sierra National Forest NVUM data and reports are available for 2007, 2012, and 2017 (United States Department of Agriculture 2007a, 2017c, 2012f).

Table 96 and Table 97 show that generally the total number of forest visits has increased for each forest over the last decade and that the number of visits to specific types of sites varies year to year. Total estimated site visits includes each of the four types of site visits: day-use developed site, overnight-use developed site, general forest area, and designated wilderness.

Table 96. Summary of Sequoia National Forest visitation, 2006–2016

Visit Type	2006	2011	2016
Total Estimated National Forest Visits	640,000	626,000	777,000
Special Events and Organized Camp Use	43,000	40,585	20,000
Total Estimated Site Visits	832,000	960,000	1045,000
Day-use Developed Site Visits	136,000	257,000	189,000
Overnight-use Developed Site Visits	161,000	274,000	223,000
General Forest Area Visits	526,000	416,000	609,000
Designated Wilderness Visits	8,000	14,000	25,000

Table 97. Summary of Sierra National Forest visitation, 2007–2017

Visit Type	2007	2012	2017
Total Estimated National Forest Visits	580,000	726,000	611,000
Special Events and Organized Camp Use	8,000	21,000	6,000
Total Estimated Site Visits	1,057,000	1,312,000	1,049,000
Day-use Developed Site Visits	329,000	328,000	392,000
Overnight-use Developed Site Visits	260,000	245,000	226,000
General Forest Area Visits	429,000	682,000	404,000
Designated Wilderness Visits	40,000	56,000	26,000

Table 98 and Table 99 show that generally the recreation activities with the highest participation rates are relatively consistent for each forest year to year. The tables include 13 of the 28 activities included in the NVUM framework that were ranked within the top 10 highest participation rates, for at least 1 year on either forest. In the Sequoia National Forest, nature center activities, nonmotorized water activities, and “some other activity” were in the top 10 at least 1 year, but were not in the top 10 in the Sierra National Forest. However, downhill skiing was in the top 10 in the Sierra National Forest, but not in the Sequoia National Forest.

Table 98. Participation rates for the subset of activities with the highest percentage of visitors participating, Sequoia National Forest, 2006–2016

Activity	2006 (% Participation)	2011 (% Participation)	2016 (% Participation)
Hiking/Walking	47.7	38.3	54.4
Viewing Natural Features	83.7	29.6	45.0
Relaxing	53.1	40.4	41.6
Driving for Pleasure	35.2	32.5	34.6
Viewing Wildlife	47.2	34.6	29.9
Picnicking	18.5	15.7	15.2
Developed Camping	20.0	25.3	14.2
Other Nonmotorized	20.3	10.5	12.4
Some Other Activity	1.8	3.3	10.4
Fishing	24.6	48.4	10.0
Nature Center Activities	9.3	12.3	7.1
Nonmotorized Water	9.5	2.2	6.5
Downhill Skiing	0.9	1.1	0.2

Table 99. Participation rates for the subset of activities with the highest percentage of visitors participating, Sierra National Forest, 2007–2017

Activity	2007 (% Participation)	2012 (% Participation)	2017 (% Participation)
Relaxing	53.4	59.5	49.6
Viewing Natural Features	44.5	53.4	48.0
Hiking/Walking	39.8	39.2	44.3
Other Nonmotorized	45.2	17.1	33.7

Activity	2007 (% Participation)	2012 (% Participation)	2017 (% Participation)
Viewing Wildlife	23.3	37.2	31.1
Picnicking	26.1	22.3	25.6
Driving for Pleasure	15.7	29.9	21.0
Developed Camping	16.4	16.7	17.1
Fishing	14.6	13.2	14.8
Downhill Skiing	12.2	10.1	14.6
Nonmotorized Water	4.4	4.1	5.5
Some Other Activity	3.5	7.0	4.4
Nature Center Activities	3.7	4.7	3.2

Table 100 and Table 101 provide participation rates for the other 15 activities counted separately, many of which are important to stakeholder groups, including hunting, OHV use, motorized trail activities, motorized water activities, snowmobiling, other motorized activities, primitive camping, backpacking, horseback riding, cross-country skiing, and bicycling. Participation rates for these activities vary year to year. NVUM survey respondents were not limited to selecting just one activity, so percentages add up to more than 100.

Nationally, population growth is projected to be the primary driver of growth in the number of adult participants. The top five activities in terms of the growth of the number of participants are developed skiing, other skiing, challenge activities, equestrian activities, and motorized water activities. The lowest rates of participant growth are visiting primitive areas, motorized off-road activities, motorized snow activities, hunting, fishing, and floating water activities (Cordell 2012).

Table 100. Participation rates for other activities, Sequoia National Forest, 2006–2016

Activity	2006 (% Participation)	2011 (% Participation)	2016 (% Participation)
Hunting	0.5	0.9	10
OHV Use	1.2	3.2	7.7
Visiting Historic Sites	8.2	7.1	7.0
Motorized Trail Activity	0.5	0.7	6.6
Primitive Camping	3.9	1.2	6.4
Resort Use	2.6	4.1	6.4
Bicycling	4.4	6.0	5.3
Nature Study	5.0	7.8	5.2
Gathering Forest Products	2.8	3.9	2.6
Backpacking	1.1	1.7	1.9
Motorized Water Activities	7.2	4.8	1.5
Horseback Riding	2.4	1.0	1.3
Cross-country Skiing	0.9	0.1	0.8
Other Motorized Activity	1.1	0	0.1
Snowmobiling	0	0	0

Table 101. Participation rates for other activities, Sierra National Forest, 2007–2017

Activity	2007 (% Participation)	2012 (% Participation)	2017 (% Participation)
Nature Study	7.7	4.7	12.9
Motorized Water Activities	8.7	5.7	7.0
Gathering Forest Products	4.6	3.7	6.7
Visiting Historic Sites	6.0	8.4	6.5
Resort Use	5.2	4.1	5.7
Primitive Camping	3.5	2.1	4.2
Bicycling	3.0	7.4	3.8
Motorized Trail Activity	1.4	5.1	2.4
OHV Use	2.0	4.8	1.9
Cross-country Skiing	2.6	0.6	1.7
Backpacking	3.4	4.0	1.5
Hunting	0.1	1.0	1.4
Other Motorized Activity	1.5	0.8	0.8
Snowmobiling	1.0	0.7	0.8
Horseback Riding	1.8	1.7	0

The Sequoia National Forest is an overnight destination, rather than a day-use destination. Overnight visitors typically choose to camp in developed sites rather than primitive sites. Because overnight visitors spend more time using recreation resources and require more support services, such as restrooms, drinking water, and trash service, they require more Forest Service resources than day-use visitors (Doucette and Cole 1993). Most of the recreation in the Sequoia National Forest happens in the summer and is especially heavy on holidays and weekends. Waterbodies and cooler temperatures at higher elevations attract many visitors looking for relief from the summer heat. Off-highway vehicle use (four-wheel-drive and all-terrain vehicles, dirt bikes, and other high-clearance vehicles) is concentrated in the Greenhorn Mountains, Piute Mountains, and Kern Plateau. During winter months, most of the higher-elevation areas become inaccessible due to snow-covered roads.

Current recreation management direction for the Sequoia National Forest is based on management area prescriptions. The management areas in the existing plan are developed recreation, general dispersed recreation, water-oriented recreation, and wildlife and dispersed recreation. All prescriptions except the developed recreation are further classified by a vegetation type, yet few differences between these prescriptions exist, mostly a difference in level of development and type of facilities. Activities are identified as appropriate or requiring more direct management depending on the prescription.

Recreation management direction for the Sierra National Forest is based on the developed recreation, dispersed recreation, and dispersed recreation–no timber harvest management area prescriptions.

As the population continues to increase, there are competing public values for many areas and uses and the potential for crowding in popular areas. In addition to growth, outdoor recreation likely will reflect increases in culturally diverse populations (Winter et al. 2014). Two groups whose growth is expected to have the most influence on outdoor recreational styles and participation patterns in the future are Latinos and Asian Americans (Roberts et al. 2009). Current recreation infrastructure may not meet the needs of these two groups, which include larger developed group sites with picnic tables, grills, trash cans, and flush toilets that support day-long activities, hiking and walking, and the opportunity to be with family (Roberts et al. 2009).

An increase in recreational use, particularly unmanaged recreation, affects ecosystems by causing changes in habitat through vegetation trampling and the spread of noxious or invasive plant species to new locations. Unmanaged recreation can include areas that are difficult to manage, areas where inappropriate dispersed recreation is occurring, or areas that have unmonitored, nontraditional recreation activities (Pond 2007). Impacts from unmanaged recreation are often found in riparian areas, areas adjacent to the urban interface, areas of intense recreation use, and areas just outside developed recreation sites.

Examples of unmanaged recreation include development of rock climbing routes at newly discovered climbing areas, user-created mountain bike trails, dispersed camping in sensitive ecosystems such as riparian areas, and motorized vehicle use outside designated travel routes. Unmanaged recreation can adversely affect visitor experiences as a result of conflicting or competing uses and overcrowding. In areas where recreation damages ecosystem resources, lands may be unable to continue to support recreation uses without investments in restoration, partnership, or facility development; those lands may need to be closed to recreation.

To ensure sustainable recreation on the national forests, adaptive management will be necessary. This is particularly true for unmanaged recreation, where timely response to new uses that may damage ecosystem resources will be necessary.

Recreation Facilities

In 2007 and 2008, recreation facility analyses were conducted to address the growing concern about the Forest Service’s ability to maintain recreation sites to meet the needs of the public (United States Department of Agriculture 2007b, 2008b). The goal was to align management of recreation sites and facilities with each national forest’s recreation program niche and economic capability. The recreation programs on the national forests have been guided by recreation program niche statements and complementary niche settings developed through the recreation facility analysis process. Niche statements broadly define the scope of a national forest’s recreation program and highlight those aspects that are distinctive.

There are 115 developed recreation sites in the Sequoia National Forest. Sixty-three of those developed recreation sites are within the plan area. The Sierra National Forest offers a range of developed recreation across the forest. Some facilities are open year-round, and others are open from Memorial Day weekend through Labor Day weekend. About 62 percent of facilities have amenities that provide visitor convenience and comfort. The other 38 percent are rustic.

Sequoia National Forest Niche Statement

“The Sequoia National Forest, named for the world’s largest trees, celebrates the greatest concentration of giant sequoia groves in the world. The Giant Sequoia National Monument encompasses all the giant sequoias on the forest. The Sequoia’s landscape has soaring granite monoliths, glacier-carved canyons, caves, roaring world-class whitewater, and scenic lakes and reservoirs characterize the Sierra Nevada’s southern reach. Elevations range from 1,000 feet in the lower canyons to peaks over 12,000 feet on the crest of the Sierra, providing visitors with spectacular views in a dramatic range of settings. These mountains stand in contrast to

California's San Joaquin Valley, providing cool relief for families from the scorching heat of summer and welcome blue skies and sun during the cold fog of winter. These spectacular features provide an attractive overnight destination for visitors from far and near."

Sierra National Forest Niche Statement

"From lakeside camping and picnicking to wilderness solitude, the Sierra National Forest is destination recreation. With intensely used and highly developed lakes and the world famous Ansel Adams and John Muir Wildernesses, the Sierra provides the extreme ends of recreation settings. These sharp contrasts provide destinations for visitors to escape from the heat and routine urban life, connect with nature, family and friends. Given the proximity to large, diverse and growing urban areas, the Forest Service has a responsibility to provide heritage and conservation education to sustain this incredible landscape for future generations."

Partnerships

Partnerships, volunteerism, and cooperative management strategies have played an increasing role in maintaining and improving developed recreation facilities and trails and restoring landscapes and watersheds in the Sierra National Forest. These efforts will be critical to meeting recreation demand in the future. Concessionaires, or private businesses that operate and maintain government recreation facilities under special use permits, operate approximately 61 campgrounds in the Sierra National Forest and 30 campgrounds in the Sequoia National Forest, as well as group campgrounds, day-use facilities, and cabin rentals.

The Forest Service collects use fees at 53 campgrounds and nine day-use sites in the Sierra National Forest and nine campgrounds and four day-use sites in the Sequoia National Forest. Under the Federal Land Recreation Enhancement Act, the fees collected at these sites are used to provide services and make improvements that benefit the visitors that pay these fees.

Outfitter guides, organizational camps, and special recreation events operate under special use permits to provide recreation opportunities to the public. Table 102 shows the special use permit authorizations that each of the forests currently manages.

Table 102. Summary of special use permit authorizations, by forest

Special Use Permit Authorization Type	Sierra National Forest	Sequoia National Forest (not Including the Giant Sequoia National Monument)
Boat dock and wharf	10	0
Club	1	0
Organization camps	12	1
Private camp	3	0
Isolation cabin	1	0
Recreation residences	557	58
Resorts	19	2
Airport	0	1
Marinas	0	4
Concessions campgrounds	2	2
Outfitting and guiding services	36	22

Special Use Permit Authorization Type	Sierra National Forest	Sequoia National Forest (not Including the Giant Sequoia National Monument)
Winter recreation resort	1	1
Target range	0	1
Golf course	0	1
Cavern	0	1
Recreation events	19	5
Noncommercial group use	0	1
Vendor	1	0
TOTAL	**662**	**100**

Many facilities and programs currently available to the public are dependent on these partnerships with commercial and private operators. Table 103 summarizes recent volunteer contributions on the national forests.

Table 103. Summary of volunteer contributions, by forest

Volunteer Contributions	Sierra National Forest	Sequoia National Forest
Total volunteer hours (2010–2105)	258,704	134,782
Volunteer hours for landscape and watershed restoration (2010–2015)	496	959
Volunteer hours for trail maintenance (2010–2015)	91,364	41,354
Miles of trails maintained by volunteers (2015)	687	249

Environmental Consequences to Sustainable Recreation

Consequences Specific to Alternative A

Recreation Settings

Table 92 and Table 93 summarize the total area within each ROS spectrum class for the Sequoia National Forest and the Sierra National Forest, respectively, in the existing plans (alternative A) and the plan revision alternatives.

For the Sequoia National Forest, primitive, roaded natural, and semi-primitive motorized are currently the predominant ROS classes. For the Sierra National Forest, primitive and roaded natural are currently the predominant ROS classes. In the existing plan, ROS classes are not management areas. The 1988 Sequoia final EIS describes ROS as a tool to ensure that a diversity of opportunities and experiences are provided across the forest even as land use and vegetation management lead to changes in allocations to each ROS class and recreation demand increases. According to the final EIS, “Timber harvest practices will result in a change in the present mix of ROS acres. Over the five decade planning period, approximately 51,000 acres of the present Semi Primitive Nonmotorized and Semi Primitive Motorized area will move to Roaded Natural. Capacities of ROS classes after this shift are sufficient to sustain use increases that are expected” (Sequoia final EIS, p. 4-62). Shifts in ROS classes may continue to occur in this alternative, mostly likely as a result of travel management planning decisions.

Similarly, in the Sierra National Forest, ROS is not a management area in the forest plan. Current standards and guidelines state the forest is to maintain acreage in each ROS class (Sierra Plan, p. 4-13). The monitoring objective for ROS states:

> "Are acres in each ROS Class changing from one end of the spectrum to the other enough to cause a significant change in recreation experience levels? And to compare previous ROS Class maps to new map that shows changes made during the previous 5 years" (Sierra Plan, p. 5-4).

Managing ROS as a guide for achieving a range of settings would continue in much the same way. Existing plan direction provides broad management direction. For example, where vegetation management occurs, roads needed to access a timber sale would take precedence over the ROS setting (see Sierra Land and Resource Management Plan [LRMP], p. 4-13; Sequoia LRMP, p. 4-62). As a result, such roads may shift the ROS class toward the less primitive range of the spectrum over time. In addition, ROS would guide decisions related to developing recreation facilities, but even if the development did not fit into the current ROS class, ROS would not expressly prohibit the development. Instead, the ROS class would shift and over time, the Forest Service would evaluate the range of experiences to ensure there is still an adequate range for opportunities and experiences across the forests.

Access

There is no recommended wilderness under alternative A. Therefore, there would be no change in nonmotorized trails that allow bicycle use. Existing ROS classes would not lead to new limits on motorized recreation opportunities in the future. Motorized use would continue to be authorized in all areas where it is currently authorized until any site-specific travel management decisions are made.

In the Sequoia National Forest, future travel management decisions may affect access for motorized uses in the Piute Mountains and the Sirretta Trail. Travel management decisions would be based on the standard Travel Management Planning process, management area prescriptions in existing plans, and any resource-specific direction in existing plans. Other management decisions about maintenance levels of roads, and designated motorized and nonmotorized trails would also be based on resource-specific direction in existing plans.

Over-the-snow winter use is limited on both forests. Future decisions related to grooming trails for over-snow uses would be made based only on broad plan direction (United States Department of Agriculture 2016e, 2017e).

Visitor Use

Visitor use management under alternative A would continue to be carried out in accordance with existing management area prescriptions for each forest. As visitor use challenges emerge, management decisions would be reactive and generally involve incremental changes. Over time, this may lead to more recreation development, with limited integrated planning to determine where development makes the most sense. Use conflicts, crowding, and resource impacts associated with visitor use would be likely to continue to occur as recreation use increases and visitor use patterns and popular activities continue to evolve. Without proactive management, the types, locations, and intensities of use may not be predictable.

Recreation Facilities

The existing forest plan for the Sierra National Forest directs a number of increases in development, upgrades to certain locations, development of certain areas, and prohibition of development or expansion for other areas. The plan forecasted a higher level of development than has been possible, most likely limited by budget constraints. In the future, it will continue to be difficult to meet the direction of the existing plan for facilities and development.

The existing forest plan for the Sequoia National Forest provides general guidelines associated with the ROS classes, including capacity guidelines for sites. The metric for measuring capacity would continue to be by "people at one time." The concept of "people at one time" is outdated and likely would not be used as the sole measure for expanding sites or facilities. In the future, decisions on upgrades or new developments would be driven by opportunities, funding, and partnerships.

Consequences Common to Plan Revision Alternatives B, C, D, and E

There would be an increase in restoration activities under all plan revision alternatives. Therefore, all these alternatives would provide a greater potential to improve the long-term sustainability of recreation opportunities and settings in comparison with alternative A, which maintains current restoration activity levels.

The plan revision alternatives would have the potential for short-term adverse effects on recreation settings and opportunities by displacing visitors during restoration activities; however, these would be negligible given they are short term in nature, and recreation sites and settings would be more resilient in the long term.

Partnerships would be key to achieving sustainable recreation goals under the plan revision alternatives more than under alternative A. For example, to manage DRAs, in particular in the Sierra National Forest under alternative B at the north end of the forest, partnerships would be essential to maintain infrastructure and manage increased use. Host programs, friends groups, associations, and fee programs would be likely.

Consequences Specific to Alternative B

Recreation Settings

Table 92 and Table 93 summarize the total area within each ROS class for the Sequoia National Forest and the Sierra National Forest, respectively, under the existing plans (alternative A) and the plan revision alternatives.

Under alternative B, in the Sequoia National Forest, compared with alternative A, ROS classes would shift with more area allocated to semi-primitive motorized and rural and less area allocated to roaded natural. However, primitive, roaded natural, and semi-primitive motorized would continue to be the predominant ROS classes.

Under alternative B, in the Sierra National Forest, compared with alternative A, ROS classes would shift with more area allocated to semi-primitive nonmotorized, semi-primitive motorized, and rural, and less area allocated to primitive and roaded natural. However, primitive and roaded natural would continue to be the predominant ROS classes.

Access

For the Sierra National Forest, like under alternative A, there would be no recommended wilderness under alternative B. Therefore, there would be no change in nonmotorized trails that allow bicycle use. Existing ROS classes would not lead to new limits on motorized recreation opportunities. Motorized uses would continue to be authorized in all areas currently authorized until any site-specific travel management decisions are made. Future travel management decisions would be based on the standard Travel Management Planning process and plan direction that are more contemporary than under alternative A, including the desired conditions of the three recreation management areas (destination recreation areas, challenging backroad areas, and general recreation areas) and other plan components to assure resource protection.

For the Sequoia National Forest, there would be one recommended wilderness under alternative B, the Monarch Wilderness Addition – South. Mountain biking and motorized recreation would be prohibited within the Monarch Wilderness Addition – South. However, this area has no existing authorized motorized routes or mountain bike trails, so access for these uses would not change. Future development of opportunities for motorized recreation or mountain biking would not occur within the Monarch Wilderness Addition – South, and opportunities specifically for wilderness-based recreation would increase within this area.

Like alternative A, in the Piute Mountains and the Sirretta trail, future travel management decisions may affect access for motorized uses. Decisions would be based on the standard Travel Management Planning process and plan direction that are more contemporary than under alternative A, including the desired conditions of the three recreation management areas (destination recreation areas, challenging backroad areas, and general recreation areas) and other plan components to assure resource protection.

Visitor Use

Alternative B would provide a framework for managing visitor use that is substantially different than alternative A. This is because the three RMAs would provide a well-defined approach for managing visitor use as uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation uses. Table 1 and Table 2 summarize the total area within each RMA for the Sequoia National Forest and the Sierra National Forest, respectively, under the existing plans (alternative A) and the plan revision alternatives. Figure 52 illustrates the Relationship between ROS classes and recreation management areas.

The Sierra National Forest would manage predominantly for GRAs. Any new recreation uses and developments would be managed through project-level assessments of the effects on resource values. However, GRAs are areas of active land management, multiple uses, and dispersed recreation, so the effects of recreation uses and developments on resource values likely would be minimal, with limited user conflicts.

The Sierra National Forest also would manage large DRAs at the north end of the forest, in the vicinity of the gateway to Yosemite National Park. There would be high concentrations of use and multiple activities. Planning and developing specific high-use areas before use levels increase would help avoid conflicts and create opportunities for multiple uses collaboratively. Under alternative A, management of new high-use areas near Yosemite National Park would be reactive

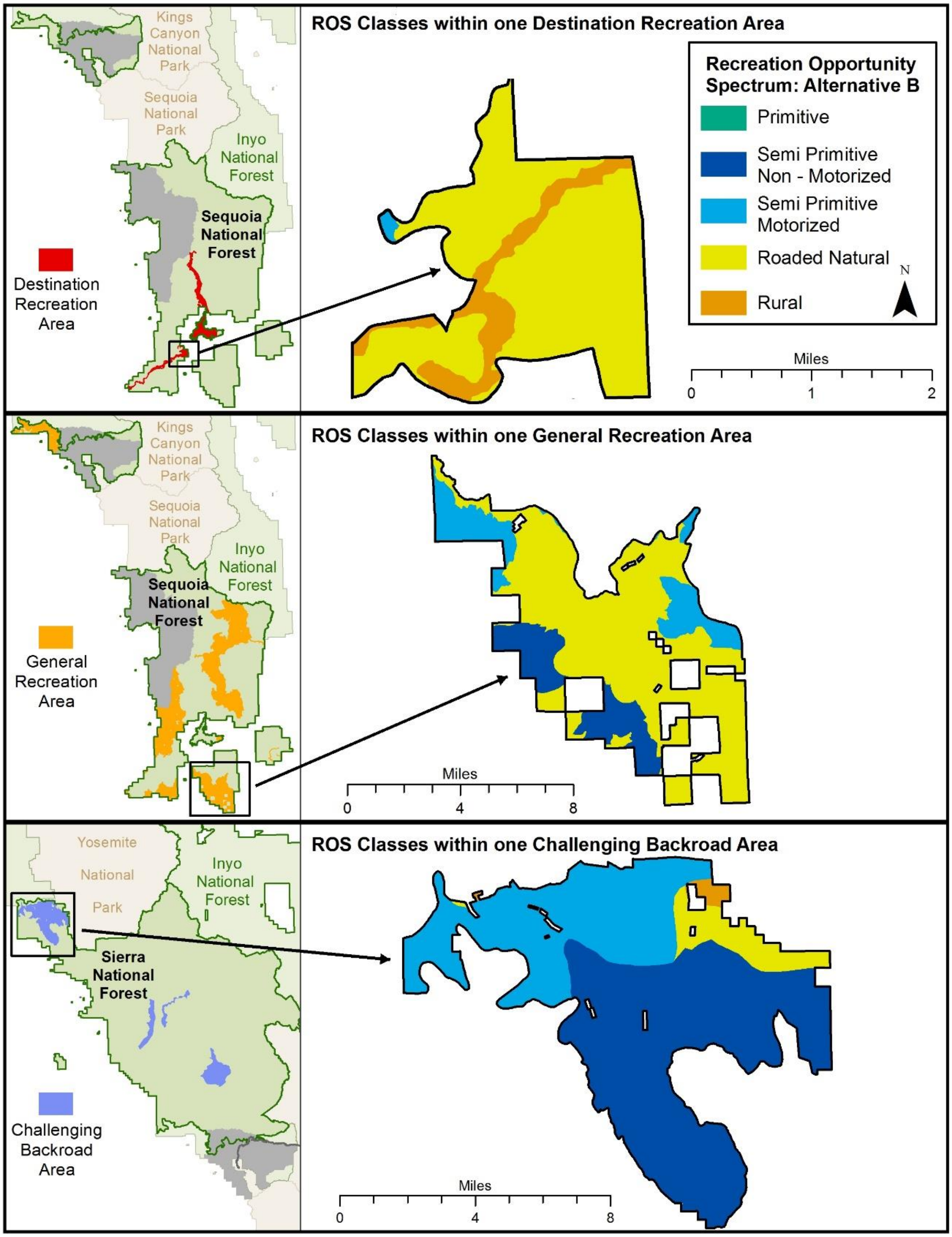

Figure 52. Relationship between ROS classes and recreation management areas.

Visitors often seek a diversity of activities within a visit, so the complement of settings and place based visitation is what this framework attempts to build upon.

and incremental whereas under alternative B, DRAs would be prioritized for more proactive planning. This would enable overflow use by Yosemite National Park visitors, but would require substantial investment.

The Sequoia National Forest would manage predominantly for CBAs and GRAs, with a small amount of DRAs (limited to the Upper Kern River and Lake Isabella). New recreation uses and developments would be expected to primarily occur in GRAs. CBAs would be managed for low-density recreation. The popularity of the Kern Plateau is increasing with both motorized and nonmotorized users because it has scenic natural features and while it is remote, it has a relatively high density of roads and trails. Use conflicts among mountain biking, motorized uses, and horse riding may occur and likely would need to be managed over time.

For both forests, alternative B would include the largest amount of CBAs among all alternatives. Motorized and nonmotorized use levels would be low, and users would be spread out, minimizing opportunities for conflict. However, conflicts may occur among road-dependent uses, such as mountain biking and motorized uses, if use levels continue to increase.

Recreation Facilities

On both forests, changes to facilities (additions and eliminations) would be driven by the RMAs and ROS as guidelines for the level of development and consistency with the broad descriptions of the areas and classes. DRAs would be where forests would focus investments, including amenity upgrades and partnership opportunities. GRAs would be considered for development opportunities as funding and partnership opportunities arise. In CBAs, new development would likely only be related to trailheads and directional and educational signage. After using the RMA guidance, the next filter for decisionmaking, regarding the appropriateness of development, would be the ROS classes.

As mentioned above, the northern portion of the Sierra National Forest, adjacent to the boundary of Yosemite National Park, would be a DRA and prioritized for future recreation development. This plan direction would position the Forest Service for such investment opportunity. If development occurs, limitations or mitigations would be needed to ensure any additional infrastructure and increased visitor use do not negatively affect riparian areas, at-risk species habitat, and other sensitive habitats.

Consequences Specific to Alternative C

Recreation Settings

Table 92 and Table 93 summarize the total area within each ROS class for the Sequoia National Forest and the Sierra National Forest, respectively, under the existing plans (alternative A) and the plan revision alternatives.

Under alternative C, in both forests, compared with alternative A, ROS classes would shift with more area allocated to primitive and rural and less area allocated to semi-primitive nonmotorized, semi-primitive motorized, and roaded natural. However, primitive, roaded natural, and semi-primitive motorized would continue to be the predominant ROS classes in the Sequoia National Forest. Primitive and roaded natural would continue to be the predominant ROS classes in the Sierra National Forest.

Under alternative C, in both forests, the wilderness recommendations are the primary reason more area would be allocated to primitive. Most of the recommended wilderness areas are in the semi-primitive nonmotorized, semi-primitive motorized, and roaded natural classes under alternative A.

Access

Under alternative C, in the Sierra National Forest, there would be 119 miles of system trails within recommended wilderness areas. It is unknown how many of these 119 miles of trails are currently used for mountain biking and would no longer be available for such use. Some of these trails cross terrain that may be difficult for mountain biking. However, with equipment improvements, difficult terrain is less of a barrier to mountain biking than it used to be. In the future, terrain difficulty may be less relevant to identifying which trails are used for mountain biking.

Under alternative C, in the Sequoia National Forest, there would be over 242 miles of system trails within recommended wilderness areas. It is unknown how many of these 242 miles of trails are currently used for mountain biking and would no longer be available for such use. Of these 242 miles of trails, 123 miles are within the Giant Sequoia National Monument.

There is limited data about existing mountain bike use within these recommended wilderness areas, so the extent of the impact on mountain biking is unclear. Future development of opportunities for motorized recreation or mountain biking would not occur within recommended wilderness areas, and opportunities specifically for wilderness-based recreation would increase within these areas.

Like alternative A, in the Piute Mountains and the Sirretta trail, future travel management decisions may affect access for motorized uses. Decisions would be based on the standard Travel Management Planning process and plan direction that are more contemporary than under alternative A, including the desired conditions of the three recreation management areas (destination recreation areas, challenging backroad areas, and general recreation areas) and other plan components to assure resource protection.

Visitor Use

Like alternative B, alternative C would provide a framework for managing visitor use that is substantially different than alternative A. This is because the three RMAs would provide a well-defined approach for managing visitor use as uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation uses. Table 1 and Table 2 summarize the total area within each RMA for the Sequoia National Forest and the Sierra National Forest, respectively, under the existing plans (alternative A) and the plan revision alternatives.

Under alternative C, islands within recommended wilderness areas would not be allocated to any one of the three RMA types. As a result, less area would be allocated to all three RMA types, compared with the other plan revision alternatives. Also, some areas allocated to GRAs and DRAs under alternative B would be allocated to CBAs under alternative C. The "Recommended Wilderness" section provides more information about visitor use management in recommended wilderness areas.

The Sierra National Forest would predominantly manage for recommended wilderness and GRAs with a small amount of CBAs and DRAs. Any new recreation uses and developments within DRAs, CBAs, and GRAs would be managed through project-level assessments of the effects on resource values. GRAs are areas of active land management, multiple uses, and dispersed recreation, so the effects of recreation uses and developments on resource values likely would be minimal, with limited user conflicts.

The Sequoia National Forest would manage predominantly for recommended wilderness, CBAs, and GRAs, with a small amount of DRAs (limited to the Upper Kern River and Lake Isabella). New recreation uses and developments would be expected to primarily occur in GRAs. CBAs would be managed for low-density recreation. The popularity of the Kern Plateau is increasing with both motorized and nonmotorized users because it has scenic natural features and while it is remote, it has a relatively high density of roads and trails. Use conflicts among mountain biking, motorized uses, and horse riding may occur and likely would need to be managed over time.

Recreation Facilities

In both forests, changes to facilities (additions and eliminations) would be driven by recommended wilderness, RMAs, and ROS as guidelines for the level of development and consistency with the broad descriptions of the areas and classes, similar to alternative B.

The Forest Service would focus investments in the DRAs, including amenity upgrades and partnership opportunities. GRAs would be considered for development opportunities as funding and partnership opportunities arise. In CBAs, new development would likely only be related to trailheads and directional and educational signage. After using the RMA guidance, the next filter for decisionmaking, regarding the appropriateness of development, would be the ROS classes.

The primary difference under alternative C is there would be more area in recommended wilderness and less areas in DRAs and GRAs; therefore, overall the development of recreation facilities would be less compared to alternative B.

Consequences Specific to Alternative D

Recreation Settings

Under alternative D, in both forests, the ROS would be the same as under alternative B.

Access

Under alternative D, in both forests, access would be the same as under alternative B, except that alternative D would not include the Monarch Wilderness Addition – South as recommended wilderness in the Sequoia National Forest (within the Giant Sequoia National Monument).

Visitor Use

Like alternatives B and C, alternative D would provide a framework for managing visitor use that is substantially different than alternative A. This is because the three RMAs would provide a well-defined approach for managing visitor use as uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation uses. Table 1 and Table 2 summarize the total area within each RMA for the Sequoia National Forest and the Sierra National Forest, respectively, under the existing plans (alternative A) and the plan revision alternatives.

The primary differences under alternative D are that more area would be allocated to GRAs and DRAs in the Sequoia National Forest and more area would be allocated to GRAs in the Sierra National Forest. As a result, less area would be allocated to CBAs in the Sequoia National Forest, and less area would be allocated to CBAs and DRAs in the Sierra National Forest compared to alternative B.

The Sequoia National Forest would manage predominantly for CBAs and GRAs, with a small amount of DRAs (Greenhorn Mountains, lower Kern River, below Lake Isabella, Upper Kern River, and Lake Isabella). New recreation uses and developments would be expected to occur primarily in GRAs. CBAs would be managed for low-density recreation. The popularity of the Kern Plateau is increasing with both motorized and nonmotorized users because it has scenic natural features and while it is remote, it has a relatively high density of roads and trails. Use conflicts among mountain biking, motorized uses, and horse riding may occur and likely would need to be managed over time.

The Sierra National Forest would predominantly manage for GRAs with a small amount of CBAs and DRAs. Any new recreation uses and developments would be managed through project-level assessments of the effects on resource values. GRAs are areas of active land management, multiple uses, and dispersed recreation, so the effects of recreation uses and developments on resource values likely would be minimal, with limited user conflicts.

For both forests, alternative D would include the largest amount of GRAs among all alternatives.

Recreation Facilities

In both forests, changes to facilities (additions and eliminations) would be driven by the RMAs and ROS as guidelines for the level of development and consistency with the broad descriptions of the areas and classes, similar to alternative B.

The Forest Service would focus investments in DRAs, including amenity upgrades and partnership opportunities. GRAs would be considered for development opportunities as funding and partnership opportunities arise. In CBAs, new development would likely only be related to trailheads and directional and educational signage. After using the RMA guidance, the next filter for decisionmaking, regarding the appropriateness of development, would be the ROS classes.

The primary differences under alternative D compared to alternative B are there would be more area in GRAs and DRAs in the Sequoia National Forest and more area in the GRAs and less areas in DRAs in the Sierra National Forest, so overall the development of recreation facilities would be more in the Sequoia National Forest and less in the Sierra National Forest.

In the Sequoia National Forest, the DRAs around the Greenhorn Mountains and the Lower Kern River may see increased development, if and when funding opportunities emerge, such as recreation fees and public-private ventures, or both. Roads and trails may be improved in these areas, as funding allows.

Consequences Specific to Alternative E

Recreation Settings

Table 92 and Table 93 summarize the total area within each ROS class for the Sequoia National Forest and the Sierra National Forest, respectively, under the existing plans (alternative A) and the plan revision alternatives.

Under alternative E, in the Sequoia National Forest, compared with alternative A, ROS classes would shift with more area allocated to primitive and rural and less area allocated to semi-primitive nonmotorized, semi-primitive motorized, and roaded natural. However, primitive, roaded natural, and semi-primitive motorized would continue to be the predominant ROS classes.

Under alternative E, in the Sierra National Forest, compared with alternative A, ROS classes would shift with more area allocated to primitive, semi-primitive nonmotorized, and rural and less area allocated to semi-primitive motorized and roaded natural. However, primitive and roaded natural would continue to be the predominant ROS classes.

Under alternative E, in both forests, the wilderness recommendations are the primary reason more area would be allocated to primitive. Most of the recommended wilderness areas are in the semi-primitive nonmotorized, semi-primitive motorized, and roaded natural classes under alternative A.

Access

Similar to alternative E, there is limited data about existing mountain bike use within these recommended wilderness areas, so the extent of the impact on mountain biking is unclear. Some trails cross terrain that may be difficult for mountain biking. However, with equipment improvements, difficult terrain is less of a barrier to mountain biking than it used to be. In the future, terrain difficulty may be less relevant to identifying which trails are used for mountain biking.

Future development of opportunities for motorized recreation or mountain biking would not occur within recommended wilderness areas, and opportunities specifically for wilderness-based recreation would increase within these areas.

Like alternative A, in the Piute Mountains and the Sirretta trail, future travel management decisions may affect access for motorized uses. Decisions would be based on the standard Travel Management Planning process and plan direction that are more contemporary than under alternative A, including the desired conditions of the three recreation management areas (destination recreation areas, challenging backroad areas, and general recreation areas) and other plan components to assure resource protection.

Visitor Use

Like the other plan revisions alternatives, alternative E would provide a framework for managing visitor use that is substantially different than alternative A. However, rather than the same three RMAs, alternative E would only have GRAs and backcountry management areas (BMAs). The combination of recommended wilderness, GRAs, and BMAs would provide a well-defined approach for managing visitor use as uses and conditions change over time. The public would have more clarity and certainty about how lands would be managed for recreation uses. Table 1 and Table 2 summarize the total area within each GRA and BMA for the Sequoia National Forest and the Sierra National Forest, respectively.

Current recreation uses and access, including motorized recreation uses on existing routes and mechanized transport, would not be restricted as a result of the designation of BMAs. Recreation uses would be managed for less development and less concentration of use. A large portion of the lands recommended as wilderness under alternative C, as well as other lands, would compose the BMAs.

Both forests would predominantly manage for recommended wilderness, BMAs, and GRAs. In the Sierra National Forest, there would be 20 distinct BMAs, 8 of which would be adjacent to existing designated wilderness. In the Sequoia National Forest, there would be 18 distinct BMAs.

Any new recreation uses and developments within BMAs and GRAs would be managed through project-level assessments of the effects on resource values. GRAs are areas of active land management, multiple uses, and dispersed recreation, so the effects of recreation uses and developments on resource values likely would be minimal, with limited user conflicts.

Recreation Facilities

In both forests, changes to facilities (additions and eliminations) would be driven by recommended wilderness, BMAs, GRAs, and ROS as guidelines for the level of development and consistency with the broad descriptions of the areas and classes, similar to alternative C. The primary difference under alternative E compared to alternative B is there would be recommended wilderness, BMAs, and GRAs, but no DRAs or CBAs; so, overall the development of recreation facilities would be similar to that under alternative C.

Cumulative Effects

The analysis area for cumulative effects includes the Sierra and Sequoia National Forests, Yosemite National Park, Sequoia and Kings Canyon National Parks, Inyo National Forest, and BLM lands adjacent to these national forests and national parks. The Department of Agriculture and the Department of the Interior administer this contiguous block of Federal land. These lands provide a wide range of uses and recreation opportunities and drive much of the tourism in the region. Visitors frequently recreate on lands in multiple jurisdictions during a visit. Authorized uses, facility design, and available services are likely to directly affect which lands visitors choose to use. As a result, recreation management changes on any lands within the region may affect choices visitors make and may change visitor use patterns on the other lands in the region. All plan revision alternatives include management direction that is responsive to changing visitor use patterns, but alternative B would be the most flexible as recreation management changes on other lands in the region.

Growth in the demand for a variety of recreation settings, experiences, and opportunities is expected to increase. This region attracts visitors locally, regionally, nationally, and globally; the upward trend in visitation is likely to continue through the planning period. This growth will result in higher total volumes, concentrations, and intensities of use throughout the area and at existing recreation facilities, many of which currently suffer from increasing deferred maintenance. This growth may result in more competition for limited sites, facilities, and access to popular destinations and settings and more conflicts among different types of recreation activities. This may have negative cumulative impacts on the quality of recreation opportunities and resource conditions. All plan revision alternatives include management direction that is responsive to increasing recreation demands; alternative B, however, would be the most responsive to meeting recreation demands and ensuring the quality of recreation opportunities and resource protection across the region.

Continuing evolution in recreation equipment and technology is likely to change access patterns, types of use, and popular locations across the region. These changes may alter recreation experiences in areas where new use patterns are not compatible with different visitors expectations and lead to crowding or conflicts. These changes have the greatest potential to cumulatively affect nonmotorized recreation opportunities, such as hiking, where participants seek remote settings. All plan revision alternatives include management direction that is responsive to changing access and use patterns; alternative B, however, would be the most responsive to accommodating the widest range of potential visitor use patterns, while also meeting a wide range of visitor expectations.

Yosemite National Park and its management most influence the Sierra National Forest. Yosemite National Park is one of the most famous, busiest, and congested parks in the National Park System. The Sierra National Forest manages land at two of the four gateways to the park. Crowding in Yosemite Valley has and will continue to affect the Merced River Canyon, which leads to Yosemite Valley. As limits are imposed on parking in Yosemite, there will be more pressure for Sierra National Forest lands in the Merced River Canyon to serve as an overflow area for Yosemite Valley and provide additional recreation opportunities and overnight occupancy. Along the corridor associated with the road to the south entrance to the park, there is less direct pressure in the Sierra National Forest. However, as the National Park Service continues capital investments in infrastructure in this corridor, such as the Mariposa Grove restoration, this corridor will continue to see expansion of lodging and tourism-related development to accommodate increasing visitation.

While Yosemite National Park continues to develop and improve facilities and infrastructure inside the park, Sierra National Forest lands may become more popular for dispersed and motorized recreation opportunities, which the park does not provide. Demand may also increase in the Sierra National Forest for recreation opportunities similar to those within the park, which require more facilities, infrastructure, and services.

Alternative A would be the least capable of handling the cumulative effects related to adjacent public land. Alternative B provides management direction specific to the gateways to Yosemite, but would require significant additional investment and partnerships to implement. Alternatives C, D, and E would not provide less management direction specific to the gateways to Yosemite. Alternative C would emphasize more primitive recreation opportunities, while alternative D would emphasize more motorized recreation opportunities, and alternative E would be on the spectrum in between alternatives C and D.

The Sequoia National Forest is contiguous with much of the boundary of Sequoia and Kings Canyon National Parks. There are similar but much less intense use pressures compared with Yosemite National Park and the Sierra National Forest. The parks feature vast designated wilderness and outstanding opportunities for primitive recreation. The Sequoia National Forest may be able to provide recreation opportunities complementary to Sequoia and Kings Canyon National Parks and support a broad range of opportunities for the region.

Alternative A would be the least capable of handling the cumulative effects related to adjacent public land. Alternative C would emphasize more primitive recreation opportunities, similar to opportunities available within the parks. Alternative D would emphasize motorized recreation. Alternatives B and E would be on the spectrum in between alternatives C and D, with B closer to D and E closer to C.

Both forests will be managing for continued tree mortality and its consequences for the next several decades. Much of the financial resources available, from fee receipts to operating budgets and grants, have and will continue to need spending on hazard tree removal around developed recreation sites. Over time, the changed condition will become exacerbated, and the scenic and recreational attributes may diminish. All plan revision alternatives respond with a managerial framework that provides some prioritization on maintaining and investing in existing recreation sites. In all alternatives, as tree mortality leads to increased hazardous fuels and the potential for extensive and intensive wildland fire, both forests will continue to be challenged to maintain existing infrastructure and improve the aesthetics that the public expects.

Since climate change is predicted to produce warmer temperatures and drier conditions influencing snowpack, drought, and hydrologic flow, activities dependent on snow and snowmelt would be affected. Warmer temperatures may cause recreationists to shift their activities to higher elevations during the summer months (Morris and Walls 2009). These changes resulting from climate change may alter the timing of summer recreation opportunities, such as causing fishing opportunities to occur earlier and for a shorter season or shifting the timing of motorized and nonmotorized summer activities to occur earlier and for a longer season. Alternative D would provide direction for increased management activities to protect the physical settings where recreation activities occur; however, alternative B provides effective management direction to respond to changes in recreation due to climate change. Alternatives C and E provide adequate management direction to respond to changes in recreation due to climate change.

Analytical Conclusions

Table 104. Sustainable recreation indicators by alternative, Sierra National Forest and Sequoia National Forest combined

Indicator	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Recreation Settings	Most semi-primitive motorized and roaded natural, least primitive and semi-primitive nonmotorized	Most semi-primitive motorized and roaded natural, least primitive and semi-primitive nonmotorized	Least semi-primitive motorized and roaded natural, most primitive and semi-primitive nonmotorized	Most semi-primitive motorized and roaded natural, least primitive and semi-primitive nonmotorized	Least semi-primitive motorized and roaded natural, most primitive and semi-primitive nonmotorized
Access	Access not affected. Opportunities for wilderness-based recreation would not increase significantly and may decrease in some areas.	Existing access not affected. Future development of opportunities for motorized recreation or mountain biking would not occur within the Monarch Wilderness Addition – South, and opportunities for wilderness-based recreation would increase within this area.	Mountain biking and motorized recreation prohibited across the largest total area. Opportunities specifically for wilderness-based recreation would increase across the largest total area.	Existing access not affected.	Mountain biking and motorized recreation prohibited across a smaller total area than under alternative C, but larger than under alternatives A, B, and D.

Indicator	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Visitor Use	Recreation management would be reactive and generally involve incremental changes. Over time, this may lead to more recreation development, with limited integrated planning to determine where development makes the most sense. Use conflicts, crowding, and resource impacts associated with visitor use would be likely to continue to occur as recreation use increases and visitor use patterns and popular activities continue to evolve. Without proactive management, the types, locations, and intensities of use may not be predictable.	RMAs provide a well-defined approach for managing visitor use as uses and conditions change over time. More clarity and certainty about how lands would be managed for recreation uses compared with alternative A. Largest amount of CBAs. Sierra National Forest: Large DRAs at the north end of the forest, in the vicinity of the gateway to Yosemite National Park.	RMAs and recommended wilderness provide a well-defined approach for managing visitor use as uses and conditions change over time. More clarity and certainty about how lands would be managed for recreation uses compared with alternative A. Lands within recommended wilderness areas would not be allocated to any one of the three RMA types. DRAs would be smallest in alternative C.	RMAs provide a well-defined approach for managing visitor use as uses and conditions change over time. More clarity and certainty about how lands would be managed for recreation uses compared with alternative A. Largest amount of GRAs. Sierra National Forest: DRAs smaller than under alternative B, but larger than under alternative C. Sequoia National Forest: DRAs would be largest under alternative D.	GRAs, 20 distinct BMAs, and recommended wilderness provide a well-defined approach for managing visitor use as uses and conditions change over time. More clarity and certainty about how lands would be managed for recreation uses compared with alternative A. Does not include DRAs or CBAs.
Recreation Facilities	Sierra National Forest: Budget constraints have limited development. Difficult to meet the direction of the existing plan. Sequoia National Forest: Opportunities, funding, and partnerships would drive decisions on upgrades or new developments.	DRAs: Where the Forest Service would focus investments, including amenity upgrades and partnership opportunities. GRAs: Considered for development opportunities as funding and partnership opportunities arise. CBAs: New development likely would only be related to trailheads and directional and educational signage. Sierra National Forest: DRA adjacent to the boundary of Yosemite National Park would be prioritized for future recreation development.	More recommended wilderness and less DRAs and GRAs than under alternative B, so overall the development of recreation facilities would be less.	More GRAs and less DRAs than alternative B but more than alternative C, so overall the development of recreation facilities would be less than under alternative B but more than under alternative C.	Similar to alternative C.

Scenery

Analysis and Methods

Indicator

- Percentage of scenic integrity objectives by alternative

Methods

For comparative purposes, we mapped the desired scenic integrity objectives for alternatives B, C, D, and E. The geographic information system was used to calculate the number of acres in each scenic integrity objective class. For scenic stability, we compared the amount and kind of fuel treatment needed to reach the desired vegetation condition that reflects the natural range of variation (which leads to scenic stability).

Assumptions

- Restoration treatment of fuels (prescribed fire and mechanical treatment) that moves the vegetative condition toward the natural range of variation faster has a positive effect on scenic stability, ultimately sustaining the scenic character; mechanical treatment of fuels moves the vegetative condition toward the natural range of variation faster than prescribed fire.
- Climate change may increase the frequency of large high-intensity wildfires or areas with high levels of tree mortality, or in areas where fuels have accumulated in excess of NRV.

Affected Environment

Outdoor recreation contributes to human health and well-being by offering a variety of physical and mental health benefits. Eighty-four percent of the Californians polled in the most recent Comprehensive Outdoor Recreation Plan statewide survey said outdoor recreation was an “important” or “very important” contributor to their quality of life (Roberts et al. 2009).

National forest scenery contributes to the identity and sense of place for local communities by serving as the backdrop and backyard to residents. The scenery of each national forest is a significant attraction to visitors and creates a sense of place and connection to the land. State and local tourism and marketing efforts feature the magnificent vistas, meandering rivers, and forested settings; they contribute to the economic sustainability of communities. The scenic character of a national forest is a combination of physical, biological, and cultural images that gives an area visual and cultural identity and helps to define a “sense of place.” Scenic character provides a frame of reference from which to determine scenic attractiveness and to measure scenic integrity.

Scenery Resources

To evaluate scenery resources, the current forest plans used the Visual Management System, which was a systematic approach to inventory, analyze, and monitor scenic resources, but did not recognize or incorporate natural disturbance processes such as fire, insects, and disease. The Forest Service has been transitioning from the Visual Management System to the newer Scenery Management System, which uses different scenery evaluation terminology. A cross-walk between the two systems’ terminology is shown in Table 105.

Table 105. Cross-walk between Visual Management System and Scenery Management System terminology

Visual Management System Terminology (Visual Quality Objectives)	Scenery Management System Terminology (Scenic Integrity Objectives)
Preservation	Very High
Retention	High
Partial retention	Moderate
Modification	Low
Maximum modification	Very Low

Scenic Character

All landscapes have definable scenic character attributes. In most national forest settings, scenic character attributes are positive natural elements such as landform, vegetation patterns, and water characteristics. In pastoral or rural settings, positive cultural elements may include historic elements such as split rail fences, stone walls, barns, orchards, hedgerows, and cabins. In urban settings, scenic character attributes may include a fabric of architectural styles. A combination of these attributes defines scenic character.

Descriptions of different types of scenic character include:

- **Naturally Evolving** – Scenic character expressing the natural evolution of biophysical features and processes, with very limited human intervention. These landscapes are largely associated with wilderness areas.
- **Natural Appearing** – Scenic character that expresses predominantly natural evolution, but also human intervention, including cultural features and processes.
- **Cultural** – Scenic character expressing built structures and landscape features that display the dominant attitudes and beliefs of specific human cultures. These landscapes are largely associated with areas containing recreation site development, administrative sites, or public uses under special use permits.
- **Pastoral** – Scenic character expressing dominant human-created pastures, meadows, and associated structures, reflecting valued historic land uses and lifestyles. Pastoral lands also occur on private lands outside the National Forest System administrative boundary, where they may be viewed while traveling on forest roads or trails.
- **Agricultural** – Scenic character expressing dominant human agricultural land uses producing food crops and domestic products. These landscapes generally occur on private lands that are outside the National Forest System administrative boundary, but may be visible while traveling on national forest roads or trails.
- **Historic** – Scenic character expressing valued historic features that represent events and periods of human activity in the landscape.
- **Urban** – Scenic character expressing concentrations of human activity, primarily of commercial, cultural, educational, residential, and transportation structures, and supporting infrastructure. These landscapes generally occur on private lands, but may be visible while visiting a national forest.

Scenic Integrity

Scenic integrity measures the degree to which a landscape is free from visible disturbances that detract from the natural or socially valued appearance, including any visible disturbances from human activities or extreme natural events outside the natural range of variation. Scenic integrity measures these disturbance effects in degrees of consistency, harmony, dominance, and contrast with the valued scenic character.

Scenic integrity uses a graduated scale of five levels ranging from very high integrity to low integrity. It is emphasized within view of travel ways, use areas, and special places. These levels include:

- **Very High Integrity** – The valued scenery appears natural or unaltered. Only minute visual disturbances to the valued scenery, if any, are present.
- **High Integrity** – The valued scenery appears natural or unaltered, yet visual disturbances are present; however, they remain unnoticed because they repeat the form, line, color, texture, pattern, and scale of the valued scenery.
- **Moderate Integrity** – The valued scenery appears slightly altered. Noticeable disturbances are minor and visually subordinate to the valued scenery because they repeat its form, line, color, texture, pattern, and scale.
- **Low Integrity** – The valued scenery appears moderately altered. Visual disturbances are co-dominant with the valued scenery and may create a focal point of moderate contrast. Disturbances may reflect, introduce, or “borrow” valued scenery attributes from outside the landscape being viewed.
- **Very Low Integrity** – The valued scenery appears heavily altered. Disturbances dominate the valued scenery being viewed; they may only slightly borrow from, or reflect, valued scenery attributes within or beyond the viewed landscape.

Many of the landscapes that include wilderness areas and areas within the primitive nonmotorized and semi-primitive nonmotorized ROS classes have high to very high scenic integrity. Common developments that alter scenic integrity include, but are not limited to, power lines, communication sites, substations, propane tanks, geothermal developments, ski areas, hydropower facilities, reservoirs, recreation facilities, resorts, and temporary conditions like dust and smoke.

Scenic integrity objectives are developed in coordination with recreation settings, management direction, and scenic classes. Scenic classes represent the relative landscape value by combining visibility mapping inventories and scenic attractiveness inventories. Generally, scenic classes 1 and 2 have high public value; classes 3, 4, and 5 have moderate value; and classes 6 and 7 have low value.

Scenic Stability

Scenic stability is the degree to which the scenic character and its scenery attributes can be sustained through time and ecological progression. In other words, it looks at the ecological sustainability of the valued scenic character and its scenery attributes. Because attributes such as rock outcroppings and landforms change relatively little over time, scenic stability focuses on the dominant vegetation scenery attributes. Scenic stability recognizes major changes to the landscape that are outside the natural range of variation, such as large wildfires and land clearing for developments, but it also includes subtle, incremental changes that can severely diminish or eliminate scenic character.

The natural range of variation can be used to assess the scenic stability of forest landscapes. This can be measured in terms of the landscape's departure from the natural range of variation. Insufficient fire or too much fire on the landscape can determine the level of departure from the natural range of variation. Departures in fire regime, insect outbreaks, and other disturbances from the natural range of variation help assess scenic stability.

Scenery Resources in the Sequoia National Forest

The most common developments in the Sequoia National Forest that alter scenic integrity include power lines, communication sites, substations, propane tank storage, geothermal development, ski areas, hydropower facilities, reservoirs, recreation facilities, resorts, and temporary conditions like dust and smoke.

In the Sequoia National Forest, many of the valued scenery characteristics attributed to vegetation are at high risk of being impaired due to overly dense vegetation; ecosystem stressors, such as insect and disease outbreaks; and departures from characteristic fire return intervals. These conditions render landscapes susceptible to severe wildfire (see the "Terrestrial Vegetation Ecology" and "Fire Trends"). As such, these landscapes are characterized by conditions outside the natural range of variability and have lower scenic stability.

Scenery Resources in the Sierra National Forest

Scenic integrity uses a graduated scale of five levels ranging from very high integrity to very low integrity. Nearly 50 percent of the Sierra National Forest contains naturally evolving landscapes with limited human intervention (preservation and retention). These landscapes are largely wilderness and within the semi-primitive nonmotorized ROS class and have very high to high scenic integrity. For the landscapes outside the wilderness, the Sierra National Forest has natural-appearing landscapes. Although it is on these landscapes that development occurs, they are expected to have a high scenic integrity. There are a few areas where developments, such as power lines, hydroelectric facilities, transportation systems, and ski runs, are visual disturbances because they are noticeable and slightly detract from the form, line, color, texture, pattern, and scale of the surrounding landscape. However, other developments contribute to the enhancement of the scenery experience. For example, the hydroelectric facilities have led to the construction of reservoirs. Lakes and reservoirs can enhance the scenery experience.

The insect outbreak on the west slope of the Sierra causing significant tree mortality has affected many of the valued vegetation scenery attributes in the Sierra National Forest (see chapter 3 "Agents of Change" section, specifically Figure 7, Figure 8, Figure 9, and Table 9). These areas are at high risk of wildfire. Forest landscapes characterized by these conditions are considered to have low scenic stability. Still, much of the landscape that may not yet have been affected by tree mortality is at risk of being impaired or seriously threatened due to dense vegetation conditions and encroachment, ecosystem stressors such as insect and disease outbreaks, and fire return interval conditions that render landscapes susceptible to severe wildfire.

Areas where tree mortality has not yet affected the landscapes (including wilderness areas) have high to very high scenic integrity. Departures in fire regime, insect outbreaks, and other disturbances from the natural range of variability help assess scenic stability. Insufficient fire or too much fire on the landscape can determine the level of departure from the natural range of variability.

Environmental Consequences to Scenery

All alternatives would help move vegetation conditions toward the natural range of variation, but the pace, scale, and types of treatments would vary between alternatives. Mechanical treatments for restoration may have short-term impacts on scenic integrity compared with hand treatments or prescribed fire, but over the long term, scenic character benefits through increased scenic stability. There would be short-term scenic integrity losses with fire but long-term potential increases in scenic integrity, especially with the reestablishment of the role of fire on the landscape.

Scenic Stability

Consequences Specific to Alternative A

Under the existing plans, scenic stability would increase across the Sierra and Sequoia National Forests, which in turn would improve scenic character, to the extent that vegetation restoration treatments can be conducted. Constraints on diameter limits, limited operating periods, listed species, budget, and operational capacity limit the current pace and scale of treatments.

Consequences Specific to Alternative B

This alternative would increase scenic stability across the landscape, which in turn would improve scenic character more than alternatives A and C, and less than alternative D. The fire management zones in this alternative would facilitate more managed wildfire and prescribed fire over time and as a result achieve ecological restoration more readily than alternative A. The wildlife habitat management areas would be in place to ensure species persistence while at the same time allow for restoration. This alternative would help trend vegetation toward achieving the natural range of variation.

Consequences Specific to Alternative C

This alternative would increase scenic stability across the landscape, which in turn would improve scenic character similar to alternative A but less than alternatives B and D. Although alternative C would have slightly more acres for managing wildfires to meet resource objectives compared with alternative A, it would treat fewer areas with mechanical treatments and more areas with prescribed and managed fire than alternative A. There also would be more recommended wilderness under alternative C than under alternatives A, B, D, or E. These lands would be more likely to maintain scenic stability or increase scenic stability over time. While prescribed fire may have limited applications in designated wilderness, there would be opportunities for prescribed fire in recommended wilderness to the extent that wilderness characteristics are not affected. Limitations on motorized equipment could further limit the use of prescribed fire for any pretreatment activities.

Consequences Specific to Alternative D

This alternative would increase scenic stability across the landscape across the largest area and faster, which in turn would improve the scenic character more than alternatives A, B, and C. This alternative would have the most amount of mechanical treatment and prescribed fire of all the alternatives, which would increase the rate of achieving the natural range of variation more quickly and with more precision, thus providing the highest protection for scenic character.

Consequences Specific to Alternative E

This alternative would be similar to alternative C but with less recommended wilderness. Prescribed and managed wildfire would be facilitated with fire zones. Since there is less recommended wilderness under alternative E, compared with alternative C, there would be slightly more opportunity to achieve results of ecological restoration on more of the landscape without the constraints on motorized equipment that exist in recommended wilderness.

Scenic Integrity Objectives

Consequences Common to All Alternatives

All projects implemented in the Sierra and Sequoia National Forests would require a site-specific assessment of their potential impacts on scenic resources. If mitigation is needed, the ROS/Scenery Management System Guidebook would provide management guidance to ensure scenic integrity objectives (SIOs) are met and mitigation is consistent across the forests. The prescribed SIOs for the forests would guide the design and implementation of management activities.

Activities such as motorized use, vegetation management, fire management, livestock grazing, minerals exploration and extraction, recreation, and the construction and maintenance of utility corridors can change the character of natural landscapes. The specific effects of these activities on scenic resources are dependent on time and intensity. Effects on scenery are typically greatest in the first 5 years following activities.

Mechanical thinning treatments would occur under all alternatives to meet vegetation and wildlife management objectives. Thinning often improves scenic quality, particularly where there are opportunities to enhance scenic views, regenerate aspen stands, and grow bigger trees, especially ponderosa pine. Well-designed treatments can provide for a landscape consistent with the public's expectation for high-quality scenery by increasing the variety of vegetation species or reducing stand homogeneity (stands with uniform spacing and tree size), or both. In general, short-term change to the existing scenic integrity resulting from mechanical treatments is more acceptable where existing disturbance is already apparent in the natural landscape. In areas where little evident change in the natural scenery has previously occurred, disturbance may be less acceptable to the public. These areas are typically associated with visually sensitive viewsheds assigned more stringent SIOs.

There is the potential to temporarily affect the existing landscape from annual mechanical treatment activities under all alternatives. Mechanical treatments that target aspen regeneration, as well as other vegetation conditions, could change the short-term character of the landscape in some local areas. Short-term effects on the scenic landscape include unnatural-appearing slash piles, stumps, denuded vegetation, bare soil, and scarring. Project design or mitigation, or both, under all alternatives would consider scenic resources, so vegetation would appear natural, particularly in the long term. In many instances, variety, texture, and color are actually enhanced along with the primary goal of improving wildlife or vegetation conditions, or both. The scenery management system (SMS) incorporates this type of human-caused effect to achieve the more farsighted desired SIOs.

Table 106 shows the acres and percentage of the Sequoia National Forest for each scenic integrity objective by alternative. The visual quality objectives for alternative A were converted to scenic integrity objectives as shown in the cross-walk in Table 105. Because alternative A does not include approximately 254,000 acres of lands that were added to the Sequoia National Forest in the Lake Isabella area, caution should be used in comparing alternative A with the other alternatives.

Table 106. Desired scenic integrity objectives by acres and percentage of forest by alternative, Sequoia National Forest

Scenic Integrity Objective	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Very High	255,574 24%	300,628 37%	453,513 56%	300,628 37%	437,700 54%
High	159,734 15%	345,247 43%	213,228 26%	345,247 43%	241,285 30%
Moderate	394,009 37%	163,182 20%	145,019 18%	163,182 20%	130,105 16%
Low	191,680 18%	1,487 <1%	1,485 <1%	1,487 <1%	1,452 <1%
Very Low*	63,893 6%	0	0	0	0

* Although the maximum modification objective was used in the Visual Management System, the current Scenery Management System tends to not have objectives for very low scenic integrity. Thus, the maximum modification/very low objective will not be compared with alternatives B, C, D, and E.

Table 107 shows the acres and percentage of the Sierra National Forest for each scenic integrity objective by alternative. The visual quality objectives for alternative A were converted to scenic integrity objectives as shown in the cross-walk in Table 105. Alternative C would have the highest percentage of very high scenic integrity objective compared with all alternatives, mainly due to the higher acreage of recommended wilderness and the increase in the PCT width in this alternative. Alternatives B and D would have the same scenic integrity objectives. Alternative A has the highest amount of low scenic integrity objective of all alternatives, primarily because of the difference in approaches to mapping the older visual quality objectives.

Table 107. Desired scenic integrity objectives by acres and percentage of forest by alternative, Sierra National Forest

Scenic Integrity Objective	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Very High	579,066 41%	552,902 43%	757,685 59%	552,902 43%	694,604 54%
High	106,791 7%	539,741 42%	369,009 28%	539,741 42%	427,596 33%
Moderate	264,255 19%	193,845 15%	159,809 12%	193,845 15%	164,303 13%
Low	397,091 28%	5,223 <1%	5,195 <1%	5,223 <1%	5,195 <1%
Very Low*	70,905 5%	0	0	0	0

* Although the maximum modification objective was used in the Visual Management System, the current Scenery Management System tends to not have objectives for very low scenic integrity. Thus, the maximum modification/very low objective will not be compared with alternatives B, C, D, and E.

Consequences Specific to Alternative A

Under alternative A, scenery management for the forests would maintain its present course. The existing plans do not have adopted SIOs; therefore, under alternative A, no new direction or adopted SIOs would occur. SIOs could be adopted with a separate analysis and forest plan amendment. Alternative A proposes no recommended wilderness areas and retains the greatest amount of land that would be managed for timber production.

Consequences Specific to Alternatives B and D

Desired conditions and guidelines for scenery are similar between alternatives B and D. These alternatives would incorporate SIOs and subsequently increase the use of high-quality scenery as a component of the recreation experience and setting. Under these alternatives, the revised plan would adopt SIOs for each entire forest and include guidance for the forests to follow the ROS/SMS Guidebook for project analysis and implementation. Decisions related to scenery would be consistent with the SMS.

There would be a small amount of recommended wilderness under alternative B in the Sequoia National Forest, so there would be slightly more acres in the very high category and slightly less in the high category. This shift would have negligible effects compared with the other plan revision alternatives.

Consequences Specific to Alternatives C and E

The effects under alternatives C and E would be similar to those under alternative B and D in regards to using the new scenery management system differently than under the existing plans (alternative A). One difference in these alternatives is the amount of recommended wilderness, which would increase the amount of very high scenic integrity in both these alternatives compared with alternatives A, B, and D. Alternative C would have 452,627 acres in very high scenic integrity between the two forests, and alternative E would have 325,617 acres in the very high category. The effect is that alternative C and to a slightly lesser extent alternative E would have the least management activity disturbance to scenery. The potential for less use of prescribed fire in these two alternatives may not improve scenic integrity in the long term if uncharacteristic wildfires become more common as a result of less treatment to restore to the natural range of variability.

Cumulative Effects

Areas modified by power lines and other infrastructure will continue to appear highly managed over the next 10 to 15 years, and scenic integrity will remain moderate to very low in those areas. Vegetation treatments, and utilities and infrastructure development on adjacent private, state, and Federal lands may influence overall scenic integrity. Restoration treatments across the landscape will trend toward the natural range of variation and protection of the scenic character. Driving for pleasure and other scenery dependent activities in the Sierra National Forest could be affected slightly by human disturbance to areas under other administrations. Wildfire and other disturbance processes, if large in scale and intensity, may result in lowered scenic character in those areas affected by the disturbance.

Designated Wilderness

The Wilderness Act of 1964 requires the preservation of wilderness character and recognizes multiple values and public benefits found in these areas. Wilderness provides outstanding opportunities for solitude and for primitive and unconfined recreation. Wilderness is also important for maintenance of species diversity, protection of threatened and endangered species, protection of watershed, scientific research, and various social values.

Analysis and Methods

Indicator

- Protection of wilderness character qualities

Methods

The analysis area for effects on existing designated wilderness includes the 10 existing designated wildernesses in the Sequoia and Sierra National Forests. The time frame for the environmental consequences related to existing designated wilderness areas is the expected life of the forest plan, or 10 to 15 years.

This analysis includes a qualitative discussion of the effects of the proposed management direction in the different alternatives on existing designated wilderness areas.

The following wilderness character “qualities” are considered in this analysis for designated wilderness (conceptually related to, but functionally different from, “wilderness characteristics,” which are used in the wilderness recommendation process):

- Natural
- Undeveloped
- Untrammeled
- Opportunities for solitude or unconfined primitive recreation
- Other features of value

Wilderness Character Qualities

The Wilderness Act, section 4(b) indicates each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area. The Forest Service has identified five “qualities” that are used to assess wilderness character from the statutory language of the Wilderness Act (Landres 2008):

Natural: This quality pertains to terrestrial, aquatic, and atmospheric resources, and ecological processes. The natural qualities of wilderness for this analysis are based on the concepts of naturalness discussed in “Beyond naturalness: rethinking park and wilderness stewardship in an era of rapid change” (Cole and Yung 2012), and the discussion on ecosystem connectivity and diversity contained in “Chapter 1: Terrestrial, Aquatic, and Riparian Ecosystems” of the Sequoia and Sierra National Forest Assessment (United States Department of Agriculture 2013b, c). The natural quality of wilderness is protected to the extent biological diversity and ecological resilience are sustained, ecosystem structure and function are maintained, and natural disturbance processes are sustained.

Undeveloped: This quality pertains to whether wilderness is essentially without permanent improvement or modern human occupation. This quality is influenced by what are commonly called the “section 4c prohibited uses;” that is, the presence of modern structures, installations, habitations, and use of motor vehicles, motorized equipment, or mechanical transport.

Untrammeled: This quality pertains to whether wilderness is essentially unhindered and free from the actions of modern human control or manipulation. Any activity or action that controls or manipulates the components or processes of ecological systems inside the wilderness influences this quality.

Opportunities for solitude or primitive and unconfined recreation: This quality pertains to whether visitors can find opportunities for solitude in wilderness, or to engage in primitive-type or unconfined recreation activities.

Other features of value: Unlike the preceding four qualities that apply to every wilderness, this fifth quality is unique to an individual wilderness based on the features that are inside that wilderness. These features typically occur only in specific locations within a wilderness and include cultural resources, historic sites, paleontological sites, or any feature not in one of the other four qualities that has scientific, educational, scenic, or historical value.

Affected Environment

In Sequoia National Forest, 313,663 acres (approximately 28%) are designated wilderness, with 13,289 of those acres in the GSNM. In Sierra National Forest, 553,056 acres (approximately 42%) are designated wilderness. There are 10 designated wilderness areas either partly or wholly within the administrative boundary of the forests. Table 108 shows the acres of each designated wilderness in both forests. Eight of these wilderness areas (818,520 acres) are part of the third-largest contiguous block of wilderness in the continental United States, which also includes other wilderness areas located in the Inyo National Forest, Sequoia and Kings Canyon National Parks, and Yosemite National Park. The Kaiser Wilderness and Kiavah Wilderness areas are slightly set apart from the contiguous block, but the boundaries are relatively close. The Golden Trout Wilderness and the Monarch Wilderness are both partially in the GSNM.

Table 108. Designated wilderness areas, by forest

Designated Wilderness	Sequoia National Forest Acres	Sierra National Forest Acres	Total Wilderness Acres
South Sierra	28,680	0	60,280[1]
Golden Trout	106,723[2]	0	303,769[3]
Domeland	94,341	0	133,720[4]
Jennie Lakes	10,510	0	10,510
Monarch	14,876[5]	20,584	44,216[6]
Kiavah	45,245	0	86,245[7]
Ansel Adams	0	152,131	231,516[8]
Dinkey Lakes	0	30,863	30,863
John Muir	0	327,492	652,790[9]
Kaiser	0	21,986	21,986
Total	300,375	553,056	1,575,999

[1] Includes 31,600 acres of South Sierra Wilderness that is within the Inyo National Forest.
[2] Does not include 4,532 acres of Golden Trout Wilderness that is within the Giant Sequoia National Monument.
[3] Includes 4,532 acres of Golden Trout Wilderness that is within the Giant Sequoia National Monument and 192,514 acres that is within the Inyo National Forest.
[4] Includes 39,379 acres of Domeland Wilderness that is Bureau of Land Management land.
[5] Does not include 8,756 acres of Monarch Wilderness that is within Giant Sequoia National Monument.
[6] Includes 8,756 acres of Monarch Wilderness that is within Giant Sequoia National Monument.
[7] Includes 41,000 acres of Kiavah Wilderness that is managed by the Bureau of Land Management.
[8] Includes 78,712 acres of Ansel Adams Wilderness that is within the Inyo National Forest and 763 acres that is National Park Service land within Devils Postpile National Monument.
[9] Includes 325,298 acres of John Muir Wilderness that is within the Inyo National Forest.

Existing forest plan direction for the Sequoia National Forest and Sierra National Forest provides general management direction for all designated wilderness areas, including protecting and maintaining the five qualities of wilderness character in designated wilderness. Wilderness-specific management plans currently provide detailed direction for managing the South Sierra, Golden Trout, Domeland, Ansel Adams, Dinkey Lakes, and John Muir Wilderness areas.

Table 96 and Table 97 show that generally the total number of designated wilderness visits has increased for each forest over the last decade. While Sierra National Forest designated wilderness visits decreased in 2017, it was most likely due to record snowpack in the winter 2016/2017, which would have made much of designated wilderness difficult to access until mid- to late summer. NVUM data is only collected every 5 years. As a result, periodically high snow levels and other impacts on wilderness access may obscure general trends in NVUM data.

Environmental Consequences to Designated Wilderness

Consequences Specific to Alternative A

Existing forest plans and amendments would continue to provide general management direction for all designated wilderness areas. Natural ecological processes and disturbances would continue to be the primary forces affecting the composition, structure, and patterns of vegetation. Opportunities for solitude and primitive and unconfined recreation would be maintained, and no new permanent developments or human occupancy would be authorized.

Wilderness-specific management plans would continue to provide detailed direction for managing the South Sierra, Golden Trout, Domeland, Ansel Adams, Dinkey Lakes, and John Muir Wilderness areas. The Ansel Adams, Dinkey Lakes, and John Muir Wilderness-specific plans include three visitor use zones. To protect natural qualities in areas identified as popular destination areas, impacts associated with visitor use would be concentrated and managed to protect sensitive resources within the area. There would be an emphasis on using existing campsites and managing user trails within this area. Where they exist, group size limits, wilderness permits, trailhead quotas, and campsite restrictions (adjacent to water) would continue to be implemented to effectively manage visitor use levels to minimize impacts on natural qualities and to maintain or improve opportunities for solitude. To protect opportunities for primitive and unconfined recreation, as well as solitude, a majority of the lands would be managed for low density and minimal evidence of visitation.

Alternative A lacks specific guidelines and components to provide for restoration in wilderness or to address invasive species for areas without current management plans specific to the wilderness.

Consequences to Designated Wilderness from Other Relevant Resource Programs

Natural, unplanned ignitions would continue the long-term ecological processes in existing wilderness areas. There could be a short-term loss of vegetation, reduction in water quality due to sedimentation, and effects from smoke; these effects are typically understood as natural ecological processes that help maintain natural qualities. However, with increasing frequency and intensity of high-severity fires, the extent and intensity of effects of fire may be outside the natural range of variation and have substantial negative effects on natural qualities.

Table 109 shows the proportions of the three different fire management zones within designated wilderness areas under alternative A. Both the Wildland-urban Intermix Defense and Threat Zones emphasize hazardous fuels reduction treatments, which would be likely to have negative effects on untrammeled and natural qualities. Some wildfires within designated wilderness areas may be allowed to burn when conditions allow and if they can be done in a safe manner, in order to meet resources objectives, which may have positive effects on natural qualities. See the Wildland Fire Management section for more details.

Table 109. Fire management zones within designated wilderness, alternative A

Fire Management Zone	Sequoia National Forest Acres (%)	Sierra National Forest Acres (%)
Wildland-urban Intermix Defense	95 (<0.1%)	1,353 (0.2%)
Wildland-urban Intermix Threat	13,562 (4.5%)	33,953 (6.1%)
Not Wildland-urban Intermix	286,718 (95.5%)	517,750 (93.6%)

Note: Only includes existing designated wilderness and does not include lands within the Giant Sequoia National Monument.

Alternative A does not provide management direction to increase restoration activities on adjacent lands to existing wilderness which may negatively affect natural qualities of wilderness areas because the frequency and intensity of large, high-severity fires may increase.

Consequences Specific to Alternative B

Consequences under alternative B would be similar to those under alternative A, except the three-visitor-use-zone approach included in the existing Ansel Adams, Dinkey Lakes, and John Muir Wilderness-specific management plans would also apply to the Kaiser Wilderness to enhance protection of wilderness qualities.

Consequences to Designated Wilderness from other Relevant Resource Programs

Table 110 shows the proportions of the four different fire management zones within designated wilderness areas under alternatives B and D. Community Wildfire Protection and General Wildfire Protection Zones emphasize hazardous fuels reduction treatments which would be likely to have negative effects on untrammeled and natural qualities. Some wildfires within designated wilderness areas may be allowed to burn when conditions allow and if it can be done in a safe manner, in order to meet resources objectives, which may have positive effects on natural qualities. See the Wildland Fire Management section for more details, including the differences between the General Wildfire Protection Zone (alternatives B and D) and the GFZ (alternatives C and E).

Alternative B would provide management direction for more restoration activities on lands adjacent to designated wilderness than alternative A. Restoration of adjacent lands would be beneficial to protecting natural qualities of wilderness areas because it may reduce the frequency and intensity of large, high-severity fires.

Table 110. Alternative B and D fire management zones within designated wilderness, Sequoia National Forest and Sierra National Forest

Fire Management Zone	Sequoia National Forest Acres (%)	Sierra National Forest Acres (%)
Community Wildfire Protection	1,566 (0.5%)	604 (0.1%)
General Wildfire Protection	4,132 (1.4%)	1,402 (0.3%)
Wildfire Restoration	65,856 (21.9%)	11,780 (2.1%)
Wildfire Maintenance	228,821 (76%)	539,270 (97.5%)

Note: Only includes existing designated wilderness and does not include lands within the Giant Sequoia National Monument.

Consequences Specific to Alternatives C and E

Consequences under alternatives C and E would be the same as those under alternative B, except where related to consequences from other relevant resource programs, as described below.

Consequences to Designated Wilderness from other Relevant Resource Programs

Table 111 shows the proportions of the three different fire management zones within designated wilderness areas under alternatives C and E The Wildland-Urban Intermix Defense Zone emphasizes hazardous fuels reduction treatments which would be likely to have negative effects on untrammeled and natural qualities. Some wildfires within designated wilderness areas may be allowed to burn when conditions allow and if it can be done in a safe manner, in order to meet resources objectives, which may have positive effects on natural qualities. See the Wildland Fire Management section for more details, including the differences between the General Zone (alternatives C and E) and the General Wildfire Protection Zone (alternatives B and D) and the differences between the Maintenance Zone (alternatives C and E) and the Wildfire Maintenance Zone (alternatives C and E).

Table 111. Alternative C and E fire management zones within designated wilderness, Sequoia National Forest and Sierra National Forest

Fire Management Zone	Sequoia National Forest Acres (%)	Sierra National Forest Acres (%)
Wildland-urban Intermix Defense	95 (<0.1%)	1,353 (0.2%)
General Fire	68,581 (22.8%)	12,034 (2.2%)
Wildfire Maintenance	231,699 (77.1%)	539,669 (97.6%)

Note: Only includes existing designated wilderness and does not include lands within the Giant Sequoia National Monument.

Alternatives C and E would provide management direction for more restoration activities on lands adjacent to designated wilderness than alternative A, but less than alternative B. Restoration of less adjacent lands would result in higher frequency and intensity of large, high-severity fires than alternative B and restoration would be less beneficial to protecting natural qualities of wilderness areas.

Consequences Specific to Alternative D

Consequences under alternative D would be the same as those under alternative B, except the three-visitor-use-zone approach included in the existing Ansel Adams, Dinkey Lakes, and John Muir Wilderness-specific management plans would not apply to the Kaiser Wilderness to enhance protection of wilderness qualities.

Consequences to Designated Wilderness from other Relevant Resource Programs

Management direction would be similar to that under alternative B.

Cumulative Effects

Past, present, and reasonably foreseeable actions that have the potential to cumulatively affect designated wilderness areas include activities such as vegetation management, mining, increasing recreation use, and fuels reduction activities that would occur adjacent to existing wilderness areas. These actions may impact opportunities for solitude inside designated wilderness areas, depending on the frequency and proximity of actions to wilderness boundaries. For example, mining activities adjacent to a designated wilderness may increase the sights and sounds of motorized equipment heard within a wilderness, negatively affecting opportunities for solitude.

Expansion of a developed recreation site adjacent to a designated wilderness may increase use levels within the wilderness, negatively affecting opportunities for solitude. The overall effects are unlikely to be large within designated wilderness under each alternative. The differences in cumulative effects among the alternatives are also unlikely to be large.

Analytical Conclusions

Alternative A lacks specific guidelines and components to provide for restoration in wilderness or to address invasive species for areas without current management plans specific to the wilderness. Alternative A also does not provide management direction to increase restoration activities on adjacent lands to existing wilderness, which may negatively affect natural qualities of wilderness areas.

Alternatives B, C, and E would have the most beneficial effects on wilderness qualities by applying the three-visitor-use-zone approach included in the existing Ansel Adams, Dinkey Lakes, and John Muir Wilderness-specific management plans to the Kaiser Wilderness as well. Alternative D would not include this approach for the Kaiser Wilderness.

Alternatives B and D would have the most beneficial effects on wilderness qualities because restoration activities on lands adjacent to designated wilderness may reduce the frequency and intensity of large, high-severity fires. Alternatives C and E would have less beneficial effects than alternatives B and D, but more than alternative A.

Recommended Wilderness

National forests are required by the 2012 Planning Rule (36 CFR 219.7(2)(v)) to “identify and evaluate lands that may be suitable for inclusion in the National Wilderness Preservation System and determine whether to recommend any such lands for wilderness designation.” Any lands a

Forest Supervisor recommends for wilderness designation through forest plan revision would be a preliminary administrative recommendation, and are referred to as “recommended wilderness.”

There is a four-step process outlined in FSH 1909.70 that provides direction for inventory, evaluation, analysis, and recommendation. Not all lands inventoried and evaluated are analyzed through the NEPA process. Appendix B documents the inventory and evaluation of lands, including the rationale for those that are not analyzed in this environmental impact statement.

Analysis and Methods

Indicators

- Protection of wilderness characteristics in recommended wilderness areas (conceptually related to, but functionally different from, “wilderness character qualities,” which are used in management of designated wilderness areas)
- Ability to conduct vegetation, fire, watershed, and wildlife habitat management
- Special use permit authorizations
- Recreation activities and access
- Ability to manage recommended wilderness

Methods

The analysis area includes recommended wilderness areas under alternatives B, C, and E (as identified in Appendix B, Wilderness Recommendation Process for the Sequoia and Sierra National Forests). The analysis area for alternatives A and D, which does not include recommended wilderness, includes the same areas, but without management as recommended wilderness. The time frame for the environmental consequences related to any recommended wilderness would be the expected life of the forest plans. If recommended wilderness areas are eventually designated by Congress, the time frame for related environmental consequences may be longer term.

This analysis includes a qualitative discussion of the effects of the proposed management direction of recommended wilderness areas, or lack thereof, under the different alternatives.

Assumptions

- As described in Appendix B, Wilderness Recommendation Process for the Sequoia and Sierra National Forests, designation of a recommended wilderness area would require an act of Congress. This outcome is not analyzed here because such congressional action is highly unpredictable.
- Generally, evaluated areas contiguous with designated wilderness would require less management effort to protect wilderness characteristics than areas that are not contiguous with designated wilderness. This is because there may be fewer new miles of boundary to mark, monitor, and maintain, especially in areas where a high proportion of the boundary of the recommended wilderness is contiguous with the designated wilderness boundary. In addition, locally based wilderness stewardship partners and patterns (for example, staging areas, strategies, and tools) have already been developed.
- Generally, motorized access to trailheads that provide efficient access to recommended wilderness areas would also enable protection of wilderness characteristics with less

management effort than areas where access requires significant travel time. However, motorized access to trailheads and along boundaries of recommended wilderness areas is also likely to be associated with unauthorized motorized incursions into recommended wilderness areas. Especially in remote areas with nearby motorized access, it may be difficult to prevent motorized incursions.

- Some areas included in alternatives as recommended wilderness are partly or entirely within inventoried roadless areas (IRAs) under the 2001 Roadless Rule. Managing lands as recommended wilderness that are in IRAs will add some complexity to management in some areas. For example, vegetation management and timber harvest would be more constrained in recommended wilderness that is also within IRAs than in areas that are IRAs but not recommended wilderness. Motorized equipment would only be allowed for at-risk species habitat restoration within recommended wilderness that is also within IRAs, whereas motorized equipment would be allowed for a wider range of management activities in areas that are IRAs but not recommended wilderness.
- Generally, the additional protection of wilderness characteristics as a result of recommending wilderness in areas that are not already in IRAs would be greater than the additional protection of wilderness characteristics as a result of recommending wilderness within existing IRAs. Motorized recreation is already restricted within IRAs, so there would be less change in management in recommended wilderness that is within IRAs than in recommended wilderness that is not already in IRAs.
- Generally, recommended wilderness areas that are partly or entirely within IRAs would require less management effort to protect wilderness characteristics than areas that are not within IRAs, especially in areas where a high proportion of the recommended wilderness is within IRAs. This is because uses within IRAs are already restricted, the additional restrictions in recommended wilderness would be minimal, and the public and the Forest Service have already established use and stewardship patterns in these areas that are generally compatible with recommended wilderness.

Affected Environment

Appendix B, Wilderness Recommendation Process for the Sequoia and Sierra National Forests, documents the process to identify and evaluate lands that may be suitable for inclusion in the National Wilderness Preservation System. The appendix also documents the process used for identifying which evaluated areas to analyze in one or more alternatives in the draft environmental impact statement. Not all lands inventoried and evaluated are analyzed through the NEPA process.

The existing condition for areas included in the wilderness recommendation process, including those that were brought into an alternative for analysis through this environmental impact statement, can be found in the appendix and is incorporated by reference instead of repeated in this section. The appendix contains detailed information and maps for each area included as recommended wilderness in the analysis and the rationale for areas or portions of areas that are not included in the analysis.

Environmental Consequences for Recommended Wilderness

Consequences Specific to Alternative A

Protection of Wilderness Characteristics

There is no recommended wilderness under alternative A. Areas identified in the wilderness evaluation would be managed under existing plan direction. Within these areas, some lands currently have substantial wilderness characteristics that may change over time. For example, recreation activities, such as motorized uses, may increase in ways that decrease wilderness characteristics of opportunities for solitude or primitive and unconfined recreation. Wilderness characteristics may also change based on ecological restoration treatments over time, such as vegetation, fire, watershed, and wildlife habitat management.

It is not possible to know the locations of all the future ecological restoration treatments under alternative A, but it is likely that natural characteristics may be subject to short-term impacts in some areas, given the needs to restore resiliency to the landscape. Natural characteristics of lands within the timber base may decrease in the short term in areas when and where management treatments are implemented. It is likely that in the long term, lands with vegetation treatments would be within the natural range of variability, be more resilient, and retain natural characteristics. Many of the lands evaluated have steep slopes and would be difficult to access and treat. Managed wildfire and prescribed burning are more likely to affect these lands than timber.

Demographic changes, including a population increase, and shifts in cultural preferences for outdoor recreation may lead to more people recreating on these lands. Natural characteristics of the land may decrease as more people recreate in some areas. New developed recreation facilities to accommodate such use may also decrease natural characteristics. Some lands evaluated may change in other wilderness characteristics over time as well. For example, opportunities for solitude or primitive and unconfined recreation may decrease in some areas as recreation uses continue to increase.

Ability to Conduct Vegetation, Fire, Watershed, and Wildlife Habitat Management

Active management within areas identified in the wilderness evaluation would not be limited. This would facilitate restoration projects particularly related to tree mortality and wildfire. However, many of the lands evaluated have steep slopes and would be difficult to access and treat. Managed wildfire and prescribed burning are more likely to affect these lands than timber.

Special Use Permit Authorizations

There would be no effect on special use permit authorizations. In the future, authorizations such as recreation events, outfitting and guiding, and land use authorizations may increase because there would be no limitations based on recommended wilderness.

Recreation Activities and Access

All activities currently occurring within areas identified in the wilderness evaluation would continue under current management. Access to areas by the existing road and trail system would not be affected. Future development of opportunities for motorized recreation or mountain biking may occur, and additional roads and trails may be designated or constructed, providing additional access and use opportunities. Existing trails and roads may be maintained using motorized equipment and mechanical transport. Opportunities specifically for wilderness-based recreation would not increase significantly and may decrease in some areas.

Access would not change for people who are only able to access National Forest System lands by a motor vehicle. People with disabilities that require use of a wheelchair or mobility device would continue to be allowed to use such devices where foot travel is allowed and access with such devices is feasible under existing conditions.

Ability to Manage Recommended Wilderness

No lands would be managed as recommended wilderness.

Consequences Specific to Alternative B

Table 112. Alternative B recommended wilderness area names and acreage, both forests

National Forest	Recommended Wilderness Area Name	Total Acres	Acres in GSNM
Sequoia	Monarch Wilderness Addition – South	4,906	4,906
Sierra	None	0	0

Note: This table indicates which lands are within the GSNM. The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision, which indicates the recommended wilderness process for the Monument would occur during the forest plan revision.

Protection of Wilderness Characteristics

Under alternative B, there is one recommended wilderness, the 4,906-acre Monarch Wilderness Addition – South. Management as a recommended wilderness would protect the existing wilderness characteristics of naturalness.

Ability to Conduct Vegetation, Fire, Watershed, and Wildlife Habitat Management

Active management would be limited within the Monarch Wilderness Addition – South. This would not be a significant change in management because it is such a small area and the effect likely would be minimal. Many of the other lands evaluated have steep slopes and would be difficult to access and treat. Managed wildfire and prescribed burning are more likely to affect these lands than timber. See the discussion in alternative C for details about the limitations on active management that might be expected in recommended wilderness.

Special Use Permit Authorizations

There could be some effects on special use permit authorizations within the Monarch Wilderness Addition – South. For example, there could be some additional limitations on authorizations, such as recreation events, outfitting and guiding, and land use authorizations, where such a special use is proposed within the Monarch Wilderness Addition – South. See the discussion in alternative C for details about the limitations on special use permit authorizations that might be expected in recommended wilderness.

Recreation Activities and Access

Mountain biking and motorized recreation would be prohibited within the Monarch Wilderness Addition – South. However, this area has no existing authorized motorized routes or mountain bike trails, so access for these uses would not change. Future development of opportunities for motorized recreation or mountain biking would not occur within the Monarch Wilderness Addition – South, and opportunities specifically for wilderness-based recreation would increase within this area.

Access would not change for people who are only able to access National Forest System lands by a motor vehicle. People with disabilities that require use of a wheelchair or mobility device would continue to be allowed to use such devices where foot travel is allowed and access with such devices is feasible under existing conditions.

Ability to Manage Recommended Wilderness

The Monarch Wilderness Addition – South is contiguous with the Monarch Wilderness. Approximately 98 percent of the area is inventoried roadless area. Approximately 50 percent of Agnew Inventoried Roadless Area is within the area. There are three trailheads that provide access for motorized vehicles to staging areas, which would help minimize the time required to access the Monarch Wilderness Addition – South to perform management.

Consequences Specific to Alternative C

Table 113. Alternative C recommended wilderness area names and acreage, Sierra National Forest

Recommended Wilderness Area Name	Total Acres	Acres in GSNM
Ansel Adams Wilderness Addition	37,057	0
Ansel Adams Wilderness Granite Creek Additions (1)	6,950	0
Ansel Adams Wilderness Granite Creek Additions (2)	2,949	0
Ansel Adams Wilderness Mt. Raymond Additions (1)	9,117	0
Ansel Adams Wilderness Mt. Raymond Additions (2)	661	0
Bear Mountain	9,245	0
Devil Gulch	37,132	0
Dinkey Lakes Wilderness Additions (1)	8,317	0
Dinkey Lakes Wilderness Additions (2)	4,178	0
Dinkey Lakes Wilderness Additions (3)	16,318	0
Ferguson Ridge	7,729	0
John Muir Wilderness Additions – Southwest	3,359	0
John Muir Wilderness Additions – West (1)	1,299	0
John Muir Wilderness Additions – West (2)	1,205	0
Monarch Wilderness Addition – West	42,512	13,213
Shuteye	14,418	0
Sycamore Springs	15,269	0
TOTAL ACRES Alt. C Recommended Wilderness	217,715	13,213

Note: This table indicates which lands are within the GSNM. The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision, which indicates the recommended wilderness process for the Monument would occur during the forest plan revision.

Table 114. Alternative C recommended wilderness area names and acreage, Sequoia National Forest

Recommended Wilderness Area Name	Total Acres	Acres in GSNM
Cannell Peak	27,208	0
Dennison Peak	7,056	7,056
Domeland Wilderness Addition - South	14,657	0
Domeland Wilderness Addition - West	18,799	0

Recommended Wilderness Area Name	Total Acres	Acres in GSNM
Domeland Wilderness Fish Creek Addition	3,932	0
Golden Trout Wilderness Addition - Southwest	27,962	23,826
Golden Trout Wilderness Additions (1)	3,488	0
Golden Trout Wilderness Additions (2)	967	0
Golden Trout Wilderness Additions (3)	491	0
Golden Trout Wilderness Additions (4)	28,173	0
Hatchet Peak	6,064	6,064
Jennie Lakes Wilderness Addition	5,252	5,252
Long Canyon	15,771	15,771
Monarch Wilderness Addition - South	5,469	5,469
Saturday Peak	8,191	0
Slate Mountain	15,977	15,977
South Sierra Wilderness Additions - West (1)	2,155	0
South Sierra Wilderness Additions - West (2)	2,834	0
Stormy Canyon	40,466	2,617
TOTAL ACRES Alt. C Recommended Wilderness	234,912	82,032

Note: This table indicates which lands are within the GSNM. The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision, which indicates the recommended wilderness process for the Monument would occur during the forest plan revision.

Protection of Wilderness Characteristics

Under alternative C, 36 areas would be managed differently than under alternative A, with respect to recommended wilderness. In the Sierra National Forest, this would include 12 areas (133,922 acres) contiguous with existing designated wilderness and 5 areas (83,793 acres) that are not, for a total of 217,715 acres. There are 13,213 acres of one area contiguous with existing designated wilderness that are within the GSNM. In the Sequoia National Forest, this would include 12 areas (114,179 acres) contiguous with existing designated wilderness and 7 areas (120,733 acres) that are not, for a total of 234,912 acres. Portions of 8 areas (82,032 acres) are in the GSNM. Of these, 3 areas (34,547 acres) are contiguous with existing designated wilderness and 5 areas (47,485 acres) are not. Management as recommended wilderness would protect the existing wilderness characteristics of these lands.

Wilderness characteristics of naturalness and opportunities for solitude or primitive and unconfined recreation would be more protected, across a larger total area than alternative A. For example, mountain biking and motorized recreation within recommended wilderness areas would be prohibited. As a result, experiences would be enhanced for those seeking areas with primitive recreation opportunities.

Ability to Conduct Vegetation, Fire, Watershed, and Wildlife Habitat Management

Active management would be limited within recommended wilderness areas. However, many of the recommended wilderness areas have steep slopes and would be difficult to access and treat if active management were not limited. In general, decisions about active land management that may impact wilderness, management approaches for enhancing wilderness qualities, and whether to recommended wilderness are highly contested by stakeholders.

Trade-offs among the natural, undeveloped, and untrammeled wilderness qualities are inherent in situations where humans have caused changes in natural conditions. For example, in some wilderness areas, past human activity, including climate change, has altered plant and animal communities, but among the public, there are different views about whether ecological restoration projects are appropriate. Some members of the public may suggest that once recommended or designated, wilderness areas should have no interference by humans (untrammeled), even if the result is that vegetation patterns change outside the natural range of variation (naturalness). Other members of the public may suggest that habitat should be actively restored to help keep wilderness areas within a natural range of variation even if the result is an increase in interference by humans in the short term.

As a result of the expected level of interest in any management actions in recommended wilderness, it may be controversial and therefore difficult to manage. However, projects or activities for the purpose of ecological restoration for at-risk species habitat may use motorized equipment within recommended wilderness if the projects or activities are temporary. Active management for habitat restoration would be more likely for species listed as threatened or endangered under the Endangered Species Act to meet species' recovery objectives.

If necessary to protect life or property during wildfires, management actions would be taken in recommended wilderness. On the other hand, prescribed fire in recommended wilderness may be controversial and pretreatment actions that normally involve motorized equipment, such as chainsaws or helicopters, would be completed without motorized equipment and may be more complex, time-consuming, and expensive. Due to the level of tree mortality and conditions outside the natural range of variation, there may be greater demand from the public in the future for management actions to restore fire-adapted ecosystems in recommended wilderness. While the public debate about prescribed fire in recommended wilderness continues, there is unlikely to be much active vegetation management in these areas (Cole and Yung 2012, Lawhon 2012). Similarly, watershed restoration in recommended wilderness may be more complex, time-consuming, and expensive without motorized equipment.

Special Use Permit Authorizations

There may be some effects on special use permit authorizations within recommended wilderness. For example, there may be some additional limitations on authorizations, such as recreation events, outfitting and guiding, and land use authorizations, where such a special use is proposed within recommended wilderness. The primary special use permit authorizations within recommended wilderness areas are for outfitting, guiding, and grazing.

Existing special use permit authorizations would be allowed to continue in recommended wilderness areas, including commercial services (for example, outfitting and guiding), livestock grazing, tribal uses, water uses/rights, and mining claims, as well as maintenance of supporting facilities. However, new installations, structures, motorized equipment, and mechanical transport would be prohibited. As a result, permit holders would generally not be able to use motorized equipment or mechanical transport for access within recommended wilderness or to maintain supporting facilities within recommended wilderness. For example, outfitters or guides would not be authorized to provide mountain biking services in recommended wilderness.

Range improvements requiring motorized equipment or mechanical transport in recommended wilderness would need to be assessed for the effects on wilderness characteristics prior to being authorized.

Recreation Activities and Access

Mountain biking and motorized recreation would be prohibited within recommended wilderness areas. However, there is limited data about existing mountain bike use within these recommended wilderness areas, so the extent of the impact on mountain biking is unclear. Future development of opportunities for motorized recreation or mountain biking would not occur in recommended wilderness areas and opportunities specifically for wilderness-based recreation would increase within these areas.

Under alternative C, in the Sierra National Forest, there would be 119 miles of system trails within recommended wilderness areas. It is unknown how many of these 119 miles of trails are currently used for mountain biking and would no longer be available for such use. Some of these trails cross terrain that may be difficult for mountain biking. However, with equipment improvements, difficult terrain is less of a barrier to mountain biking than it used to be. In the future, terrain difficulty may be less relevant to identifying which trails are used for mountain biking.

Under alternative C, in the Sequoia National Forest, there would be over 242 miles of system trails within recommended wilderness areas. It is unknown how many of these 242 miles of trails are currently used for mountain biking and would no longer be available for such use. Of these 242 miles of trails, 123 miles are within the Giant Sequoia National Monument.

Access would not change for people who are only able to access National Forest System lands by a motor vehicle. People with disabilities that require use of a wheelchair or mobility device would continue to be allowed to use such devices where foot travel is allowed and access with such devices is feasible under existing conditions.

Ability to Manage Recommended Wilderness

In the Sierra National Forest, 12 areas (133,922 acres) are contiguous with existing designated wilderness and 5 areas (83,793 acres) are not. There are 13,213 acres of one area contiguous with existing designated wilderness that are within the GSNM. In the Sequoia National Forest, 12 areas (114,179 acres) are contiguous with existing designated wilderness and 7 areas (120,733 acres) are not. Portions of 8 areas (82,032 acres) are in the GSNM. Of these, 3 areas (34,547 acres) are contiguous with existing designated wilderness and 5 areas (47,485 acres) are not. The recommended wilderness areas contiguous with existing designated wilderness (248,101 acres total, across both forests) would generally require less management effort to protect wilderness characteristics than the areas not contiguous (204,526 acres total, across both forests) with existing designated wilderness. In the Sierra National Forest, 66 percent of recommended wilderness areas would be within IRAs. In the Sequoia National Forest, approximately 74 percent of the total recommended wilderness area is inventoried roadless area.

There are numerous trailheads that provide access for motorized vehicles to staging areas, which would help minimize the time required to access the recommended wilderness areas to perform management. Recommended wilderness area boundaries were drawn specifically to exclude motorized routes. However, as a result, there are several areas where motorized routes exist just outside recommended wilderness area boundaries. Managing motorized uses near those boundaries to ensure motorized vehicles do not enter recommended wilderness areas may be difficult. Prohibiting mountain biking in recommended wilderness areas where mountain biking had occurred in the past may also be difficult. As a result, user conflicts may occur.

Consequences Specific to Alternative D

There is no recommended wilderness under alternative D. All areas identified in the wilderness evaluation would be managed under the same plan direction as alternative B, except for the Monarch Wilderness Addition – South, which would not be a recommended wilderness area under alternative D.

Consequences Specific to Alternative E

Table 115. Alternative E recommended wilderness area names and acreage, Sierra National Forest

Recommended Wilderness Area Name	Total Acres	Acres in GSNM
Ansel Adams San Joaquin Wilderness Addition (Ansel Adams Wilderness Addition)	37,057	0
Devil's Gulch 1 (Devil Gulch)	37,132	0
Devil's Gulch 2 (Ferguon Ridge)	7,729	0
Devil's Gulch 3 (Portion of Evaluation Polygon 772 between Devil Gulch and Ferguson Ridge)	1,286	0
Dinkey Lakes Wilderness Bear Mountain Addition (Bear Mountain)	9,245	0
Sycamore Springs	15,269	0
Monarch Wilderness Kings River Addition (Monarch Wilderness Addition - West, John Muir Wilderness Additions - Southwest, and Portions of Evaluation Polygon 1378)	56,356	22,336
TOTAL ACRES Sierra Alt. E Recommended Wilderness	164,074	22,336

Note: Names in parentheses indicate the names used in alternative C and Appendix B to refer to the same areas. While the Monarch Wilderness Kings River Addition includes lands within both Sierra National Forest and Sequoia National Forest, this table only includes lands within the Sierra National Forest. In addition, this table indicates which lands are within the GSNM. The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision indicating the recommended wilderness process for the Monument would occur during the forest plan revision.

Table 116. Alternative E recommended wilderness area names and acreage, Sequoia National Forest

Recommended Wilderness Area Name	Total Acres	Acres in GSNM
Cannell Peak	30,983	0
Domeland Wilderness Addition (Portions of Domeland Wilderness Additions - West, Fish Creek Addition, and Evaluation Polygon 1394)	29,192	0
Golden Trout Wilderness Addition (Portions of Golden Trout Wilderness Additions - (1), Southwest, and Evaluation Polygon 1387)	41,430	10,188
Monarch Wilderness Kings River Addition (Portions of Evaluation Polygon 1378)	14,301	14,217
Oat Mountain (Portion of Evaluation Polygon 227)	10,981	0
Stormy Canyon	34,656	0
TOTAL ACRES Sequoia Alt. E Recommended Wilderness	161,543	24,405

Note: Names in parentheses indicate the names used in alternative C and Appendix B to refer to the same areas. While the Monarch Wilderness Kings River Addition includes lands within both Sierra National Forest and Sequoia National Forest, this table only includes lands within the Sequoia National Forest. This table indicates which lands are within the GSNM. The wilderness evaluation included GSNM lands to be responsive to the GSNM Record of Decision indicating the recommended wilderness process for the Monument would occur during the forest plan revision.

Protection of Wilderness Characteristics

Under alternative E, 12 areas would be managed differently than under alternative A, with respect to recommended wilderness. This would include six areas on the Sierra National Forest, five areas on the Sequoia National Forest, and one area that would include land within both forests. The Monarch Wilderness Kings River Addition would include a total of 70,657 acres (56,356 acres within the Sierra National Forest and 14,301 acres within the Sequoia National Forest), would be contiguous with existing designated wilderness, and would include 36,553 acres within the GSNM.

On the Sierra National Forest, recommended wilderness would include one other area (37,057 acres) contiguous with existing designated wilderness and five other areas (70,661 acres) that are not. Alternative E would recommend including a total of 164,074 acres in the National Wilderness Preservation System, including 22,336 acres of the Monarch Wilderness Kings River Addition that would be within the GSNM.

On the Sequoia National Forest, recommended wilderness would include two other areas (70,622 acres) contiguous with existing designated wilderness and three areas (76,620 acres) that are not. Alternative E would recommend including a total of 161,543 acres in the National Wilderness Preservation System, including 14,217 acres of the Monarch Wilderness Kings River Addition and 10,188 acres that would be within the GSNM. Management as recommended wilderness would protect the existing wilderness characteristics of these lands.

Wilderness characteristics of naturalness and opportunities for solitude or primitive and unconfined recreation would be more protected, across a larger total area, than they would be under alternative A. For example, mountain biking and motorized recreation within recommended wilderness areas would be prohibited. As a result, experiences would be enhanced for those seeking areas with primitive recreation opportunities.

Ability to Conduct Vegetation, Fire, Watershed, and Wildlife Habitat Management

Active management would be limited within recommended wilderness areas, as described for alternative C. However, under alternative E, the total area where active management would be limited would be less than under alternative C.

Special Use Permit Authorizations

Special use permit authorizations would be limited within recommended wilderness areas, as described for alternative C. However, under alternative E, the total area where special use permit authorizations would be limited would be less than under alternative C.

Recreation Activities and Access

Mountain biking and motorized recreation would be affected within recommended wilderness areas, as described for alternative C. However, under alternative E, the total area where mountain biking and motorized recreation would be affected would be less than under alternative C. Future development of opportunities for motorized recreation or mountain biking would not occur in recommended wilderness areas, and opportunities specifically for wilderness-based recreation would increase within these areas.

Under alternative E, there is a total of 8.4 miles of motorized routes (Hites Cove in the Sierra National Forest and Spanish Trail in both the Sierra National Forest and Sequoia National Forest) within recommended wilderness areas that would be closed to motorized recreation. Access to these 8.4 miles of motorized routes would be reduced for people who are only able to access National Forest System lands by a motor vehicle. People with disabilities that require use of a wheelchair or mobility device would continue to be allowed to use such devices where foot travel is allowed and access with such devices is feasible under existing conditions.

Ability to Manage Recommended Wilderness

The Monarch Wilderness Kings River Addition would include a total of 70,657 acres (56,356 acres within the Sierra National Forest and 14,301 acres within the Sequoia National Forest), would be contiguous with existing designated wilderness, and would include 36,553 acres within GSNM.

On the Sierra National Forest, recommended wilderness would include one other area (37,057 acres) contiguous with existing designated wilderness and five other areas (70,661 acres) that are not. Alternative E would recommend including a total of 164,074 acres in the National Wilderness Preservation System, including 22,336 acres of the Monarch Wilderness Kings River Addition that would be within the GSNM.

On the Sequoia National Forest, recommended wilderness would include two other areas (70,622 acres) contiguous with existing designated wilderness and three areas (76,620 acres) that are not. Alternative E would recommend including a total of 161,543 acres in the National Wilderness Preservation System, including 14,217 acres of the Monarch Wilderness Kings River Addition and 10,188 acres that would be within the GSNM.

The recommended wilderness areas contiguous with existing designated wilderness (178,336 acres total, across both forests) would generally require less management effort to protect wilderness characteristics than the areas not contiguous (147,281 acres total, across both forests) with existing designated wilderness.

On the Sierra National Forest, approximately 37 percent of the total recommended wilderness area is inventoried roadless area. On the Sequoia National Forest, approximately 66 percent of the total recommended wilderness area is IRA.

There are numerous trailheads that provide access for motorized vehicles to staging areas, which would help minimize the time required to access the recommended wilderness areas to perform management. Recommended wilderness area boundaries were drawn specifically to exclude motorized routes. However, as a result, there are several areas where motorized routes exist just outside recommended wilderness area boundaries. Managing motorized uses near those boundaries to ensure motorized vehicles do not enter recommended wilderness areas may be difficult. Prohibiting mountain biking in recommended wilderness areas where mountain biking had occurred in the past may also be difficult. As a result user conflicts may occur.

Cumulative Effects

The analysis area for cumulative effects is the same as described in the sustainable recreation cumulative effects section. Demographic and regional trends related to a population increase, tourism growth, increasing visitation, and shifts in cultural preferences for outdoor recreation, as well as changing visitor use patterns and recreation management changes, described in the sustainable recreation section cumulative effects section and the recommended wilderness affected environment section, also would be related to the effects of recommended wilderness.

A large portion of the Sierra and Sequoia National Forests, Yosemite National Park, Sequoia and Kings Canyon National Parks, Inyo National Forest, and BLM lands adjacent to these national forests and national parks, within the analysis area for cumulative effects, is existing designated wilderness and is already managed under a framework similar to the management direction for recommended wilderness. Recommended wilderness areas within each alternative are relatively small, compared with existing designated wilderness.

As a result, protection of wilderness characteristics in recommended wilderness areas under each alternative is unlikely to have large effects on the cumulative protection of wilderness characteristics across the broader region. The impacts of changes within the broader region (for example, visitor use patterns, recreation management, and vegetation management) may have localized effects within some recommended wilderness areas, such as increasing visitation or vegetation management; but overall, the effects on the protection of wilderness characteristics within recommended wilderness areas under each alternative are unlikely to be large. The differences in cumulative effects among the alternatives are also unlikely to be large. It is possible that during public engagement and the planning period, public awareness of the potential recommended wilderness areas may increase along with interest in visiting these areas. As a result, these areas may become more popular visitor destinations; this may impact the wilderness characteristics of naturalness as well as opportunities for solitude or primitive and unconfined recreation.

The ability to conduct vegetation, fire, watershed, and wildlife habitat management within recommended wilderness areas under each alternative is unlikely to have large effects on the ability to conduct such management across the broader region. The impacts of such management across the broader region may have localized effects within some recommended wilderness areas, such as improving resiliency to disturbance. In some cases, such management may end up not occurring with recommended wilderness areas and those areas would not receive the benefits or efficiencies of implementing such management at larger geographic scales. However, the overall effects are unlikely to be large within recommended wilderness areas under each alternative. The differences in cumulative effects among the alternatives are also unlikely to be large.

Cumulative effects related to special use permit authorizations within recommended wilderness areas and the broader region would be unlikely under each alternative.

Changes in recreation activities and access in the broader region and within recommended wilderness areas under each alternative are unlikely to have large effects on recreation and access across the broader region. The differences in cumulative effects among the alternatives are also unlikely to be large. The impacts of restrictions on motorized recreation and mountain biking within the broader region and within recommended wilderness may have localized effects, decreasing in some areas, while displacing and increasing in other areas. Generally, large areas suitable for motorized recreation, mountain biking, nonmotorized recreation, and primitive recreation are likely to remain open to the public across the region.

Changes in the broader region are unlikely to affect cumulative effects related to the ability to manage recommended wilderness areas under each alternative. The differences in cumulative effects among the alternatives are also unlikely to be large.

Analytical Conclusions

Table 117. Recommended wilderness indicators by alternative, Sierra National Forest and Sequoia National Forest combined

Indicator	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Protection of wilderness characteristics	Lowest	Low	Highest	Lowest	Lower than alternative C, but higher than alternatives A, B, and D
Ability to conduct vegetation, fire, watershed, and wildlife habitat management	Highest	High	Lowest	Highest	Higher than alternative C, but lower than alternatives A, B, and D
Special use permit authorizations	May increase, no limitations based on recommended wilderness	May be some additional limitations within the Monarch Wilderness Addition – South	Limitations across the largest total area	May increase, no limitations based on recommended wilderness	Limitations across less area than alternative C, but more than alternatives A, B, and D
Recreation activities and access	Access not affected. Opportunities for wilderness-based recreation would not increase significantly and may decrease in some areas.	Existing access not affected. Future development of opportunities for motorized recreation or mountain biking would not occur within the Monarch Wilderness Addition – South, and opportunities for wilderness-based recreation would increase within this area.	Mountain biking and motorized recreation prohibited across largest total area. Opportunities specifically for wilderness-based recreation would increase across the largest total area.	Existing access not affected.	Mountain biking and motorized recreation prohibited across a smaller total area than alternative C, but larger than alternatives, A, B, and D
Ability to manage recommended wilderness	Not applicable	4,906 acres contiguous with designated wilderness, 0 acres not contiguous	248,101 acres contiguous with designated wilderness, 204,526 acres not contiguous	Not applicable	178,336 acres contiguous with designated wilderness, 147,281 acres not contiguous

Eligible and Suitable Wild and Scenic Rivers

Congress created the National Wild and Scenic Rivers System in 1968. It is intended to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The Wild and Scenic Rivers Act,[44] which established the system, is notable for safeguarding the special character of these rivers, while recognizing the potential for their appropriate use and development. It encourages river management that crosses political boundaries and promotes public participation in developing goals for river protection. Section 5(d)(1) of the act states:

> In all planning for the use and development of water and related land resources, consideration shall be given by all federal agencies involved to potential national wild, scenic and recreational river areas, and all river basin and project plan reports submitted to the Congress shall consider and discuss any such potential. The Secretary of the Interior and the Secretary of Agriculture shall make specific studies and investigations to determine which additional wild, scenic and recreational river areas within the United States shall be evaluated in planning reports by all federal agencies as potential alternative uses of the water and related land resources involved.

As outlined in the Wild and Scenic Rivers Act, in developing a proposed new plan or proposed plan revision, National Forests are required by the 2012 Planning Rule (36 CFR 219.7(c)(2)(vi)) to "identify the eligibility of rivers for inclusion in the National Wild and Scenic Rivers System, unless a systematic inventory has been previously completed and documented, and there are no changed circumstances that warrant additional review."

The 2012 Planning Rule also requires the Forest Service to manage those eligible and suitable rivers to protect the values that support their inclusion in the National Wild and Scenic Rivers System until Congress makes a final determination on their designation.

There is a four-step process outlined in FSH 1909.12, Chapter 80, that provides direction for inventory, eligibility determination, classification, and suitability. Additional guidance can be found in the Interagency Wild and Scenic Rivers Coordinating Council technical paper: The Wild & Scenic River Study Process (Interagency Wild and Scenic Rivers Coordinating Council 1999).

The Wild and Scenic Rivers study process for the Sierra National Forest and Sequoia National Forest is documented in detail in Appendix C.

Analysis and Methods

Indicator

- Miles of river segments determined to be eligible for inclusion in the National Wild and Scenic Rivers System, in addition to those determined to be eligible in previous studies

Methods

The analysis area includes eligible wild and scenic rivers, as identified in Appendix C. As shown in Chapter 2, protection measures for these segments would be applied under all the plan revision alternatives. The time frame for the environmental consequences related to any eligible wild and scenic rivers would be the expected life of the forest plans. If Congress eventually designates eligible wild and scenic rivers, the time frame for related environmental consequences may be

[44] Public Law 90-542; 16 U.S.C. 1271 et seq.

longer. This analysis includes a qualitative discussion of the effects of the proposed management direction of eligible wild and scenic rivers.

Assumptions

- Designation of a wild and scenic river segment will require an act of Congress. This outcome is not analyzed here because such congressional action is highly unpredictable.

Affected Environment

The extent of the National Wild and Scenic Rivers System currently includes 13,436.0 miles of 226 rivers designated by Congress, including rivers in 41 states and the Commonwealth of Puerto Rico; this is a little more than one-quarter of 1 percent of the nation's rivers. The Forest Service, BLM, National Park Service, and US Fish and Wildlife Service manage the National Wild and Scenic Rivers System. As shown in Table 118, below, states also manage portions of the National Wild and Scenic Rivers System.

Table 118. Total miles of rivers in the National Wild and Scenic Rivers System by managing entity and classification, nationwide

Managing Entity	Wild	Scenic	Recreational	Total
Forest Service	1,878.5	1,318.3	1,980.8	5,177.6
Bureau of Land Management	1,640.0	414.5	648.0	2,702.5
National Park Service	1,766.9	851.1	832.4	3,450.4
US Fish and Wildlife Service	1,043.0	10.0	0	1,053.0
States	139.4	343.9	569.2	1,052.5
Total	6,467.8	2,937.8	4,030.4	13,436.0

In California, the National Wild and Scenic Rivers System includes 2,095.2 miles of 26 designated rivers. The Forest Service manages approximately 60 percent of the total miles in all or portions of 23 of the 26 designated rivers in California. The BLM and National Park Service manage the other 40 percent of the designated river miles in California, as shown in Table 119.

Table 119. Total miles of rivers in the National Wild and Scenic Rivers System by managing entity and classification, California

Managing Entity	Wild	Scenic	Recreational	Total
California total (Forest Service, BLM, National Park Service)	806.0	225.2	1,064.0	2,095.2
Forest Service, Pacific Southwest Region	538.5	117.7	597.4	1,253.6
Sierra National Forest	31.5	0	11.5	43
Sequoia National Forest	75	0	30.3	105.3

The Sierra National Forest contains five designated rivers and the Sequoia National Forest contains three designated rivers. These rivers are included in the total mileage listed above and shown on the maps below and Table 120.

Table 120. Summary of Designated Wild and Scenic Rivers, Sierra National Forest and Sequoia National Forest

Name	Sierra National Forest Miles	Sequoia National Forest Miles	Other National Forest, National Park Service, and BLM Miles	Total Miles
Merced	11	0	68.5	79.5
South Fork Merced	16	0	27	43
Kings	7	0	0	7
Middle Fork Kings	7	0	24.9	31.9
South Fork Kings	2	9.5	30.6	42.1
North Fork Kern	0	51.5	27	78.5
South Fork Kern	0	44.3	28.2	72.5
Total	43	105.3	206.2	354.5

The Merced, South Fork Merced, Kings, Middle Fork Kings, South Fork Kings, North Fork Kern, and South Fork Kern Wild and Scenic Rivers were added to the National Wild and Scenic Rivers System in 1987. In 1992, segments were added to the Merced and South Fork Merced Wild and Scenic Rivers designations.

River Segments Previously Studied

Congress has not made a final determination on other river segments on both forests that have been previously studied for eligibility and a subset that have also been studied for suitability. These previous studies are described in detail in Appendix C and are summarized below. The process for reviewing the river segments that were previously studied is also documented in Appendix C.

The five rivers that the Forest Service found suitable and recommended for inclusion in the National Wild and Scenic Rivers System are shown on the maps below and Table 121. These river segments continue to be managed as "recommended" wild and scenic rivers until Congress makes a final determination on their designation.

Table 121. Summary of suitable river segments recommended by the Forest Service for inclusion in the National Wild and Scenic Rivers System in the Sierra National Forest and Sequoia National Forest

Name	Sierra National Forest Miles	Sequoia National Forest Miles	Other National Forest, National Park Service, and BLM Miles	Total Miles
North Fork San Joaquin	14	0	0	14
Middle Fork San Joaquin	4	0	18	22
San Joaquin	12	0	0	12
South Fork San Joaquin	8	0	13	21
South Fork Kern	0	1	0	1
Total	38	1	31	70

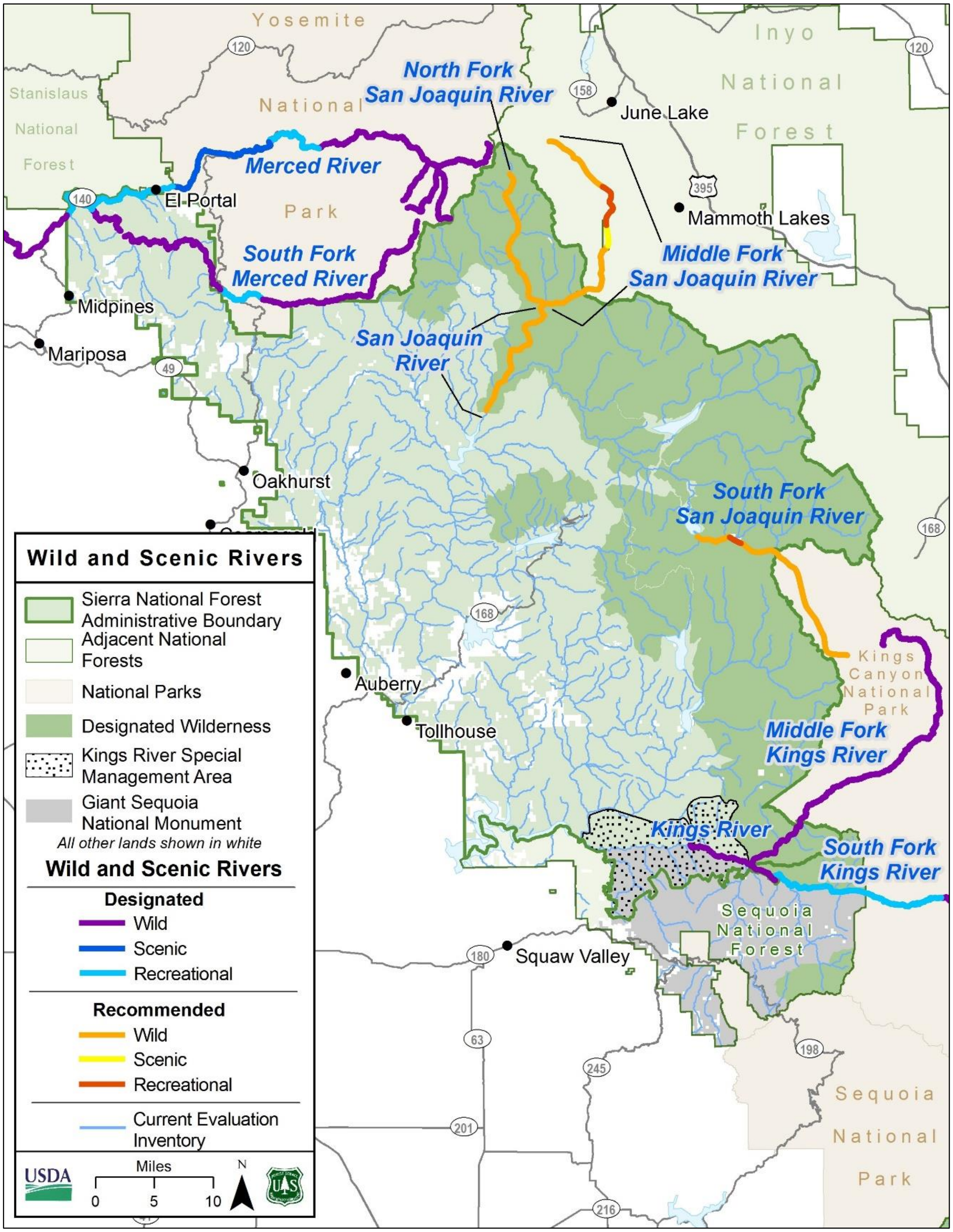

Figure 53. Designated and Recommended Wild and Scenic Rivers, Sierra National Forest

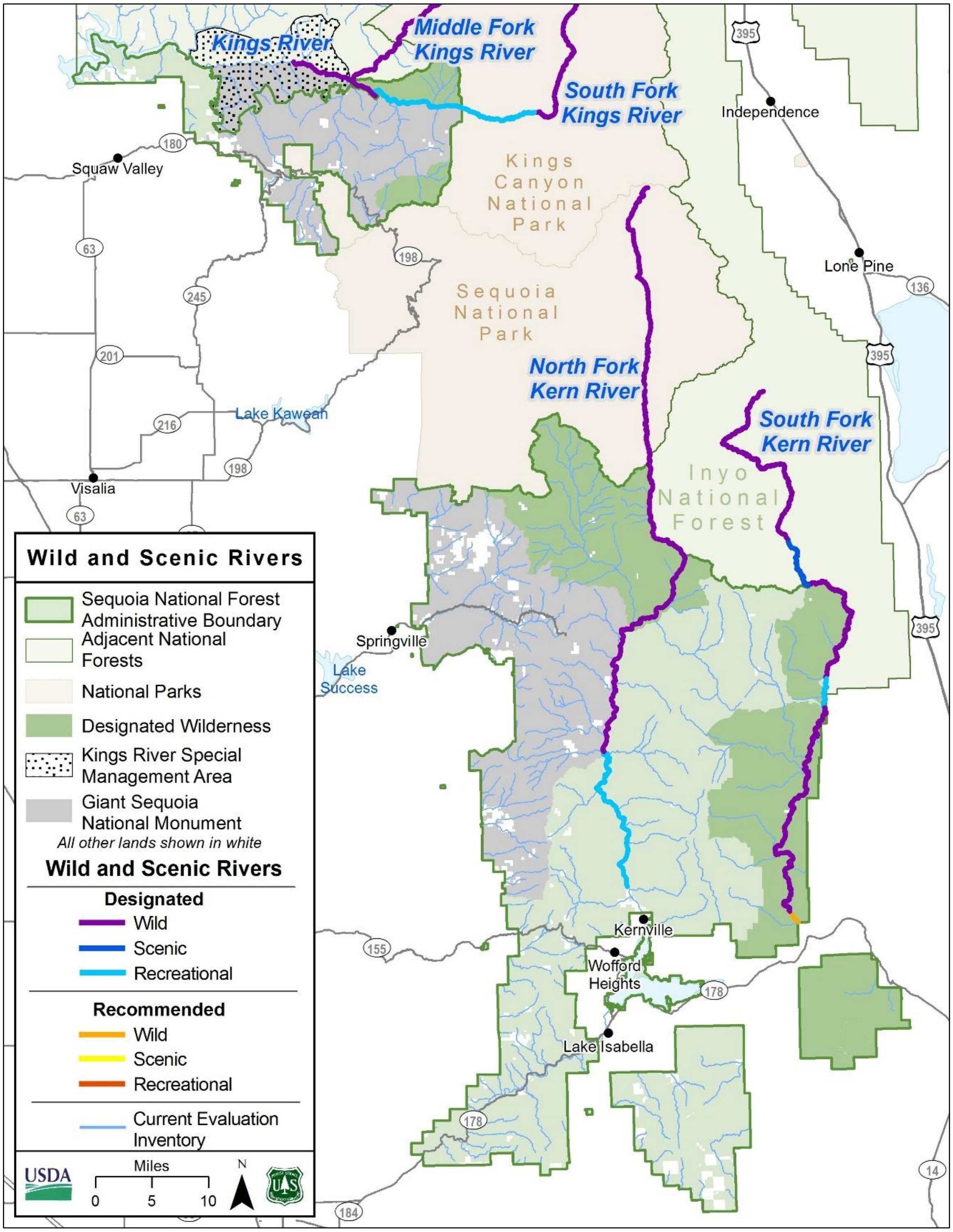

Figure 54. Designated and Recommended Wild and Scenic Rivers, Sequoia National Forest

Eleven river segments were determined to be eligible in previous wild and scenic river studies and have not yet been studied for suitability. These segments are summarized below in Table 122, are shown in maps in Appendix C. The segments also were included in the inventory and were reviewed to determine if there were any changed circumstances or new information. These river segments are managed to protect the values that support their inclusion in the National Wild and Scenic Rivers System, until Congress makes a final determination on their designation.

Table 122. Summary of river segments determined to be eligible in previous studies, Sierra National Forest and Sequoia National Forest

Name	Sierra National Forest Miles	Sequoia National Forest Miles	Other National Forest, National Park Service, and BLM Miles	Total Miles
Kings River Segment 3	3.9	0	0	3.9
Kings River Segment 4	7.5	0	0	7.5
Kings River Segment 5	0	1.3	0	1.3
Kern River Segment 1	0	3.1	4.3	7.4
Kern River Segment 2	0	12.7	0	12.7
Kern River Segment 3	0	11.5	0	11.5
Little Kern River (Headwaters to Table Meadow Creek)	0	12.4	0	12.4
Little Kern River (Table Meadow Creek to Kern River)	0	12.0	0	12
North Fork Middle Fork Tule River	0	2.7	0	2.7
North Fork Tule River	0	3.9	0	3.9
South Fork Kern River	0	0.3*	0	0.3
Total	11.4	59.9	4.3	75.6

* This segment begins at the downstream end of the designated South Fork Kern Wild and Scenic River and ends at the beginning of the suitable/recommended South Fork Kern Wild and Scenic River segment.

Environmental Consequences to Eligible and Suitable Wild and Scenic Rivers

Consequences Common to All Alternatives

The 2012 Planning Rule specifically requires the Forest Service to manage those eligible and suitable rivers. This is to protect the values that support their inclusion in the National Wild and Scenic Rivers System until Congress makes a final determination on their designation. It requires that forest plans must provide plan components, including standards and guidelines, to protect designated wild and scenic rivers. The 2012 Planning Rule also requires that rivers found eligible or determined suitable for the National Wild and Scenic Rivers System be managed to protect the values that provide the basis for their suitability for inclusion in the system.

FSH 1909.12, Chapter 80, Section 84.2 states:

> "A Responsible Official may authorize site-specific projects and activities on National Forest System lands within eligible or suitable river corridors only where the project and activities are consistent with all of the following:

a) "The free-flowing character of the identified river is not adversely modified by the construction or development of stream impoundments, diversions, or other water resources projects.

b) "Outstandingly remarkable values of the identified river area are protected.

c) "For all Forest Service-identified study rivers, classification of an eligible river must be maintained as inventoried unless a suitability study is completed that recommends management at a less restrictive classification (such as from wild to scenic or scenic to recreational)."

FSH 1909.12, Chapter 80, Section 84.3, provides additional interim protection measures. Any site-specific projects and activities on National Forest System lands within Forest Service-identified eligible or suitable river corridors (one-quarter mile from the normal high-water mark on each side of the river segment) that a responsible official authorizes must also be consistent with the interim protection measures in FSH 1909.12, Chapter 80, Section 84.3. These interim protection measures have been incorporated into the draft forest plans for the Sequoia National Forest and Sierra National Forest. In addition, the set of plan components developed for other aspects of the plan, such as riparian area plan components, will also provide for management of eligible or suitable river corridors consistent with the interim protection measures.

Table 123 and Table 124 are summaries of the results of the eligibility studies, including preliminary classifications of eligible river segments. The wild and scenic rivers study process and detailed study results for the Sierra National Forest and Sequoia National Forest are documented in Appendix C.

Table 123. Sequoia National Forest wild and scenic river eligibility study results summary

Study Results	Number of River Segments (Approximate Mileage)
Total Eligible	54 (341 miles)
Preliminarily Classification: Wild	29 (155.5 miles)
Preliminarily Classification: Scenic	13 (89.6 miles)
Preliminarily Classification: Recreational	12 (95.9 miles)

Table 124. Sierra National Forest wild and scenic river eligibility study results summary

Study Results	Number of River Segments (Approximate Mileage)
Total Eligible	10 (35.5 miles)
Preliminarily Classification: Wild	3 (17.1 miles)
Preliminarily Classification: Scenic	1 (3.0 miles)

Study Results	Number of River Segments (Approximate Mileage)
Preliminarily Classification: Recreational	6 (15.4 miles)

The interim protection measures that have been incorporated into the revised forest plan would protect the free-flowing character and the identified outstandingly remarkable values for all eligible rivers. In addition, the set of plan components developed for other aspects of the plan, such as riparian area plan components, will also protect the free-flowing character and the outstandingly remarkable values for all eligible rivers.

Cumulative Effects

Additional eligible rivers may be identified in existing or future planning efforts or through separate river studies on adjacent national forests. They also may be identified on lands managed by other agencies—the BLM, National Park Service, U.S. Fish and Wildlife Service, and State of California—that manage the National Wild and Scenic Rivers System. No negative cumulative effects are expected to occur on designated or eligible wild and scenic rivers as a result of any of the alternatives.

Analytical Conclusions

No negative effects are expected to occur on designated or eligible wild and scenic rivers as a result of any of the alternatives. The interim protection measures that have been incorporated into the revised forest plan would protect the free-flowing character and the identified outstandingly remarkable values for all eligible rivers. In addition, the set of plan components developed for other aspects of the plan, such as riparian area plan components, will also provide for protection of the free-flowing character and the outstandingly remarkable values for all eligible rivers.

The Forest Service does not anticipate that there would be adverse impacts on our ability to manage the eligible river corridors. This is because most of the eligible river corridors are preliminarily classified as wild and are within existing designated wilderness, as shown the Appendix C maps. The impacts on our ability to manage eligible river corridors preliminarily classified as scenic and recreational would likely be negligible. This is because they include a relatively small portion of the total rivers and area in the national forests.

Any project-level planning in eligible river corridors would need to be consistent with the preliminary classifications. It also would need to protect the free-flowing character and outstandingly remarkable values that provide the basis for their inclusion in the National Wild and Scenic Rivers System. This would be accomplished by following forest plan direction until such time as a negative suitability determination is made or Congress makes a final determination on their designation.

Pacific Crest National Scenic Trail

The National Trail System is composed of 30 congressionally designated trails (11 national scenic trails and 19 national historic trails), which stretch for a hundred or thousands of miles each and more than 55,000 miles in total. National scenic and historic trails traverse wilderness, rural, suburban, and urban areas in 49 states connecting with every distinct ecological area or biome in the U.S. They protect crucial conservation areas, provide wildlife migration corridors, and provide education, recreation, and fitness opportunities for people of all ages.

Congress designated the Pacific Crest National Scenic Trail in 1968 as one of the original national scenic trails. The National Trails System Act[45] directed that these long-distance trails provide for the maximum outdoor recreation potential and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which such trails may pass. The act recognizes citizen stewardship and volunteerism, which have been an integral component of the planning, management, and maintenance of the trail.

Beginning in southern California at the Mexican border, the PCT travels 2,650 miles through California, Oregon, and Washington until reaching the Canadian border (Figure 55). First conceived in the 1930s, the trail traverses the highest elevations of the Sierra Nevada and Cascade Mountains and was designed to include portions of the historic John Muir and Skyline Trails. The PCT is one of 11 national scenic trails, and it is considered one of the most remote, long-distance trails with over 54 percent of its path in designated wilderness. Oriented in a north-south direction, the PCT is the only completed west coast national scenic trail.

The selected route location for the PCT was published in the *Federal Register* on January 30, 1973. The route traverses portions of 25 national forests,6 national parks, 7 BLM field offices, 4 national monuments, 1 national scenic area, and state and private lands in the states of California, Oregon, and Washington. The Regional Forester of the Pacific Southwest Region is the lead official for coordinating matters concerning the study, planning, and operation of the PCT (Forest Service Manual 2353.04).

Figure 55. The Pacific Crest National Scenic Trail

[45] Public Law 90-543

The "Pacific Crest National Scenic Trail Comprehensive Plan" was signed by the Chief of the Forest Service in 1982 and set forth direction to guide the development and management of the PCT (United States Department of Agriculture 1982). The primary policy is to administer the PCT consistent with the nature and purposes for which this national scenic trail was established: to provide for high-quality scenic, primitive hiking and horseback riding opportunities and to conserve natural, historic, and cultural resources along the corridor.

The Comprehensive Plan directed that each "National Park, Bureau of Land Management District and National Forest will integrate the direction and guidance provided by the Comprehensive Plan into their respective land management planning processes." Executive Order 13195, Trails for America in the 21st Century (2001), recognized the importance of "Protecting the trail corridors associated with national scenic trails . . . to the degrees necessary to ensure that the values for which each trail was established remain intact."

The PCT Association, a 501(c)(3) nonprofit, is recognized as the Federal Government's major partner in managing and maintaining the PCT. A 2015 memorandum of understanding outlines the tenants of the Forest Service, BLM, National Park Service, California State Parks, and PCT Association's relationship. The PCT Association serves to recruit, train, and supervise volunteers to assist with trail management and maintenance. The collaborative work focuses on engaging youth and developing citizen stewardship, providing quality recreation experiences for hikers and equestrians, and restoring the ecosystem; it is funded, in part, through cooperative agreements with Federal agencies.

Analysis and Methods

Indicators

- Recreation opportunities
    - PCT management area acres allocated to each ROS class
        - Measure of the amount of each ROS class in the management area displays the emphasis on recreation activities, setting, and experience ranging from primitive to urban
    - PCT management area miles of motorized roads and trails
        - Measure of the amount and proximity of motorized use (prohibited on the PCT tread) in the management area
    - PCT management area acres within designated wilderness and outside designated wilderness
        - Measure of the amount of surrounding area or trail corridor that provides for high-quality scenic, primitive hiking and horseback riding opportunities and conserves natural, historic, and cultural resources
- Visitor patterns and visitor use management
- Competitive events

- Scenery
    - ♦ PCT management area acres within each scenic integrity objective
        - Measure of the overall plan for the scenery surrounding the trail to have a natural appearance and the degree to which a landscape is free from visible disturbances that detract from the natural or socially valued appearance, including any visible disturbances from human activities or extreme natural events outside the natural range of variation
- Vegetation management and fuels treatment
- Lands special uses

Methods

There are three distinct PCT use patterns:

1. **Day use:** The largest user group, these travelers typically originate from within a 75-mile (1.25-hour driving time) radius.
2. **Section use:** The second-largest user group, these travelers typically live on the West Coast in one of the three states through which the trail travels.
3. **Entire trail:** These thru-hikers and equestrians have a broad geographic draw from across the United States and abroad and share the goal of completing the entire trail.

The analysis area for the PCT considers local, regional, and national scales based on the unique and distinctive role and contributions the trail plays, providing recreation opportunities and connecting three states and numerous public land entities.[46]

To identify the management area boundaries for each alternative, a geographic information systems model was constructed with the following criteria for each alternative (see maps in volume 3).

- Alternative A: Mileage of trail (length) multiplied by 6-foot width (general trail clearing width for 24-inch trail with pack stock use)
- Alternative B: Mileage of trail (length) multiplied by up to one-half mile of centerline width (foreground), based on topography visible from 5-foot height on the trail
- Alternative C: Alternative B plus up to 4 miles of centerline width (middle ground), based on the Scenic Attractiveness A inventory layer
- Alternative D: Mileage of trail (length) multiplied by up to one-quarter mile of centerline width (foreground), based on topography visible from 5-foot height on the trail
- Alternative E: Same as alternative C

In this section, key components for the environmental consequence analysis for the PCT are based on the scenic and recreation resources. The recreation opportunity spectrum provides for the varied recreation opportunities along the trail in terms of setting, activity, and experience (United States Department of Agriculture 1982).

[46] Forest Service Handbook 1909.12, chapter 20, section 22.32 3(f)

Scenic resources are analyzed based on scenic integrity objectives and distance zones (United States Department of Agriculture 1995b). Scenic integrity objectives range from very high to low. Distance zones are defined as foreground, middle ground, and background. Foreground views are considered those within approximately 0.5 miles of the viewer; middle ground views are views of objects or scenic resources between approximately 0.5 miles and 4 miles from the viewer; background views are views that extend beyond 4 miles from the viewer, to the horizon.

Assumptions

- Of the scenery management distance zones, details are more easily seen from the foreground and middle ground, which usually has the most visual sensitivity (United States Department of Agriculture 1995b).
- The forest plan does not make site-specific decisions regarding travel management within the PCT management area. No roads or trails would be opened or closed in this forest plan decision.
- The more acres within the PCT management area, the higher the protection of the resources, qualities, values, and associated settings consistent with the nature and purposes of the Pacific Crest National Scenic Trail.

Affected Environment

Recreation Opportunities

The PCT is a long-distance trail that is designed with a native surface tread to meet pack and saddle “more difficult” design and maintenance standards for most of its length. Rustic bridges constructed of native materials provide for resource protection or accommodate those users with a moderate skill level. Trail-wide, the PCT is open to foot and horse travel and closed to motorized[47] and mechanized travel.[48]

The existing Sierra and Sequoia forest plans recognized the Pacific Crest National Scenic Trail and defined visual management standards and guidelines; they did not define a trail corridor or identify other desired conditions, resources, qualities, or values to be specifically managed.

There are locations along the PCT where the trail has been located in an interim location to have a continuous path from Mexico to Canada. These temporary locations may be along motorized road shoulders or motorized trails with the long-term objective of relocating the trail to an optimal, nonmotorized location. For example, in the Sequoia National Forest, the portion of National Forest System Road 27S11 (Horse Canyon) that is surrounded by the Kiavah Wilderness is open to motorized use, and the interim location of the PCT is along part of the road. The long-term objective will be to relocate the trail to a nonmotorized location.

“Optimal Location Review” is a project-level analysis process that ensures the PCT is located in the setting that best meets the congressional intent for location, outstanding recreation opportunities, and scenic resources. Actual relocation of the trail requires National Environmental Policy Act review and compliance, and significant relocations require congressional approval. On private lands, easements that have been acquired may be as narrow as 10 feet and are typically

[47] 36 CFR 261.20
[48] Regional Order 88-4 and 36 CFR 212.21

insufficient to provide optimal recreation opportunities and to protect the scenic values of the trail.

PCT management is designed to harmonize with and complement established multiple-use plans to ensure continued benefits from the lands. Managers protect the integrity of the trail by avoidance, mitigation, and modifying management practices as needed.

Table 125 displays the number of miles of the PCT and other trails by national forest, within and outside designated wilderness. Almost all the other trails outside designated wilderness are open to mountain biking. Many of the other trails outside designated wilderness are open to motorized recreation. This table does not include National Forest System roads open to motorized recreation.

Table 125. Pacific Crest Trail and other trail mileage, within and outside designated wilderness, by forest

Trail Type	Sequoia National Forest Miles (% of all trails)	Sierra National Forest Miles (% of all trails)
PCT within wilderness	34 (3.3%)	27 (2.6%)
PCT outside wilderness	13 (1.2%)	0 (0%)
Total PCT	47 (4.5%)	27 (2.6%)
Other trails within wilderness	262 (25.1%)	591 (57.4%)
Total trails within wilderness	296 (28.4%)	618 (60%)
Other trails outside wilderness	735 (70.4%)	411 (40%)
All trails	1,044 (100%)	1,029 (100%)

Note: The table includes miles of “standard terra” trails, which have a surface consisting predominantly of the ground and are designed and managed to accommodate use on that surface. This table does not include snow or water trails or National Forest System roads open to motorized recreation.

The PCT travels through a total 47 miles within the Sequoia National Forest in five segments from the Piute Mountains in the south to the Inyo National Forest boundary, near Olancha Pass in the north. The first and southernmost segment travels through the Piute Mountains and is outside designated wilderness (see Figure 56). The trail then travels north through BLM land. When it reenters the Sequoia National Forest, the second segment travels through the Scodie Mountains, partly along Road 27S11 (Horse Canyon), and mostly within the Kiavah Wilderness. The trail again travels north through BLM land (Chimney Peak Wilderness). When it reenters the Sequoia National Forest, the third segment travels through the Domeland Wilderness to Road 22S05 (Sherman Pass Road) near Kennedy Meadows. The fourth segment travels through Kennedy Meadows (outside designated wilderness) and crosses into the Inyo National Forest. When the PCT reenters the Sequoia National Forest, the fifth segment travels through the South Sierra Wilderness and exits the north boundary of the Sequoia National Forest into the Inyo National Forest.

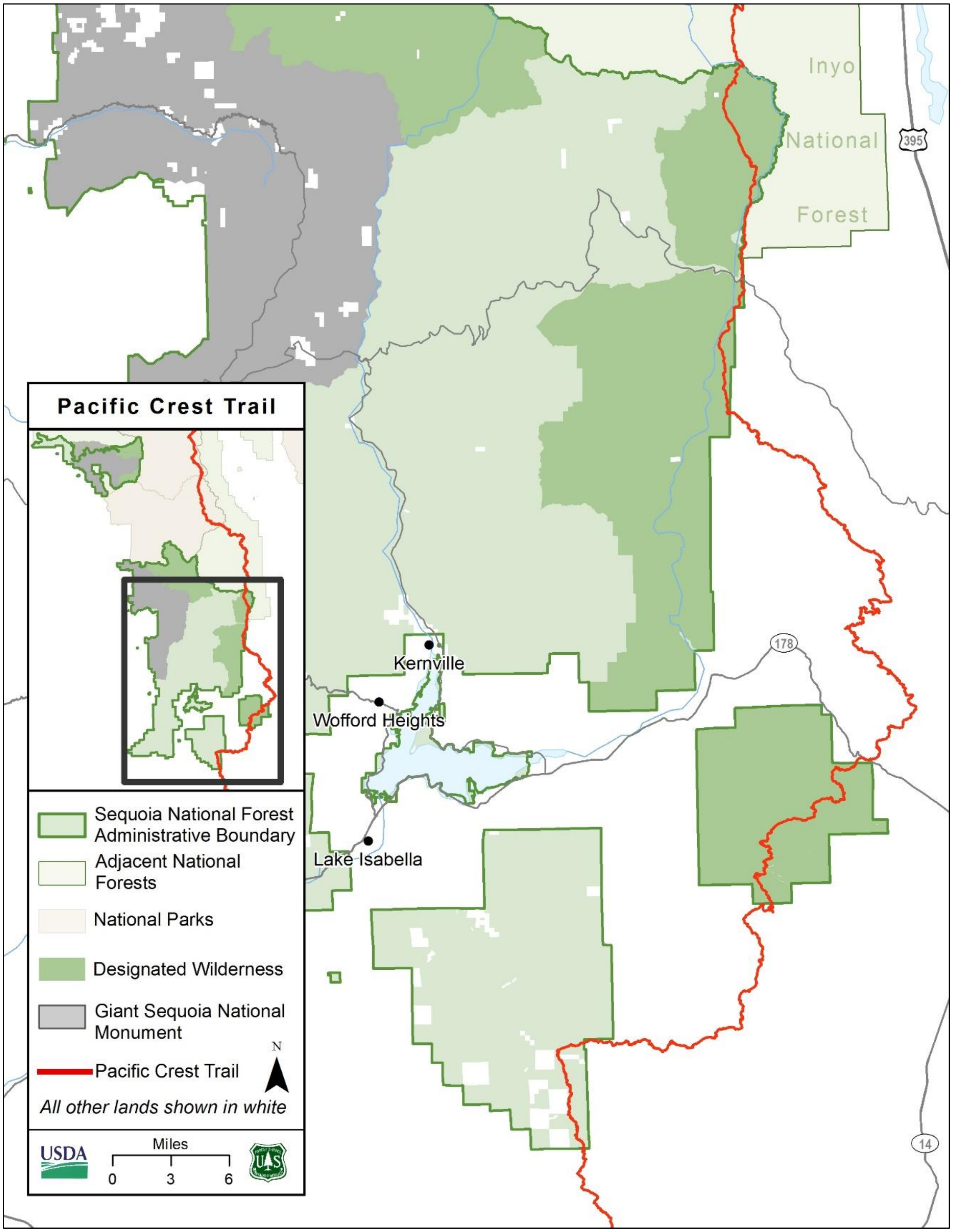

Figure 56. Map of Pacific Crest Trail, Sequoia National Forest

The largest portion of the PCT outside designated wilderness and within the plan area is in the Piute Mountains in the most southern section of the Sequoia National Forest. Within the Piute Mountains, there are numerous miles of nonsystem trails that are not authorized in the Sequoia National Forest Motor Vehicle Use Map but are of interest to the motorized recreation community; some of these trails cross the PCT.[49] Within the Sequoia National Forest, the PCT crosses 7 roads and 11 nonsystem off-highway vehicle routes in the Piute Mountains. Advocates for off-highway vehicle and motorcycle riding have expressed their desire to have many of these added to the designated system. For these unauthorized routes to be added to the designated system of trails, they must be evaluated in a site-specific travel management analysis that is outside the scope of this forest plan revision analysis. There is no change proposed in travel management. Within the Sequoia National Forest, there are 735 miles of other trails outside designated wilderness, most of which are open to mountain biking. Approximately 386 miles of these trails (53 percent) are open to motorized recreation.

Within the Sierra National Forest, the PCT travels for 27 miles, from the north boundary of Kings Canyon National Park to the Inyo National Forest boundary, near Reds Meadow (see Figure 57). This segment is entirely within the John Muir Wilderness and crosses no roads or vehicle routes. Between Squaw Lake and the Inyo National Forest boundary, the PCT is on lands administered by the Inyo National Forest even though it is within the Sierra National Forest. Within the Sierra National Forest, there are 411 miles of other trails outside designated wilderness, most of which are open to mountain biking. Approximately 185 miles of these trails (45 percent) are open to motorized recreation.

Visitor Use

There are numerous points of entry along the 2,650 miles of the Pacific Crest National Scenic Trail as it passes through numerous jurisdictions. Therefore, it is cost-prohibitive to obtain monthly or annual visitor use totals for the whole trail. However, it is likely that visitor use on the PCT within both the Sierra National Forest and Sequoia National Forest has been increasing significantly.

Visitor use management is the process of planning for and managing characteristics of visitor use and its physical and social setting, using a variety of strategies and tools, to sustain desired resource conditions and visitor experiences. Since the trail is within 2 hours travel time from the metropolitan centers of San Diego, Los Angeles, Sacramento, Portland, and Seattle, there is a high demand for day and weekend use. Day users are the largest portion of visitors. Recently, interest in long-distance hiking of the PCT (section use and entire trail use) has been increasing, the popularity of long-distance trails has been growing, and the numbers of PCT users is expected to continue to increase. The New York Times Bestseller book by Cheryl Strayed, *Wild: From Lost to Found on the Pacific Crest Trail* (Strayed 2012), and the subsequent movie have increased interest in the PCT from a broad audience.

Entire trail users and section users traveling greater than 500 miles are required to obtain a permit. Table 126 shows the significant increase in the numbers of permits issued and completions reported each of 6 recent years (https://www.pcta.org/our-work/trail-and-land-management/pct-visitor-use-statistics/). Successful completion of the entire length of the trail in one season is highly dependent on snow conditions and wildfire activity.

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[49] 36 CFR 212.56

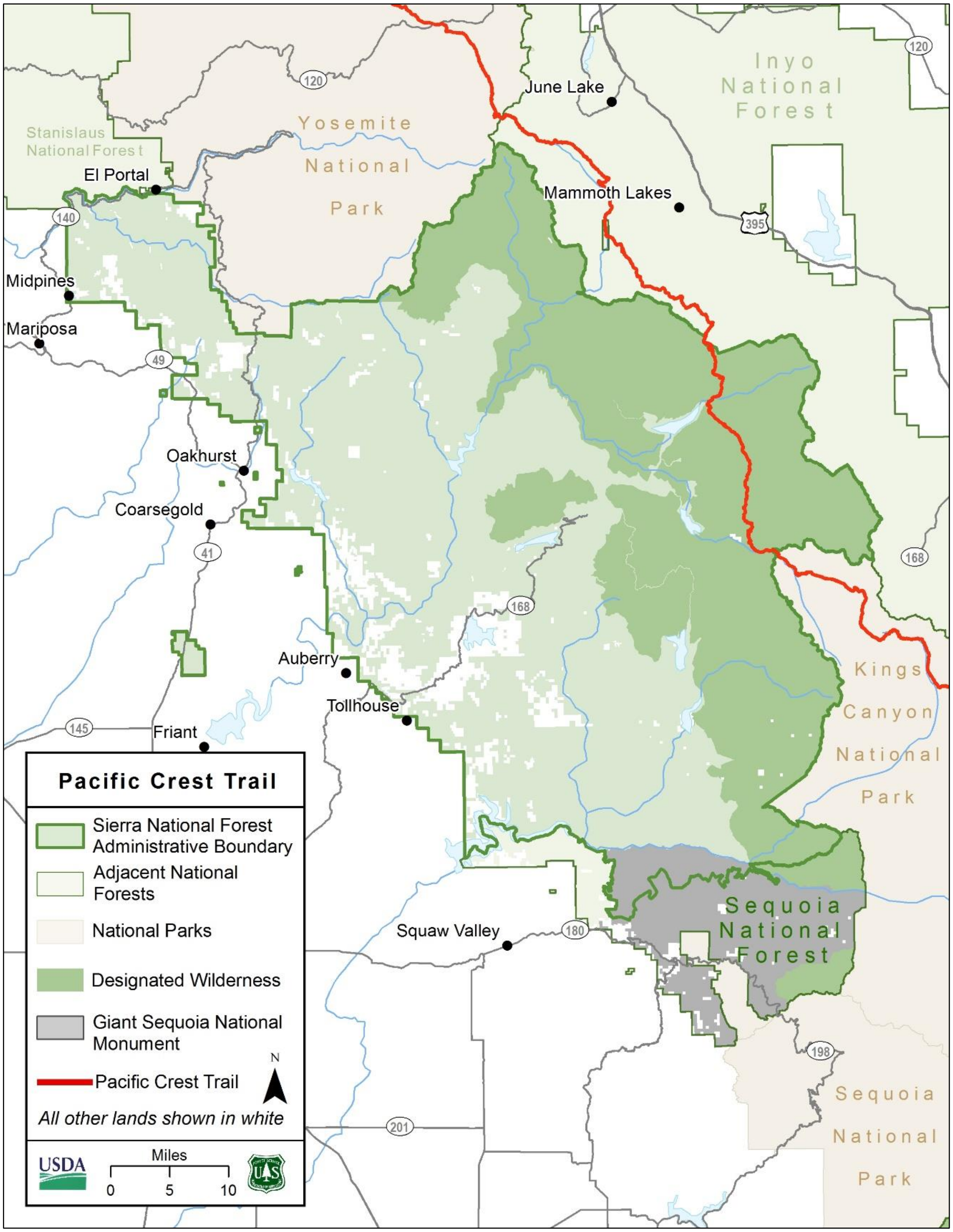

Figure 57. Map of Pacific Crest Trail, Sierra National Forest

Table 126. Section and entire trail permits issued for the Pacific Crest Trail, 2013–2018

Year	Total Number of permits issued	Northbound thru-hike permits	Southbound thru-hike permits	Section hike permits	Thru-ride permits	Section ride permits	Completions reported
2013	1,879	988	53	834	1	3	275
2014	2,655	1,367	94	1,179	7	8	489
2015	4,453	2,486	322	1,633	4	8	663
2016	5,670	3,164	334	2,159	5	8	753
2017	6,078	3,496	438	2,135	6	3	524
2018	7,331	4,506	491	2,316	6	12	1,146

In 2015, 8 percent of the permits issued were to international travelers from 34 countries with the most number from Canada, Germany, and the United Kingdom, respectively. The majority of the permits (92 percent) were to recreationists originating from the United States represented by all 50 states and the District of Columbia, with the most number being issued to California, Washington, and Oregon state residents, respectively.

Within the central Sierra Nevada, land managers within the Forest Service and National Park Service have been concerned about increasing visitor use on the John Muir Trail, which uses the same trail tread as the PCT in the Sierra National Forest, the Inyo National Forest, and Yosemite and Sequoia and Kings Canyon National Parks. Figure 58 shows from 2011 to 2015, the number of John Muir Trail permits issued has more than doubled. In 2015, Yosemite National Park implemented an exit quota permit system to address access and resource concerns related to increased use (http://www.nps.gov/yose/planyourvisit/jmtfaq.htm). The Sequoia National Forest and the Sierra National Forest are not aware of any current visitor capacity issues on the segments of the PCT within each forest.

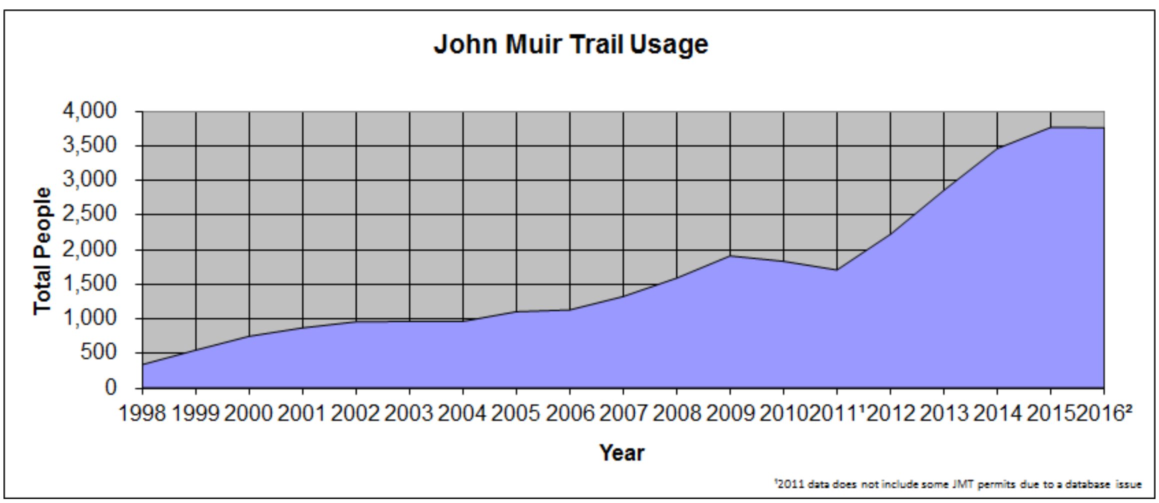

Figure 58. John Muir Trail usage (which uses the same trail tread as the Pacific Crest Trail for most of its route), 1998–2016

Competitive Events

Interest in trail running has increased in recent years. A study the Outdoor Foundation completed for the 2014 Outdoor Recreation Participation Report (Outdoor Foundation 2014) noted that 6.8 million Americans ages 6 and older participated in trail running in 2013, which is 2.3 percent of the population. The study concluded that running, including jogging and trail running, was the most popular activity among Americans when measured by the number of participants and by the number of total annual outings. Trail running by individuals is allowed on the PCT without restrictions. Recreation special use permits are required for trail running events that charge fees for participation or have more than 75 people participating. By policy, competitive event permits are not allowed in designated wilderness.[50]

Competitive events may disrupt or displace hikers and equestrians using the section of the PCT at the same time and location of the event. However, there are economic and health benefits related to trail running and riding events that are positive for individuals and communities. Some PCT users not directly involved in events enjoy encountering events and celebrate the activity, free food, and companionship. Others users are concerned about the number of encounters they experience over a short period of time, with limited sight distance and passing zones on the trail. Public concerns regarding competitive events displacing individual users of the PCT has been raised on social media. While there is currently no comprehensive list of events on the PCT, for the races that have been compiled, available data show a range in participation from 75 to 800 people and total approximately 3,500 annually.

Within the Sequoia National Forest, no competitive events have been permitted on PCT segments outside designated wilderness. Within the Sierra National Forest, no competitive events are allowed on the PCT because it is entirely within designated wilderness.

Scenery

The PCT travels through a variety of management areas within National Forest System lands. Each national forest plan contains forestwide direction that defines the allowable uses (such as hikers and equestrians) of the trail and the visual resource objectives. The Sequoia National Forest and the Sierra National Forest both currently employ a standard for visual quality objectives of retention or partial retention in the areas viewed as foreground from the PCT (approximately one-half mile of centerline of the trail) and modification in the middle ground and background distance zones.

Since the trail crosses many national forests, it is important to note the forest plans for the majority of the national forests that the PCT travels through were developed in the 1980s and are under the old visual resource management standards; they have not been amended for the Scenery Management System to replace them.

Within the Sequoia National Forest, most of the scenery visible from the PCT is currently protected with a visual quality objective of retention or better. Within the Sierra National Forest, the scenery visible from the PCT contains outstanding scenic vistas and panoramic views. In the John Muir Wilderness, PCT visitors experience stunning vistas of the Sierra Crest.

[50] Forest Service Manual 2323.13h

Vegetation Management and Fuels Treatment

In the last 10 years, wildfire has played a role in the accessibility of the PCT for hikers and equestrians and the visibility of scenery from the trail. In the last 50 years, 235,521 acres of the total PCT corridor have burned; almost half of that area burned in the past 10 years.

Within the Sequoia National Forest, the 2012 Clover Fire and the 2000 Manter Fire are examples of large, high-severity burns that have affected the recreation experience on the PCT. Though the trail tread itself was not damaged, some of the trails that provide access to the PCT were closed by fallen trees. Within the Sierra National Forest, more than 10 percent of the trail has burned, but not by high-intensity fire. Fire is expected to continue to impact the trail and trail users.

In addition, in 2012, heavy precipitation followed by a significant wind event caused the closure of a majority of the trails that provide access to the PCT in the Sierra National Forest when up to 100 trees per mile fell on the access trails. As a result, fuel loading from the downed trees is high (United States Department of Agriculture 2011c).

Lands Special Uses

The national increase in demand for renewable energy, especially wind development, has impacted the scenic integrity of the trail at a landscape scale in Kern County, California, in the vicinity of the PCT, south of the Sequoia National Forest. So far, such infrastructure has not directly impacted the PCT within the Sequoia National Forest. However, authorizations for new or larger transmission lines, pipelines, and other utilities have impacted the scenic integrity of the trail corridor in all three states through which the trail passes.

Table 127 and Table 128 summarize BLM information about the number of applications and authorizations, as well as acres involved, as of October 2015. Wind testing authorizations exclude projects submitted for development. In addition, prior to 2003, the BLM authorized more than 3,000 wind turbines on public lands. Those developments are not reflected in this table.

Table 127. California Bureau of Land Management wind energy applications and authorizations, October 2015

Area	Testing Applications (number)	Testing Authorizations (number)	Development Applications (number)	Development Authorizations (number)
Statewide	15	13	3	3
Desert	15	9	1	3
Central California	0	1	1	0
Northern California	0	3	1	0

Table 128. California Bureau of Land Management wind energy applications and authorizations acreage, October 2015

Area	Testing Applications (acres)	Testing Authorizations (acres)	Development Applications (acres)	Development Authorizations (acres)
Statewide	219,878	93,590	26,009	26,795
Desert	219,878	52,738	6,720	26,795
Central California	0	0	7,882	0
Northern California	0	40,852	11,407	0

Energy corridor rights-of-way, communication sites, and wind turbines have a high potential to have long-term effects on scenic resources. Cleared rights-of-way and utility structures contrast and may be incongruent with existing landscapes. Cleared rights-of-way generally contrast highly with the surrounding landscape. Within both the Sequoia National Forest and Sierra National Forest, there are no existing authorizations for lands special uses, such as wind turbines, utility transmission lines, or pipelines, across or along the PCT.

Socioeconomic Considerations

The Outdoor Recreation Economy Report identifies that outdoor recreation generates $887 billion in consumer spending annually, sustaining 7.6 million American jobs, and $124.5 billion in Federal, state, and local tax revenue each year (Outdoor Industry Association 2017) The outdoor recreation economy thrives when Americans spend their dollars in the pursuit of outdoor recreation. This spending occurs in two forms: the purchase of gear and vehicles, and dollars spent on trips and travel. It is estimated that for every dollar spent on gear and vehicles, four dollars are spent on trips and travel.

PCT resupply points in or near the Sequoia National Forest and Sierra National Forest include the towns of Tehachapi, Mojave, Onyx, and Lake Isabella, as well as Muir Trail Ranch and Vermillion Valley Resort. These areas receive an influx of recreation-related supply and service requests as PCT users pass through them. While the economic contribution of PCT users specifically has not been studied, California State Parks estimated recreational visitors to California parks and participants in the major recreation activities in California spent over $20 billion on trip expenditures and equipment in 2008 (California State Parks 2011). Trip expenditures include a variety of goods and services such as overnight lodging, restaurant meals, groceries, and gasoline. The sources of direct recreation expenditures vary considerably among the regions. In that report, the “Sierra region” had the largest direct expenditures ($3.5 billion) associated with visitation to federally managed lands.

Environmental Consequences to the Pacific Crest National Scenic Trail

Recreation Opportunities

Consequences Common to All Alternatives

The 1982 PCT Comprehensive Management Plan allows for the full range of the recreation opportunity spectrum to be experienced, with rural and urban sections of the trail “generally be(ing) as short as necessary to allow passage across or under highways and railroads or passage through developed areas.”

In all alternatives, the ROS, motorized recreation access, and mountain biking trails would continue to be authorized in all areas where they are currently authorized until any site-specific travel management decisions are made.

Table 129 and Table 130 show the acres of each ROS class within the PCT management area under each alternative, for each forest. Within the Sequoia National Forest and the Sierra National Forest, no acres of the PCT management area are within the urban, rural, or roaded modified ROS classes under any of the alternatives.

Table 129. Recreation Opportunity Spectrum (ROS) classes within the Pacific Crest Trail Management Area, by alternative, Sequoia National Forest

ROS Class	Alternative A (Acres)	Alternative B (Acres)	Alternatives C and E (Acres)	Alternative D (Acres)
Primitive	5	1,916	7,717	1,060
Semi-primitive Nonmotorized	38	14,704	32,267	8,677
Semi-primitive Motorized	3	748	2,875	359
Roaded Natural	15	3,514	3,525	2,164
Total PCT Management Area	61	20,882	46,384	12,260

Table 130. Recreation Opportunity Spectrum (ROS) classes within the Pacific Crest Trail Management Area, by alternative, Sierra National Forest

ROS Class	Alternative A (Acres)	Alternative B (Acres)	Alternatives C and E (Acres)	Alternative D (Acres)
Primitive	41	14,631	81,449	7,893
Semi-primitive Nonmotorized	1	373	2,982	177
Semi-primitive Motorized	0	29	1,731	14
Roaded Natural	0	0	461	0
Total PCT Management Area	42	15,033	86,623	8,084

Letters and public comments expressed concerns about potentially losing access for motorized recreation within the PCT management area. However, in all alternatives, motorized recreation would continue to be authorized in all areas where it is currently authorized until any site-specific travel management decisions are made. A PCT management area would not in itself preclude authorization of currently unauthorized routes within the corridor if travel management decisions have not yet been made in the area. See PCT “Affected Environment,” “Sustainable Recreation Affected Environment,” and “Environmental Consequences” for more information about travel management. There would also be no change in nonmotorized trails that allow bicycle use, based on the PCT management area.

Table 131 and Table 132 show the miles of motorized roads and trails within the PCT management area under each alternative, for each forest.

Motorized roads and trails only exist outside designated wilderness areas.

Table 133 and Table 134 show the acres within designated wilderness and outside designated wilderness within the PCT management area under each alternative, for each forest.

Table 131. Motorized roads and trails within the Pacific Crest Trail Management Area, Sequoia National Forest

Roads/Trails	Alternative A (miles)	Alternative B (miles)	Alternatives C and E (miles)	Alternative D (miles)
Motorized Roads	0	3.1	3.1	0.6
Motorized Trails	2.3	3.6	14.3	2.9
Total Motorized Roads and Trails within PCT Management Area	2.3	6.7	17.4	3.5

Table 132. Motorized roads and trails within the Pacific Crest Trail Management Area, Sierra National Forest

Roads/Trails	Alternative A (miles)	Alternative B (miles)	Alternatives C and E (miles)	Alternative D (miles)
Motorized Roads	0	0	0.3	0
Motorized Trails	0	0	0	0
Total Motorized Roads and Trails within PCT Management Area	0	0	0.3	0

Table 133. Area within designated wilderness and outside designated wilderness within the Pacific Crest Trail Management Area, Sequoia National Forest

Designated Wilderness	Alternative A Acres (%)	Alternative B Acres (%)	Alternatives C and E Acres (%)	Alternative D Acres (%)
Within	43 (70%)	16,568 (79.3%)	37,487 (81%)	9,725 (79.3%)
Outside	18 (30%)	4,315 (20.7%)	8,897 (19%)	2,536 (20.7%)
Total	61	20,883	46,384	12,261

Table 134. Area within designated wilderness and outside designated wilderness within the Pacific Crest Trail Management Area, Sierra National Forest

Designated Wilderness	Alternative A Acres (%)	Alternative B Acres (%)	Alternatives C and E Acres (%)	Alternative D Acres (%)
Within	42 (100%)	15,004 (99.8%)	84,431 (97%)	8,070 (99.8%)
Outside	0	29 (0.2%)	2,200 (3%)	14 (0.2%)
Total	42	15,033	86,631	8,084

Within the PCT management area, motorized recreation access and mountain biking trails would continue to be authorized in all areas where they are currently authorized until any site-specific travel management decisions are made. New permanent roads would not be permitted within the PCT management area unless required by law to provide access to private lands or documented as the only prudent and feasible alternative. New motorized recreation and mountain biking trails within the PCT management area may be authorized in site-specific travel management decisions and would be designed to minimize the visual, sound, and resource impacts on the PCT.

Visitor Use

Consequences Common to all Alternatives

The numbers of PCT users are expected to continue to increase, based on increasing interest in the PCT recently and increasing use on the John Muir Trail, which uses the same trail tread as the PCT in the Sierra National Forest. Visitor use would be similar in all alternatives. The alternatives would not directly affect the amount of use. Managers may use visitor use management strategies to minimize impacts on the physical trail resource and social setting.

Competitive Events

Consequences Specific to Alternative A

Within the Sequoia National Forest, no competitive events have been permitted on PCT segments outside designated wilderness. Within the Sierra National Forest, no competitive events are allowed on the PCT because it is entirely within designated wilderness.

If a competitive event were proposed on any portion of the 13 miles of the PCT within the Sequoia National Forest that are outside wilderness, the application would be reviewed using the standard procedure, and a permit may be issued.

Consequences Common to Alternatives B, C, D, and E

Within the PCT management area, competitive events may be authorized to cross the 13 miles of the PCT within the Sequoia National Forest that are outside wilderness, but would not be allowed to occur on the trail. This would decrease the potential for displacement of individual PCT users, including hikers, equestrians, and trail runners. Other trails outside designated wilderness would continue to be open for competitive events, subject to standard application review and permit procedures.

Scenery

Consequences Specific to Alternative A

Existing plans do not include specific guidance for designing projects to improve scenic character and scenic character stability within the desired landscape character. Scenic character is managed using Agriculture Handbook 701, “Landscape Aesthetics, A Handbook for Scenery Management,” which replaced the Visual Management System. This document provides guidance that applies to all national forests (United States Department of Agriculture 1995b). Continuing to use the Visual Management System and visual quality objectives would be contrary to current Forest Service policy. The Visual Management System is not an adaptive system and does not respond to changing ecological conditions; the Scenery Management System does.

Consequences Common to Alternatives B, C, D, and E

Within the PCT management area, at least 95 percent of the area is within “very high” or “high” scenic integrity objectives.

Table 135 and Table 136 show the acres within each scenic integrity objective within the PCT management area under each alternative, for each forest.

Table 135. Area within each scenic integrity objective within the Pacific Crest Trail Management Area, Sequoia National Forest

Scenic Integrity Objective	Alternative A Acres (%)	Alternative B Acres (%)	Alternatives C and E Acres (%)	Alternative D Acres (%)
Very High	43 (70.5%)	16,621 (79.6%)	37,621 (81.1%)	9,738 (79.4%)
High	16 (26.2%)	3,376 (16.2%)	7,871 (17.0%)	1,922 (15.7%)
Moderate	2 (3.3%)	886 (4.2%)	892 (1.9%)	601 (4.9%)
Low	0	0	0	0
Total	61	20,883	46,384	12,261

Table 136. Area within each scenic integrity objective within the Pacific Crest Trail Management Area, Sierra National Forest

Scenic Integrity Objective	Alternative A Acres (%)	Alternative B Acres (%)	Alternatives C and E Acres (%)	Alternative D Acres (%)
Very High	42 (100%)	15,004 (99.8%)	84,431 (97.5%)	8,070 (99.8%)
High	0	29 (0.2%)	2,200 2.5%)	14 (0.2%)
Moderate	0	0	0	0
Low	0	0	0	0
Total	42	15,033	86,631	8,084

Vegetation Management and Fuels Treatment

Consequences Common to all Alternatives

Vegetation and fuels management, such as mechanical thinning, have a high potential to alter the landscape and affect scenic resources. Activities typically reduce scenic integrity in the short term because of cut vegetation, slash, stumps, disturbed soils, and landing and road construction. The length of time treated areas may appear moderately to highly altered depends on the treatment methods and mitigation measures implemented. In the long term, treatment activities may maintain or enhance scenic integrity, scenic character stability, and resiliency to insects, disease, and large-scale wildfire.

In all alternatives, vegetation management for ecosystem restoration would be allowed in the PCT management area to retain the desired condition of a natural-appearing landscape. Hauling and skidding along the trail would not be allowed to protect the trail integrity. Temporary roads may be allowed within the PCT management area and would be designed to minimize visual, sound, and resource impacts on the trail. Planning for scenic elements and adherence to design criteria would minimize short-term impacts and reap long-term benefits, thereby meeting scenic integrity objectives.

Management efforts to control insect infestations and diseases that include removal of infected trees and a distance around them may appear as clear-cutting to forest visitors. These impacts may also occur in areas of high scenic value and may reduce scenic quality in the short term.

Lands Special Uses

Consequences Common to All Alternatives

Within the PCT management area, new permits for mineral materials, such as sand, gravel, pumice, cinders, and other common minerals, would not be issued. Leasable minerals, such as oil, gas, and geothermal energy, are available for leasing but must contain a "no surface occupancy" stipulation.

Utility rights-of-way would be located where impacts already exist and would be limited to a single crossing of the PCT unless documented as the only prudent and feasible alternative.

Consequences Specific to Alternatives C and E

New utility rights-of-way across or along the PCT would be prohibited.

Cumulative Effects Analysis

The cumulative effects analysis area for the PCT management area is all lands through which the trail travels in the state of California. This area was selected because of ongoing and proposed activities in neighboring national forests, adjacent state and BLM lands (such as renewable energy development and energy corridor developments), and private lands that the trail traverses connecting the Sequoia National Forest and Sierra National Forest. The overall effects are unlikely to be large within the PCT management area under each alternative. The differences in cumulative effects among the alternatives are also unlikely to be large.

Recreation Opportunities and Visitor Use

The population in California is expected to grow at approximately 500,000 people each year and reach 50 million by 2050 (California Department of Finance 2014). Increased demand for outdoor recreation opportunities and the need for improvement of all types of recreation experiences are expected to continue. Project-level actions taken to limit visitor use on the John Muir Trail and PCT will have consequences to nearby points of entry and visitors seeking alternative connecting routes to the PCT. Visitor use management actions by Federal land management agencies to limit impacts on the trail's physical resources and social settings are likely to increase as a cumulative effect.

Competitive Events

Interest in competitive events is likely to continue with increases in permit applications expected for trail running races primarily between Memorial Day and Labor Day. These commercial recreation special use permits are prohibited in designated wilderness. Other trails outside designated wilderness would continue to be open for competitive events, subject to standard application review and permit procedures.

Scenery and Vegetation Management and Fuels Treatment

Vegetation and fuels treatments are planned or proposed for much of the land within the cumulative effects analysis area outside designated wilderness. This, combined with the planned or proposed treatments under all alternatives, could result in cumulative effects on scenic resources. In the short term, many areas would appear to be slightly to moderately altered until the longer-term ecological and scenic integrity objective are achieved.

Lands Special Uses

Renewable energy and energy corridor developments are expected to increase south of the Sequoia National Forest and within and adjacent to existing energy projects and corridors. These would be significant and permanent landscape modifications. Where solar panel arrays and additional wind farms are developed, there may be dramatic changes to the existing landscape and scenic integrity from the associated structures. These types of energy developments would also require additional transmission lines to connect to existing energy corridors and may lead to development of new energy corridors or expansion of existing energy corridors.

Analytical Conclusions

Overall, based on the amount of area identified within the PCT management area, alternatives C and E would both provide the most protection for the resources, qualities, values, and associated settings and primary uses of the Pacific Crest National Scenic Trail. This is because the PCT management area would be largest under these alternatives. The PCT management area would be smaller under alternative B, followed by alternative D, then alternative A.

Short-term negative effects on scenic resources would be the largest under alternative D, which would treat more acres mechanically and with wildfire and prescribed fire than alternatives A, B, C, and E. Likewise, long-term positive effects may be larger under alternative D, followed by alternative B, if treatment activities successfully maintain or enhance scenic integrity, scenic character stability, and resiliency to insects, disease, and large-scale wildfire.

Heritage Resources

Background

This section summarizes the current heritage resources environment in the Sequoia and Sierra National Forests and the potential consequences to heritage resources from the draft forest plans and their alternatives.

Heritage resources (also sometimes referred to as “cultural resources”) are an object or definite location of human activity, occupation, or use identifiable through field survey, historical documentation, or oral evidence. Heritage resources are prehistoric, historic, archaeological, or architectural sites, structures, places, or objects and traditional cultural properties. Heritage resources include the entire spectrum of resources for which the Forest Service is responsible, from artifacts to cultural landscapes without regard to eligibility for listing on the National Register of Historic Places (NRHP). These resources represent past human activities or uses and, by their nature, are considered an irreplaceable and nonrenewable resource if not managed for preservation over the long term.

Because heritage resources represent important cultural values, they are of special concern to the public. Interest in our heritage and concern over the destruction of archaeological sites have prompted the passage of national, state, and local legislation that is designed to promote and protect these examples of our nation’s historical and traditional legacy. As a result, a variety of laws, regulations, and policies provide direction for managing and protecting heritage resources on National Forest System lands. This guidance is independent from forest plan direction and does not change across alternatives.

Every endeavor that results in ground disturbance or brings an increase of public or agency use has the potential to affect heritage resources. Activities that disturb the ground include such activities as digging postholes for sign placement, timber harvest, constructing a new bathroom, enhancing a campground, laying fiber optic cable, large-scale vegetation management, or fire prevention and suppression activities. In addition, projects may have indirect effects on areas of the landscape that are important for cultural and tribal values. The consequences to tribes and tribal resources are discussed separately in the “Tribal Relations and Uses” section.

The Forest Service Heritage Program has operated under the premise of “flag and avoid” heritage resources during project implementation for years. A “flag and avoid” strategy works for protection of heritage resources on small footprint types of projects because scheduling and heritage staff can be made available to accomplish compliance with section 106 of the National Historic Preservation Act.

Sites that have been “flagged and avoided” usually have not been evaluated; thus, until evaluated, they must be treated as if they are historic properties eligible for listing on the NRHP. This presents a major management challenge given the number of sites already known and the increased numbers that will be discovered during surveys as larger landscape areas are being evaluated for restoration projects. Having to manage resources that may not be eligible for listing on the NRHP takes away valuable staff time that could be better spent on managing and monitoring those resources that are listed or eligible for listing, inventorying areas that have not been previously surveyed for heritage resources, and providing recordation and evaluation for newly identified heritage assets.

Analysis and Methods

It is not possible to evaluate the impacts of the alternatives on specific heritage sites because a high percentage of known sites have not been evaluated and because the draft forest plans are programmatic in nature. Instead, the analysis is based on considering the amount of potential ground disturbance as a proxy for the potential for impacts on heritage resources.

Indicators and Measures

The amount of ground disturbance that might occur under each alternative is used as an indicator because of the potential for ground disturbance to adversely affect heritage resources. This is complicated by the fact that the total occurrences of cultural sites are unknown due to the lack of a complete survey and inventory in the two national forests.

Affected Environment

Heritage resources in the two national forests represent a diversity of cultures and their uses of the landscapes, including native people, colonial California, late 19th and 20th century state history (such as the Gold Rush) and American history, Civilian Conservation Corps history, and Forest Service history.

The area encompassed by the two draft forest plans has at least a span of 9,000 years of human occupation and use. People arrived in California more than 13,000 years ago (Johnson et al. 2002). The exact date of Native American arrival is unknown. Occupation of the lower southern Sierra Nevada foothills began prior to 9,000 years ago and would have been limited in many locations due to high-elevation glaciation. As the climate and resource availability changed, so did the people as they adapted to changing environmental conditions and the distribution of plants and animals used for sustenance and shelter.

Cultural Resources Surveys

The prehistoric Native American past is embodied in the rock art and prehistoric archaeological sites that range in size from small stone lithic scatters to large villages occupied for hundreds of years that dot the contemporary landscape. Local tribes highly value these sites as the very embodiment of their past and the places where their ancestors lived, worshiped, and died. It is a tangible link to a long history, but despite their persistence through time, sites are extremely vulnerable to damage by ground-disturbing activities and even from high-intensity fire. Prehistoric Native American sites are also vulnerable to illegal looting and illicit excavation.

Historic period sites are also extremely vulnerable to destruction by disturbing activities, including wildfire, especially wooden cabins, flumes, lookouts, and old mine buildings. Looting of historic artifacts at historic sites is as much of a problem as that on deeply buried Native American sites.

The presence of prehistoric and historic sites reflects the human use of the area encompassing the two national forests. Table 137 shows the approximate number of acres surveyed in the Sequoia and Sierra National Forests. The total extent of the heritage resource database for the two national forests has not been determined. However, from an evaluation of survey data, it is estimated that approximately 13 percent of the Sequoia National Forest and 29 percent of the Sierra National Forest have been inventoried for heritage resources, equating to approximately 23 percent of the entire acreage comprising the two forests (the Giant Sequoia National Monument is not included in these calculations). Most of these surveys have been project specific rather than large-scale or systematic surveys. Almost 512,300 acres of land of the total 2.265 million acres comprising the area of the two national forests (excluding the Giant Sequoia National Monument) have been inventoried for heritage resources; 7,322 heritage resource sites have been recorded within that area.

Table 137. Heritage survey for Sequoia and Sierra National Forests

Heritage Survey Attributes	Sequoia[1]	Sierra	Total
Total Acres	865,000	1,400,000	2,265,000
Approximate Acres Surveyed	112,300	400,000	512,300
Percent Surveyed	13%	29%	23%

[1] Does not include Giant Sequoia National Monument

Those heritage surveys have identified a total of 2,836 sites in the Sequoia National Forest and 4,486 sites in the Sierra National Forest as shown in Table 138. Of those totals, 94 percent of the sites in the Sequoia National Forest are unevaluated, and 92 percent of the sites in the Sierra National Forest are unevaluated for the NRHP. This means all unevaluated sites (93 percent of all the known sites on the two national forests) are considered to be eligible properties for listing on the NRHP and must be managed as such until an eligibility determination is submitted to the Office of Historic Preservation for the State Historic Preservation Officer’s concurrence; or it must be submitted directly to the Keeper of the National Register for a determination.

Table 138. Number of heritage sites for Sequoia and Sierra National Forests by type

Type of Site	Sequoia	Sierra	Total
Prehistoric	1,581	3,401	4,982
Historic	518	799	1,317
Multi-Component	87	176	263
Unidentified	650	106	756
Contemporary	0	2	2
Protohistoric	0	2	2
Total Sites	2,836	4,486	7,322

Table 139 summarizes the numbers of site evaluations and designations on each national forest for sites that have undergone evaluation. Of those evaluated, 53 percent of the sites in the Sequoia National Forest were found not eligible, and 56 percent of the sites in the Sierra National Forest were not eligible. Given only a small portion of the known heritage sites have been evaluated, the two national forests are currently managing potentially non-eligible heritage resources, all of which need to be considered as eligible during the planning process and avoided.

Table 139. Number of heritage site determinations and number of historic landmarks on the NRHP for the Sequoia and Sierra National Forests

Heritage Site Determinations	Sequoia[1]	Sierra	Total
NRHP Listed	1	1	2
National Historic Landmark	0	1	1
State Historic Landmark	1	0	1
NRHP Eligible	77	173	250
Not Eligible	87	221	308
Total Determinations	165	395	560
No Determination	2,671	4,091	6,762

[1] Does not include Giant Sequoia National Monument

Environmental Consequences to Heritage Resources

Heritage resources are nonrenewable, and any effect can result in the unacceptable destruction or damage to examples of the area's heritage. Not all effects are necessarily adverse; others may be avoided, either through project design or the implementation of standard protection measures. Heritage resources also need to be reviewed not only as individual resources, but holistically at larger landscape levels. What may appear to be individual sites, or dots on a map, may very well be historic districts (for example, mining complexes, ranching complexes, or cultural landscapes) that include village sites with surrounding special use areas containing trails, plant gathering areas, lithic quarries, and other essential resources.

Consequences Common to all Alternatives

Regardless of the alternatives, all site-specific projects would consider effects on heritage resources at the outset of every project planning process. Compliance with section 106[51] of the

[51] Section 106 of the National Historic Preservation Act of 1966 requires Federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment.

National Historic Preservation Act of 1966, as amended, would be completed prior to making a decision to implement a project, approve a permit, or undertake an activity. The section 106 process may be completed by consultation with the State Historic Preservation Officer, tribes, the public, and other stakeholders, and at times with the Advisory Council on Historic Preservation using the regulatory process codified at 36 CFR 800 as amended or through implementation of the stipulations of the Region 5 Programmatic Agreement (United States Department of Agriculture 2013a, f).

All alternatives include direction to reduce fuels and restore fire to the landscape, but using different approaches and with a different pace and scale of restoration. The extent that each alternative reduces the extent and severity of wildfires would reduce the risk of inadvertent impacts on heritage sites from fire suppression activities and from damage from high soil heating.

Consequences Common to Alternatives B, C, D, and E

The emphasis on variable treatment intensities and on restoring and managing for vegetation heterogeneity under alternatives B, C, D, and E should provide opportunities to design projects around small sites to minimize or avoid disturbances to heritage resources. Avoidance would follow the standard practice of using the “flag and avoid” strategy. It also would encourage designing projects to reduce threats to heritage resources from large, high-intensity wildfires by allowing low-intensity treatments around small sites to promote an increase in resiliency and sustainability of forests.

Management activities (such as mechanical thinning, prescribed burning, and managing wildfires to meet resource objectives), appropriately implemented to avoid direct and indirect effects on heritage resources and tribal values, may afford greater protection compared with consequences from continued forest growth and density increases that lead to larger and higher-intensity wildfires. Activities associated with wildfire suppression under emergency conditions often have adverse impacts on heritage resources, such as running a dozer line through sites and areas sensitive to tribes.

Alternatives B, C, and D encourage managing wildfires to meet resource objectives, especially in the wildfire maintenance zone. Some wildfires are also managed to meet resource objectives under alternative A in wilderness and remote areas. Decisions to manage wildfires and on-the-ground activities would consider the location of known sites and where possible, resource advisors would be consulted to develop strategies to minimize or mitigate impacts. The desired outcome is to restore fire to the landscape similar to conditions that have occurred historically such that the impacts on sites would not be substantially different from what they have been exposed to for centuries. There would be some additional opportunity under alternatives B and D, which is discussed separately for those alternatives.

Consequences Specific to Alternative A

Alternative A represents the existing plans (as amended) and would have no measurable direct effects on any known heritage resources from continuing activities currently allowed under the existing plans. This is because planned projects involving ground-disturbing activity would either avoid direct and indirect effects on heritage resources or would include project-specific mitigation measures to address any adverse effects on specific heritage resources by reducing them to acceptable levels or following existing processes when effects cannot be adequately mitigated.

During wildfires, there are risks to sites and resources from fires that burn at a high intensity with heat pulses into the soil that can damage individual resources and threaten sites where large, high-intensity fires result in surface erosion, the movement of soils, and the rearrangement of sites. In some cases, high-intensity fire can ruin the ability to date some artifacts, especially obsidian, by changing the hydration bands. Fire also can burn wood or natural fiber artifacts.

Consequences Specific to Alternative B

Alternative B emphasizes ecological fire resilience and restoration of fire as an ecosystem process with a greater focus on large-scale, landscape-level projects. There would be more mechanical thinning treatments and more prescribed burning than under alternative A. As only 13 percent of the Sequoia National Forest and 29 percent of the Sierra National Forest have been inventoried for heritage resources, a large-scale, on-the-ground effort would be needed to identify heritage resources in previously unsurveyed areas. Known sites that are unevaluated are managed as if they were eligible for listing on the NRHP, resulting in the need to include additional mitigation measures when designing projects.

Vegetation treatment measures that emphasize low-intensity fire and increased use of hand treatment in and around known sites would lower the potential for adverse impacts on heritage resources. Prescribed burning can be compatible with heritage sites and heritage resources if the fire can burn at a low intensity or with mitigations to protect them, such as constructing fire lines to exclude fire or covering or protecting features to reduce the risk of ignition.

Alternative B emphasizes restoring fire to the landscape, which would include a consideration of heritage resources in determining where and how it can be used to meet resource objectives. This would benefit heritage resources by reducing fuels while reducing impacts by managing the fire's intensity. Projects would be designed to avoid and minimize impacts and effects on heritage sites and to indirectly improve the resilience of sites by reducing threats from fire and other uses. Treatments along strategic roads and ridgetops, especially in the wildfire restoration zone, would be expected to increase the potential to manage wildfires in this zone over time, further reducing the risk of high-intensity fire impacts on heritage sites.

Consequences Specific to Alternative C

Alternative C places an emphasis on providing more short-term protections for wildlife habitat. This alternative proposes to add the most areas recommended for wilderness designation of all the alternatives. Additionally, this alternative would have more areas with restrictions or limitations on the intensity and extent of treatment using mechanical vegetation management methods. This would afford greater short-term protection by resulting in less impacts on known and unknown heritage resources. Conversely, those restrictions and protection measures could have more indirect effects by leaving more areas with levels of surface fuels outside the natural range of variation, which could damage sensitive sites and resources if they burn at a high intensity in wildfires.

Alternative C emphasizes more use of prescribed burning in lieu of mechanical treatments where possible. As described for alternative B, prescribed burning can be compatible with heritage sites and heritage resources, but careful planning is needed, especially where fuels are heavy and there is no mechanical pretreatment to reduce them prior to burning. Some work by hand or to remove small-diameter trees and other vegetation may occur, but funding would limit the extent. Most prescribed burning would need to be designed in existing heavy fuel conditions, which may mean some burns would become more backlogged if suitable conditions for a favorable burn outcome do not occur as frequently due to climate change with drier spring conditions and longer fire seasons into the fall.

Consequences Specific to Alternative D

Alternative D has the greatest increase in the pace and scale of ecological restoration that could involve ground-disturbing activities. Given the increase in development, such as the increase in recreation opportunities and the increase in the scale of treatments, the need for project-level survey and design mitigations would be the greatest in this alternative compared with the other alternatives. There is some uncertainty in how project planning may need to change to ensure surveys do not become obstacles to achieving the increased amount of restoration in this alternative.

Alternative D would have similar effects and benefits as described for alternative B. The increase in area of mechanical treatments with greater fuel reductions would require more coordination and consultation to design projects to avoid and minimize impacts and effects but would result in a greater reduction in the potential for large, high-intensity fires. Alternative D would have the most ability, primarily through increased stewardship funding opportunities, to do additional preparatory work, including evaluation of sites, to mitigate impacts and to avoid and minimize the potential for impacts on heritage sites and heritage resources during mechanical treatments and prescribed burning.

Consequences Specific to Alternative E

The consequences under alternative E would be similar to those under alternative C because the management direction is similar in these two alternatives. The unique backcountry management area direction under alternative E, which would allow more motorized and mechanized access than under alternative C, would mean greater consideration of heritage resources would be needed than under alternative C. However, compared with alternatives A, B, and D, the potential effects under alternative E on heritage resources would be less, given that alternative E would manage more areas for recommended wilderness and for more primitive and semi-primitive recreation settings.

Cumulative Effects

Cumulative effects are difficult to evaluate because of the large proportion of known sites that have not been evaluated. Each of the two national forests manages for “no effect” or “no adverse effect” on heritage resources for all planned management activities. This lessens the risk of cumulative effects by presuming known sites are eligible for inclusion on the NRHP and protecting them.

Some project activities may result in unplanned or inadvertent adverse impacts on heritage resources. Such unplanned or inadvertent adverse impacts are addressed and mitigated on a case-by-case basis through consultation with the State Historic Preservation Officer, tribal partners, other interested parties, the public, and at times the Advisory Council on Historic Preservation. Heritage resources are nonrenewable resources, and the destruction or damage to them cannot be reversed. The alternatives all have a restoration component, but care must be taken to protect significant heritage resources, such as prehistoric and historic sites, traditional cultural properties, traditional gathering and use areas, sacred sites and landscapes, and archaeological and historic districts.

Analytical Conclusions

At the project level, all the alternatives have the potential to impact heritage resources given that less than 23 percent of the plan area has been systematically inventoried for heritage resources and that 93 percent of all known recorded sites remain unevaluated for the NRHP. A "flag and avoid" strategy works for protection of heritage resources on small footprint types of projects because scheduling and heritage staff can be made available to accomplish compliance with section 106 of the National Historic Preservation Act. It becomes more problematic with larger, landscape-scale projects encompassing thousands of acres because of the unknowns relating to heritage resources. Large-scale projects generally have to be phased in terms of section 106 compliance, or the use of predictive modeling could be employed to assist with informing on the "likely" location of heritage resources, with an outcome for an increase in unplanned or inadvertent effects on known or unknown heritage resources.

Alternative A would continue a slow rate of restoration that is suitable for continuing a "flag and avoid" strategy. However, it would leave much of the forest and heritage resources at risk of damage from large, high-intensity fires. Alternatives C and E would reduce the amount of restoration accomplished using mechanical methods, which would reduce the potential for direct impacts on heritage resources. Alternatives C and E would use more prescribed fire but less mechanical pretreatment of fuels, which would require careful planning to avoid burning at a high intensity where fuels are heavy. Alternatives B and D strive to balance the greater risks of impacts on heritage sites by increasing the amount of mechanical thinning treatments and the amount of prescribed burning that would restore vegetation conditions and lower the risk of large, high-intensity wildfires over time. This would benefit heritage resources that would be damaged by fires that burn at a high intensity.

Tribal Relations and Uses

Background

This section summarizes the current tribal relations programs in the Sequoia and Sierra National Forests and the potential environmental consequences to tribes and tribal resources of implementing the draft forest plans and the alternatives.

The indigenous peoples of the Sequoia and Sierra National Forests have an unbroken union with this area for at least 14,000 years (Moratto 1984, Spier 1978, Jones and Klar 2007). The long-term relationship tribal people have with the landscape differs from that of most members of the public (Zedeño et al. 1997). A tribe's creation accounts, indigenous place names, sacred geography of ceremonial and religious sites, hunting-gathering and fishing areas, and valued resources all culminate to form part of the tribal identity and welfare (McAvoy et al. 2004). Changes in any proportion or condition of these closely tied people, places, and resources can result in impacts or improvements in the health of tribes and the environment. Thus, the rivers, forests, mountains, and meadows we look at on a map or experience in the national forests are intrinsic to the traditions and livelihoods to tribes, and the tribes are very concerned about impacts or changes to those areas.

The Federal Government has a trust responsibility to federally recognized American Indians, as well as a public trust for the management of natural, cultural, and heritage resources. As land managers, Forest Service staff know that the areas they currently manage are also ancestral lands to many tribes, creating the need to have effective relationships with these tribes. The agency is directed by Federal policy, laws, and associated authorities to engage in formal consultation, and to provide avenues for additional communication and collaboration with federally recognized tribes. Nearly every action the Forest Service undertakes has the potential to affect tribal relations and uses either directly or indirectly (Toupal 2003). Effects on tribal relations and uses can be adverse or beneficial, short term or long term. Some effects may be mitigated or avoided either through tribal consultation, such as knowledge learned regarding potential impacts or consequences of management actions, or redesign, such as practices that avoid, reduce, or mitigate undesired impacts (Toupal 2003, Burger 2008).

Positive relationships with tribes are important to maintain. Tribes maintain traditional ecological knowledge and pass it down through generations through oral and, in modern times, written accounts using contemporary technologies and tools. Resources that are important to tribes need to be reviewed not only as individual resources, but holistically at a landscape level (Zedeño et al. 1997, Watson et al. 2011). Tribal communities are interested in consultation, collaboration, and coordination on overall resource condition of the forests. However tribes are also keenly interested in access to the forests and in vegetation management and watershed function pertaining to ecological goods and services necessary to maintain, enhance, and perpetuate tribal traditions and livelihoods. In managing tribal resources, it is important to consider the ecocultural attributes for associated ecological goods and services that may differ between the public and tribes regarding valued resources (Burger et al. 2008).

The people of various tribes rely on different ecosystems across the bioregion that provide natural and cultural resources necessary to perpetuate tribal traditions and livelihoods (Anderson and Moratto 1996, Lake and Long 2014). This includes gathering from and tending trees such as California black oaks (Haney 1992) and pinyon pines (Zeanah 2002, Farris 1982) for primary food sources, medicinal plants, basketry and construction materials from plants, the harvesting of fish and game, and culturally important subsistence and spiritual activities (Anderson and Moratto 1996), including cross-Sierra travel and trade trips (Arkush 1994), and sacred ceremonies (Kroeber 1925, Moratto 1984).

The current condition of the National Forest System lands contributes to limited or denied access to traditional foods, leading to food insecurity and increased mental and physical health problems (Jernigan et al. 2012). This also can increase the loss of intergenerational traditional knowledge and practices among tribal communities (Turner and Turner 2008), which is an international and national issue of concern for indigenous peoples (Pimentel et al. 1997, Food and Agriculture Organization of the United Nations 2015).

Analysis and Methods

No modeling was used for this analysis, but there are some frameworks and tools that can be applied for considering risk, or the consequences with alternatives regarding the change in condition or effects, on tribally valued resources and cultural practices in response to alternatives (Toupal 2003, Burger 2008, Pollard et al. 2008). This analysis was developed after a series of meetings where tribes, tribal groups and organizations, traditional cultural practitioners, and other interested individuals consulted and collaborated on the development of the plan (United States Department of Agriculture 2015f). At these meetings, attendees were able to see draft materials and visit with Forest Service officials and staff officers and subject matter experts regarding the intent of revising the plans. Input was considered in developing the proposed action, refining the proposed action, and developing alternatives. The analysis uses a qualitative analysis of the following indicators and measures.

Indicators and Measures

For many years, the Forest Service has maintained a primary suppression approach to fire management that has led to great success in the initial attack and suppression of wildfires (Show and Kotok 1924, Stephens and Ruth 2005). This fire management approach has been in direct conflict with tribal efforts to continue natural and human-induced fire on the landscape to benefit and maintain tribal uses (Lake and Long 2014). Historical tribal fire use across the landscape provided for the numerous resources that were subsequently encountered by the influx of Europeans (Anderson and Moratto 1996).

Higher-severity and more extensive fires across the landscape have and are impacting natural and cultural resources, tribal values, tribal areas of importance, and sacred sites (Timmons et al. 2012, Welch 2012). Uncharacteristic fire and fire deficits (for example, reduction in natural and tribal ignitions) both impact tribal values and interests. This change in the frequency and extent of fire has contributed to increased forest density and homogeneity and increased fuel loading of ecosystems. This has made it harder for tribes to travel through the forests and has decreased shrub and non-forest conditions.

Policy decisions, administrative actions, and physical impacts on the ground can affect tribal access. Specific concerns from resource management activities, including road building or other modifications on the landscape, could affect tribal members accessing valued places (gathering areas or sacred sites) or practicing cultural activities. These specific concerns are best addressed at the site-specific level during project or activity planning. However, designated areas located in the plan area, such as wilderness, wild and scenic rivers, and national scenic and historic trails, and recommending additional areas for designation in forest plans might impact the reserved rights and interests of tribes.

Wilderness designations are controversial with the general public as well as with tribes (Stumpff 2000). This concern was particularly expressed in tribal forums held in the Sequoia and Sierra National Forests. Forest Service staff recognizes the importance of working with tribes on protected areas, such as wilderness, to create collaborative management strategies that meet mutual interests. The idea of maintaining these areas in their “pristine” condition through a “hands-off” approach lacks consideration for traditional ecological knowledge and associated practices conducted by tribes, tribal groups and organizations, and traditional cultural practitioners (Stumpff 2000, McDonald et al. 2000, Watson et al. 2011). This is especially true when it does not recognize that tribes have historically managed these “wilderness” landscapes through the introduction of fire at appropriate times of the year and in specific locations (Blackburn and Anderson 1993).

Plants and animals that are traditionally and currently important for cultural uses (for instance, food, fiber-basketry, medicinal, and spiritual) cannot be sustainably used at levels tribes desire when the ecosystems they occur within are degraded, managed for other conflicting interests or values, or are not accessible to tribes for traditional cultural purposes. Planning fuels and fire treatments across the landscape typically address the bio-physical aspects of fire regimes (Collins and Stephens 2010); they, do not, however, commonly incorporate socio-cultural values with the understanding of how tribal communities are dependent on fire in different ecosystems, habitats, and a range of resources affected by fire in the short and long term necessary to perpetuate tribal traditions and cultural practices (Anderson and Moratto 1996, Toupal 2003, Raish et al. 2005, Carver et al. 2009). Traditional knowledge can inform fuels, wildfire, and forest management approaches better suited to address tribal concerns, as well as aid in fulfilling the trust responsibility for the management of natural and cultural resources (Lake and Long 2014, Mason et al. 2012).

Reduction of the Threat of Wildfire to Tribal Resources

Large, high-intensity wildfires damage and destroy resources and sites important to tribes. The alternatives take different approaches to reduce the fire threat across the national forests. The reduction in the fire threat is evaluated in the "Fire Management" section.

Amount of Recommended Wilderness that Might Limit Access to Areas Important to Tribes or Use of Tribal Resources

Many sites of importance to tribes and many resources of tribal interest are located in remote locations and have been used traditionally for many generations. Designating these areas as wilderness may limit or impair access to these sites or the ability of tribes to continue to conduct ceremonies and gather resources in traditional ways, including managing the land using traditional practices. The area of recommended wilderness in each alternative is used as a proxy for the potential to impact tribal use of the land and resources.

Number of Sites Restored Specifically for Tribal Resources

For thousands of years, tribes directly or indirectly managed the environment surrounding resources of tribal importance. With modern management and the current changed environment, many resources that tribes use are in diminished quantity and quality and are in need of restoration. The alternatives vary in their approach to improving resources of tribal importance.

Assumptions

- The potential effects on tribes and tribal resources is an agency consideration at the outset of any and every project planning process.
- Each of the national forests will continue to regularly conduct government-to-government meetings to provide opportunities to the tribes to consult on all proposed activities on National Forest System lands. Consultation with tribes is guided by a variety of laws, regulations, executive orders, and policies that provide direction for interacting with tribes on National Forest System lands. For example, USDA Departmental Regulation 1340-007 (United States Department of Agriculture 2008a) provides policy and implementation guidance to implement the 2000 Executive Order 13175 on Consultation and Coordination with Indian Tribal Governments. This guidance is independent from forest plan direction and does not change across alternatives.
- The forests will continue to also include tribal groups and organizations, traditional cultural practitioners (United States Department of Agriculture 2008a), and interested individuals in discussions about tribal relations and uses.
- The tribal relations programs on each national forest may need to increase as tribal consultation increases. Tribes, tribal groups and organizations, traditional cultural practitioners, and interested individuals have expressed an interest in more opportunities to consult and collaborate on proposed activities. This may be a challenge given expected budgets.

Affected Environment

Forests often serve as sources of traditional medicines, food, firewood, and basketry materials for tribes. Certain areas also may be particularly sacred and valued for their importance in sustaining cultural traditions and beliefs. When implementing the forest plan, the Forest Service may, through separate decision, conduct or authorize various types of activities that have a substantial impact on tribes (Vogel 2001, Toupal 2003, Burger et al. 2008). Those impacts would vary widely depending on the level of collaboration maintained with tribal concerns. These could include grant programs, timber sales, mining, road building, recreational development and use, archaeological excavations, energy development, and other program and project activities (Yablon 2004).

Many cultural resources are both fire- and water-dependent. Basketry materials, such as redbud, deer grass, willow, chaparral, and sour berry bush, need fire enhancement (Anderson 1999). Mints and various teas and medicines, such as yarrow, thrive on water and are found in wetlands, meadows, and water drainages; they still, however, need fire to maintain their health and usability (Anderson and Moratto 1996). Without an occasional burn, these resources would become less abundant, have increased diseases or pests, and develop morphological characteristics unsuitable for traditional uses. Similarly, without fire, meadows, creek banks, and river and lake shores become overgrown with stronger, bigger vegetation (such as willows, alders, and conifers that require more water from the water table). Acorn (oaks) and pine nuts (pines) are the least groundwater-dependent food sources, but they must be able to absorb precipitation. Without a good rainfall or when too much overhead canopy develops, acorn and pine nuts will either not grow, or they will not produce at the levels tribes desire. Fire helps to reduce the canopy, and the amount of duff on the ground, which can become breeding grounds for insects that destroy the acorn and pine nut crops (California Department of Water Resources 2014).

Environmental Consequences to Tribal Relations and Uses

Consequences Common to all Alternatives

All alternatives retain and continue with existing tribal consultation, sacred site, and non-timber forest products mandates and agreements. Forest plan direction for resource management, such as heritage, vegetation, soils, water, riparian, aquatic, and wildlife, for all alternatives is designed to provide for protection of cultural resource sites or traditional cultural properties.

Resources of tribal importance, such as oaks, are indirectly benefited by restoration actions that thin trees around medium- and large-diameter oaks where they can form fuller, healthier crowns, thereby improving the number and quality of acorns produced. All alternatives also would provide for habitat and watershed conditions that would greatly contribute to species viability at sustainable and harvestable levels. Invasive species would be managed to avoid encroachments on culturally significant foods, fiber and material, and medicinal resources. Also, resource conditions would be monitored.

Researchers have worked with tribes in other regions to identify and address approaches for mapping tribal landscape values related to fuels and fire management that can benefit tribes by enhancing access to and the quality of resources (Carver et al. 2009, Lake 2013). Fire can be targeted at specific locations, forest types, or habitats to promote a range of tribally valued resources. For example, in riparian areas where a decreased water supply has degraded vegetation, fire can be used to emulate flooding disturbance to enhance willows for basketry materials and wildlife habitats. It also can be used to emulate burning in oak-dominated forests to increase access to acorns and feeding locations for wild game, and to reduce insect infestations (for example, acorn weevil and moth pests) that damage traditional food sources (nuts, berries, and greens) or species gathered for traditional purposes (Anderson 1999). Fire also can be used in different seasons for different objects or to align both public and tribal objectives, such as reducing hazardous fuels around communities and enhancing access to desired forests and resources (Carver et al. 2009, Lake 2013). This increased consideration of the approach and timing of restoring fire to the landscape would occur in all alternatives.

Management activities (for example, mechanical thinning, prescribed burning, managing wildfires to meet resource objectives, and recreation), implemented to avoid or mitigate adverse effects on heritage and cultural resources and tribal values (Carver et al. 2009), may afford greater protection compared with consequences from continued forest growth and increasing forest density leading to larger and higher-intensity wildfires (Miller and Urban 1999, Miller et al. 2009a). Activities associated with wildfire suppression under emergency conditions can inadvertently have adverse impacts on heritage and cultural resources (Welch 2012). Such impacts could result from fire suppression actions of running a dozer line through sites and areas important to tribes, tribal groups and organizations, traditional cultural practitioners, and interested individuals.

Other examples are burnout or back-burning that adversely affect sites, or establishing water bars on fire lines and leaving excessive vegetation cover to prevent erosion during mop-up and burn area emergency response. This could reduce access and mobility of tribal practitioners who use the fire line that is often along a former historic Indian trail along ridge systems (Lake 2011, Welch 2012). It is standard practice to use resource advisors during wildfires to help identify cultural resources and mitigate or avoid impacts. Additionally, national forest personnel may consider developing fire management agreements with tribes whereby tribal representatives and heritage consultants are officially designated within the incident management team organizational structure for wildfires (Lake 2011).

Consequences Common to Alternatives B, C, D, and E

The emphasis on variable treatment intensities and on vegetation heterogeneity under alternatives B, C, D, and E should provide additional opportunities for tribes to consult, collaborate, and actively participate in planning processes. They also should provide opportunities to identify potential mechanisms for how tribes can be involved with the implementation of landscape restoration treatments (for instance, the Tribal Forest Protection Act and along Federal/tribal jurisdictional boundaries).

The proposed forest plans would include the desired condition that “the need for tribal access to traditional sites is acknowledged and supported.” While the tribes need access to traditional areas and sites, there are some sacred sites where American Indians conduct ceremonies that require privacy and solitude and freedom from auditory or visual distractions and obstructions. Building roads to or near such sites may lead to increased visitation by the public or Forest Service staff, which could affect ceremonies and undermine cultural practices. Roads or resource management activities also may alter the character and diminish the value of historic or cultural places. Consultation would occur to identify concerns and adjust management so that adequate access for agency management or public use does not compromise cultural practices at traditional, cultural, and spiritual places.

The forest plans would include a possible management approach recognizing the national forests could increase their capacity to improve tribal relations by considering employee exchange opportunities carried out under “Service First” or other mechanisms, beyond standard agency workforce cultural transformation mandates that focus on hiring diverse personnel (Brown and

Harris 1993). Providing opportunities for tribal relations staff to temporarily exchange jobs would provide a better reciprocal understanding of programs and promote better use of tribal programs and legislation that would mutually benefit the national forests and tribe. This approach is similar to interagency details and could extend to intergovernmental details for work assignments between tribes and the Forest Service, or at higher regional or national scales with agreements between the Bureau of Indian Affairs for tribes and the Forest Service.

Consequences Specific to Alternative A

Alternative A represents the continuing direction from the existing plans (as amended). The forest plan revision process has provided tribes, tribal groups and organizations, traditional cultural practitioners, and interested individuals additional information regarding the planning process in general. Tribes have expressed an interest in not doing business as usual. While the government-to-government meeting process improves communication and is used under alternative A, tribes, tribal groups and organizations, traditional cultural practitioners, and interested individuals may have fewer opportunities to be involved in the management process and to maintain or improve tribal values. Alternative A does not have tribal interests and values integrated explicitly into plan components.

Reduction of the Threat of Wildfire to Tribal Resources

Alternative A reduces fuels to try to reduce the impacts of large, high-severity wildfires that can affect tribal resources and values, but at a pace and scale where large fires are still likely to occur. This may benefit oak trees in the long term where large fires kill conifer trees and where oaks resprout, but it would take many decades before burned mature oak stands can recover and produce acorn crops suitable for gathering and use.

Amount of Recommended Wilderness that Might Limit Access to Areas Important to Tribes or Use of Tribal Resources

Alternative A would not add new areas recommended for addition to the National Wilderness Preservation System and would not contribute to the potential for reduced access. Alternative A would not add additional constraints on tribal access to gather, use resources, or hold ceremonies in these areas.

Number of Sites Restored Specifically for Tribal Resources

Under alternative A, the Forest Service opportunistically would develop or design projects specifically to improve or maintain resources of tribal importance. Very few if any improvements would be made specifically to benefit resources of importance to tribes.

Consequences Specific to Alternative B

Alternative B is the draft forest plans that were developed to carry forward existing direction still relevant and not in need of change and to address those identified needs for change based on comments received during the scoping process and input from tribal forums that each national forest hosted. It includes integration of tribal interests and values in desired conditions for other resources and a plan objective to restore areas of tribal interest.

Reduction of the Threat of Wildfire to Tribal Resources

The proposed pace and scale of ecological restoration under alternative B could improve ecological sustainability and benefit tribal interests and values when projects incorporate traditional ecological knowledge, support active involvement (for example, government-to-government consultation and coordination), and foster traditional management practices (Carver et al. 2009). For example, areas that are important for basketry materials or traditional food sources would benefit from hazardous fuels treatments that reduce surface and ladder fuels or reduce tree density, which fosters access and mobility and increases the observation and locating of valued resources.

This alternative considers opportunities for managing wildfires to meet resource objectives that can be informed by the tribal consultation process and collaborative fire planning. For example, National Forest Heritage Program staff would consult and communicate with Tribal Historic Preservation Officers and tribal leadership about identifying landscape values at risk, and under what conditions fire should be suppressed or managed for ecological and cultural resource objectives. See details for "Wildland Fire Decision Support System" (Noonan-Wright et al. 2011) and for "Heritage/Tribal Values" (United States Department of the Interior 2010, Timmons et al. 2012, Welch 2012).

The pace and scale of ecological restoration that incorporates traditional ecological knowledge (Lake and Long 2014) could provide opportunities to tribes to develop tribal economies (Carver et al. 2009). In general, ecological sustainability benefits tribal interests, and can foster access to and support uses of habitats and resources for traditional cultural purposes. See the sections on ecological sustainability of terrestrial, aquatic, and riparian ecosystems for more detail. Most, if not all, traditional tribal management and uses were and are compatible with modern principles of ecological sustainability. Ecological restoration projects that incorporate tribal place-based knowledge would provide tribes, tribal groups and organizations, traditional cultural practitioners, and interested individuals with opportunities to protect, restore, and preserve traditional gathering areas, ceremonial areas, and sacred sites (Watson et al. 2009).

Amount of Recommended Wilderness that Might Limit Access to Areas Important to Tribes or Use of Tribal Resources

Alternative B would add one area within the Giant Sequoia National Monument as recommended for addition to the National Wilderness Preservation System. While many tribal activities could still occur within areas recommended for wilderness, some activities, such as gathering and ceremonial uses, may be restricted or more difficult if areas are managed as wilderness.

Number of Sites Restored Specifically for Tribal Resources

The Sequoia and Sierra National Forests each include a plan objective to implement restoration or maintenance actions on 3 areas and 5 areas of tribal importance in 15 years, respectively. These projects would be determined in consultation with the tribes and integrated with other restoration projects where possible. While these activities could occur under alternative A, they are more likely to occur under alternative B because of the specific plan objective.

In addition to areas improved specifically for tribal resources, alternative B includes desired conditions for tribal relations and uses that encourage the coordination with tribes to recognize traditional ecological knowledge in managing resources. This encourages silviculture and fuels managers to design mechanical treatments to restore tribally valued trees or use areas while simultaneously achieving other restoration needs. Ecological restoration of springs and meadows would consider those that are important for many tribal uses, including meadows and water sources along cross-Sierra traditional travel routes (Arkush 1993, Chartkoff 2001). Reintroducing fire that increases ecological sustainability is beneficial to tribes when designed to avoid using diesel and gasoline, such as drip torch fuel mix, where basketry and food plants are gathered, and considering appropriate seasons and frequencies of burning.

Consequences Specific to Alternative C

Alternative C places an emphasis on providing more short-term protections for wildlife habitat by reducing the amount of mechanical thinning and emphasizing more use of fire to restore ecosystems. This alternative proposes recommending more acres of wilderness than other alternatives.

Reduction of the Threat of Wildfire to Tribal Resources

Alternative C treats the least amount of area to restore vegetation and reduce the risk of large, high-intensity wildfires using mechanical treatments. Alternative C is designed to achieve a reduction in the risk of large wildfires through thinning only smaller trees and using prescribed burning and managed wildfires. The areas with prescribed burning and managed wildfires could benefit resources of tribal interest by restoring fire to the ecosystem; however, the uncertainty around whether these fires would be allowed to occur without pretreatment, due to the high tree mortality, may mean the risk of large, high-intensity wildfires is the highest in this alternative compared with alternatives B and D, leaving many resources of tribal interest at high risk.

Amount of Recommended Wilderness that Might Limit Access to Areas Important to Tribes or Use of Tribal Resources

Alternative C would add the largest number of new areas recommended for addition to the National Wilderness Preservation System. While many tribal activities could still occur within areas recommended for wilderness, some activities, such as gathering and ceremonial uses, may be restricted or more difficult in recommended wilderness.

The western approach toward the adoption of wilderness has been found to be controversial in the Native American communities (Watson et al. 2011). Tribal leaders and traditional cultural practitioners are concerned that access to sacred places, traditional gathering areas, and tribal resources would be impacted with additional wilderness designation. Most of the tribal opinions are opposed to the addition of wilderness areas. This is because historically, the tribal communities had access to their entire ancestral territory and actively managed those lands now titled as wilderness through the use of fire for cultural subsistence, ceremonial, and livelihood objectives at the appropriate times and places (Anderson and Moratto 1996). Wilderness designation can hinder access to, and severely limit desired tribal practices in, tribal cultural properties (Parker and King 1998) and traditional gathering areas; it may limit or potentially prevent some traditional practices from occurring (Zedeño et al. 1997).

Tribes, tribal groups and organizations, traditional cultural practitioners, and interested individuals also commented that additional restrictions that wilderness status and regulations impose may include the number of people who gather at a site for religious purposes, which may be limited and infringe upon tribal rights. Conversely, some tribes believe that designating areas as wilderness may afford those locations with what tribes would consider as “last resort” significant protections that could prevent over-access and damage to sacred sites. Management plans for wilderness areas would include tribal perspectives and attempt to incorporate traditional ecological knowledge and associated traditional practices to maintain the integrity of the area.

Number of Sites Restored Specifically for Tribal Resources

Alternative C would have the same number of sites restored specifically to benefit tribal resources as alternative B. However, more of the restoration would be accomplished with prescribed burning and hand treatments and with limited mechanical thinning to remove only small-diameter trees due to restrictions on tree removal for wildlife species. In the Sequoia and Sierra National Forests, for example, this may limit the ability to remove encroaching conifer trees near oak trees important for gathering. This would be the case more than under the other alternatives.

Consequences Specific to Alternative D

Alternative D is the most aggressive in terms of emphasizing an increased pace and scale of ecological restoration. Whenever there is an increase in development, such as the increase in recreation opportunities afforded under this alternative, or an increase in the scale of treatments, there is the potential for increased direct and inadvertent effects on tribal resources, traditional cultural properties, and sacred sites. This is especially true given the small amount of lands on each national forest that has been inventoried for heritage resources (see “Heritage Resources” section).

Reduction of the Threat of Wildfire to Tribal Resources

Alternative D reduces the threat of wildfire to tribal resources the most of all alternatives. The most areas in focus landscapes and the most strategic areas along roads and ridges would be treated. This presents a higher potential for inadvertent impacts on tribal resources in the short term, but with greater long-term benefits by restoring tribal use areas across the landscape.

Amount of Recommended Wilderness that Might Limit Access to Areas Important to Tribes or Use of Tribal Resources

Similar to alternative A, there are no additional areas recommended for wilderness under alternative D. Areas that are currently accessible and used by tribes would continue to be accessible.

Number of Sites Restored Specifically for Tribal Resources

Under alternative D, the Sequoia and Sierra National Forests would each include a plan objective to implement restoration or maintenance actions on 6 areas and 12 areas of tribal importance in 15 years, respectively, a larger number than in the other action alternatives (B, C, and E). These projects would be determined in consultation with the tribes and integrated with other restoration projects where possible. While these activities could occur under alternative A, they are more likely to occur under the action alternatives because of the specific plan objective.

Under alternative D, there would also be more areas restored indirectly due to the larger treated area where vegetation desired conditions could also favor improvement of conditions for resources of value to tribes, such as oaks, pinyon pine, willow, or meadows.

Consequences Specific to Alternative E

The effects under alternative E would be similar to those under alternative C. Where alternative E differs from alternative C is that it would have less acres recommended for wilderness than alternative C; instead, it would include the unique backcountry management area, which would allow more motorized and mechanized access than alternative C.

Reduction of the Threat of Wildfire to Tribal Resources

The effects of alternative E would be similar to the effects of alternative C.

Amount of Recommended Wilderness that Might Limit Access to Areas Important to Tribes or Use of Tribal Resources

Since alternative E would have less acres recommended for wilderness than alternative C, and it instead would include the unique backcountry management area, which would allow more motorized and mechanized access than alternative C, more areas would remain accessible to tribes compared with alternative C. However, compared with alternatives A, B, and D, some activities, such as gathering and ceremonial uses, would potentially be restricted or more difficult under alternative E.

While the backcountry management areas under alternative E would focus on more primitive and semi-primitive recreation settings, the motorized and mechanized uses that would be allowed to continue could impact resources and sites important to tribes. However, this impact would occur to a lesser extent than under alternatives A, B, and D.

Number of Sites Restored Specifically for Tribal Resources

The effects under alternative E would be similar to the effects under alternative C.

Cumulative Effects

Tribes, tribal groups and organizations, and traditional cultural practitioners depend on the land and resources that cross multiple jurisdictions and ecosystems. Much of the lands in the analysis area are managed by Federal land management agencies. These all have requirements for government-to-government meetings with tribes to consult and coordinate management of the land and resources to meet tribal and agency responsibilities. Land and resource management under the forest plans are generally consistent with management across the Federal agencies regarding tribal relations and uses. The increased emphasis on restoring fire to the landscape in all alternatives would complement the increased restoration of fire within adjacent national parks, resulting in increased resilience of sites and resources important to tribes across a mixed-jurisdictional landscape.

Analytical Conclusion

All alternatives would continue the important government-to-government meetings for activities that may affect tribes. Alternatives B, C, D, and E include additional plan direction that improves the integration of tribal interests into restoration project planning. These alternatives would provide for an increased opportunity to improve access to and use of resources important to tribes, tribal groups and organizations, and traditional cultural practitioners.

All the alternatives could have some level of effect on tribal heritage resources given that less than one-fifth of the plan area has been systematically inventoried for heritage resources and that most known recorded sites remain unevaluated for their qualifications for inclusion in the NRHP. Meeting the increased pace and scale of restoration treatments would require a variety of management practices to ensure compliance with section 106 of the National Historic Preservation Act. This includes pre-project surveys for heritage resources and tribal consultation and collaborative risk planning between Forest Service heritage and cultural resource staff, Tribal Historic Preservation Officers, and involved tribal practitioners, to predict where particular valued resources or potential sacred sites may occur in anticipated treatment areas (Timmons et al. 2012, Welch 2012).

Reduction of the Threat of Wildfire to Tribal Resources

The amount of active vegetation management that might reduce threats from large, high-intensity wildfires to sites and resources of tribal importance increases the most under alternative D, followed by alternative B. The use of prescribed burning would reduce risks from future wildfire and would improve conditions for many resources of interest to tribes. All alternatives would address minimizing impacts on tribes at specific locations during project planning; alternatives B, C, D, and E include specific plan direction to incorporate opportunities to improve sites and resources important to tribes during project planning.

Amount of Recommended Wilderness that Might Limit Access to Areas Important to Tribes or Use of Tribal Resources

Alternatives A and D would have the least impact on access to sites and resources by tribes, tribal groups and organizations, and traditional cultural practitioners since no new areas would be recommended for wilderness designation. Alternative C would have the most potential impact because access to and use of areas may create additional barriers for tribal members. The ability to conduct ceremonies and to gather resources could be impaired or limited in areas managed to maintain their wilderness characteristics. Ground-disturbing activities associated with tribal use of these areas may be limited or perceived to be unacceptable by the public.

Number of Sites Restored Specifically for Tribal Resources

Alternatives B, C, D, and E include a plan objective that provides tribes, tribal groups and organizations, traditional cultural practitioners, and interested individuals with opportunities to protect and restore sacred sites and resources used traditionally by tribes, and to provide opportunities for consultation, engagement, collaboration, and tribal economic benefits and values. In addition to those specific restoration projects, alternative D would provide more opportunities to restore other sites and resources than alternative B by having more landscape restoration treatments. Alternative D would also require more coordination to protect tribal sites and resources due to the increased amounts of mechanical treatments.

Alternatives C and E provide fewer additional opportunities to restore tribal resources because mechanical treatments are more limited; instead, alternatives C and E rely more heavily on prescribed burning. This may result in less opportunity to protect individual tribal resources, such as large, old oak trees in the Sierra and Sequoia National Forests, from damage during burning. This is because mechanical pretreatment to reduce or rearrange fuels is less likely to occur.

Benefits to People and Communities

Background

This topic is divided into three sections that address the social and economic benefits derived from the national forests: forest products and management, economic conditions, and social conditions. These areas are of particularly high interest to the public and are a focus of the 2012 Planning Rule. A strong emphasis on integration of social, economic, and ecological considerations occurred during the development of the emerging plan components of the draft forest plans and the alternatives in this draft environmental impact statement. Thus, social and economic consequences are also mentioned in other revision topics; this section, especially the economic conditions and social conditions, relies heavily upon the analysis presented in those other topic areas. This section focuses on the economic and social consequences of the alternatives.

Forest Products and Management

This section addresses the subject of providing forest products and summarizes the current environment in the Sequoia and Sierra National Forests in terms of estimated available forest product quantities by alternative and the resources associated with the harvest of those forest products. Forest products discussed in this section include those that would be harvested on lands suitable and not suitable for timber production, as determined in the timber suitability analysis. This analysis, along with the sustained yield limit and the projected wood sale program, can be found in Appendix F in volume 2: “Timber Suitability.”

The desired conditions for forest products and management are:

1. Predictable and sustainable forest product yields contribute to maintaining and improving local and regional industry infrastructure sufficient to meet the needs of the desired pace and scale of ecological restoration over the next several decades.
2. Production of timber contributes to ecological, social, and economic sustainability, and associated desired conditions. A sustainable mix of forest products (including both sawtimber and non-sawtimber) is offered under a variety of harvest and contract methods in response to market demand and restoration needs.
3. Salvage of dead and dying trees captures as much of the economic value of the wood as possible while retaining key features in quantities that provide for wildlife habitat, soil productivity, and ecosystem functions.

Further analysis related to forest products and management may also be found in the “Terrestrial Vegetation” section, “Socioeconomic” section, and “Appendix F: Timber Suitability.” Appendix F is hereby incorporated by reference and made a part of this document.

Background

The southern Sierra Nevada has a rich history of timber production (Mckelvey and Johnston 1992). Timber harvest began in the early 1800s, emerging as a core occupation following the gold rush of 1848 to support mining communities. Timber was primarily used for housing construction, mining support, and railroad ties. The most efficient mode of transportation was by river, but logs were also transported via railroad in the central Sierra Nevada and by V-shaped flumes in the southern Sierra Nevada. Due to costly harvest and transport, only high-value species, such as ponderosa and sugar pine, were harvested until the early 1930s, when more efficient logging equipment was available.

Concurrently, starting in the early 1900s, a shift toward suppression of wildfires occurred, which allowed many seedling and sapling trees that fires would have periodically thinned to survive and grow (North et al. 2009c). In the mixed conifer zone, the seedlings and saplings were often tree species such as incense cedar and white fir that grow in the shade of other trees. The ingrowth of these trees and the lack of periodic thinning by fire or management contributed to the incremental increase in forest density over time to the point that many forest stands today are substantially denser than they were historically, reducing their resilience to stressors such as drought, insects, and pathogens.

Timber harvest on national forests increased after World War II, peaking in the 1970s. Timber harvest in the 1970s to 1990s consisted primarily of even-aged management: clear-cutting stands of ponderosa pine, mixed conifer, and red fir, followed by reforestation. These harvests for regeneration purposes produced larger, more valuable timber sales, which funded much of the development and maintenance of the current transportation system. The retention of timber receipts in trust funds for reforestation and other resource enhancement use (specifically, the K-V funds established by the Knutson-Vandenberg Act of 1930) provided for plantation maintenance and fuel reductions in natural stands among other activities (FSH 6509.11, chapter 71.1).

In the 1990s, timber harvest methods shifted from primarily even-aged management to more stand-maintenance-thinning prescriptions, focusing on pine and mixed conifer in the lower to mid-slopes. This shift in management was the result of changing management objectives, generally geared toward reducing impacts of timber harvest on habitat for species such as the California spotted owl, and reducing fuels and the threat of wildfire in wildland-urban intermix areas. Much like thinning carrots in a garden, thinning trees in a forest reduces the number of trees on a site, allowing remaining trees to increase crown and photosynthetic production, and overall growth rate. By reducing competition, the residual trees grow larger and faster than in untreated stands. This allows them to grow taller to capture more sunlight and larger to develop thicker bark to be more resilient to periodic fire, and ultimately better preparing them to survive to become large and old trees.

Current thinning practices on national forests in the Sierra Nevada maintain key ecological features, such as biological legacies, snags, and large, down logs, favoring retention of the larger, older cohort. Biological legacies are trees that are substantially larger and older than the majority of the trees on the landscape, likely retained during previous harvests or survivors of stand-replacing disturbance events; they often have cavities or other valuable wildlife characteristics. In the short term, thinning of small-diameter trees improves forest health and fire resilience of the residual forest.

In the long term, favoring only larger, older trees and removing the younger cohort eventually results in a decline in overall stand health as older trees succumb to insects or disease in these dynamic systems. To achieve long-term sustainability, forests should be managed to provide for heterogeneity (variety) of open and dense clumps and stands of trees with abundant old trees and a mixture of age classes across the landscape. This can be accomplished in the current, more homogenous forest by using forest management techniques such as group selection (the creation of gaps in a forest canopy by removing small patches of trees) combined with periodic selection or variable density thinning to achieve restoration objectives, maintain habitat connectivity, and contribute a dependable flow of forest products to existing and prospective local economic infrastructure (North et al. 2009c, Schmidt et al. 2006).

Since adoption of the original forest plans in 1988 for the Sequoia National Forest and 1992 for the Sierra National Forest, timber harvest from national forests has steadily declined for a number of reasons, including policy and legal constraints, such as restrictions on harvesting in unroaded areas, prescriptive and restrictive forest plan direction that limited the intensity and extent of tree removal as a forest management tool, and appeals and litigation of individual projects. This has contributed to a loss of the forest products industry infrastructure in the southern Sierra Nevada, except for one remaining mill at Terra Bella and small local operations for production of commercial firewood or other specialty wood products.

Current levels of tree mortality, linked to the collective effects of insects, pathogens, and a warming climate—all exacerbated by 4 years of below-average precipitation—appear likely to affect future yields of forest products. While projected harvests are well below annual growth rates, the sudden loss of living conifers and over extensive acreages may result in reduced yields in areas where mortality is high. Prompt and effective reforestation can reduce this effect, but areas with high mortality may be unable to provide sawtimber-sized trees for several decades.

Analysis and Methods

Analysis Area

The analysis area consists of all National Forest System lands within the southern Sierra forests (Sequoia and Sierra), with the primary focus on lands identified as suitable for timber production. The rationale for this analysis area is that this is the area that primarily affects these two forests' production of timber and other wood products. Some factors outside these lands can have some effect on timber production in the Sierra and Sequoia National Forests. These include timber production on adjacent national forests and lands of other ownership, as well as operation of wood processing facilities outside the national forest boundaries. These will be addressed as appropriate regarding their influence on forest products and management of the southern Sierra Nevada national forests. It is important to note that the Giant Sequoia National Monument is not suitable for timber production and is not part of the area covered by this Forest Plan revision effort, as it is covered by the existing Giant Sequoia National Monument Plan.

Lands Suited for Timber Production

Lands identified as suitable for timber production include forested lands not administratively withdrawn that have a reasonable assurance of regeneration, and where forest management is consistent with other multiple-use management objectives. Approximately 131,348 to 455,846 acres within the southern Sierra Nevada forests area are considered suitable for timber production, depending on alternative. See maps in volume 3 for the composition of lands suitable for timber production by cover type, and Appendix F, "Timber Suitability," for more detailed methodology on the determination of suitable lands.

Lands Not Suited for Timber Production

Timber harvest may be used as a tool for purposes other than timber production in order to enhance other multiple-use values. Forest product removal from lands not suited for timber production is most common in response to salvage, hazard-tree removal or other safety concerns, scenic vista enhancement, fuel reduction, wildlife habitat improvement, or access, among other reasons. In addition, timber harvest on lands not suitable for timber production may respond to restoration objectives, such as conifer encroachment in meadows, aspen enhancement, and hardwood restoration, or to modify stand structure and composition toward desired conditions.

In these cases, timber harvest would be used as a tool to achieve the desired conditions, but is not part of the programed regeneration harvest plan for lands deemed suitable for timber production. As forest product removal from these lands is more responsive than proactive, these lands are not the focus of this analysis and will not be discussed further in this section. It should be noted, however, that an unknown proportion of the acreages of anticipated commercial thinning may occur on lands not suited for timber production but on which trees may be harvested for other multiple-use purposes.

Temporal Scale

The analysis period consists of two decades (20 years). Although the National Forest Management Act provides that forest plans are to be revised at least every 15 years, it limits the sale of timber to less than the sustained yield limit for each decade of the plan (16 U.S.C. 1611). Providing estimates of the annual projected wood sale quantity and the annual projected timber sale quantity, for each of first two decades, aligns with the National Forest Management Act decadal periods limiting the sale of timber. It also provides an estimate for the second decade, if revision of the plan is delayed beyond the 15-year period.

Indicators and Measures

- The amount of forest products removed is measured by wood volume. Generally, sawtimber is measured in hundreds or millions of cubic feet, although many persons prefer to use thousands of board feet. Fuelwood volume is generally measured in cords, and biomass is measured in cubic feet. A conversion factor of 1 cubic foot of sawtimber equals 5 board feet was used in this analysis, although this ratio varies with log diameter, and some recent timber sales in the Sierra National Forest have yielded as much as 7 board feet per cubic foot. One cord of fuelwood is approximately equal to 85 cubic feet (.85 Ccf or 85 cf). Although these conversion factors are approximations, the degree of accuracy is adequate for the programmatic analysis presented covering two national forests over a time span of two decades. (Note: Volume calculations were determined using the Forest Vegetation Simulator (Dixon 2002) to model Forest Inventory and Analysis data by vegetation type and prescription class.)
- The area restored to improve forest health and resilience to disturbance is measured in acres. (Note: The area treated is a function of the available area and workforce capability to treat these acreages.)

Assumptions

- "Area restored" refers to areas that are treated and a commercial timber product removed. An area where prescribed burning only or other service work is performed, is not a measure under the forest products indicator.
- It is assumed that a sustainable supply of sawtimber would enable the existing mill in Terra Bella to continue to operate through the 20-year analysis period. Timber industry representatives indicate approximately a minimum of 50,000 hundred cubic feet (25 million board feet [MMbf]) removed annually from the Sierra and Sequoia National Forests would ensure persistence (United States Department of Agriculture 2013b, c). The likelihood of each alternative to produce sufficient volume to meet this assumption will be evaluated.
- It is assumed that opportunities to use biomass will remain the same for the first decade of the analysis period but could increase in the second decade if a demonstrated consistent supply of biomass leads to new facilities or utilization opportunities.
- It is assumed the contract authorities for forest product removal will continue to include timber sales, stewardship contracts (both integrated resource service contracts and integrated resource timber contracts), and stewardship agreements.

Affected Environment

The Sequoia and Sierra National Forests comprise approximately 2.4 million acres of land, including approximately 60 percent forested lands. These forested lands consist primarily of

Sierra mixed conifer, pine (specifically, eastside pine, ponderosa pine, and Jeffrey pine), and red fir stands. Approximately 1.9 million acres are withdrawn from timber production due to administrative designations, such as National Wilderness Preservation System, inventoried roadless area, experimental forest, research natural area, and other designated areas (Appendix F). Of the remaining forested area that is not withdrawn, 131,348 to 455,846 acres total, depending on the alternative considered, have a reasonable assurance of successful conifer regeneration and are on lands with management objectives consistent with timber harvest being a primary or secondary multiple-use objective. These lands are identified as suitable for timber production.

Table 140 displays the percentage of area in the major California wildlife habitat relationship cover types for alternative B. The percentages do not change substantially for the other alternatives. The existing condition under current direction (alternative A) is that the Sequoia National Forest contains 127,375 acres, and the Sierra National Forest contains 328,471 acres considered suitable for timber production. See Appendix F for more information regarding timber suitability determinations for each alternative.

Table 140. Percentage of cover type of lands suitable for timber production, combined for Sequoia and Sierra National Forests, alternative B

Cover Type	Percent
Sierra Mixed Conifer	41
Red Fir	12
Eastside Pine	11
Ponderosa Pine	11
Montane Hardwood-Conifer	10
Jeffrey Pine	7
Montane Hardwood	5
Lodgepole Pine	2
Other	1

The Sequoia and Sierra National Forests provide timber to three remaining sawmills: Sierra Forest Products in Terra Bella (Tulare County), and Sierra Pacific Industries in Chinese Camp and in Standard (both in Tuolumne County). The Terra Bella mill is the last remaining sawmill in California south of Yosemite National Park. The Sierra and Sequoia National Forests are the primary sources of Federal sawtimber products for the sawmill at Terra Bella. Haul costs and competition with other national forests and private timberlands make the two northerly mills less economically feasible for the Sierra and Sequoia National Forests.

Maintenance of local forest products infrastructure is key to sustainable restoration goals. Not only does timber harvest contribute to the economy in an ecologically sustainable way, it is a tool used to improve forest health by reducing densities in a precise manner. This is unlike disturbance agents, such as insects, pathogens, and wildfire and the other management tool of prescribed fire. Timber harvest can identify specific trees to remove or retain and can manipulate the distribution of fuels to influence the effects of prescribed burning or wildfire on residual trees and other desired resources, such as particular nest or denning trees or snags used by wildlife. As with all actions, timber harvest is designed to achieve desired conditions, taking into account other appropriate management objectives, such as riparian habitat conservation, habitat management, and scenic stability.

The availability of sufficient sawmill infrastructure is an essential requisite for efficient timber production. The sustained supply of sawtimber likely enables business decisions that lead to maintenance and investments in infrastructure to support current deliveries. Expanded supplies may lead to expanded investments that provide for expanded timber production on related forest lands. In the absence of a consistent flow of forest products at levels that can sustain the infrastructure, the sawmill at Terra Bella is unlikely to keep operating. In recent years the Sierra and Sequoia National Forests have supplied approximately 70 percent of the log volume processed by the Sierra Forest Products mill at Terra Bella.

On National Forest System lands, trees too small or of insufficient quality for use as sawtimber can often be removed and used as biomass, providing enhanced forest management capabilities. Projects that are able to efficiently remove both sawlogs and biomass products are capable of meeting a broad set of management objectives. A dependable supply of valuable forest products enhances the likelihood that infrastructure would be available to meet these needs.

Biomass value is typically relatively low, generally one-half to one-quarter of the cost to harvest and transport it to an end-use facility. Therefore, small changes in operating or transportation costs for harvesting biomass can greatly affect economic viability. Current trends in use of biomass for energy production in California have relied on incentives or requirements for energy producers to use a certain fraction of their material from areas of tree mortality. Additionally, transportation and utility right-of-way holders have expended costs of transportation in order to dispose of hazard trees threatening their facilities at biomass for energy plants. These recent incentives and subsidies have resulted in more biomass being produced from the Sierra and Sequoia National Forests over the past several years, although it is unclear how long these factors will persist. Therefore, there is greater uncertainty regarding future demand for biomass than exists for sawtimber.

Forest Products

The term forest products often refers to sawtimber, the most common commercial wood product. The two southern Sierra forests have supplied an average of approximately 4.4 million cubic feet of sawtimber per year, with the Sierra National Forest providing approximately 70 percent of that volume. With salvage of dead trees from recent fires and the recent drought, annual harvests up to 7 million cubic feet (both forests combined) have been accomplished, but this is an anomaly related to the massive mortality in recent years. The sharp increase in volume results from harvesting relatively minor portions of recent severe fires, and harvesting trees killed by insects and drought primarily along roads and in recreation sites.

In addition to sawtimber, the forests also supply pulpwood, posts, poles, firewood/fuelwood, wood pellets (for home and industrial heating), and biomass (substituting for fossil fuel to generate electricity). Many forest users, including tribes, residents, and recreationists, participate in firewood collection. This has averaged approximately 5,000 cords per year across the two forests (data derived from Region 5 Cut and Sold Reports, 2010–2014 [(United States Department of Agriculture 2016c)).

Special Forest Products

The southern Sierra forests are also a source for a variety of special forest products. Special forest products are generally collected in small quantities for personal use or larger amounts for commercial purposes, and are often authorized through a permit system. These products may include bark, berries, boughs, bulbs, Christmas trees, cones, ferns, fungi (mushrooms), mosses, nuts, roots, seeds, transplants, and wildflowers. Forest users, including tribes, depend on many of these special forest products for their medicinal properties, decorative uses, native propagations, landscaping, family or tribal tradition, or ceremonial purposes.

Area Restored

Many decades of fire suppression have resulted in overcrowded, dense forests vulnerable to disease and insect infestation, uncharacteristic wildfire, and the effects of a warming climate. Many management methods (including timber harvest, prescribed fire, mastication, hand piling, and burning) can and would be used to restore the landscape to a more resilient condition. The most common treatment is thinning, which improves forest health and resilience and can often move treated areas more directly toward desired conditions. Group selection is utilized to promote shade-intolerant species (specifically pine) regeneration by creating small openings that are large enough that seedlings needing sunlight can grow. Group selection also restores seral stage heterogeneity that has been lost due to the ingrowth of shade-tolerant species and the reduction in thinning that would have occurred by wildfires but didn’t occur because of fire suppression. When available, revenue generated from timber removal may be reinvested into other more expensive restoration treatments.

Recent Changes in Forest Conditions

Several disturbance agents have greatly affected forest stands in the Sierra and Sequoia National Forests in recent years. Large fires such as the Aspen (2013), French (2014), Rough (2015), and Railroad (2017) have burned hundreds of thousands of acres with variable severity, but including significant acreage of stand-replacement severity (greater than 70 percent overstory mortality). A series of drought years from 2012 through 2016 interacted with overly dense stands, bark beetle infestation, and disease to cause significant tree mortality across both forests. The Sierra National Forest has an estimated 760,000 acres that experienced elevated mortality; 631,000 acres have an elevated tree mortality in the Sequoia National Forest (includes mortality within the Giant Sequoia National Monument).

The highest levels of mortality tend to occur at elevations below 6,000 feet, although mortality has also occurred at higher elevations. All conifer species have been affected; however, large-diameter ponderosa and sugar pines have suffered the greatest proportional losses due to their susceptibility to western pine beetle and mountain pine beetle. In some stands, 60 percent or more of the mature pine component has died over the past several years. These disturbances are expected to continue into the future, although it is difficult to predict the rate of loss of trees and stands to these disturbance agents.

These disturbances may affect the future ability to produce forest products. Fewer acres exist with high density in commercial–sized trees, and stand-level growth rates have decreased due to the loss of growing stock. However, current volume data suggest that adequate acreage of stands exists with standing volume capable of supporting commercial thinning at the levels described in all alternatives over the life of the plan. Appendix F contains more detailed information regarding stand level volume.

Environmental Consequences

Consequences Common to all Alternatives

Special Forest Products

Use of special forest products and personal-use fuelwood is generally anticipated to remain consistent with current conditions into the future, with minimal increases due to population trends. It is also anticipated to be relatively consistent across all alternatives. While alternative C includes additional acres recommended for wilderness designation, this is not anticipated to play a significant role in special forest product and fuelwood availability considering the scale of remaining forested areas available for collection and the typical remoteness of these recommended wilderness areas. There could be some consequences for tribal gathering under alternative C, which we have described in more detail in the "Tribal Relations and Uses" section. Special forest product and fuelwood removal is tied more closely with demand than locational availability. In other words, people would travel to obtain these products. As demand is not anticipated to change across alternatives, special forest products and personal-use fuelwood will not be addressed further in relation to any alternative.

Forest Products

All alternatives project some level of forest product removal. Table 141 displays ranges in volumes projected to be removed. The estimated harvest levels shown in Table 142 are anticipated to occur in both the first and second decades of the plan period, with a few cautions. An analysis of current standing volumes indicates that there are a sufficient amount of well-stocked acres to support these harvest volumes. The exception is for the upper limit of alternative D on the Sequoia National Forest, where it is not likely that two decades of harvest near the maximum of alternative D could be supported (Appendix F). Sufficient standing volumes exist to support all other harvest levels projected in Table 143, including the lower end of alternative D on the Sequoia National Forest (Appendix F). The type of harvest projected in this analysis is a commercial thinning to remove approximately 25 percent of standing volume, which is typical of current restoration projects on these two forests. Significant future losses of living trees due to fires, droughts, insects, or other disturbances could reduce future yields.

Both national forests have projected sawtimber harvests that are a very small fraction of the estimated sustained yields (Appendix F). Relative to the projected maximum sawtimber levels associated with alternative B, the percentage of the sustained yield is 5 and 8, respectively, for the Sequoia and Sierra National Forests. While alternative D would increase these percentages, the highest value would be 12 percent for the Sierra National Forest. If biomass is produced at the highest levels estimated, the estimated timber sale quantity under alternative B for sawtimber plus biomass, expressed as a percent of the sustained yield limit, would be 8 percent for the Sequoia National Forest and 9 percent for the Sierra. The highest percentage would be 14 percent under alternative D for the Sierra National Forest.

While the harvest of sawtimber is not estimated for mortality related to high-intensity fire, droughts, and other unplanned disturbances, salvage and sanitation harvests can have an effect on the projected decadal harvest volume. Initially, this mortality may supplement or displace the planned harvest of living trees. It would be expected that the quantities would range from very low with alternatives C and E to approximately equal amounts in the remaining alternatives. In the longer term, the loss of living forests after significant disturbance events, in effect, can erase significant acreages of growing forests and reduce the total capacity of a national forest to maintain a specified harvest level.

Table 141. Projected decadal timber harvest volumes by product type and alternative.

National Forest	Product	Alternative A	Alternative B	Alternatives C and E	Alternative D
Sequoia	Sawtimber (MMcf)	3–5	5–8	2–4	6–12
Sequoia	Sawtimber (MMbf)	15–25	25–40	10–20	30–60
Sequoia	Biomass (MMcf)	0-2	0-4	0-2	0-6
Sequoia	Fuelwood (MMcf)	1–2	1–3	1–2	1–3
Sierra	Sawtimber (MMcf)	10	20–40	5–10	30–60
Sierra	Sawtimber (MMbf)	50	100–200	25–50	150–300
Sierra	Biomass (MMcf)	0-3	0-6	0-3	0-10
Sierra	Fuelwood (MMcf)	2–3	2–3	2–3	2–3

These harvest volumes are projected for the first and second decade under the revised forest plans. Note that the millions of cubic feet (MMcf) and millions of board feet (MMbf) for sawtimber are alternate units for describing the same volume; that is, they are not additive.

When the number of acres affected reaches a threshold value, the capability of any specific national forest to maintain the projected yields will decline. The ability to minimize or reverse this impact is dependent on the successful reestablishment of thriving forests. Without that happening, the total available sawtimber volume that would ordinarily be able to offer projected harvests, would decline and start a trend that, in essence, reduces the total acreage available and suitable for timber production.

Projected sawtimber harvests are displayed as a range of values. The minimum value under alternatives A and B is based on the current condition (5-year average), although volume output is expected to decrease under alternative A due to limited organizational capability, fewer acres available that support commercial thinning, and fewer acres available without significant constraints. Alternative B would produce more volume than alternative A due to somewhat decreased restrictions and an emphasis on larger landscape-scale projects. The minimum volume output for alternative D is estimated to be in the middle of the range for alternative B due to greater flexibility in achieving desired conditions and encouragement of larger, landscape-level projects; the minimum ranges for alternatives C and E are somewhat less than the current condition due to the additional limitations on tree removal related to management for California spotted owl and fisher habitat.

The maximum value in the range is the amount of saw log volume available for removal, when consistent with management objectives, and would be part of a contract or project that is economically viable. This maximum value is based on Forest Vegetation Simulator modeling of likely prescriptions associated with each alternative using Forest Inventory and Analysis plot data across the analysis area. It assumes an increased agency workforce with increased funding over the current condition because of the increased effort needed for project design, analysis, and implementation over more and larger treatment areas. Additionally, the maximum values for timber output were evaluated for feasibility given the recent tree mortality by estimating acreage with sufficient standing live tree volume to support commercial thinning harvests using current volume data layers prepared by the Pacific Southwest Region Remote Sensing Laboratory (Appendix F).

As stated above, fuelwood demand is expected to remain consistent with current conditions or increase slightly due to population trends. Fuelwood output does not vary between alternatives in the Sequoia and Sierra National Forests because there is adequate supply to meet the anticipated demand. Also, differences in management among the alternatives is not expected to strongly affect public fuelwood gathering.

Area Restored

All alternatives include silvicultural practices designed to contribute to the restoration of a more resilient landscape, such as variable-density thinning. Table 142 displays the acres projected for treatment over the next decade as a range. The values for all alternatives are projected to approximate the harvest volumes estimated in Table 141 alternative A shows a decrease from recent treatment levels, due to the aforementioned decreased organizational capacity, and decreased opportunity due to existing restrictions on treatments and loss of available acres due to extensive tree mortality. Alternative B ranges from maintaining an existing level of treatments and volume production, to substantially increasing acreage treated and volume production.

Table 142. Projected 10-year harvest area in acres by management practice and alternative

National Forest	Management Practice	Alternative A	Alternative B	Alternatives C and E	Alternative D
Sequoia	Thinning	3,000–5,000	5,000–8,000	2,000–4,000	6000–12,000
Sequoia	Group Selection	1,000	1,000–1,500	0	1,500–2,000
Sierra	Thinning	10,000	20,000–40,000	5,000–10,000	30,000– 60,000
Sierra	Group Selection	3,000	3,000–4,500	0	4,500–6,000

Alternative C is anticipated to provide forest products over a reduced acreage due to existing and additional constraints on removal of saw log-size trees, and differing treatment prioritizations that emphasize the use of prescribed burning instead of tree cutting and restoring areas using wildfires that can be managed to meet resource objectives. Alternative D dramatically increases the area treated and volume produced by reducing some standards and guides, most notably within Focus landscapes. This approach is consistent with recent research demonstrating the risk of loss of mature forest stands is much greater due to disturbances, including fire, drought, and insects acting in concert with overly dense stands, than is the risk of loss of mature forest characteristics due to carefully designed treatments aimed at improving resilience to the stressors listed above (Stephens et al. 2018, Stevens et al. 2017, North et al. 2009b). Alternative E would closely mirror alternative C in its effect due to very similar land allocations and plan components.

It is important to note that the treated acres in Table 142 refer to areas harvested with the removal of a timber product, which is a subset of the projected total of mechanically treated acres of each alternative. Treated areas would be managed primarily with variable density thinning, which is an approach that selectively removes trees to increase spatial and structural variation, while retaining selected elements or biological legacies (large/old trees, snags, and logs) in a desired arrangement (such as aggregated in clumps or dispersed in a uniform pattern). Thinning reduces stand density and improves overall stand health, as individual trees have increased access to available resources such as water, sunlight, and nutrients. These additional resources result in accelerated growth and canopy development, while improving the likelihood that individual trees survive, when confronted with insects and pathogens, drought, and low- to moderate-intensity wildfire (Latham and Tappeiner 2002).

Group selection openings would generally be small areas between 0.5 to 3 acres in size where most or all trees are removed to facilitate the establishment of a new age cohort. Group selection generally mimics historical disturbance processes by regenerating approximately 15 percent of the forested stand, increasing heterogeneity across the landscape and contributing early seral regeneration patches, within an overall uneven-aged landscape (Franklin et al. 2002, North et al. 2012a, North et al. 2009a). In addition to providing valuable forest products for society, the precision of these treatments increases the likelihood that the associated restoration goals of moving toward desired conditions are achieved. Fire, even if used intentionally, does not allow that level of specificity for tree arrangement, size, and species distribution. The combination of variable-density thinning and group selection, as described above, is consistent with restoring desired conditions based on the natural range of variability in Sierra mixed conifer forest types (North et al. 2009b, North 2012).

Consequences Specific to Alternative A

Alternative A strives to maintain the current level of activity, using existing management direction as provided by the 2004 Sierra Nevada Forest Plan Amendment Record of Decision (United States Department of Agriculture 2004b). Alternative A assumes future funding and project design consistent with current levels. Generally, less than 5 to 10 percent of the landscape has been restored in the last 10 years. Alternative A is forecasted to treat fewer acres and harvest less volume than recent levels, for several reasons. Disturbances, such as uncharacteristically severe fire, and insects and disease interacting with stand density and droughts, have caused significant tree mortality over the past several years, significantly reducing the acreage of forest with sufficient stocking to support commercial thinning. Recent production also has been increased with salvage of recently dead trees; however, wood quality deteriorates rapidly following mortality, and most of the recent mortality has deteriorated below merchantable quality. Additionally, increased costs and flat budgets would likely reduce staff capacity in the coming years.

Forest Products

Based on historic averages combined for both forests, alternative A might produce approximately 28 million cubic feet of sawtimber (140 MMbf), with an additional 5 million cubic feet in other products (miscellaneous convertible products such as biomass, posts, and poles) and 11 to 17 million cubic feet in fuelwood over a 10-year period. However, recent losses of standing timber volume due to mortality and reduced capability due to the loss of additional funding, such as the Collaborative Forest Landscape Restoration program, would likely result in reduced volumes of 13 to 15 million cubic feet of sawtimber (65 to 75 MMbf), up to 5 million cubic feet of miscellaneous products (likely biomass), and 4 to 6 million cubic feet of fuelwood over a 10-year period for both forests. Note that annual acreages may be obtained by simply dividing decadal estimates by 10.

Implementation projects are generally designed to thin relatively small-diameter sawtimber trees, reducing fuel adjacent to communities at risk of loss or damage from uncharacteristic wildfire. There are some biomass removal opportunities in conjunction with sawtimber removal, but the lack of a consistent market combined with pricing structure challenges result in most biomass opportunities going unused. Most biomass that cannot be economically sold and removed from the forest is piled and burned to reduce fuel and meet the project objectives. Revenue generated from individual projects could be used to offset the costs of other restoration activities that require additional funding to implement, such as watershed or habitat improvements. This alternative would produce more revenue than alternatives C and E, but less than alternatives B and D.

Recent saw log supplies appear to be sufficient to sustain the current operation of the related sawmills; however, the capability of continued operations, given projected supplies and future costs and product values, is unknown. Timber volume outputs forecasted under alternative A may be insufficient to sustain local sawmill infrastructure.

Area Restored

Alternative A, based on historic averages, would harvest timber from approximately 39,000 acres per decade across the Sierra and Sequoia National Forests (see Table 142). However, with reduced staff capacity and opportunity, approximately 15,000 acres are forecasted to have timber harvest in the first decade under alternative A. In addition to ecological restoration needs, treatments are prioritized based on proximity to the wildland-urban intermix. The majority of treatments would be in the montane ecological zone, with minor amounts in the upper montane ecological zone. Forest types in the montane zone include Sierra mixed conifer, ponderosa pine, and montane hardwood-conifer, while the upper montane zone includes red fir, Jeffrey pine, and lodgepole pine.

Based on historic averages, projects are generally designed to treat approximately 1,000 acres across a 5,000-acre area, or approximately 20 percent of a small landscape (generally a sub-watershed). At the stand level, these acres have an improved likelihood of resilience to the effects of insects and pathogens, climate change, and wildfire. This scale of treatment may result in less uncharacteristic wildfire activity at the local project scale, but by itself is not sufficient to alter the increasing trend in large wildfires expected with climate change (see the "Fire Trends" section). In addition, many standards and guidelines limit tree density reduction, potentially leading to increased inter-tree competition for scarce resources and increased tree mortality. Related to thinning and improving the sustainability of forest products, this alternative restores more acres than alternatives C and E, but less than alternatives B and D.

Consequences Specific to Alternative B

Alternative B incorporates four strategic fire management zones: community wildfire protection, general wildfire protection, wildfire restoration, and wildfire maintenance zones. Approximately half of the lands suitable for timber production are located in the two "protection" zones. Alternative B prioritizes fuel reduction and restoration treatment in the two protection zones, on strategic ridges, and along key roads that can facilitate larger landscape prescribed burns or that can increase the opportunity to manage wildfires when they can meet resource objectives. Treatments are also prioritized to improve resilience and reduce the risk of loss of habitat for old-forest-dependent species within the wildlife habitat management area. At least 20 percent of the landscape is anticipated to be restored through various management activities, including timber harvest.

Forest Products

Based on stand modeling combined with projected capabilities, alternative B would produce approximately 25 to 48 million cubic feet of sawtimber (125 to 240 MMbf), with up to an additional 10 million cubic feet in other products (miscellaneous convertible products such as biomass, posts, and poles) and 4 to 6 million cubic feet in fuelwood over a 10-year period across both forests (see Table 141 and Appendix F). This alternative is expected to harvest more volume and produce more revenue than alternatives A, C, and E, but less than alternative D.

Revenue generated from implementation of individual projects could be used to offset costs of other restoration activities that may otherwise remain unfunded. With an increase in area treated, more biomass removal opportunities, in conjunction with sawtimber removal, are available, provided a consistent market could use these opportunities. Larger, landscape-scale ecological restoration projects (such as whole watersheds) are encouraged under alternative B. If designed in ways to increase economic efficiencies, increased revenues may be generated per project. Through stewardship contracting, or trust funds, this revenue could be used to restore additional or more costly areas than under alternative A. This revenue is needed as the recent mortality event has resulted in significant dead, woody material with little to no value. Meeting fuels objectives for many treatments will require a significant portion of this woody material to be removed or disposed of by burning.

Alternative B is forecasted to produce greater saw log volumes than alternatives A, C, and E but less than alternative D. However, anticipated harvest levels may not support sustaining the local sawmill infrastructure unless production approaches the maximum values in Table 141. If closure of the sawmill at Terra Bella occurred, this would likely further reduce timber harvest levels, acres of mechanical restorations treatments, and revenue to support other restoration activities.

Area Restored

Alternative B would harvest timber from approximately 25,000 to 48,000 acres per decade across both southern Sierra forests based on projected forest capabilities (see Table 142 and Appendix F). Treatments are prioritized based on strategic fire management zones, with an emphasis on treating within the two wildfire protection zones. However, treatments are not limited to the protection zones, and some treatment is prioritized within the wildlife habitat management area to improve resilience to disturbances such as fire, insects, and drought. Vegetation types treated under alternative B would be comparable to those treated under alternative A.

Alternative B encourages larger, landscape-scale projects, with the intent that greater areas would be analyzed and more area restored. Compared with alternative A, fewer limitations on tree removal would increase the likelihood that the thinning of dense stands would be more biologically effective at achieving resilient conditions and result in more sustainable forest stands over increased acres. Examples of relaxed limitations that can improve effectiveness include the ability to conduct mechanical thinning in portions of California spotted owl PACs of up to 30 percent of a given PAC, and exceptions to the 30-inch diameter limit that would allow thinning of overstocked stands where a majority of the stand basal area is comprised of trees greater than 30 inches in diameter. At the stand level, these acres would have increased resilience to the effects of insects, pathogens, climate change, and wildfire, and would come closer than alternatives A, C, and E; but they would not quite be sufficient to alter the increasing trend in large wildfires expected with climate change (see the “Fire Trends” section). This scale of treatment would result in less uncharacteristic wildfire activity at the project scale, and could have similar benefits at the landscape scale in some areas. This alternative restores more acres than alternatives A, C, and E, but less than alternative D.

Consequences Specific to Alternative C and Alternative E

Alternative C focuses on emphasizing short-term protections for wildlife habitat; it relies more on standards and guidelines to minimize localized effects of active management on species such as the California spotted owl, fisher, listed amphibians, and other species of conservation concern. Commercial timber sales are generally limited to small-diameter sawtimber removal, with maintenance of greater stand densities and higher canopy cover. Treatments similar to those under alternative A could occur in portions of the wildland-urban intermix defense zone. However, it is anticipated that prescriptive constraints, such as diameter limits, limited mechanical treatments in California spotted owl territories and home range areas, and retaining higher canopy cover for fisher, would reduce the area treated to one half or less of current levels.

Alternative E is very similar to alternative C, with the difference that a large proportion of the recommended wilderness under alternative C would be instead allocated to the backcountry management area under alternative E. Additional acreage also would be allocated to the backcountry management area. Vegetation management and timber harvest are less constrained in the backcountry management area than in recommended wilderness, but the management direction for timber harvest is very similar to that for inventoried roadless areas under the 2001 Roadless Rule. In fact, substantial portions of the backcountry management area would be within existing inventoried roadless areas. Therefore, alternative E could produce a small amount of timber volume in backcountry management areas, as a result of hazard tree salvage or thinning for restoration purposes, but the amount is expected to be quite small annually and likely no more than an additional 10 percent of alternative C output. Therefore, throughout this analysis, consequences anticipated for alternative E will be assumed to be the same as those indicated for alternative C unless specified otherwise.

Forest Products

Based on modeling and projected forest capability, alternatives C and E would produce approximately 7 to 14 million cubic feet of sawtimber (35 to 70 MMbf), with up to an additional 5 million cubic feet in other products (miscellaneous convertible products such as biomass, posts, and poles) and 4 to 6 million cubic feet in fuelwood over a 10-year period (see Table 141 and Appendix F). These two alternatives generate the least amount of forest products, and associated revenue, of all the alternatives analyzed in detail.

The implementation of alternatives C and E likely would produce limited revenue, as lower-value product removals, such as biomass and small-diameter sawtimber, in generally smaller-scale projects, restrict the efficiencies more common with projects designed in other alternatives. Smaller projects, combined with smaller-diameter removal, contribute to more costly harvest operations that likely would need to be supplemented with appropriated dollars to accomplish objectives. Since budgets are expected to remain similar to those of the last 5 years, appropriated funds would cover the costs of fuel reduction on fewer acres overall, because the limited commercial harvests would produce less revenue to cover the costs of treatments.

The reduced supply of valuable saw logs likely would affect the continued operation of related sawmills. Sawmills already operating near threshold levels would face an uncertain future. If the related sawmills close, the costs of restoration would increase substantially and would substantially limit the amount of restoration that can be accomplished. The volume outputs under alternative C are sufficiently low, so the sawmill at Terra Bella would likely close unless lands of other ownership significantly increased their timber harvest levels. Closure of the sawmill at

Terra Bella would likely further reduce timber harvest levels, acres of mechanical restorations treatments, and revenue to support other restoration activities.

Area Restored

Alternatives C and E anticipate timber harvest from approximately 7,000 to 14,000 acres per decade across all southern Sierra forests (see Table 142 and Appendix A). Thinning treatments would focus on small- to medium-sized trees and would be focused primarily in the wildland-urban intermix defense zone immediately surrounding communities. Prescribed fires and wildfires managed to meet resource objectives would be the preferred methods of restoration treatment, thereby substantially reducing product output or timber harvest opportunities.

Alternatives C and E encourage less intensive treatments, meant to minimize impacts on existing habitat in the short term. At the stand level, these treatments would improve the likelihood of resilience to the effects of insects and disease, climate change, and wildfire. However, these effects would be to a much lesser degree than under alternatives A, B, and D, due to the minor density reductions associated with only small-diameter tree removal. Minor reductions in inter-tree competition are not likely to provide sufficient increased access to growing space and the related site resources, and any benefits are short term because of the continued growth of trees.

Limited increases in tree vigor, combined with the limited acreages affected by treatment, are unlikely to provide a significant improvement in the status of forest health. Retention of high stand densities would continue to contribute to mortality, thus increasing fuel levels and contributing to stand conditions trending away from overall desired landscape conditions. The additional tree mortality would reduce live standing timber volume and reduce future opportunities for commercial thinning or other harvests to be part of an ongoing restoration program.

While wildfire risk would be reduced in the short term at the stand level within the treated areas, the low levels of accompanying mechanical thinning that would assist the effectiveness and efficiency of prescribed fire or wildfire managed to meet resource objectives may actually limit fire use. This scale of treatment could result in less uncharacteristic wildfire activity at the local project scale, but would not be sufficient to alter the increasing trend in large wildfires across the landscape expected to occur due to climate change and other stressors. Sustaining higher stand densities and the resulting tree mortality anticipated due to drought and insects would continue the trend of increasing the amount of uncharacteristically high fire severity when unplanned ignitions occur.

Under alternatives C and E, almost all funding for vegetation treatments would have to come from congressionally appropriated funds or from partnership dollars because there is little opportunity for stewardship or trust fund support. Both of these depend on the sale of commercial forest products to generate funds. These alternatives mechanically restore the least amount of acres of all the alternatives analyzed in detail.

Consequences Specific to Alternative D

Alternative D includes an emphasis on an increased pace and scale of ecological restoration, including improving the resilience of forests to fire, drought, climate change, insects, and pathogens. It emphasizes long-term habitat conservation by making areas more resilient to stressors, recognizing there may be short-term impacts on habitat associated with active management. Treatments focus on effective density reductions, lengthening the time that treatments are effective before growth increases stand density to levels outside the natural range of variation. More strategic treatments in the restoration zone would occur than under alternative B and the other alternatives. By conducting more mechanical treatments in the areas that are feasible to treat with mechanical equipment, alternative D would create landscape conditions that would allow for greater use of fire (both prescribed fire and management of wildfires to meet resource objectives) in areas that are difficult to treat with mechanical equipment. This would lessen the risks from large, high-intensity wildfires to other forest stands.

During thinning, increased numbers of medium and large trees would be removed to favor the development and vigor status of even larger trees. In particular, concentrating restoration treatments within focus landscapes would likely reduce uncharacteristically severe wildfire over a much larger portion of the landscape than the footprint of the treatments, as the treatment footprint would be large enough to alter landscape-scale fire behavior. Up to 60 percent of the landscape is anticipated to be restored through various activities, including timber harvest.

Forest Products

Based on modeling and the projected capability, alternative D would produce approximately 36 to 72 million cubic feet of sawtimber (180 to 360 MMbf), with up to an additional 16 million cubic feet in other products (miscellaneous convertible products such as biomass, posts, and poles) and 4 to 6 million cubic feet in fuelwood over a 10-year period in both forests (see Table 141 and Appendix F). This produces the most revenue of any alternative analyzed in detail. Note that yields at the upper range of alternative D are not likely to be sustained on the Sequoia National Forest due to a lack of acres that would benefit from this type of thinning.

Revenue generated from implementation of individual projects could be used to offset costs of other restoration activities that may otherwise remain unfunded. Provided the existence of biomass utilization infrastructure exists, increased biomass removal, often linked with saw log harvests, would increase. Larger, landscape-scale projects (such as whole watersheds) would be encouraged under alternative D, particularly within focus landscapes, resulting in more revenue generated per project due to increased efficiencies associated with reduced logging costs. Through stewardship contracting, or trust funds, this revenue could be utilized to treat additional or more costly areas than under alternatives A, B, C, and E. For example, funds generated by the sale of forest products could be applied to road maintenance, small fuels mastication, prescribed burning, habitat enhancements, and aquatic organism passage projects.

The projected annual volume of forest product removal is anticipated to sustain the mill at Terra Bella, as well as other forest product infrastructure over time. However, the maximum production estimated may exceed the current capability for the Terra Bella mill, which has only run one production shift since 2006. The forecast harvest volume is likely less than needed for this mill to reinstate a second shift. Therefore, industrial infrastructure may not support reaching the upper limit of timber harvest forecasted for alternative D. Once the existing local mill is at capacity, haul costs associated with Chinese Camp and Standard, California (the two closest mills), may be cost prohibitive in achieving the desired conditions depending upon fluctuations in the timber markets. These factors might limit the maximum volume harvested and acres treated under alternative D.

Area Restored

Alternative D is anticipated to harvest timber from approximately 36,000 to 72,000 acres per decade across the Sierra and Sequoia National Forests (see Table 142 and Appendix F. While treatments in the two wildfire protection zones would be of higher priority, treatment could occur in all strategic fire management zones. The majority of treatments would be in the montane ecological zone, with minor amounts in the upper montane ecological zone. The montane zone consists primarily of Sierra mixed conifer, ponderosa pine, and montane hardwood-conifer, while the upper montane zone consists of red fir, Jeffrey pine, and lodgepole pine.

Alternative D encourages larger landscape-scale projects, with the intent that larger areas would be analyzed and more area restored. Decreased tree density and increased heterogeneity at the landscape and stand level would improve resistance and resilience to the effects of insects and pathogens, drought, climate change, and wildfire in montane and upper montane forests. These benefits would be due to healthier, more vigorous trees, and stand structure and composition being less prone to continuous, large-scale insect outbreaks. In addition, the wildfire risk would be reduced over time (see the "Terrestrial Vegetation Ecology" and "Fire Trends"). Individual treated stands would have fuel profiles less prone to severe wildfire behavior and effects; this scale of treatment would result in less uncharacteristic severe wildfire activity at the project and landscape scale, extending beyond the treated areas. Of all alternatives analyzed in detail, this alternative would restore the most acres and results in more resilient forested stands consistent with desired conditions.

Cumulative Effects

Alternatives B and D project an increase in area treated and volume removed as the pace and scale of restoration increase. These alternatives likely would produce enough sawtimber to maintain the existing local forest products infrastructure, including the mill at Terra Bella and local specialty markets. Maintenance of the existing infrastructure is important to community economic health, as well as ensuring future opportunities for restoration implementation. However, in the absence of new or expanded sawmill infrastructure, existing capacity issues may limit achievement of the objectives under alternative D. Organizational capacity may also limit achievement beyond the lower limits forecasted for alternative D. Additionally, the reduction in standing live tree volume due to recent and future droughts, insect infestations, and severe wildfires also could reduce the ability to achieve alternative D objectives toward the maximum values projected.

New markets, such as biomass or additional forest products milling facilities, may further increase the pace and scale of restoration, especially under alternatives B and D. New markets allow for competition, potentially resulting in increased revenue. A small biomass facility is anticipated to be constructed in North Fork, California, which would facilitate sustained and possibly increased biomass utilization for the Sierra National Forest; however, the small scale of this facility (2-megawatt production) and longer haul distance mean this plant would not likely take appreciable volume from the Sequoia National Forest. The relatively marginal cost to value ratio in the biomass industry means there is considerable uncertainty regarding future biomass markets and therefore biomass harvest levels.

Alternatives A, C, and E would be unlikely to maintain a consistent flow of sawtimber sufficient to maintain the existing local forest products infrastructure. Currently, the mill in Terra Bella relies on timber taken from private lands for a portion of its supply. However, this accounts for less than one-third of the mill's annual log consumption, and it appears unlikely that a larger sustainable supply would be available from other landowners.

Alternative B could also fail to sustain the local forest products infrastructure if timber volume outputs are not near the maximum values for this alternative shown in Table 141. The absence of the mill in Terra Bella, or similar capacity wood processing infrastructure that could service the

Sierra and Sequoia National Forests, would mean that rather than having a consistent forest products market to help defray costs of restoration, nearly all restoration would have to be accomplished with limited appropriated dollars and at a much smaller scale than at current levels (alternative A).

While alternative D projects the greatest annual volume removal, no alternative prescribes harvest at levels nearing the sustained yield limit (see "Appendix F: Timber Suitability"). This means there is more opportunity to increase the pace and scale of restoration given increased fiscal and personnel capacity without jeopardizing the long-term sustainability of the forest and forest productivity. Current landscape volume estimates show adequate amounts of well-stocked acres to support harvest levels forecasted for all alternatives for the first 10 years, although thinning at alternative D levels in the second decade would become more difficult for the Sierra National Forest and likely would not be feasible in the Sequoia National Forest, particularly for the upper limit of alternative D (Appendix F).

Alternatives B and D would use a variety of restoration tools, such as mechanical fuel reduction treatments, timber harvest, hand treatments, and prescribed fire, to achieve desired conditions. Under these alternatives, it is expected that substantial portions of large landscapes may be restored in the next 10 to 15 years. In addition to improved forest health, growth, and resilience to disturbance agents, treating more area (especially reducing densities in montane and upper montane forest stands) would increase the likelihood that large landscape areas can withstand the adverse effects of many of the fires experienced in recent years, maintaining much of their forest structure and composition. These forests would continue to provide habitat and future multiple-use timber harvest opportunities into the future, without a substantial loss in social, ecological, and economic value.

Alternatives A, C, and E would likely result in lower levels of restoration treatments intended to achieve desired conditions than either alternative B or D. The increased emphasis under alternatives C and E to use fire may be more limited than intended, due to the low levels of accompanying mechanical thinning that would assist the effectiveness of prescribed fires or wildfire managed to meet resource objectives. As the trend of elevated wildfire intensities continues to increase under these alternatives, losses of forest structure to wildfire would adversely impact habitat availability, aquatic health, recreation opportunities, and future economic and multiple-use opportunities associated with timber harvest. Recent elevated tree mortality exacerbates this trend by increasing surface fuels into the future, which increases the severity of future fires, and increasing the potential for mass fires (Stephens et al. 2018).

Analytical Conclusions

Alternative A would continue management near current levels of mechanical treatments, with limited improvements in forest health and resilience to disturbance agents and climate change at the project (stand) level. Landscape resilience would continue to decline. The supply of timber products would be unlikely to sustain the existing forest products industry infrastructure, including the mill at Terra Bella.

Alternative B would increase the pace and scale of mechanical treatments to modify existing conditions, incrementally improving forest health and resilience to disturbance agents and climate change. It likely would generate enough volume to sustain the needs of the existing forest products industry infrastructure, including the mill at Terra Bella. Treatments likely would need to approach the upper range for alternative B to improve forest resilience to disturbance and climate change at the landscape scale, as well as to sustain industry infrastructure.

Alternatives C and E would decrease the pace and scale of mechanical treatments from the existing conditions; however, small improvements in forest health and resilience would occur in the short term at the project (stand) level, similar to alternative A. This alternative would be unlikely to sustain the existing forest products industry infrastructure, including the mill at Terra Bella, thereby limiting restoration management options into the future to those funded by only appropriated dollars.

Alternative D would increase the pace and scale of mechanical treatments to modify existing conditions, improving forest health and resilience to disturbance agents and climate change, and generating enough timber volume to sustain the needs of the existing forest products industry infrastructure, including the mill at Terra Bella. However, in the absence of new or expanded infrastructure, capacity issues could limit achievement of desired objectives. Once the existing local mill is at capacity, haul costs associated with Chinese Camp and Standard, California (the next two closest mills), may be cost prohibitive. Thus, infrastructure capacity would then become an additional factor limiting restoration treatments that involve commercial harvests, besides other limiting factors, including organizational budget and capability, and the availability of sufficiently well-stocked forest stands to support these restoration treatments.

Production Livestock Grazing

The beneficial and adverse effects of production livestock grazing are described throughout this document, and this section includes a summary of those effects. Appendix E describes a list of current grazing allotments and their status for both forests. A range suitability analysis under the 2012 Planning Rule is not required, and previous grazing suitability determinations have not changed.

Current Grazing

Within the Sequoia National Forest plan analysis area, there are 33 active and 9 vacant cattle allotments for a total of 689,841 acres (excluding the Giant Sequoia National Monument). In 2012, 27 permits were authorized to graze 4,761 cattle in the plan area at various times throughout the year (United States Department of Agriculture 2013b).

Sierra National Forest has 38 cattle allotments. Within the plan analysis area there are 30 active and 8 vacant allotments for a total of 908,027 acres (excluding the San Joaquin Experimental Range). Refer to appendix E for a summary table of current allotments.

In 2017, for the entire forest, the Sequoia National Forest permitted 7,968 head of cattle (mature cow with nursing calf) and 9 head of horses under a term grazing permit on National Forest System lands during summer and winter grazing seasons for a total 50,549 animal unit months (AUMs). By contract, in 1988 the forest permitted 65,000 AUMs (United States Department of Agriculture 1988a), showing an overall decline of 22 percent in permitted AUMs in 29 years.

That same year, Sierra National Forest permitted 3,393 head of cattle (mature cow with nursing calf) and 14 head of horses under a term grazing permit on National Forest System lands during summer and winter grazing seasons for a total of 20,040 AUMs; authorized use in 2017 was less at 18,207 AUMs. By contract, in 1991 the forest permitted 37,000 AUMs on 36 active allotments (United States Department of Agriculture 1991), showing an overall decline of 46 percent in permitted AUMs in 27 years. Permitted use has remained stable over the last 12 years as reported in the Grazing Statistical Report from 2006 to 2017 shown in Figure 59.

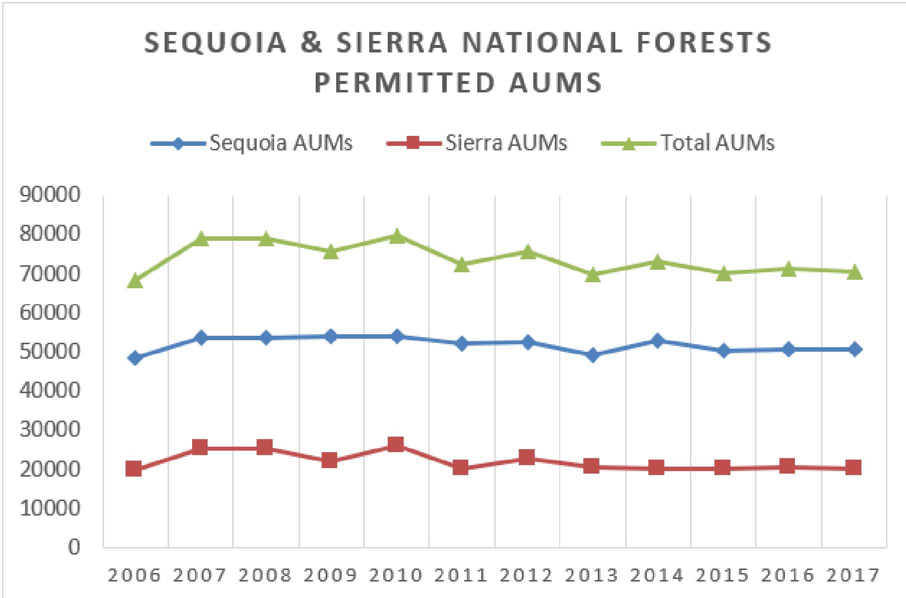

Figure 59. Sequoia and Sierra National Forests Animal Unit Months (AUMs) from 2006–2017
(Source: USFS Natural Resource Manager (NRM) website, Annual Grazing Statistical Report: Detail at Forest Level). For the Sequoia National Forest this was done for the whole forest, including the GSNM.

Across the entire forest, including the GSNM, 28 of 47 active allotments (60 percent) in the Sequoia National Forest have had environmental analysis and an allotment management decision made since passage of the Rescissions Act of 1995 (P.L 104-19, Section 504(a)). In the Sierra National Forest, 21 of 27 active allotments (78 percent) have had environmental analysis and allotment management decisions since 1995. This environmental analysis addresses grazing permit issuance and a required scheduling of allotment analysis in compliance with the NEPA. Twenty-seven allotments in the Sequoia National Forest and 12 allotments in the Sierra National Forest are scheduled for NEPA analysis or re-analysis within the next decade (2017–2028) as described in the National Allotment NEPA Schedule (United States Department of Agriculture 2017b).

Livestock permittees who use National Forest System lands in the Sequoia and Sierra National Forests contribute to the local economy in Kern, Tulare, Fresno, Madera, and Mariposa Counties. In addition, local ranchers and forest permittees contribute to the social well-being and economic sustainability of the local communities. These families participate and support many local activities and community tourism events. The local communities depend on rangeland resources for their livelihood by meeting the public needs for interrelated resource uses, such as livestock and wildlife forage, terrestrial and aquatic wildlife habitats, outdoor recreation, and healthy watersheds.

The total number of beef cattle across Kern and Tulare Counties is 971,000 (Tulare and Kern 2011 County Crop Reports). The total permitted number of cattle grazed in the entire Sequoia National Forest is 7,968 or 0.82 percent of the two county totals. The total number of beef cattle across Fresno, Madera, and Mariposa Counties is 501,840 (Fresno, Madera, and Mariposa 2011

County Crop Reports). The total permitted number of cattle grazed in the Sierra National Forest is 3,393 or 0.68 percent of the three county totals.

Economic sustainability of these ranches owned by permittees over the next 20 years is the most difficult to predict. Their future will depend on the ability to maintain a viable and profitable livestock operation based on the availability of a sustainable forage base. Ranchers are already faced with the need to manage for diverse goals and have been encouraged to produce products with a higher market value, such as organic and natural meats. In most cases, it is the herd size authorized in the Forest Service grazing permit that limits the ability of many permittees to rely on ranch income alone. Each permit has a certain capacity, resulting in a set number of permitted livestock that the range can support for the season of authorized use. Many permittees have already diversified their operation to supplement their income from part-time to full-time, off-ranch work.

To cope with reductions of National Forest System lands for summer grazing, ranchers favor leasing more private land. However, these lands are in short supply, and there is strict competition for the leases. In a 2002 University of California Berkeley report to the Sierra Nevada Alliance, 40 to 50 percent of ranching income was attributed to their access to these summer grazing lands. Those interviewed who graze on National Forest System land said they have no desire to sell their ranches, but a third stated they would have to consider selling if they lost their Forest Service grazing permit. The majority of ranchers surveyed responded that living and working amidst natural beauty was a highly important reason to continue ranching, and that although ranching is not seen as the ideal way to make a living, most ranchers want their children to continue ranching and to pass on the family tradition (Sulak and Huntsinger 2002).

Analysis and Methods

Analysis Area

While the analysis area consists of all National Forest System lands in the Sequoia National Forest (outside GSNM) and Sierra National Forest (excluding San Joaquin Experimental Range), the primary focus includes lands identified as suitable for livestock production.

Lands Suitable for Production Livestock Grazing

Lands identified as suitable for livestock production include National Forest System lands not administratively withdrawn that have been identified in grazing allotments. The status of grazing allotments is either active or vacant. Active allotments have current grazing permit holders authorized to graze the designated allotment. Vacant allotments have no existing permit holder and are generally suspended from grazing until environmental analysis to reactivate the allotment has been completed. A project-level suitability analysis would also be done prior to any allotment reactivation.

Approximately 689,841 acres within National Forest System lands administered by the Sequoia National Forest (outside GSNM) are considered suitable for livestock grazing and production. Of those lands, approximately 195,880 acres or 28 percent are in vacant status. Approximately 908,027 acres within National Forest System lands administered by the Sierra National Forest are considered suitable for livestock grazing and production. Of those lands, approximately 157,543 acres or 17 percent are in vacant status. See Appendix E (Volume 2: Appendices) for a summary of current allotments and a map of lands not suitable for production livestock.

Grazing

Lands identified as not suitable for livestock production include National Forest System lands administratively withdrawn from production grazing where the allotments have been closed and are no longer delineated. Lands not suitable for livestock production are those lands where livestock grazing has been found to be incompatible with the desired conditions or result in substantial and permanent impairment of the land. Approximately 118,508 acres or 15 percent of 808,696 acres administered by the Sequoia National Forest (outside GSNM) are considered not suitable for livestock grazing and production. Approximately 157,452 acres or 11 percent of 1,400,000 acres of all lands administered by the Sierra National Forest are considered not suitable for livestock grazing and production. Suitability determinations were carried forward unchanged to the revised plan. Refer to Volume 2: Appendix E for maps of lands suitable for production livestock grazing.

Temporal Scale

The analysis period consists of two decades (20 years). Discussion on climate change extends to 50 years.

Indicators and Measures

The primary indicators used in rangeland management, both regionally and nationally, are:

- Livestock grazing use as measured by the amount of AUMs permitted annually as a measure of forage consumed
- Rangeland vegetation improved as measured by area in acres of allotments maintained at or improved toward desired conditions
- Forest plan direction adequacy as measured by plan components for grazing activities that maintain or restore habitat elements for federally listed terrestrial, aquatic, and plant species

Measures used in this analysis and forest plan monitoring:

- Amount of AUMs permitted annually as a measure of forage consumed
- Area in acres of allotments maintained at or improved toward desired conditions
- Number of active allotments that are NEPA and ESA sufficient

Assumptions

- Previous grazing suitability determinations are carried forward for this plan revision. The final decision to authorize or discontinue livestock grazing at the allotment level is made following project-level NEPA analysis.
- If implementation of current grazing management standards and guidelines from the Sequoia and Sierra Forest Plans (United States Department of Agriculture 1988c, 1991), as amended (United States Department of Agriculture 2004b) were to continue, vegetation and watershed conditions trends are expected to meet or move toward desired conditions for the next 20 years. Monitoring and adaptive management are used to adjust management to maintain and improve rangeland resources.
- Acres administered to standard includes the complexity of permit administration workloads where a more complex workload is reflected by fewer acres administered to standard as compared with a less complex workload.

- Commercial livestock grazing opportunities in the Sequoia and Sierra National Forests will be constrained at or near current levels. Opportunities for domestic sheep or goat grazing may be available at lower elevations for the purpose of vegetation management but absent in or near potential suitable or occupied bighorn sheep habitat.
- Average forage production likely will decline over time with warmer temperatures, and increased frequency and duration of drought conditions as projected by climate modeling (Vose et al. 2016a). Local demand for production livestock forage will exceed forage being made available and authorized.

Affected Environment

Range forage in the annual grass-oak woodland type is provided mostly by annual grasses and a variety of annual forbs in the composition, as well as rushes and grasses in ephemeral drain ways, swells, and riparian areas. Typical shrubs include buckbrush, deerbrush, poison oak, and mountain mahogany. In both forests, at higher elevations (3,500 to 10,000 feet), the primary forage areas are wet and dry meadows. Wet meadows occur where water is at or near the surface for most of the growing season, following spring runoff. These different meadow types have a great variety of herbaceous plant species. Plant species may differ, but plant genera common to wet meadows usually include sedges, rushes, and graminoids, with intermixed forbs. The grazing program covers about 689,841 acres of grassland (annual and perennial), chaparral, and open forest.

Grazing occurs primarily on foothill annual grassland and hardwood vegetation types (123,000 acres; see Table 18) and in montane meadows from 4,500 to 10,000 feet in elevation. There are 7,650 acres of meadows within the plan area within the Sequoia National Forest. Much of the highest-quality wet meadowland is in the Golden Trout Wilderness (Kern Plateau). The Sierra National Forest has a variety of rangelands similar to the Sequoia on the west slope of the southern Sierra Nevada. The annual grass and hardwood vegetation types (263,000 acres; see Table 18) are found from the valley floor up to 1,500 feet in elevation, mostly on south-facing slopes. Chaparral occurs from 1,500 feet up to 3,500 feet, and commercial forest land occurs higher than 3,500 feet. There are 16,886 acres of meadows on National Forest System lands within the Sierra National Forest.

As stated in the forest assessments (United States Department of Agriculture 2013b, c, d) for both forests, livestock grazing is likely to be sustained within the plan area over the next 20 years based on past site-specific range analyses. Projects have been successful in improving livestock management. Additionally, the emphasis on ecological restoration at the watershed scale will contribute to the direct and indirect sustainability of grazing in the Sequoia and Sierra National Forests. Meadow restoration is a priority; this restoration will sustain and improve forage base levels. Each forest uses bioengineering to stabilize degraded riparian areas to reduce stream bank erosion, improve and restore overall hydrologic function, and remove encroaching conifers.

The demands for grazing in the Sequoia and Sierra National Forests are expected to continue at or above present levels, since national forest summer, winter, and spring rangelands are essential to the local ranch operations that depend on them.

Potential Grazing Effects on Rangeland Ecosystems

Since the 1980s, numerous studies have documented the adverse effects and disturbance that livestock grazing can have on riparian areas and uplands. Livestock tend to congregate during the warm weather season in riparian areas. Therefore, disturbance from livestock to riparian areas is often disproportionately greater than disturbance to adjoining uplands (Skovlin 1984, Kauffman and Krueger 1984, Fleischner 1994, Magilligan and McDowell 1997). Some concluded, following an extensive review of the literature, that livestock grazing has no documented beneficial ecological effects on riparian areas and at best nonsignificant negative effects and that livestock grazing is not sustainable (Belsky et al. 1999). Several studies describe the benefits of reduced cattle stocking rates (Clary and Webster 1989, Elmore and Kauffman 1994, Burton and Kozel 1996, Weller 1996). However, there is disagreement on publications that contrast newer grazing systems to more traditional and destructive grazing systems (Belsky et al. 1999).

Livestock grazing and associated management have both direct and indirect physical disturbance effects of varying degrees on landscapes and associated terrestrial and aquatic habitats. These potential disturbances include changes to the watershed hydrologic process, primarily infiltration and secondary effects on peak flows, erosion, contaminant transport, and water quality degradation. Disturbance is also caused by removing vegetation by herbivory. This can change plant communities and wildfire frequency and intensity, reduce ground cover, and, potentially, expose soils. This can lead to wind and water erosion and changes to soil structure and bulk density. This would result from compaction or loose soils by livestock trailing and hoof trampling and loose and exposed soils from stream bank, sod, or plant root shearing. Ultimately, erosion can lead to lowered water tables.

Repeated grazing in key forage areas can stress desirable forage plants, leading to diminished root reserves, reduced plant vigor, and shifts in composition of plant communities. Conversion from deep-rooted perennial graminoids to annual species is possible when grazing is coupled with other environmental stressors or change agents, such as wildfire or drought.

The effects of livestock disturbance on terrestrial wildlife are displacement from resting, foraging, and breeding habitats and water sources, trampling of individuals or ground nests, and exposure to disease and parasites. The effects of livestock herbivory on terrestrial wildlife species are reductions in vertical hiding and nesting cover, competition for forage resources, concentrated urine and dung defecation in wildlife foraging and resting areas, vector introduction of invasive plant species, such as star thistle, and dewatering of meadow and riparian habitats.

In the plan area, livestock grazing is identified as a potential primary stressor to three terrestrial animal species of conservation concern: willow flycatcher, Behr's metalmark, and Tehachapi fritillary butterflies. There are six federally listed terrestrial species in the plan area, five of which are found in meadow or riparian habitats. Grazing disturbance is not identified as a primary stressor under Forest Service control for any of these species (Table 63). In the Sierra National Forest, cattle have been removed from many of the high-elevation allotments that provide potential suitable habitat for Sierra Nevada bighorn. U.S. Fish and Wildlife terms and conditions are in place for grazing where these riparian-dependent species or critical habitat, or both, occur inside any allotments. See "Federally Listed Threatened, Endangered, Proposed, and Candidate Wildlife, Fish, and Plants" for a description of those effects.

The effects of livestock disturbance on aquatic species can include accelerated erosion and soil deposition into streams and lakes, hindered trout fry emergence in gravels and decreased winter survival by filling in channel pore spaces, loss of over-hanging streambanks, reductions in shading, increased water temperatures from riparian tree and shrub browsing, shallower and wider stream channels, replacement of deep-rooted plant species with shallow-rooted plant species, and lowered streambank stability.

In the plan area, livestock grazing is identified as a potential primary stressor for five aquatic species (Table 85): foothill yellow-legged frog, Kern Canyon slender salamander, California golden trout, Kern River rainbow trout, western pearl shell. There are six federally listed aquatic species in the plan area where grazing activities may impact their habitats and contribute to the primary stressors under Forest Service control (Table 63): Little Kern golden trout, Lahontan cutthroat trout, Paiute cutthroat trout, Yosemite toad, Sierra Nevada yellow-legged frog, and the northern DPS of mountain yellow-legged frog. Each of these species has U.S. Fish and Wildlife Service terms and conditions in place for grazing where the species or critical habitat, or both, occur inside any allotments. See “Federally Listed Threatened, Endangered, Proposed, and Candidate Wildlife, Fish, and Plants” for a description of those effects.

A review and summary of grazing effects on ecosystems in the Sierra Nevada was prepared in the Sierra Nevada Ecosystem Project Report to Congress (SNEP 1996). At the request of the Forest Service, the University of California Rangeland Science Team gave that large body of work a critical review, summarized it, and reported back (Allen-Diaz et al. 1999). The review noted that grazing is most often treated as a yes or no proposition, but it is really a complex process, where timing, frequency, duration, season of use, and intensity matter. The terms grazing and overgrazing are not defined in most of the statements where they are used. In many studies it is also difficult to determine when historic grazing versus current grazing is discussed. Without detailed descriptions of grazing season, frequency, intensity, and system, as well as a quantitative description of the range site, riparian type, or stream class, it is difficult to interpret the work with regard to current livestock management in the Sierra Nevada.

The lack of tested, real-world solutions in the literature and the real need for new approaches to studying and defining sustainable riparian grazing were problematic (Allen-Diaz et al. 1999). A survey (Tate 2005) of grazing management and corresponding riparian health on 300 stream reaches across California indicated that site-specific grazing management practices were correlated with riparian health; common grazing practices (such as herding and off-site watering) were positively associated with improved riparian and stream health. Sustainable riparian grazing is dependent on working directly with grazing managers to identify grazing practices that maintain riparian health yet are logistically and economically feasible. It also depends on conducting research at the ranch and grazing allotment scale to ensure the results are relevant at the management scale (Tate 2005).

A recent assessment of montane meadows that examined habitat, streams, and hydrology (Purdy et al. 2012) indicates that while range condition and plant species composition has improved, other issues with hydrology and habitats for animal species still remain (Viers et al. 2013). Both montane meadows and spring-fed wetlands provide many important functions. In oak woodlands, livestock grazing modifies these spring-fed wetland functions (Allen-Diaz and Jackson 2005).

Special Aquatic Features

Within the plan area, in the Sequoia National Forest there are a total of 7,650 acres of meadow. These acreages include 5,801 meadow acres in active grazing allotments and 987 meadow acres in vacant allotments. In the Sierra National Forest there are a total of 16,886 acres of meadow. These acreages include 12,120 meadow acres in active grazing allotments and 1,201 meadow acres in vacant allotments. The landscape of meadows extent depends on location. Researchers from UC Davis sampled 11 randomly selected meadows on each forest, as part of a Sierra Nevada meadow hydrology assessment (Fryjoff-Hung and Viers 2013). Otherwise, assessments have focused on key grazing area meadows within active grazing allotments. Rangeland conditions for these are described below. The condition rating of key grazing areas may not represent the overall condition of special aquatic features across the forest (Long et al. 2014).

Within these meadow ecosystems and suitable rangelands in the Sequoia National Forest, there are 23 known fens and 173 potential sites that have not been visited. In the Sierra National Forest there are 75 known fens and 41 potential sites that have not been visited. Within these meadow complexes, fens play an important role in nutrient cycling and groundwater discharge, provide habitat for rare species, and are a major sink for atmospheric carbon (Weixelman and Cooper 2009). Proper functioning condition information for fens indicated that most either were properly functioning, or had an upward trend, or no trend. A small proportion was found to have a downward trend.

Current Rangeland Conditions

As reported in the Sequoia and Sierra National Forest Assessments (United States Department of Agriculture 2013b, c, d), the figures below show the functional score for 51 key meadow sites in the Sequoia National Forest and 60 key meadow sites in the Sierra National Forest (from USFS R5 Long-Term Monitoring Project data). The sites displayed represent the long-term monitoring plots established at key sites from 1999 to 2004. These plots are revisited every 5 years. Conditions reflect the latest reading for each of these sites.

The condition or plant functional scores are 0–25 for early seral, 26–50 for mid seral, 51–75 for late seral, and more than 75 for potential natural vegetation. The wetland score on the y-axis indicates the abundance of wetland plant species, with larger numbers corresponding with a higher proportion of wetland species. On the x-axis, a score above 50 would correspond to the late seral and potential natural vegetation categories shown below in Figure 60 and Figure 61. These figures indicate that over half the meadows surveyed in the Sequoia and Sierra National Forests have late seral vegetation close to natural vegetation, with a good percentage of wetland species present.

These same key meadow sites were also assessed for percent bare ground as part of the overall functional condition rating. Sites below 10 percent bare ground are generally in satisfactory condition in terms of soil stability. A bare ground cover of 10 percent or greater usually indicates significant meadow degradation. The average percent bare ground for meadow sites in both the Sequoia and Sierra National Forests was 6.5 percent. In the Sequoia National Forest, 69 percent of the meadow sites had moderate to high protective ground cover (Figure 62). In the Sierra National Forest, 93 percent of the meadows had high protective ground cover (Figure 63).

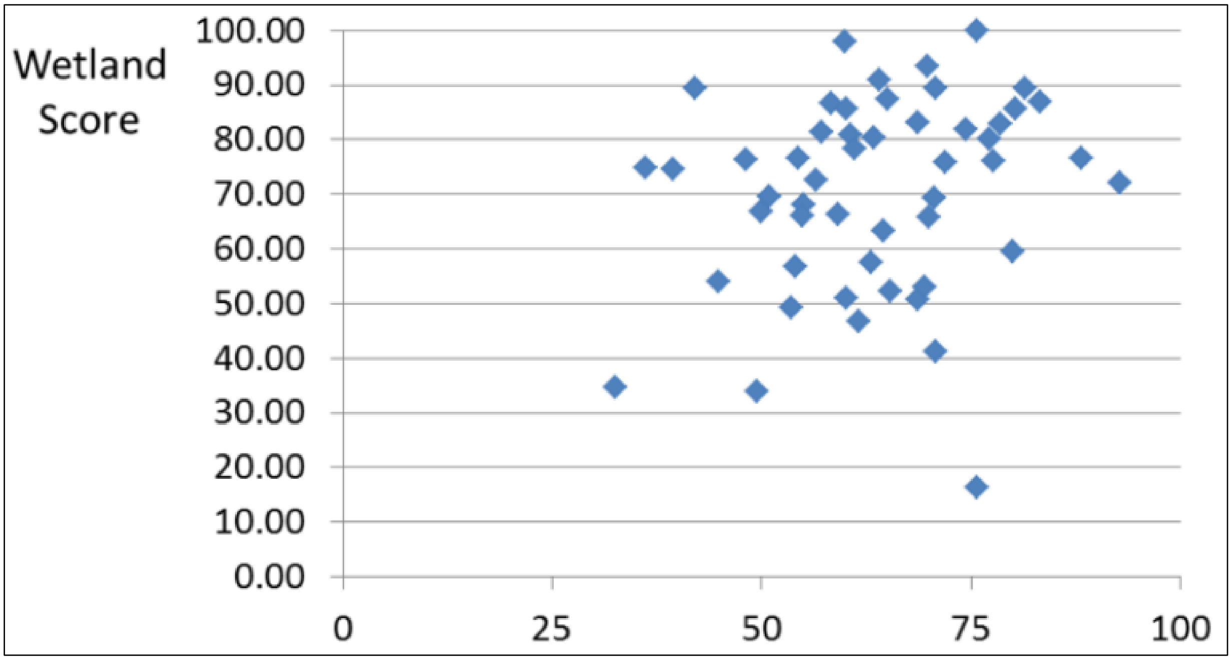

Figure 60. Condition rating of 51 meadow monitoring sites in the Sequoia National Forest.
Plant functional score is on the y-axis, and wetland score is on the x-axis. The numbers of point above 50 on the x-axis and the y-axis indicate better condition.

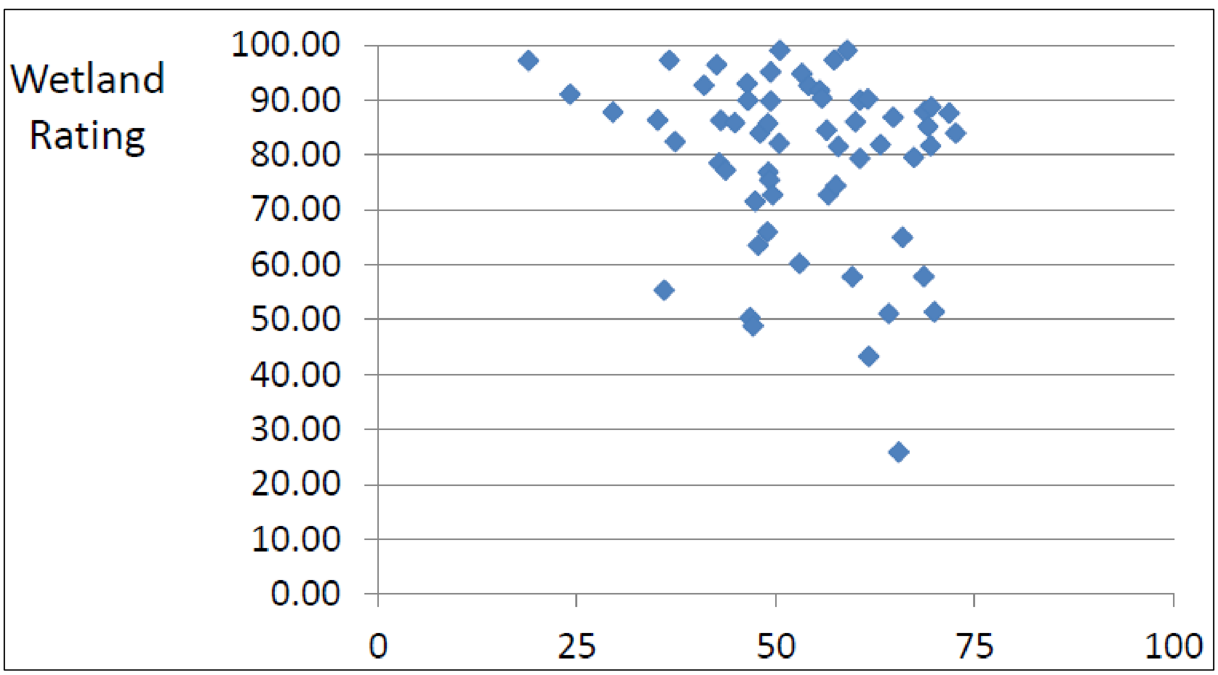

Figure 61. Condition rating of 60 meadow monitoring sites in the Sierra National Forest.
Plant functional score is on the y-axis, and wetland score is on the y-axis. The numbers of point above 50 on the x-axis and above 50 on the y-axis indicate better condition.

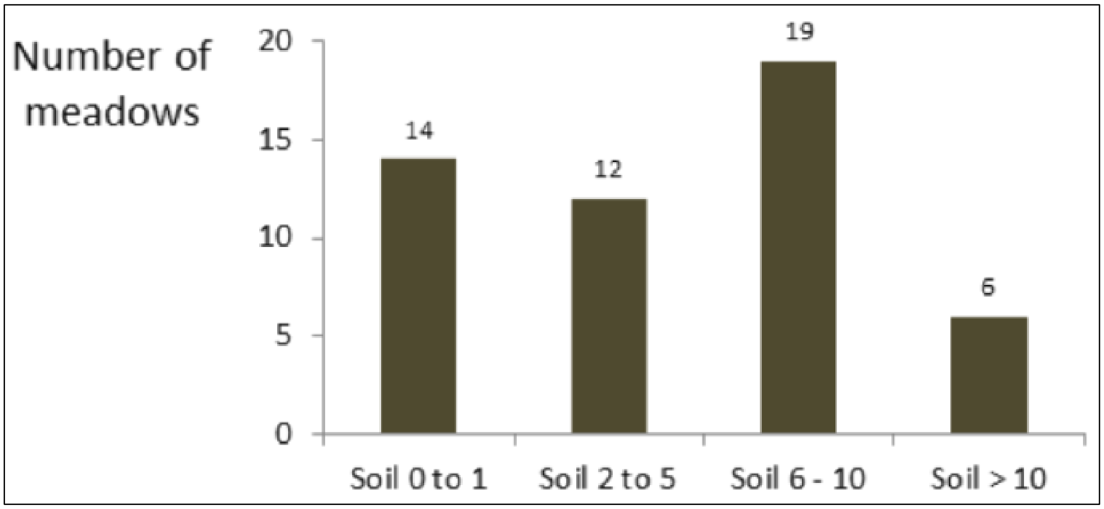

Figure 62. Sequoia National Forest – Bare Soil Cover (%) on 51 Meadow Monitoring Sites. The x-axis indicates the amount of bare soil present in the meadows.

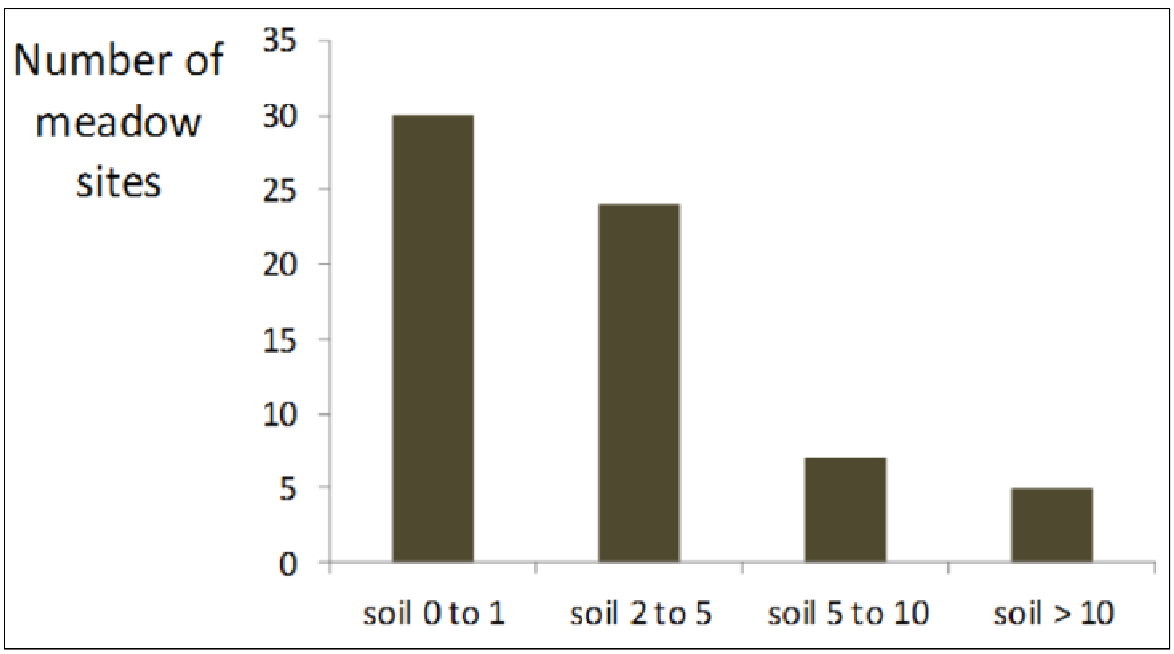

Figure 63. Sierra National Forest – Bare Soil Cover (%) on 60 Meadow Monitoring Sites. The x-axis indicates the amount of bare soil present in the meadows.

Riparian Condition – Proper Functioning Condition Assessments

Selected riparian areas and wetlands within the plan area have been inventoried and monitored to determine whether these areas are functioning properly based on a qualitative assessment of the interaction between vegetation, landform and/soils, and hydrology to determine hydrologic function. The forest plan standard and guideline is to ensure that characteristics of special features are, at a minimum, at proper functioning condition. Other rating categories include functional-at-risk (FAR) and non-functional. In the Sequoia National Forest, assessments of the hydrologic function of meadow habitats and other special aquatic features during range management analysis have been inventoried and monitored for specific allotments but have not been summarized across the plan area. In the Sierra National Forest, assessment of hydrologic function of meadow habitats and other special aquatic features during range management analysis are summarized in Table 143.

Table 143. Hydrologic function assessments of meadows and/special aquatic features during allotment analysis

Sierra National Forest	Total Number of Assessments	FAR Upward Trend	FAR No Trend Apparent	FAR Downward Trend	Non-functional	Proper Functioning Condition
Total number by assessment rating	55	14	8	3	0	30

Since 2006, seven range NEPA decisions have been completed within the Sequoia plan area and include analysis of 30 individual allotments. All of the range NEPA completed thus far has been primarily in annual grass and/oak woodland systems. A recurring issue requiring mitigation, through allotment analysis, was the need to improve the riparian component of many riparian areas, primarily springs and relatively small portions of streams within annual grass systems. All the sites required fencing to reduce livestock impacts and move the area to an acceptable standard (United States Department of Agriculture 2013b).

The long-term meadow condition and trend monitoring program was initiated in 1999. In 2012, the Forest Service and the University of California, Davis Rangeland Watershed Laboratory established a partnership to conduct the first comprehensive analysis of the long-term monitoring program dataset conducted by the Forest Service between 1997 and 2015 on montane meadows in the Sierra Nevada, including sites in the Sequoia and Sierra National Forests. Meadow health was assessed using the rooted frequency (Bonham 2013) data to calculate a suite of indicators of meadow condition and trend, including species richness, diversity (Simpson's and Shannon-Wiener indices), and evenness. Soil stability scores (Burton et al. 2010, Winward 2000) were calculated from plant functional trait groups, which are based on life form, life span, plant height, growth form (clonal or not), and nitrogen fixing ability. Between 1997 and 2012, a significant increase in mean species richness and Shannon-Weiner diversity was found in meadows in both forests. There was no significant change in the Ratliff condition class of good condition in both forests during this time.[52]

Rangeland Condition on Annual Grassland and Blue-Oak Interior Live Oak Woodland

In both forests, variations in precipitation and temperature cause far more variation in species composition and production than do grazing influences, even though livestock grazing can result in temporary changes in species composition (succession). As a general rule, if adequate residual dry matter is left at the end of the grazing season, then the condition and overall trend of the annual grasslands are considered meeting or moving toward desired condition as described in the Region 5 Range Environmental Analysis Handbook (USDA FS 1969). A moderate degree of grazing maintains satisfactory litter cover, or residual dry matter, to protect against soil deterioration and obtain efficient production from the fluctuating quantity of forage on foothill ranges.

[52] UCDRWL website: http://rangelandwatersheds.ucdavis.edu/main/projects/sierra_nevada_meadows_analysis.html).

A recurring issue requiring mitigation, through allotment analysis, has been the need to improve the riparian component of many riparian areas, primarily springs and relatively small portions of streams within annual grass and/oak woodland systems (United States Department of Agriculture 2013b, c, d). Another persistent issue has been the lack of successful blue oak regeneration and recruitment (Merriam et al. 2013).

Effectiveness of Current Grazing Direction and Information Gaps

The trend in head of cattle on Forest Service grazing allotments in California from 1980 through 2010 is shown in Figure 64. Reductions in the number of head relative to 1980 numbers were 21, 38, and 49 percent in 1990, 2000, and 2010, respectively.

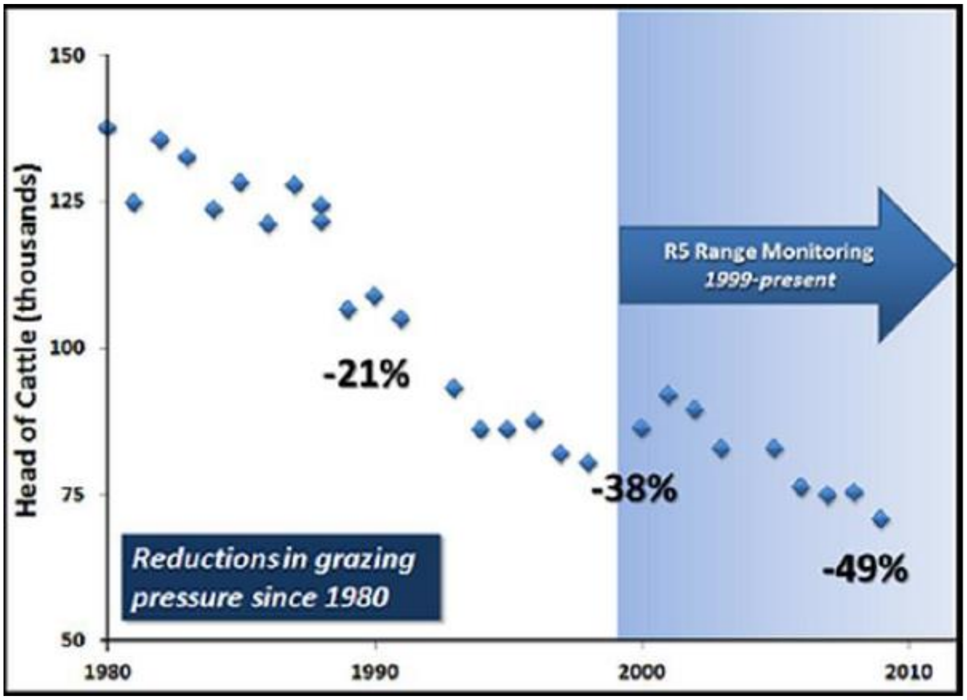

Figure 64. This figure represents the trend in head of cattle on Forest Service grazing allotments in California from 1980 through 2010. The long-term meadow condition and trend monitoring program was initiated in 1998.

A comprehensive study of modern conservation strategies and livestock production objectives (Oles et al. 2017) found that changes in plant community were not associated with livestock stocking rates or precipitation at the allotment scale. However, changes in both factors significantly affected changes in plant communities at the meadow scale. This analysis suggests the reductions in stocking rates have improved the balance between riparian conservation and livestock production goals. However, changing climate conditions (reduced snowpacks and the change in the timing of snowmelt) may negate those benefits at specific sites and adaptive site-specific management strategies are required to meet grazing pressure limits and safeguard ecosystem services.

Patterns of Rangeland Drought

As stated in the “Climate Change” section of this document, mean annual temperatures in the plan area have increased in the last several decades, mostly with increased nighttime temperatures (Mallek et al. 2012). At higher elevations, overall snowfall and spring snow water equivalent (amount of water in snowpack) have remained steady in most southern Sierra Nevada areas, but snowmelt occurs earlier in the year. Changes in temperatures and amounts and timing of precipitation have led to earlier peak stream flow rates in most Sierra Nevada streams, with higher spring flows and lower summer flows. Warming temperatures are leading to glacial recession across the southern Sierra Nevada.

Since 1982 the southern part of the United States has exhibited unfavorable trends in growing conditions resulting from warmer temperatures and decreasing precipitation (Vose et al. 2016b). During that period the Sierra Nevada showed moderately high increases in temperature while precipitation has been decreasing (years 1982–2012). Also, there have been moderately high decreases in vegetation abundance (years 2000–2013). In Region 5, cumulative drought corresponded with reductions in biomass to vary from low to moderately high across the Sequoia and Sierra National Forest grazing allotments, particularly at the southern end of the Sierra Nevada from 2000 to 2015 (Reeves 2016).

Environmental Consequences

Since the 1988 Sequoia and 1991 Sierra National Forest Land and Resource Management Plans have been implemented, there have been three forest plan amendments in each forest with specific updates in direction to production livestock grazing (United States Department of the Interior 1995b, United States Department of Agriculture 2001c). In 1995 the Sierra National Forest grazing amendment emphasized establishing a proper utilization level based on desired vegetation conditions and proper functioning condition on grazable rangelands. In 2001 and 2004, the Sierra Nevada amendments focused on using adaptive management to improve riparian conservation and achieve proper hydrologic function of riparian systems and watersheds, in addition to conservation of high-value aquatic and wildlife habitats, such as aspen and willow plant communities. The 2001 and 2004 amendments complemented the goals and objectives already in place under the Sierra's 1995 plan amendment.

All active grazing permits have incorporated allowable utilization levels based on the rangeland assessments consistent with each forest plan; additional adjustments have been made to grazing permits consistent with the 2004 Sierra Nevada plan amendment. In addition to these two previous plan amendments, there have been incremental adjustments to the grazing program when addressing specific grazing impacts on federally listed species. Management terms and conditions required as a result of consultation with the U.S. Fish and Wildlife Service and their authorized incidental take have been incorporated in the term grazing permits where applicable.

Consequences Specific to Alternative A

Livestock Grazing Use

Under alternative A, there would be no change to the existing management direction for livestock grazing. Current management direction for term grazing permits and allotment management plans would remain in place. New permits and management plans would follow direction identified in the Sequoia and Sierra Forest Plans as amended in 2004 (United States Department of Agriculture 2004b). There would be no anticipated change in the overall permitted use from existing conditions unless identified during project-level NEPA analysis. Commercial livestock grazing opportunities on the two forests would continue to be constrained at or near current levels.

Permitted livestock use could decline over the next 50 years with warmer temperatures, increased frequency and duration of drought conditions, and more frequent and larger wildfires. There would be the potential for a slight downward trend in permitted AUMs due to shifts in the plant communities and associated forage production. In Sierra Nevada riparian and meadow ecosystems, changes in plant community were not associated with either the livestock stocking rate or precipitation at the allotment scale. Associations between elevation, site wetness, precipitation, and changes in the plant community suggest that changing climate conditions (for example, reduced snowpacks and a change in timing of snowmelt) could trigger shifts in plant communities, potentially impacting both conservation and agricultural services (Oles et al. 2017), Existing local demand for production livestock forage will exceed forage being made available and authorized.

Under alternative A, there would be no new recommended wilderness or eligible wild and scenic rivers (Table 1 and Table 2). Allotment grazing levels and the commitment of forage resources to grazing would continue to be assessed and determined at the allotment level during NEPA analysis. Existing wilderness designation would continue to prohibit access by motorized vehicle and mechanized equipment for maintenance of stock water developments and salt placement, and it potentially would restrict installation of new range improvements (water troughs) unless approved following a minimum requirements decision. Overall, the annual operating costs to the current permittees would remain static.

Rangeland Vegetation Improved

If implementation of the current Sequoia and Sierra grazing management strategies (USDA FS 2004) were to continue, vegetation and watershed condition trends would be expected to remain stable or continue to improve, for the next 20 years, particularly within riparian conservation areas. However, in montane meadow complexes, plant communities likely would shift from wetland-obligate to wetland-facultative species. In terrestrial ecosystems, moderate change is anticipated under all alternatives in amount and extent of annual grass conversions, in the montane zones, due to climate change and the trend in large wildfires as modeled during the next mid-century (2035–2064). Reductions in biomass will vary from low to moderately high across the Sequoia and Sierra National Forest grazing allotments, particularly at the southern end of the Sierra Nevada.

Adaptive management and monitoring have been key components of the Sequoia and Sierra grazing management strategy with particular focus on aquatic, riparian, and meadow ecosystems and associated species (USDA FS 2004). Existing rangeland assessment processes have allowed managers to take action to adjust utilization allowances and grazing management strategies to protect herbaceous and woody riparian plants, aspen, meadows, and blue oak woodlands. However, these adjustments using low-intensity grazing approaches rarely can restore special aquatic features, such as fens, springs, or ephemeral pools important to aquatic-dependent species. In general, livestock management strategies have been lacking in timely response or adaption to drought, shifts in forage plant communities, loss of herbaceous forest understory vegetation, or creation of postfire transitory range.

Improved meadow and riparian sites would result in increased forage available to grazing animals, along with improved overall ecological health of rangelands, which also benefits native fauna. These improvements in ecological integrity may offset anticipated declines in forage production due to climate change and shifts from mesic to more xeric forage plant species or expansion of annual grasses into montane and upper montane zones during the next mid-century (50+ years).

Under alternative A, in the Sierra National Forest 46,037 acres of CARs have allotments. Of these, 22,536 acres are in active allotments. Under alternative A, in the Sequoia National Forest

124,835 acres of CARs have allotments. Of these acres, 80,813 are in active and 44,022 are in vacant allotments.

Consequences Specific to Alternatives B, C, D, and E

Livestock Grazing Use

Under alternatives B, C, D, and E, there would be several updates to the existing management direction for livestock grazing as compared with alternative A. Current management direction for term grazing permits and allotment management plans would be updated where applicable for changes in design criteria for disturbance to stream banks, lakeshores, fens, and breeding pools for federally listed amphibians. New permits and management plans would follow direction identified in the revised draft Sequoia and Sierra Forest Plans in "Forestwide Desired Conditions and Management Direction," "Social and Economic Sustainability" and "Multiple Uses, Rangeland Livestock Grazing."

In the action alternatives, grazing standards are focused on making timely adjustments to management practices where grazing is found to prevent or retard attainment of desired conditions for key riparian and upland rangeland vegetation types. Grazing guidelines provide annual or seasonal livestock indicators that trigger a need to move or remove livestock from a key use area or allotment. For all alternatives, procedures for conducting rangeland condition evaluations used to determine allowable utilization guidelines would remain in the regional rangeland analysis and planning guide (R5-EM-TP-004 2017 [(United States Department of Agriculture 2017d) and incorporate the most recent agency rangeland and watershed evaluation methods.

There would be no anticipated change in overall permitted use from existing conditions unless identified during project-level NEPA analysis. Commercial livestock grazing opportunities in the Sequoia and Sierra National Forests would continue to be constrained at or near current levels. All action alternatives have more adaptable management direction than alternative A. They also would reflect changes in direction that had been incorporated into existing grazing permits and allotment management plans in the past for the protection of federally listed species or Forest Service species of conservation concern.

Under alternatives B, C, D, and E, permitted livestock use could decline over the next 50 years with warmer temperatures, increased frequency and duration of drought conditions, and more frequent and larger wildfires. There would be the potential to offset declining permitted use if transitory rangelands become available postfire. Postfire burned areas within suitable grazing allotments would be evaluated to determine appropriate rest for vegetation recovery and adjustments to permitted grazing from available forage. Where feasible and suitable, grazing can be used as a tool to reduce vegetation buildup to lower the risk of unwanted wildfire. Under all alternatives, existing local demand for production livestock forage would exceed forage being made available and authorized.

Rangeland Vegetation Improved

Under alternatives B, C, D, and E, with implementation of the modified Sequoia and Sierra grazing management strategies (United States Department of Agriculture 2004b), vegetation and watershed condition trends would be expected to be stable or continue to improve, for the next 20 years, particularly within riparian conservation areas. However, in montane meadow complexes, plant communities likely would shift from wetland-obligate to wetland-facultative species. In terrestrial ecosystems, moderate change is anticipated under all alternatives in the amount and extent of annual grass conversions, in the montane zones, due to climate change and trend in large wildfires as modeled during the next mid-century (2035–2064).

Reductions in biomass will vary from low to moderately high across the Sequoia and Sierra National Forest grazing allotments, particularly at the southern end of the Sierra Nevada. The highest probability of percent change due to large wildfires is under alternatives A, C, and E, and less under alternatives B and D. This is because alternatives B and D would allow for more restoration efforts in the foothill, montane, and upper montane ecological zones, which correspond with the location of active grazing allotments.

Under alternatives B, C, D, and E, adaptive management and monitoring would be emphasized as key components of the Sequoia and Sierra grazing management strategy. There would be continued focus on aquatic, riparian, and meadow ecosystems and associated species. There also would be added focus on active restoration of these riparian and meadow ecosystems, management criteria indicators for fens and Yosemite toad breeding pools, and timely management response to drought and postfire transitory range. Like alternative A, existing rangeland assessment processes would allow managers to take action to adjust utilization allowances and grazing management strategies to facilitate protections of herbaceous and woody riparian plants, aspen, meadows, and blue oak woodlands.

Alternatives B through E would also be more responsive in maintaining and restoring special aquatic features, such as fens, springs, or ephemeral pools important to aquatic-dependent species. These alternatives encourage livestock management strategies with timely response and adaptation to drought, shifts in forage plant communities, loss of herbaceous forest understory vegetation, or creation of postfire transitory range.

Improved meadow and riparian sites would result in increased forage available to grazing animals, along with improved overall ecological health of rangelands to a greater extent than alternative A. These improvements in ecological integrity would be more likely to offset anticipated declines in forage production due to climate change and shifts from mesic to more xeric forage plant species or expansion of annual grasses into montane and upper montane zones during the next mid-century (50+ years), to a greater extent than alternative A.

Consequences Specific to Alternatives B, C, and E

Under alternative B, conservation watersheds have been introduced along with watershed direction to reduce sedimentation, which would enable improvements to water quality over time within allotments. Within conservation watersheds (Table 144) in the Sierra National Forest, 409,425 acres of allotments, with 261,681 acres of active allotments, are found. Within the conservation watersheds (Table 144), the Sequoia National Forest has a total of 325,531 acres in allotments, with 207,400 acres in active allotments. Under alternatives C and E, there would be an increase in CARs acreage from alternative A, as well as the addition of conservation watersheds in the Sequoia National Forest and Sierra National Forest. In the Sequoia National Forest, the higher-elevation acres can be in wilderness or inventoried roadless areas, within vacant or active allotments in the upper South Fork Kern, the upper North Fork Kern, and the Lower Kern conservation watersheds. These conservation watersheds contain all the proposed CARs.

Under alternative C, in the Sequoia National Forest, 177,532 acres of CARs have allotments. Of these acres, 86,203 acres are in active and 91,329 acres are in vacant allotments. In the Sierra

Table 144. Comparison of land allocations for aquatic conservation (critical aquatic refuges and conservation watersheds) in suitable rangelands. The last two columns compare the acreage of land allocations across the alternatives with alternative A.

Alternative	Sequoia National Forest CAR and/or Conservation Watershed Acres	Sierra National Forest CAR and/or Conservation Watershed Acres	Acreage Change in the Sequoia National Forest	Acreage Change in the Sierra National Forest
Alternative A	124,835	46,037	N/A	N/A
Alternative B	325,531	409,425	200,696	363,388
Alternative C	325,531	559,334	315,692	513,297
Alternative D	0	0	-124,835	-46,037
Alternative E	325,531	559,334	200,696	513,297

National Forest, 197,605 acres of CARs have allotments. Of these acres, 78,390 acres are in active, 18,503 acres are in vacant, and 100,712 acres are in closed allotments. Under alternatives B, C, and E, the additional CARs or conservation watersheds plan components do not prohibit livestock grazing activities. Forest plan components for these management areas allow for the continued use of livestock. Further improvements to riparian areas and meadows within these watersheds would improve forage.

During implementation of restoration actions within conservation watersheds, specific project design features may be created to reduce the impacts of livestock grazing on restoration efforts (for example, meadow restoration where willows are planted), and to ensure that grazing activities promote attainment of functional watershed condition indicators, consistent with the purpose of the conservation watershed. Under the alternatives, the impacts of these design features on livestock grazing would be determined and analyzed at the project level. The forest plan contains standards and guidelines that apply to livestock grazing within riparian conservation areas. These are not new standards and guidelines and are adapted from the 2004 Sierra Nevada Forest Plan Amendment.

Alternatives C and E include new recommended wilderness in both the Sierra National Forest and Sequoia National Forest, although the total recommended wilderness acreage would be smaller under alternative E. Under alternative C, these recommended wilderness additions would restrict vehicle access to four active and two vacant allotments in the Sequoia National Forest and nine active and two vacant cattle allotments in the Sierra National Forest. Alternative B includes one new recommended wilderness in the Sequoia National Forest that is entirely within the GSNM. Alternatives A and D have no new recommended wilderness areas.

Wilderness designation would not restrict current permitted grazing levels. However, wilderness designation likely would curtail reactivation of vacant allotments, would prohibit motorized vehicle access for maintaining stock water developments and salt placement, and would restrict installation of new range improvements (water troughs), unless approved following a minimum requirements decision.

Other issues that can arise after a wilderness designation include a limited ability to propose new rangeland improvements, such as water developments or drift fences, which can hinder the ability to reach desired rangeland conditions. Also, widely held public expectations of pristine conditions beyond those conditions used by the Forest Service to describe wilderness character (see Revision Topic 3: Sustainable Recreation and Designated Areas; also Appendix B) often lead to frustration at seeing livestock in a wilderness setting. Visitors hazing or maliciously harassing authorized livestock in wilderness has become more frequent in recent years.

Effectively controlling livestock herds under these circumstances can often require doubled up workloads by the grazing permittees (Sims, personal communication). Adverse effects under alternative C would be greater than those under alternatives A, B, and D. Overall, the annual operating costs to the current permittees could increase under these conditions. The extent of these effects is uncertain at this programmatic level.

The effects under alternative E would be similar to those under alternative C, except for one difference. Some of the recommended wilderness areas under alternative C are replaced under alternative E with backcountry areas. There would be no impacts on livestock grazing in these backcountry areas under alternative E, because commercial livestock grazing would be permitted in these backcountry areas.

In summary, under alternatives B, C, and E, grazing activities would be governed by desired conditions, plan direction for riparian conservation areas, conservation watersheds, at-risk species, recommended wilderness, and water quality in the forest plan area. Under alternative D, grazing could be affected by other plan direction that calls for maintaining or improving the quality or quantity of watershed resources, such as water quality, while ensuring sustainable continuation of multiple uses.

Cumulative Environmental Consequences

Fire Management. In both forests, under alternatives B, C, D, and E in the various wildfire management zones, where feasible and suitable, grazing can be used as a tool to reduce vegetation buildup to lower the risk of unwanted wildfire. Postfire burned areas in suitable grazing allotments would be evaluated to determine appropriate rest for vegetation recovery and adjustments to permitted grazing from available forage.

Ecological Integrity–Species of conservation concern. For great gray owl (GGO), under alternatives B, C, D, and E most plan components regarding livestock grazing have been carried forward from the existing plans and are the same across alternatives. Guidelines are included to remap GGO protected activities centers (GGO PACs) or retire GGO PACs when they are no longer active.

For willow flycatcher, current direction (alternative A) includes survey requirements and livestock grazing direction for occupied sites. Under alternatives B, C, D, and E, livestock grazing direction only pertains to known occupied sites (presently, there is no overlap of occupied sites and livestock grazing on either forest).

For Yosemite toad, under alternatives B, C, D, and E, there are specific plan components that have been updated. This direction pertains only to the Sierra National Forest (there are no known occurrences in the Sequoia National Forest allotments). Guidelines that exclude livestock grazing within areas occupied by Yosemite toads during the breeding and rearing season, except where a site-specific management plan is developed, would change to a new system to determine appropriate management strategies. In the new system, known and/or highly suitable Yosemite toad breeding pools would be assessed for hydrological functionality. Allowable utilization and disturbance levels would be set based on meadow hydrologic function. Allowable utilization levels would range from 0 percent to 40 percent; allowable alteration to breeding pools would not exceed 20 percent.

Acres of riparian ecosystems restored are projected to be highest under alternative D at 1,000–1,500 acres of meadow in both forests and 15–25 miles of streams restored in both forests. Riparian restoration is slightly lower under alternative B at 500–1,000 acres of meadow and 15–25 miles of streams restored in both forests. Miles of streams restored are highest under alternative C at 20–30 miles for both forests. Ecological restoration of aquatic and riparian habitats will remain a priority under all alternatives. Under all alternatives, short-term impacts from restoration efforts may be adverse to individual permittees at the allotment scale if temporary changes in livestock management are needed to minimize disturbance on these sites. However, long-term impacts under all action alternatives would be beneficial once restoration objectives have been reached, such as benefits sustaining desired forage plant species and permitted grazing levels over time.

A rangeland condition and biodiversity assessment on national forests within the region is in progress by the Forest Service and University of California, Davis to estimate trends over the last 20 years. Over 800 monitoring sites have been established in the national forests in California since 1999. Results from this study are expected in the near future, which will provide a more meaningful assessment of rangeland condition and trend and response to grazing management, as well as to weather and other factors. Alternatives B, C, D, and E would provide the best means of adjusting rangeland and watershed evaluation assessments or adapting management to any new information from these monitoring efforts.

Both critical aquatic refuges and conservation watersheds would contain suitable rangelands where U.S. Fish and Wildlife Service terms and conditions are currently in place to protect federally listed aquatic species. Additional protections for species of conservation concern may also influence range management.

Ecological Integrity–Special Aquatic Features. All four action alternatives would continue existing design criteria for management and protection of fens. A management indicators technical guide has recently been developed to assess ground disturbance, and it provides managers and livestock producers a quantifiable measure of permitted disturbance levels on these special aquatic features and the need to move or remove livestock if disturbance levels are exceeded. Alternatives B, C, D, and E provide an additional riparian conservation standard to limit disturbance on fens from livestock annually at 15 to 20 percent and to make further adjustments if fen conditions are trending downward.

During implementation of restoration actions within conservation watersheds, specific project design features may be created to reduce the impacts of livestock grazing on restoration efforts (for example, meadow restoration where willows are planted) and to ensure grazing activities promote attainment of functional watershed condition indicators, consistent with the purpose of the conservation watershed. Under the alternatives, the impacts of these design features on livestock grazing would be determined and analyzed at the project level. The forest plan contains standards and guidelines that apply to livestock grazing within riparian conservation areas. These are not new standards and guidelines and are adapted from the 2004 Sierra Nevada Forest Plan Amendment.

In summary, under all alternatives, grazing activities would be governed by desired conditions, plan direction for riparian conservation areas, conservation watersheds, at-risk species, and water quality in the forest plan area.

Benefit to people and communities. The forestwide rangeland management goal to provide stability to local ranching communities would continue under all alternatives. Under alternatives B, C, D, and E, a desired condition is added to provide for open space, grazable landscapes, rural landscapes, and cultural heritage. Under alternative A, long-term impacts on grazing opportunities could result from no increase in restoration activities to reduce the risk of uncharacteristic wildfires or to improve forest and rangeland health. Under alternatives B, C, D, and E, short-term impacts from restoration efforts may be adverse to individual permittees at the allotment scale with long-term benefits once restoration objectives have been reached.

Analytical Conclusions

Under all alternatives, there would be no change in rangeland suitability acres. Any adjustments to the suitability analysis and subsequent suitability determinations would involve project-level NEPA.

All alternatives would continue authorized grazing at current levels over the 20-year analysis period. Alternatives B, C, D, and E would have modest improvements in riparian conservation areas and resilience to disturbance and climate change at the allotment level. Landscape-scale resilience would continue to decline over the next mid-century in the foothill, montane, and upper montane ecological zones due to upward trends in large wildfires, annual grass conversion, and climate change and prolonged patterns of persistent drought. Permitted livestock use is likely to decline over the next 50 years.

Alternatives B, C, D, and E provide design criteria that are less prescriptive and more adaptive than alternative A. Rangeland assessment processes remain in the regional rangeland analysis and planning guide (R5-EM-TP-004 2017). This approach would allow timely updates to rangeland assessment procedures using best available science and new information.

Reductions in biomass will vary, from low to moderately high, across the Sequoia and Sierra National Forest grazing allotments, particularly at the southern end of the Sierra Nevada. The highest probability of percent change due to large wildfires is under alternatives A and C and less under alternatives B and D. This would be due to restoration in the foothill, montane, and upper montane ecological zones, which corresponds with the location of active grazing allotments. Under all alternatives, at the allotment scale, short-term impacts from restoration efforts would be offset by long-term benefits, such as sustaining permitted grazing levels over time, once restoration objectives have been reached.

Economic Conditions

Background

Forest management influences the economic sustainability of the communities that surround the forests and impacts the provision of forest benefits that affect the quality of people’s lives both locally and further removed from the plan area. This section examines potential effects on the benefits to people by examining potential changes in the key benefits that the forests provide (such as recreation opportunities, clean air and water, forest products, grazing, species habitat, and energy). Current threats resulting from uncharacteristic wildfire and declining forest health bring into question the long-term sustainability of these important benefits. Plan alternatives that address these concerns are examined as to their potential to improve the sustainability of key forest benefits while also examining the short- and long-term tradeoffs associated with these management actions.

Analysis and Methods

Study Area and Data Sources

The information describing local economic conditions is obtained from "Chapter 6: Assessing Social, Cultural and Economic Conditions" in the individual national forest assessments that were written for the plan revision (United States Department of Agriculture 2013b). Key national forest contributions are examined for the geographic areas where National Forest System land management supports economic activities. These areas represent the counties where national forests provide opportunity for production of commodities and forest visitation and also those counties where forests have made the most direct expenditures in management (such as spending on projects and Forest Service employee salaries).[53] This information on key economic contributions of the forests is obtained from the Forest Service Economic Contribution model (United States Department of Agriculture 2015g, h).

The forests also provide benefits to communities located further away from the administrative boundaries (such as water for municipal and agricultural uses and electricity for residences) and moreover provide nonmarket benefits where quantifying economic contributions is difficult (such as the value of the biodiversity in the forests). The key forest benefits were identified using "Chapter 7: Benefits to People" in the national forest assessment referenced earlier, as well as the national forest "distinctive roles and contributions" statements for each forest that were developed for the plan revision and are included in the forest plans.

Methodology for Analysis

Two separate analyses are conducted: (1) a restoration funding analysis looking at the potential opportunities and challenges for funding the increased pace and scale of management activities under the plan alternatives, and (2) a forest benefits analysis looking at potential short- and long-term effects on the key national forest benefits that support jobs in local economies and improve the quality of people's lives throughout the region.

The restoration funding analysis is undertaken to provide context for the opportunities and challenges that the forests will face funding increased pace and scale project implementation under each alternative. The different approaches to mechanical thinning in each of the alternatives has consequences for funding restoration using the value of the biomass in the forest. This analysis examines whether there are reasonable opportunities in the forest to develop projects that will generate revenues to not only pay for themselves but also contribute to other restoration projects. Given that forest budgets are not expected to increase, these acres will need to play a critical role in funding any increased pace and scale of restoration.

The first step was identifying the number of acres in the forest where timber may be harvested and that contain at least 4,000 cubic feet of volume per acre. This includes areas suitable for timber as well as volume that may be generated as a byproduct of treatments designed to restore desired conditions across the forests. The assumption is restoration thinning would remove around 25 percent of the volume from these acres and the amount harvested (at least 1,000 cubic feet per acre) would generate revenue sufficient to pay for restoration. The second step was to then examine the number of restoration acres expected to occur under the direction for each

[53] These are Fresno, Kern, and Tulare Counties for the Sequoia National Forest, and Fresno, Madera, and Mariposa Counties for the Sierra National Forest.

alternative and determine if there are enough of the revenue-generating acres in the forests to sustain this desired restoration pace and scale over the life of the plan.

The forest benefits analysis looks at potential changes in seven key forest benefits important for communities and people locally (for example, supporting jobs and quality of life) and across the region (for example, water quality and quantity, recreation opportunities, air quality, forest products, grazing, energy generation, and biodiversity). This qualitative analysis examines how the plan alternatives indirectly affect these key national forest benefits and what these potential effects mean for people and communities. Jobs supported by forest products are estimated quantitatively using Forest Service modeling (United States Department of Agriculture 2014a). These jobs supported result from expected economic activity in the area and represent the estimated average annual employment that would be supported by forest products activity under each of the alternatives.

Important to this look at national forest benefits is consideration of the tradeoffs associated with potential short- and long-term effects. Short-term effects would be expected while the types of restoration activities expected under the various alternatives are occurring. These types of effects typically involve restricted national forest access or other consequences to resources (such as sedimentation or smoke) due to activities such as mechanical thinning or use of prescribed fire. Long-term effects would be expected after restoration activities are completed and represent the expected resulting conditions and consequences of these activities on the sustainability of national forest benefits. Examples of these types of long-term effects would be reduced fuel loads and improved forest heath from restoration activities that lower the long-term risk associated with uncharacteristic wildfire, drought, and forest insects and diseases. These improved conditions would increase the sustainability of forest benefits to people.

The following assumptions are made in conducting these analyses:

- All the potential effects on benefits to people and communities are indirect in nature, as the plan is programmatic and does not compel any action to occur or authorize any projects or activities.
- National forest base funding and staffing levels remain constant and representative of current trends across alternatives and for the life of the plan.
- Funding for increased restoration and management activities is obtained from outside existing national forest budgets through stewardship contracts and partnership opportunities, and thus represents new money into the local economy.
- There are no current or expected future changes to mining activities or the associated program as a result of the proposed plan alternatives.

Affected Environment

This section presents:

- A description of the economic conditions within the counties that intersect the national forest administrative boundary where forests provide opportunity for production of commodities and forest visitation and also those counties where the forests have made direct expenditures in management
- A description of the key economic contributions the national forests make that influence economic conditions and influence economic sustainability

- A description of how uncharacteristic wildfire and disease and insect pathogen mortality in vegetation threaten key national forest economic contributions

Economic Conditions

Economic conditions are described by examining two key factors: the economic health and local fiscal conditions surrounding the national forests.

Economic health is the overall health, or prosperity, of an economy, and this influences its ability to adapt to change. An economy already facing job loss and low incomes is likely to be less able to adapt to national forest management changes that affect key economic sectors. Three key statistics are presented below as measures of this economic well-being: the annual unemployment rate, average earnings per job, and per capita income.

Local fiscal conditions represent the finances of local governments, specifically the sources of revenue and the targets of spending. Local governments rely on revenues generated from activities on national forest lands. These revenues can be summarized in three broad categories: direct, indirect, and secondary. Direct includes the direct subventions from the Federal Government and include Federal Forest Reserve and Payment in Lieu of Taxes.[54] Indirect revenues are the timber, sales, and transient occupancy taxes collected as a direct result of timber activity on the national forests and the visitors to the national forests that buy and pay sales tax and pay transient occupancy taxes. Secondary revenues are those taxes collected because those businesses providing these services use a portion of the revenues received to pay their taxes.

Management decisions that affect all these activities have the potential to impact county revenues. To determine the context of these payments, it is necessary to understand how important these revenues are to local budgets and also understand the current overall budget conditions of local governments. Communities facing difficult fiscal conditions would feel an impact from changes in these revenues, thus leading to the potential for reduced public services provision in the area. The context of these factors is examined below.

Economic Health

With higher unemployment, lower earnings, and lower per capita income than California as a whole, the counties in the study area for the forests are facing relative challenges to their economic health. Thus, communities in these forest counties may be less able to adapt to forest management changes that would affect key economic sectors than would communities located in other counties across the state. The economic conditions in these forest counties are similar to conditions throughout counties in the rest of the bioregion. These data are presented in Table 145 (Headwaters Economics 2018).

Table 145. Economic health in counties surrounding the Sierra and Sequoia National Forests

County	Unemployment Rate, 2017	Average Earnings, 2016	Per Capita income, 2016
Mariposa	5.8%	$48,293	$50,521
Madera	8.0%	$61,798	$38,317
Fresno	8.6%	$53,736	$40,943

[54] Congress passed 2018 spending bill P.L. 115-141 that included reauthorization of the Secure Rural Schools program, including retroactive payments to states for fiscal year 2017. Some counties choose to instead receive payments under the 1908 Act, commonly called 25 percent payments.

County	Unemployment Rate, 2017	Average Earnings, 2016	Per Capita income, 2016
Tulare	10.4%	$52,463	$38,509
Kern	9.3%	$58,905	$38,506
Bioregion*	**7.5%**	**$54,150**	**$44,060**
California	**4.8%**	**$69,552**	**$57,558**

* The bioregion is meant to represent communities in and around the national forests in the region. It is comprised of the counties that intersect the area examined in the "Final Sierra-Nevada Bioregional Assessment" (Headwaters Economics 2018).

Local Fiscal Conditions

The counties bordering the national forests receive important revenues from the sales taxes collected on the travel spending by visitors to the region.[55] There is also some revenue collected from the timber products sold, but this is a very small amount in comparison with visitor-related revenues. Table 146 shows these sources are a significant portion of the total local tax revenue collected, particularly in smaller rural counties, such as Mariposa County, with a less diverse economy dependent on visitation to the recreation opportunities in the area, including Yosemite National Park. Therefore, it is important to recognize that these smaller rural forest counties can be reliant on visitors to the area and the resulting tax revenues that are essential for providing key public services, such as fire, safety, and roads.

Table 146. Fiscal contributions in counties surrounding the Sierra and Sequoia National Forests

County	2016 Total County Tax Revenues Collected ($ million)	2016 Total Tax Revenues from Visitation to Area	Percentage of 2016 Visitor Tax Revenues to Total Revenues
Mariposa	$66.6	$22.2	33.3%
Madera	$216	$9.1	4.22%
Fresno	$1,490	$41.9	2.81%
Tulare	$750.32	$14.6	1.95%
Kern	$1,830	$31.9	1.74%

Source: (Dean Runyan and Associates 2017) (California State Controller's Office 2018)

Payments in lieu of taxes (PILT) and other Federal payments (such as the 25 Percent Fund and Secure Rural Schools Act payments) are also an important contribution to local county government revenue. Table 147 provides the PILT amounts to each county from Forest Service lands.

Table 147. PILT to counties surrounding the Sierra and Sequoia National Forests

County	2015 PILT from Forest Service Lands
Mariposa	$290,111
Madera	$471,970
Fresno	$1,166,173
Tulare	$460,570
Kern	$183,598

Source: (United States Department of Agriculture 2016d)

[55] Travel-based tax receipts include transient occupancy taxes, sales taxes, and airport passenger facility charges paid by visitors, and the property tax payments and sales tax payments attributable to the travel industry income of employees and businesses.

Key National Forest Economic Contributions

Contributing to community well-being by providing a broad range of economic opportunities for national forest communities is consistent with current Forest Service direction from the U.S. Department of Agriculture to generate jobs through recreation and natural resource conservation, restoration, and management in rural areas (United States Department of Agriculture 2010). However, Federal forest management alone cannot ensure community stability because market conditions and changes in technology outside the control of forest management influence jobs in the forest products, agricultural, mining, and recreation industries. As a result, national forests cannot expect to ensure community economic well-being through their management actions alone (Charnley 2013).

While national forests are not the sole factor determining economic well-being, they do contribute economically to local communities and also to communities that are located further from the national forests. Recreation opportunities in the Sierra and Sequoia National Forests that draw visitors to the area are specifically important to local economies within the study area. Grazing and mining activities also occur in the forests and are important to local economies and culture. However, there are no current or expected future changes to mining activities or the associated program as a result of the proposed plan alternatives, so mining is not examined in detail here. Water from the national forests is also examined as a vital resource contributing economic value both on and off the forests.

Other vital national forest benefits besides these commodities may be less apparent in our daily lives and their benefits difficult to measure, but these benefits are important because they support the ecosystems and social environments in which we live (such as biodiversity in forest landscapes). However, there is no universally accepted methodology for how to quantify the benefits of these types of nonmarket benefits. Instead, the benefits biodiversity provides are described qualitatively to capture the importance of these benefits to people.

Forest Products

The forest products industry in California has been declining in size for the past few decades. In 2012, there were an estimated 77 active primary wood and paper products facilities in the state, down significantly from 262 in 1968 (McIver et al. 2015). This decline in infrastructure is an important development in terms of restoration activities in the region. Increasing the pace and scale of restoration is economically dependent on sustaining the necessary infrastructure and workforce to utilize the biomass removed from the forests.

As of 2015, timber sector jobs in the counties bordering the Sequoia and Sierra National Forests made up a small percentage of total private sector employment. This timber employment accounted for around 0.6 percent of all private sector jobs in the counties, which is a similar percentage to the state and the bioregion. Within the timber sector, wood products manufacturing accounts for most of this employment with very few jobs occurring in sawmills and paper mills and in the growing and harvesting industries. Total employment in the timber sector has been decreasing recently from around 0.8 percent of all private sector employment in 1998 to 0.6 percent today (Headwaters Economics 2018).

The closing of the North Fork Mill (with an estimated 145 employees and 33 million board feet of annual capacity) contributed to the decline in timber sector jobs in the area. The North Fork Community Development Council is working to redevelop this mill site to find uses for biomass material generated by forest management, specifically bioenergy generation. Biomass energy facilities have the potential to bring new jobs with good comparative wages into rural communities. The long-term nature of this employment would provide durable improvement and added stability to local and regional economies (Morris 2000). Since 1994, the closing of three other key sawmills in the area (located in the communities of Madera, Auberry, and Dinuba) have also contributed to the loss of sawmill capacity (an estimated loss of 97 million board feet annually) and also the loss of critical timber sector jobs in these rural economies (McKillop 2001).

Currently, the Sierra and Sequoia National Forests provide timber for three remaining sawmills in the area: Sierra Forest Products in Terra Bella, California, and Sierra Pacific Industries in Chinese Camp and Sonora/Standard, California. The Sierra Forest Products mill in Terra Bella is the last remaining mill in California south of Yosemite and economically is the only currently viable alternative for timber from these two forests.

The Terra Bella mill is important to the restoration efforts in the forests as this facility and its workforce help to transform the resulting harvest into valuable forest products that can financially support restoration. It is this revenue-generating capacity that has the potential to fund increases in the scale of necessary restoration activities on other parts of the forest. Without this mill and workforce, it would be necessary to transport harvested material further north to the other two mills at an increased cost that is likely not economical. It is estimated that the Terra Bella mill requires, at a minimum, approximately 25 million board feet of volume annually from the two national forests to remain operational (Regelbrugge 2018). These 25 million board feet are in addition to material it receives from other private and public land in the area.

Recreation and Tourism

Travel and tourism-related industries are important in the local communities surrounding the forests. Around the Sierra National Forest, travel- and tourism-related employment accounted for an estimated 16.4 percent of all employment in Fresno County and 13.5 percent in Madera County in 2015. These are both similar to the bioregion as a whole at around 19 percent. Mariposa County is especially dependent on the travel and tourism sector as 48 percent of all county employment is dependent on visitation to the area. Around the Sequoia National Forest, employment in the travel and tourism sector for Fresno, Tulare, and Kern Counties is all around 16 percent (Headwaters Economics 2018). The numbers of travel- and tourism-related jobs in all these counties have increased slightly on average from 1999 through 2015. Average annual wages in these jobs are below the average wage for all private sector jobs, so these are relatively lower-paying jobs in local communities (Headwaters Economics 2018).

The landscapes in this area provide valuable and unique recreation opportunities. The natural amenities provided by wilderness in the forests also contribute value to communities through visitor spending, attracting potential economic development opportunities, and contributing to increasing property values (Holmes et al. 2015). Also, the contributions of volunteers are an important economic consideration of recreational activities. Many of the national forest volunteers are drawn to the area for the recreation opportunities and contribute their time and energy to maintain the quality of that experience.

A study examining the value of travel and tourism estimated the percentage of total county employment and earnings generated by all travel in California. Travel and tourism is an important sector in Mariposa County, accounting for a considerable 58.8 percent of employment and 33.2 percent of earnings in 2015. These percentages are lower in Madera (5.3 percent of employment and 2.5 percent of all earnings) and Fresno (2.9 percent of employment and 1.5 percent of earnings) Counties. Travel and tourism around the Sequoia National Forest generates 3.7 percent of employment and 1.6 percent of earnings in Kern County, 2.9 percent of employment and 1.5 percent of earnings in Fresno County, and 2.5 percent of employment and 1.3 percent of earnings in Tulare County (Dean Runyan and Associates 2017).

Grazing

Pasture and rangelands within the counties bordering Sierra National Forest comprise around 40 percent of the total of all land area in farms in 2012, which is less than the percentage for the bioregion as a whole (52.4 percent). In terms of number of farming operations, cattle, sheep, and goat farming, which are the primary types of animals that are grazed on public lands, account for around 15.3 percent of all operations, again less than across the bioregion as a whole (25.4 percent; (Headwaters Economics 2018).

Pasture and rangelands within the counties bordering the Sequoia National Forest comprise around 51 percent of the total of all land area in farms in 2012, which is similar to the percentage for the bioregion as a whole (52.4 percent). In terms of number of farming operations, cattle, sheep, and goat farming, which are the primary types of animals that are grazed on public lands, account for around 19.3 percent of all operations, less than across the bioregion as a whole (25.4 percent; (Headwaters Economics 2018).

It is important to note that summer forage in the forests is critical to the economic viability of local ranches. If these ranchers did not have some access to summer grazing permits in the forests, then their businesses may no longer be economically viable. In addition, these ranchers have an impact on the local economy through an economic multiplier effect from the activity on these ranches requiring employees, materials, and services from other businesses in local communities. Therefore, impacts on the ranchers can lead to broader impacts on communities (Sulak and Huntsinger 2012).

Commodity-based Estimates of Economic Contributions

Table 148 (United States Department of Agriculture 2015g, h) provides estimates of the jobs and earnings derived from activities in the Sierra and Sequoia National Forests. These values should be used to gain an understanding of the relative context of national forest contributions and not as exact measures of these contributions. Therefore, all estimates are rounded to the nearest 10. Employment, expressed as jobs supported, represents the average annual employment and includes a combination of full- and part-time, temporary, and seasonal workers.

The majority of the jobs supported and earnings created originate from Forest Service investments that include the salaries of employees and the costs of management projects in the forests. The next largest contributions for jobs and income are for grazing in the Sequoia National Forest and forest products in the Sierra National Forest.

Table 148. Estimates of economic contributions, 2014

National Forest	Employment (Jobs)	Earnings (M$)
Sequoia	1,700	$82.8
Recreation	200	$7.6
Minerals and Energy	<10	<$0.1
Forest Products	40	$1.6
Livestock Grazing	630	$28.0
Forest Service Investments	770	$41.8
Payments to States and Counties	60	$3.8

National Forest	Employment (Jobs)	Earnings (M$)
Sierra	1,770	$85.6
Recreation	200	$7.5
Minerals and Energy	<10	<$0.1
Forest Products	530	$24.5
Livestock Grazing	170	$7.8
Forest Service Investments	800	$41.2
Payments to States and Counties	70	$4.6

Source: (United States Department of Agriculture 2015g, h)

The Importance of Water to Economic Sectors

The water flow in the Sierra National Forest feeds 10 water storage facilities and 22 operationally active hydroelectric facilities within or near the Sierra National Forest. Water rights and entitlements delivered through the Madera and Friant-Kern canals are extremely important to the economy of the San Joaquin Valley (United States Department of the Interior 2013a). Watersheds of the Sequoia National Forest drain into the Tulare Buena Vista Lakes Hydrologic Province and contribute to municipal, agricultural, recreation, warm and cold freshwater habitat, groundwater recharge, and freshwater replacement.

Wildfires affect these important water resources by removing vegetation and altering soils and ground cover, with the magnitude of post-wildfire impacts being dependent on burn severity. These changes have large implications to water resources through their effects on transpiration rates, water infiltration rates, the rates and magnitudes of erosion, peak and base stream flows, and total water yield (California Department of Water Resources 2016b). Therefore, forest management plays a large role by influencing the economic value of water from the forests.

Biomass Utilization for Energy

The wave of biomass utilization has risen and subsided in the past, and may be on the rise again with the level of mortality experienced in California in recent years. National Forest System lands can be an important source of fuel for biomass facilities if in proximity. Biomass utilization can be an important tool for reducing project-generated fuels; however, in the forests, to date such infrastructure is lacking in the local region. Given expected volumes, biomass generated would need to be supplemented by fuels from other sources to make biomass energy sustainable.

A new biomass facility is being developed in North Fork, California. This facility will be critically dependent on the forests for a consistent and reliable supply of wood. Two other biomass facilities are also being developed in the communities of Mariposa and Auberry. There are many issues besides reliable supply that limit biomass development in the area, including the cost of connecting a new facility to the grid and the comparative higher cost of wood biomass generation as compared with other renewables such as wind.

Biodiversity

The changing elevation across the national forests, combined with the variability in aspect and slope, the variety of geology and soils, and the amount and timing of precipitation, creates an extremely high diversity of ecosystems. A diversity of wildlife inhabit these varied ecosystems across the forests, including 300 wildlife species and more than 1,300 plant species (see the "Wildlife, Fish, and Plants" section). As a result, fishing, wildlife hunting, and wildlife viewing are important benefits provided to the public by the forests. The forests' terrestrial and aquatic plant and animal species are dependent on resilient, diverse ecosystems that also sustain a social and economic fabric connected to a healthy forest. Sustaining these plant and animal species contributes to local communities by providing a quality environment where visitors can enjoy these landscapes. In addition, the diversity of the plant community supports a wide range of important economic and social beneficial uses, such as food (for example, mushrooms, fruits, and ferns), medicines, floral greens, seeds and cones, and transplants.

Environmental Consequences to Economic Conditions

Restoration Funding Analysis

National forest project-level planning and implementation is guided by the budget as received from Congress and passed down through the Department of Agriculture to the Forest Service and then to the national forest. Therefore, to reflect this budget reality, the analysis assumes continuation of the trend of recent national forest budget obligations. Given this assumption, this section examines the potential funding opportunities and challenges of funding outside the appropriated national forest budget that would be expected to be available to achieve the increase in pace and scale of activities.

Consequences Common to All Alternatives

There are challenges to project funding that are outside the forest plan and the plan revision process. Increases in the pace and scale of restoration would involve increases in the costs associated with project preparation and project planning. The action alternatives would need to identify efficiencies for these planning processes to reduce the increased costs associated with additional project planning and preparation. Given current budget trends, identifying and implementing these efficiencies will be critical to the success of any alternative that is chosen.

A variety of unknown future conditions hamper the ability to develop specific estimates of the anticipated changes in revenues from forest products. Perhaps the most significant of these conditions is the value of forest products in the global marketplace. However, it is possible to characterize differences in the potential for opportunities for new revenue generation between the alternatives. Each alternative is comprised of plan components that affect the potential economic feasibility of timber harvest activities.

Since operating costs are fairly stable over a harvest area (specifically, no additional move-in move-out cost and no additional skid roads), then increases in volume or value, or both, removed per acre can potentially result in a fairly substantial increase in revenue, which can then be prioritized to accelerate the achievement of priority work within designated stewardship areas. Conversely, rules that reduce the economic value of timber harvest projects, by constraining the size and/or number of sawtimber products, are less able to provide these opportunities for increases in retained receipts. Subsequently, this would reduce the likelihood that additional funding for restoration accomplishments would become available. It is this fundamental premise that distinguishes the alternatives B, C, D, and E from each other (and is highlighted as follows).

The effects of the ongoing mortality event are also important to consider. Volumes projected in forest plans are, by definition, from scheduled harvests of living trees. Given the extent of current mortality, it may not be possible to reach the previously estimated future yields. Although events like wildfires and multiyear droughts are expected to occur in this analysis area, and commonly result in varying levels of salvage timber harvest, these unscheduled events offer no assurance of quantity over a predictable time frame. Further, while promptly reestablished national forests can begin to offer sawtimber harvests as early as the fourth decade, there is a point when the number of acres affected by stand-replacement fire would exceed growth rates capable of sustaining currently predicted harvests.

Therefore, when considering forest product value as a potential funding source for restoration activities, an important variable to consider is the magnitude and extent of tree mortality. Continued levels, due to both fire and multiyear drought effects, reduce the potential to sustain harvest levels. Inadequate levels of effective reforestation further restrict long-term harvest levels. Given the assumption that stewardship contracts, with the potential to generate and utilize credits used to increase the pace and scale of restoration, projected accomplishments may be negatively affected in both the short term and long term. This funding uncertainty, resulting from both current and future mortality, is important to consider under all the action alternatives.

This analysis examines whether there are reasonable opportunities in the forest to develop projects that will generate revenues to not only pay for themselves but also contribute to other restoration projects. Given forest budgets are not expected to increase, these acres will need to play a critical role in funding any increased pace and scale of restoration. The first step was identifying the number of acres in the forest where timber may be harvested and containing at least 4,000 cubic feet of volume per acre. This includes areas suitable for timber as well as volume that may be generated as a byproduct of treatments designed to restore desired conditions. The assumption is restoration thinning would remove around 25 percent of the volume from these acres and amount (at least 1,000 cubic feet per acre) would generate revenue sufficient to pay for restoration. The second step was to examine the number of restoration acres expected under each alternative and determine if there are enough of these revenue-generating acres in the forests to sustain the desired restoration pace and scale over the life of the plan.

Sierra National Forest

It is estimated there are approximately 96,000 acres in the forest that meet the criteria to be revenue producing.

Alternative B would be expected to mechanically treat between 2,000 to 3,000 acres per year in the forest. Therefore, over the first decade of the plan, about 20,000 to 30,000 acres would be expected to be treated. Over two decades, this number would be 40,000 to 60,000 acres treated in total, which is about 40 percent to 60 percent of the total 96,000 revenue-generating acres. Therefore, the possibility exists, given current conditions, that funding could be obtained to meet this pace and scale of restoration. It should be noted that there is uncertainty especially as we move into the future with respect to potential losses in acres to fire and mortality issues. Tree mortality can reduce or eliminate the potential of any given acre to be viable for a commercial thinning harvest if the loss of trees is sufficient to reduce standing live volume below 4,000 cf/ac (20 Mbf/ac).

Alternative C would be expected to mechanically treat around 1,000 acres per year or less annually. There are enough revenue-generating acres in the forest to sustain this level of restoration.

Alternative D would be expected to mechanically treat around 3,000 to 4,000 acres per year for totals of 30,000 to 40,000 acres in 10 years and 60,000 to 80,000 acres in 20 years. Given the analysis under alternative B, above, finding revenue-positive acres may be a challenge near the end of the plan's life.

Alternative E would have effects similar to those under alternative C.

Sequoia National Forest

It is estimated there are approximately 21,000 acres in the forest that meet the criteria to be revenue producing.

Alternative B would be expected to mechanically treat around 800 acres per year in the forest. Therefore, over the first decade of the plan, about 8,000 acres would be expected to be treated and over two decades, this number would be 16,000, which is less than the total 21,000 revenue-generating acres available. It should be noted that there is uncertainty especially as we move into the future with respect to losses in acres to fire and mortality issues. Therefore, the possibility exists, given current conditions, that funding could be obtained to meet this pace and scale of restoration; however, finding revenue-positive acres may be a challenge near the end of the life of the plan.

Alternative C would be expected to mechanically treat around 400 acres per year or less annually. There are enough revenue-generating acres in the forest to sustain this level of restoration.

Alternative D would be expected to mechanically treat around 1,200 acres per year for totals of 12,000 acres in 10 years and 24,000 acres in 20 years. Given the analysis under alternative B, above, finding revenue-positive acres would not be expected toward the end of the plan’s life.

Alternative E would have effects similar to those under alternative C.

Forest Benefits to People and Communities Analysis

Wildfire, disease, and insect pathogen mortality in vegetation are increasing in severity across the bioregion, and a high percentage of the landscape that provides the key national forest benefits is under threat (Metcalfe et al. 2013). As a result of these threats, there is great potential for disruption in the underlying ecological processes and for resulting loss and interruption in forest benefits.

This loss of benefits has a cost to the local communities and to the region as a whole. Examples of more localized costs include the loss of recreation opportunities for visitors, reductions in local employment and tax revenues from national forest commodities such as forest products and grazing, and the effects on the economies of local communities through reduced tourism in the area. When other important benefits, such as water supply, air quality, electricity generation, and biodiversity, are lost, the potential effect moves beyond the local area to people across the state who are affected by the loss of these services even if they do not live near the national forest nor ever plan to visit there.

The potential indirect effects of plan alternatives on these important forest benefits to people are examined as follows, first highlighting the similarities between the plan alternatives and then highlighting their key differences. Important to this analysis is capturing the effects of plan alternatives on the economic health, diversity, and fiscal conditions that are outlined in the “Affected Environment” section above.

Consequences Common to Alternatives B, C, D and E

There are three important potential effects that are relevant to all the plan revision action alternatives. These common effects result from the increased pace and scale of restoration that is called for in all these alternatives.

- First, all the action alternatives call for increased restoration activities in total (through more focus on mechanical thinning under alternatives B, D, and E and through more focus on use of prescribed fire and managed fire under alternative C). Therefore, all the plan revision alternatives provide greater potential to improve the long-term sustainability of key national forest benefits and contributions when compared with alternative A, which maintains current restoration activity levels.
- Second, all the action alternatives have the potential for adverse short-term effects on resources as a result of increased restoration activity that can temporarily interrupt these same national forest benefits and contributions.
- Third, the increased pace and scale of restoration in the action alternatives support jobs. Contractors from local communities are often hired to perform these restoration activities; this is important since employment opportunities in these areas are often limited. The Pacific Southwest Region has been working to improve processes to allow for more businesses in these local communities to obtain contracts for work and benefit from restoration activities. A study examining forest and watershed restoration work found that each $1 million invested in restoration activities supports approximately 16 to 24 jobs (Nielsen-Pincus 2010). This range is dependent on the type of activities performed in restoration. Investments in labor-intensive activities (such as site preparation, tree and shrub planting, and cutting small trees and brush by hand) support the greater number of jobs, whereas equipment- and technical-intensive activities (such as forest thinning, small-diameter and selective logging, masticating ground fuels, constructing stream habitat features, and excavating of floodplain and wetland features) support fewer jobs.

  Increased pace and scale of restoration also leads to employment and economic activity in a variety of other economic sectors throughout the economy beyond the effects of employment generated by the activities themselves. These multiplier effects arise from materials and equipment purchased from suppliers and restoration workers spending their paychecks for goods and services. The top two economic sectors typically affected by this multiplier effect are wholesale and retail trade, including transactions for fuel, wood products, rock, metal, and other building and landscaping products. Other common but less affected sectors include employment services, commercial and industrial machinery rental, commercial and industrial machinery repair and maintenance, and professional services such as insurance brokers and accountants (Nielsen-Pincus 2010).

There are some important differences between the alternatives. These differences arise primarily from differences in the intensity and the approach to restoration under each alternative and the resulting effects on key forest benefits for people and communities. These differences are described below.

Consequences Specific to Alternative A

Forest Products

Volumes of forest products and acres of mechanical vegetation management would follow current trends under this no action alternative. There is an important economic contribution forest products provide to local communities through job creation and the tax revenues generated from forest products and restoration activities. This no action alternative contributes economically at current levels, which are lower than would be expected under alternatives B and D and higher than expected under alternatives C and E. Under alternative A, forest product volumes would be expected to support around 150 annual full- and part-time jobs, with the majority of these jobs (approximately 110) resulting from forest products activity in the Sierra National Forest. Alternative A would produce an expected 7 million board feet annually from the two forests, which would not provide sufficient volumes to support the local forest product-based infrastructure and workforce at the Terra Bella sawmill.

Air Quality

With fewer acres of restoration activities than the other alternatives, there is the potential for continued increases in the amount of smoke from wildfires that affects communities. Emissions from wildfires are largely uncontrollable and can be large in scale, thus resulting in large air quality impacts. Therefore, under the no action alternative, emissions will be indirectly generated, and managers have little control to limit these emissions. In addition, these wildfires may occur during times of "'unfavorable"' atmospheric conditions resulting in a compounded air quality effect. Consequences include adverse effects on human health, particularly for residents of communities in the path of smoke events.

There are also potential adverse economic effects resulting from decreased recreational visitation during wildfire events and until areas are deemed safe for visitors to reenter. Continuing trends for more and larger wildfires would be expected to continue, thus increasing the likelihood that visitors to the forests would choose to stay away due to smoke. Such smoke events have potential adverse short- and long-term effects on local communities through reduced visitor spending that supports jobs and provides tax revenues. There is also additional loss of benefits to the recreational users who must find other settings for their recreational activities that may or may not provide similar opportunities or quality of the experience or may be located further away thus increasing costs of recreating.

Recreation

Alternative A is expected to result in fewer acres of restoration activities relative to the other alternatives. Consequently, current trends in uncharacteristic wildfires and forest health would be expected to continue. These current trends have the potential to adversely affect recreational settings and opportunities. These include effects on settings that support activities such as hiking, camping, mountain biking, and OHV use, as well as effects on the terrestrial and aquatic species that support hunting, fishing, and watchable wildlife activities.

Rural communities located along access routes to the national forest often have a strong tie to the economic contributions that these recreational visitors provide. This includes the visitor spending that supports jobs and the contributions to local tax revenues through the sales and lodging taxes collected. These local tax revenues support important public services that improve the quality of life in these communities. These important economic contributions of visitors would not be a reliable economic driver if the settings and opportunities that draw these visitors to the area are at risk. There also would be the additional loss of benefits to the recreational users who would have to find other settings for their recreation that may or may not provide a similar quality of experience or may be located further away, thus increasing costs of recreating and reducing the availability of outdoor experiences.

Grazing

Grazing opportunity would potentially be adversely affected as a result of no increase in restoration activities to reduce the risk of uncharacteristic wildfire and to improve forest health. These types of events increase the potential for future interruptions to grazing opportunities. Therefore, there are potential adverse long-term effects on the local communities that are dependent on forest grazing to support local businesses.

Biodiversity

There are fewer acres of restoration occurring annually under the no action alternative when compared with the other alternatives. As a result, the potential risks to forest health from uncharacteristic wildfire and tree mortality would be expected to continue. These trends can negatively impact habitat heterogeneity for many plant, wildlife, and fish species that are important for supporting hunting, fishing, plant gathering, and wildlife watching opportunities in the forests. This would adversely affect the quality of the experiences of visitors looking for these opportunities. If these visitors, therefore, make fewer trips to the forest, the economic contributions these visitors provide to local communities also would be expected to decrease.

Water

Alternative A has relatively fewer acres of restoration than the other alternatives. Therefore, continued trends in uncharacteristic wildfire and forest health would be expected to continue, resulting in a decline in the important economic benefits provided by water. The water used downstream from the forests is valuable for municipal and agricultural uses. This water is also valuable for recreational and ecological uses on the national forests as this water sustains the important water-based recreational setting and forest biodiversity that draws visitors to quality experiences. Given the fewer acres of restoration, the quantity and quality of water would be expected to continue current trends of flashiness of stream flows and increasing temperatures, thus reducing and interrupting potential benefits this water provides. In certain watersheds, the relatively increased volume of living biomass also would reduce water availability downstream, adversely affecting water quantity.

Energy

Biomass provides the opportunity to generate electricity for the region and to support local job opportunities in biomass harvesting. The fewer acres of restoration through mechanical treatments means less potential than alternatives, B, D, and E to provide biomass to support development of industry infrastructure. The alternative also does not improve predictability and reliability of supply of biomass that would be favorable to generating investment in current and new biomass facilities.

Consequences Specific to Alternative B

Forest Products

The increased pace and scale of restoration associated with the proposed action alternative would result in increases in the volumes of forest products when compared with alternative A. This alternative has the potential to contribute economically at a higher level than current levels and under alternatives C and E but at a lower level than alternative D. Under alternative B, forest product volumes would be expected to support up to 350 more annual full- and part-time jobs than are supported under alternative A. Alternative B could produce between 12.5 million board feet to 24 million board feet annually from the two forests; therefore, at the high end it gets close to but does not surpass the 25 million board feet annually necessary to provide sufficient volumes to support the local forest products-based infrastructure and workforce.

These economic contributions would help to sustain the local workforce and the infrastructure that is necessary to support the ability of the forest to increase the pace and scale of restoration and also contribute to local governmental budgets to support critical public services. In the longer term, alternative B contributes to reversing trends in vegetation management that threaten the forest products industry, such as increasing uncharacteristic wildfire, disease and mortality of vegetation, and a declining infrastructure and workforce. There would be potential short-term adverse effects on water, air, biodiversity, and recreation benefits resulting from increased restoration activities that would potentially disturb areas and restrict access during project activities.

Air Quality

With relatively more acres of restoration activities than alternative A, there is the potential for more reductions in the smoke from potential future wildfires, thus contributing to the improved long-term sustainability of air quality. This potential long-term reduction in smoke from wildfires would help to improve air quality, reduce interruptions in visitors' recreation opportunities (thus supporting local jobs and tax revenues), and improve the health of residents in local communities.

There would be some additional use of prescribed and managed fire under this alternative that could lead to reduced air quality and reduced recreational access in the short term. The use of prescribed fire would be managed to occur under favorable conditions to mitigate these potential adverse effects. These effects under alternative B would be less than those under alternatives C and E where prescribed and managed fire are a larger portion of restoration activities. There would be some increased emissions under alternative B, as compared with alternatives C and E, resulting from the increased use of machinery for mechanical thinning. These emissions would have less of a visual impact due to the difference in source. In addition, the mechanical thinning proposed in the alternative also would help to reduce the quantity of smoke that would occur during these prescribed fire activities.

Recreation

Alternative B is expected to result in more acres of restoration activities relative to alternative A, thus helping to contribute to the reduced potential of uncharacteristic wildfire and improved forest health. This would contribute to improving the sustainability of recreational settings and opportunities, and the associated economic contributions to local communities. This additional restoration activity also would provide the potential for increased adverse short-term effects on recreation opportunities through closures of recreational areas during restoration project activities. This potential adverse effect would be expected to be minor, and any closures would be minimized to the extent possible.

The direction in aquatic strategy and the introduction of conservation watersheds would not be expected to have any effect, as the plan components do not hinder, prohibit, or restrict any current recreation opportunities within these areas. In addition, the new recreational zones would not be expected to result in any changes to the number of visitors or types of recreation opportunities occurring in the forests. Therefore, there would be no expected change in the types of uses in the forest or number of visitors purchasing goods and services in local communities.

The Sequoia National Forest changes from roaded natural and rural to semi-primitive motorized would create a setting that moves toward the more primitive end of the spectrum than alternative A. The Sierra National Forest would move very slightly toward the rural end of the spectrum with increases in semi-primitive motorized and rural and slight decreases in the roaded natural. This change would be minor in the bigger picture of recreation management. It may allow for fewer new developed settings into the future in the Sequoia National Forest due to more acreage in the primitive and semi-primitive spectrum. The Sierra National Forest may see more new developed settings as more of the land base (though not significant) would be toward the roaded natural and rural end of the spectrum. This would not be expected to significantly affect any recreational use or opportunities in the forest.

Grazing

Grazing opportunity would benefit in the long term from the increase in restoration activities as compared with alternative A. This would be expected to reduce the risk of uncharacteristic wildfire and improve forest health. There would be some short-term potential for disruption to grazing opportunity due to increased restoration project activity in and around allotment areas. This short-term disruption would be expected to be minimal.

Conservation watershed plan components do not directly prohibit livestock grazing activities or restrict or limit this use. Plan components for these management areas would allow for the continued use of livestock; they would not prescribe additional standards that should increase hardship or burden on livestock operations, including the variety of management options available to livestock grazing operations.

Recommended wilderness areas under alternative B would not restrict current permitted grazing levels. However, recommended wilderness may prohibit access by motorized vehicles for the maintenance of stock water developments and salt placement, and it may restrict installation of new range improvements (such as water troughs) unless approved following a minimum requirements decision. Overall, the annual operating costs to the current permittees would be expected to increase under these conditions. Given the acreages identified for recommendation in each alternative, the adverse effects under alternative B would be less than those under alternative C, which recommends the most wilderness.

Biodiversity

With relatively more acres of restoration expected annually when compared with alternative A, current trends in uncharacteristic wildfire and tree mortality would be expected to improve. This would benefit the sustainability of important activities, such as hunting, fishing, plant gathering, and wildlife watching. This is important in maintaining the quality of the experiences of visitors looking for these opportunities and also sustain the economic contributions that these visitors provide to local communities.

The Forest Service would expect the short-term disturbance from project activity under alternative B to be larger than under alternatives C and E but less than under alternative D. There would be potential economic consequences of both the long-term benefit and short-term disruption in biodiversity, as there are a number of important species for hunting, fishing, plant gathering, and watchable wildlife that draw visitors to the forests. Simulation modeling indicates the long-term benefits of reducing wildfire risk may outweigh the short-term effects of treatments on habitat for some old, forest-associated species important for hunting and watchable wildlife activities (Roloff et al. 2012).

Water

Increased restoration activity would potentially positively affect the sustainability of the important economic benefits that water provides. Increases in the pace and scale of restoration would have the potential to reduce flashiness of stream flows and reduce temperatures. In the short term, there would be the potential for adverse effects from increased sedimentation as a result of increased restoration activities. This could have adverse short-term economic consequences on recreational visitation, and increase the downstream costs of using water from the forests. Using best management practices as outlined under Forest Service guidelines would minimize these potential adverse effects.

Energy

Biomass provides the opportunity to generate electricity for the region and also support local job opportunities in harvesting. Alternative B provides more potential to contribute additional biomass volumes to support developing an industry workforce. It also would provide more potential in creating a more favorable environment with a reliable biomass supply to support the investment in biomass facilities, specifically the new facility being developed in North Fork, California.

This investment would be required in the long term to increase the pace and scale of restoration. However, current biomass energy infrastructure is limited in the area; the economics of transporting biomass and the higher relative cost of biomass generation compared with other renewable sources could make it difficult to find new markets under current circumstances. In addition, current energy prices and the reduced cost of fossil fuels for energy generation present an immediate economic challenge to biomass energy. This emphasizes the importance of the associated sawtimber harvests having sufficient value to subsidize the costs of biomass removal.

Consequences Specific to Alternative C

Forest Products

The focus on restoration through fire under alternative C results in a decrease in the volumes of forest products produced. Under alternative C, the Forest Service would expect forest product volumes to support up to 65 fewer annual full- and part-time jobs than would be supported under alternative A. Alternative C would produce between 3.5 million board feet and 7 million board feet annually from the two forests, which would not provide sufficient volumes to support the local forest products-based infrastructure and workforce.

As a result, these economic contributions would do less to help sustain the local workforce and the infrastructure necessary to support the ability of the forest to increase the pace and scale of restoration. They also would contribute less to local governmental budgets that support critical public services. Therefore, this alternative does not contribute to sustaining the local workforce and in fact results in a reduction in jobs when compared with alternative A. This reduction in workforce and the corresponding potential loss of infrastructure has a long-term negative effect on the ability of the forests to increase the pace and scale of restoration.

Air Quality

With relatively more acres of restoration activities than under alternative A, through the use of managed fire in the upper montane areas and more prescribed fire, there is the potential for more reductions in the smoke from potential future wildfires. This would have the potential to reduce the likelihood that visitors stay away from the area during these events. In addition, the long-term reduction in smoke from wildfires would help to improve air quality and the health of residents in local communities.

There would be an emphasis on the use of prescribed fire and wildfire managed to meet resource objectives under alternative C that could lead to reduced air quality and recreational access in the short term. These activities would be planned to occur under favorable conditions to mitigate potential adverse effects. Still, given the dependence of alternative C on fire for restoration, the overall effect would be for some short-term adverse effects on air quality that would potentially have effects on human health, recreational visitation, and the resulting economic conditions in local communities.

Recreation

Alternative C has more areas recommended for wilderness; as a result, there is more potential for effects on current motorized uses and mechanical transport in these areas than under alternative A. There would be a prohibition on mountain biking and placing new fixed anchors with motorized drills for rock climbing. This alternative would also preclude any future designations for roads or motorized trails in these areas. Therefore, more than under the other alternatives, this alternative would potentially impact mountain biking and motorized uses and lead to visitors adjusting their forest visitation locations to find new opportunities. This could result in a changing pattern of visitors to the local communities in the areas most greatly affected by these restrictions in uses.

Grazing

The effects are similar to those under alternative B except that alternative C, which includes the most acres of recommended wilderness, could have more impacts on grazing than alternative B. There also would be the potential for a short-term benefit from increased restoration using prescribed and managed fire as a primary restoration tool. These restoration activities would reduce woody biomass and increase herbaceous plants in large areas of the national forest, thus having the potential to improve grazing settings.

Biodiversity

The potential effects on biodiversity are similar to those under alternative B.

Water

The potential effects on water would be similar to those under alternative B.

Energy

The focus on fire for restoration under alternative C and the lack of higher value timber harvests to subsidize biomass removal would not result in a sufficient supply of biomass to support development of current and new biomass opportunities for energy generation. In addition, this alternative would not be expected to increase the investment in local wood products infrastructure and workforce that would be required in the long term to increase the pace and scale of restoration.

Consequences Specific to Alternative D

Forest Products

Similar to alternative B, the increased pace and scale of restoration associated with alternative D would result in increases in the volumes of forest products. Under alternative D, forest product volumes would be expected to support up to 600 more annual full- and part-time jobs than are supported under alternative A. Alternative D would produce between 18 million board feet to 36 million board feet annually from the two forests, which at the mid- and higher end of this range would have the potential to provide sufficient volumes to support the local forest products-based infrastructure and workforce.

Air Quality

The potential effects on air quality would be similar to those under alternative B.

Recreation

The potential effects on recreation would be similar to those under alternative B. One difference would be in the Sequoia National Forest where more acres would be included in the destination recreation management area, specifically around the more heavily used Greenhorn Mountains and the lower Kern River. These areas would be managed for increasing recreation use and provide adequate infrastructure as needed to support these uses. This would help to sustain visitation in this developed area and, therefore, help the local communities dependent on this visitation and spending.

Grazing

The potential effects on grazing are similar to those under alternative B.

Biodiversity

The effects would be similar to those under alternative B. In addition, more emphasis would be placed on increasing vegetation heterogeneity under alternative D. This would create a mosaic of vegetation types and stages that would increase habitat diversity toward the natural range of variability and benefit most game species. Under alternative D, the increased pace and scale of mechanical thinning and use of strategic treatments along ridgetops would also be expected to produce greater forage for herbivores, such as deer and smaller mammals such as rabbits, due to increased solar exposure in early seral stages, both over the short and long term.

Water

The potential effects on water would be similar to those under alternative B.

Energy

The potential effects on the availability of a supply of wood for biomass energy generation would be similar to those under alternative B.

Consequences Specific to Alternative E

Forest Products

The potential effects on forest products volumes and the associated jobs supported would be similar to those under alternative C.

Air Quality

The potential effects on air quality are similar to those under alternative C.

Recreation

Potential effects would be similar to those under alternative C except this alternative has fewer acres of recommended wilderness and designates some of these areas as BMAs, which are not exclusive to nonmotorized uses. BMAs would be managed for less development and less concentration of use and would complement the recommended wilderness. Access would not be limited with BMAs since the current road system would be allowed to continue to provide access and opportunities for motorized uses. Conflicts in uses in the BMAs may occur if participation in trail activities grows or if mountain biking continues to increase in popularity.

Current and future roaded recreation would be limited to the existing road system; over time, these areas may experience more crowding. There is no expectation that any current recreational uses would be limited as a result of BMAs or that the number of visitors to the forest and therefore visitor spending in local communities, would be affected.

Grazing

The potential effects on grazing are similar to those under alternative B.

Biodiversity

The potential effects on biodiversity are similar to those under alternative B.

Water

The potential effects on water would be similar to those under alternative B.

Energy

Effects on the availability of a supply of wood for biomass energy generation would be similar to those under alternative C.

Cumulative Effects

The Sequoia and Sierra National Forests represent only a portion of the landscape that comprises the natural landscape in this area. The resources throughout this entire region provide economic contributions to local communities and regional benefits that improve the quality of people's lives. As a result, other land management plans on Federal and state lands in this area may cumulatively affect the long-term sustainability of benefits from recreation, air quality, grazing, and forest products.

In addition, restoration projects developed under the revised plan could have short-term effects on forest benefits resulting from disruptive project activities (such as area closures and resource disturbance). These short-term effects need to be evaluated on a case-by-case basis to determine if there would be cumulative effects from additional projects occurring on other lands in the area. The higher restoration pace and scale in alternative D would have the largest possibility for this effect.

Recreation and Air Quality

Recreation in and surrounding the national forests, national parks, and state and local public lands does not follow administrative boundaries; therefore, changes in management of recreation on all of these lands together affects the long-term economic conditions in local communities. Visitors are drawn to the entire recreational experience of the area and spend time and money near their destinations and in communities on the way to their destinations.

The Forest Service does not expect the revised forest plan to result in changes to the types of recreation opportunities available; therefore, it is not expected to have any long-term cumulative effects on the numbers or types of activities enjoyed in the area. However, events like wildfire that result in closure of areas and in smoke that reduces enjoyment of visiting the area would adversely affect communities whether the fire is burning in the national forest or in neighboring Federal, state, or private lands. The Forest Service expects the restoration activities in the revised forest plan to reduce the risk of these types of large-scale events in the long term and, therefore, would have a positive cumulative effect on recreational opportunity and air quality in conjunction with other restoration activities undertaken in the area.

Grazing

The Forest Service expects no long-term changes to grazing use as a result of the revised plan under alternative B. Alternatives C and E do have the potential to result in cost increases for current grazing allotments located within the areas recommended for consideration for wilderness once these areas are designated. Therefore, restrictions imposed on other lands that also could lead to cost increases would result in the most significant potential cumulative effects under alternatives C and E.

Forest Products

Current trends in declining forest product infrastructure and workforce has resulted in only one industrial sawmill remaining south of Yosemite National Park in Terra Bella. The management of all the lands in this area affects future trends in the harvesting of forest products, and other benefits need to be considered in conjunction with changes in the forest plan. The resulting cumulative effects on communities could substantially negatively impact the economic health, diversity of economic activity, and sustainable fiscal conditions for counties and local municipalities.

The operational mills in Terra Bella, Sonora, and Chinese Camp are the closest mills to the national forests. The mills in Sonora and Chinese Camp have longer haul distances and narrow roads, which typically make transportation costly. Therefore, cumulative effects on the Terra Bella mill from public and private timber harvesting decisions across all landscapes are critically important. This is the case not only for local communities but for the feasibility of restoration on the two forests and adjacent private forest lands.

Alternatives B and D do the most to contribute positively to sustainability of the local harvest and processing infrastructure and workforce, while alternatives C and E would make available less timber. Therefore, other as yet unidentified forested lands would need to fill the supply gap.

Analytical Conclusions

Alternative A, the current forest plan, would result in continuation of the current trends in the long-term sustainability of national forest benefits. The Forest Service expects the continuation of current management activities in the face of current resource conditions and trends to result in more disruptive events, such as uncharacteristic wildfire, and additional declines in forest health that would interrupt and reduce benefits forests provide to people and communities. This would have adverse short- and long-term effects on social and economic conditions in local communities and on people's lives, both those located near the national forests and those across the region that enjoy forest benefits.

Alternative B would be expected to help moderate current trends and improve the long-term sustainability of national forest benefits. In the short term, effects are mixed across the different national forest benefits. These short-term effects would be adverse for biodiversity and grazing, from increases in potential disturbances related to the increasing of restoration activities. The effects are mixed (both adverse and beneficial) for water, recreation, and air quality. Water quality could be affected given the potential for increased sedimentation. Recreation would receive benefits in the short term from reduced wildfire-imposed closures, but would be adversely affected by the potential for restrictions on activities resulting from restoration project activities. Air quality also would benefit in the short term from the reduced potential for wildfire, but the use of prescribed fire would create the potential for some short-term decreases in air quality as a result of these activities.

Forest products and energy generation would benefit from increased restoration activities that yield sawtimber for the Terra Bella mill and biomass for electricity production. Overall, alternative B would have long-term beneficial effects on economic conditions in local communities and on the national forests' benefits to people's lives, both those located near the national forest and those across the region that enjoy these benefits.

Alternative C would be expected to help reverse current trends and improve the long-term sustainability of some of the national forest benefits (water, recreation, air quality, and biodiversity) that contribute to people locally and across the region. The emphasis on fire for restoration instead of mechanical treatments means the long-term sustainability of developing forest products infrastructure and biomass utilization for energy generation would be adversely affected. The long-term effects on grazing are uncertain as restoration would improve sustainability, but increased recommended wilderness would raise the potential for future cost increases to ranchers if the areas are designated.

In the short term, the potential effects are similar to those under alternative B with two important differences. Air quality is expected to be adversely affected in the short term as a result of the increased amount of prescribed and managed fire emphasized under alternative C; however, given these events would be planned to occur under favorable conditions, the overall effect is uncertain. For grazing, there would be the potential for a short-term benefit from increased restoration using prescribed and managed fire as a primary restoration tool. These restoration activities would reduce woody biomass and increase herbaceous plants in large areas having potential to improve grazing settings. Overall, alternative C would have some long-term beneficial effects on economic conditions in local communities and on the national forests' benefits to people's lives. However, there would be the long-term loss of forest products and opportunities for developing biomass industries as a result of this alternative.

Alternative D would be similar to alternative B and expected to help reverse current trends and improve the long-term sustainability of national forest benefits. Key differences with alternative B result from the increased pace and scale of restoration through mechanical treatments under alternative D that could provide even greater benefits to the long-term sustainability. However, this increased intensity would also lead to potential increases in the short-term adverse effects resulting from these restoration activities.

Alternative E would be expected to have effects similar to those under alternative C. The exception is some of the additional areas recommended for wilderness that are included in alternative C are included in alternative E as backcountry management areas; therefore, associated potential impacts on grazing would be lessened.

Social Conditions

Background

This section summarizes current social conditions in the analysis area for the Sequoia and Sierra National Forests and potential impacts of implementing the revised plans or alternatives on these conditions.

The 2012 Planning Rule requires that plans contain guidance that helps a national forest contribute to social sustainability. In this plan revision effort, the Forest Service developed desired conditions for the Sequoia and Sierra National Forests to address the following identified needs: supporting the long-term sustainability of forest benefits to people, encouraging the use of partnerships, and improving communication and outreach to the public, including underrepresented populations.

Many of the challenges we face in managing National Forest System lands are rooted in the values that people hold, which influence what is desired from forest management and also help define the quality of life that is important to individuals and communities (Allen et al. 2009). People are often concerned with the potential impacts of changes in land management on their quality of life; at the same time, shifting population demographics also influence value orientations and what is considered important to individuals and communities. This plan revision effort aims to develop plans that emphasize working together with and understanding the needs of the public to manage forests in a way that contributes to social sustainability.

Analysis and Methods

This analysis focuses on three key indicators to examine impacts of alternatives on social conditions: values, civil rights, and environmental justice. While social conditions include a wide range of factors, values were chosen as an indicator because they effectively help us understand differences among alternatives from a social perspective, as well as concerns the public raised. In addition, examining impacts of alternatives on civil rights and environmental justice are a required part of an environmental impact statement and help ensure more vulnerable populations are considered in land management decisions. These three indicators are described below.

Indicators and Methods

Values

Understanding how different alternatives potentially affect people includes looking at what those changes mean in terms of people’s different value sets. Several comments received during scoping reveal the diverse values that stakeholders have regarding the management of National Forest System lands. People would be impacted differently because certain alternatives would align more closely with personal values compared with other alternatives. This analysis qualitatively examines potential impacts of alternatives on different value sets.

Based on scoping comments and previous input, including a stakeholder analysis conducted by the Center for Collaborative Policy prior to the assessment phase, we developed broad categories of forest management values that different alternatives may affect. We then took these categories along with analyses from other resources areas to summarize the extent to which the different alternatives aligned with different values. This analysis does not discuss every aspect of these broad values. Rather, it focuses on those aspects that best help us understand differences across alternatives and concerns raised by the public.

The area of focus for this indicator includes the Sequoia and Sierra National Forests. We used information the public provided regardless of location to examine people's values toward the management of these two forests. This includes viewpoints from both local and regional stakeholders, as well as stakeholders in more distant locations.

Civil Rights

USDA civil rights policy (United States Department of Agriculture 2003) requires each agency to analyze the civil rights impact(s) of policies, actions, or decisions that will affect the USDA workforce or federally conducted and federally assisted programs and activities. A civil rights impact analysis facilitates the identification of the effects of agency actions that may adversely and disproportionately impact employees or program beneficiaries based on their membership in a protected group.

A protected group is any person, group, or class of persons protected under Federal law and executive order from discrimination on any prohibited basis, that is, discrimination based on race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance programs (United States Department of Agriculture 2003).

For environmental or natural resources actions, civil rights impact analyses are not separate reports, but are an integral part of the social impact analysis in the environmental impact statement (United States Department of Agriculture 1986).

The theory of "disparate impact" is used in this civil rights impact analysis. Disparate impact is the evenhanded application of neutral policies, actions, or decisions that have the effect of excluding or otherwise adversely and disproportionately affecting protected groups. This analysis qualitatively describes whether:

- Protected groups were provided the same opportunities to participate in the forest plan revision process as others
- Management under the draft forest plans has the effect of excluding or otherwise adversely and disproportionately impacting protected groups

The area of focus for this indicator includes the Sequoia and Sierra National Forests. The analysis examines any potential civil rights impacts as a result of the national forests' plan revision process or revised plans. The Forest Service used a qualitative analysis of public engagement and review of the scope and nature of public comments to assess potential disproportionate impacts on protected groups.

Environmental Justice

Environmental justice means that, to the greatest extent practicable and permitted by law, all populations are provided the opportunity to comment before decisions are rendered on, are allowed to share in the benefits of, are not excluded from, and are not affected in a disproportionately high and adverse manner by, government programs and activities affecting human health or the environment (United States Department of Agriculture 1997).

In 1994, President Clinton signed Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requiring that each Federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations (Council on Environmental Quality 1997).

The memorandum specifically recognized the role of the NEPA in identifying and addressing environmental justice concerns, particularly related to analyzing environmental effects on minority populations, low-income populations, and Indian tribes; identifying mitigation measures as appropriate; and providing opportunities for community participation in the NEPA process (Council on Environmental Quality 1997).

This analysis examines whether there may be disproportionately high and adverse environmental effects on minority and low-income populations across alternatives. Environmental effects include human health, economic, and social effects. This is done qualitatively by examining who and where these environmental justice communities may be, describing how they interact with the national forests, and, as a result, how the different alternatives may disproportionately and adversely impact them.

The Council on Environmental Quality has oversight of the Federal Government’s compliance with Executive Order 12898 and NEPA. They have defined “minority” and “low-income” populations as follows (Council on Environmental Quality 1997):

> Low-income Populations: Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census’ Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.
>
> Minority: Individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.
>
> Minority Populations: Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent (may be made up of one minority or a sum of all minorities together) or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

To identify potential environmental justice populations, we used demographic data from the 2011 American Community Survey (ACS) 5-year estimates from the U.S. Census Bureau. The 2011 ACS 5-year estimates were the most recent data available when originally collected, analyzed, and mapped during the assessment phase. We chose the 5-year estimates over the 3- or 1-year estimates because they provide information for smaller geographies, are more precise, and are better for small populations.

We used the area of influence previously defined for each national forest in the assessment phase. For each national forest, this is the set of census county divisions (CCD) that intersects the national forest administrative boundary. CCDs are county subdivisions delineated by the United States Census Bureau in cooperation with state, tribal, and local officials for statistical purposes (U.S. Census Bureau 2015). The CCDs and counties associated with each national forest are listed below.

Sequoia National Forest: Sierra CCD in Fresno County; Woodlake-Three Rivers and Springville-Johnsondale CCDs in Tulare County; and Lake Isabella, Bakersfield, and Tehachapi CCDs in Kern County (see Figure 65).

Sierra National Forest: Coulterville, Mariposa, and Yosemite Valley CCDs in Mariposa County; Yosemite Lakes and Oakhurst-North Fork CCDs in Madera County; and Sierra CCD in Fresno County (see Figure 66).

We considered a census county division a minority population if greater than 50 percent of the population identified as non-white or Hispanic/Latino. We considered a census county division a low-income population if the percentage of people below the poverty threshold was substantially greater than at the county level.

In determining the poverty status of families and individuals, the U.S. Census Bureau uses income cutoffs that vary by family size, number of children, and age. If the total income of a person's family in the last 12 months is less than the threshold appropriate for that person's family size and composition, then that person is considered "below the poverty level" together with every family member.

To better understand the geographic location of potential environmental justice communities and more specific information regarding race and ethnicity, we examined census block group population demographics for the following categories: American Indian and Alaska Native, Asian, Black or African American, Native Hawaiian and other Pacific Islander, Hispanic or Latino, and poverty (percentage of people whose income is below the poverty level). Census block groups are the second- smallest geographical units the U.S. Census Bureau uses and are generally defined to contain between 600 and 3,000 people (United States Census Bureau 2015). We used this information to identify more specific places that had relatively large minority populations and where outreach efforts could be targeted.

Assumptions

- The framework for the social analysis uses generalities. Area residents and national forest visitors have diverse preferences and values that may not be fully captured in the description of social consequences. The general categories are useful for assessing social impacts based on particular forest-related values.
- Individuals may hold one or more of the values described in this section. As a result, the impacts of alternatives on specific individuals may be cumulative or mixed, depending on the values they hold.
- Demographics are generally the same at the time of writing this analysis as they were during the assessment.

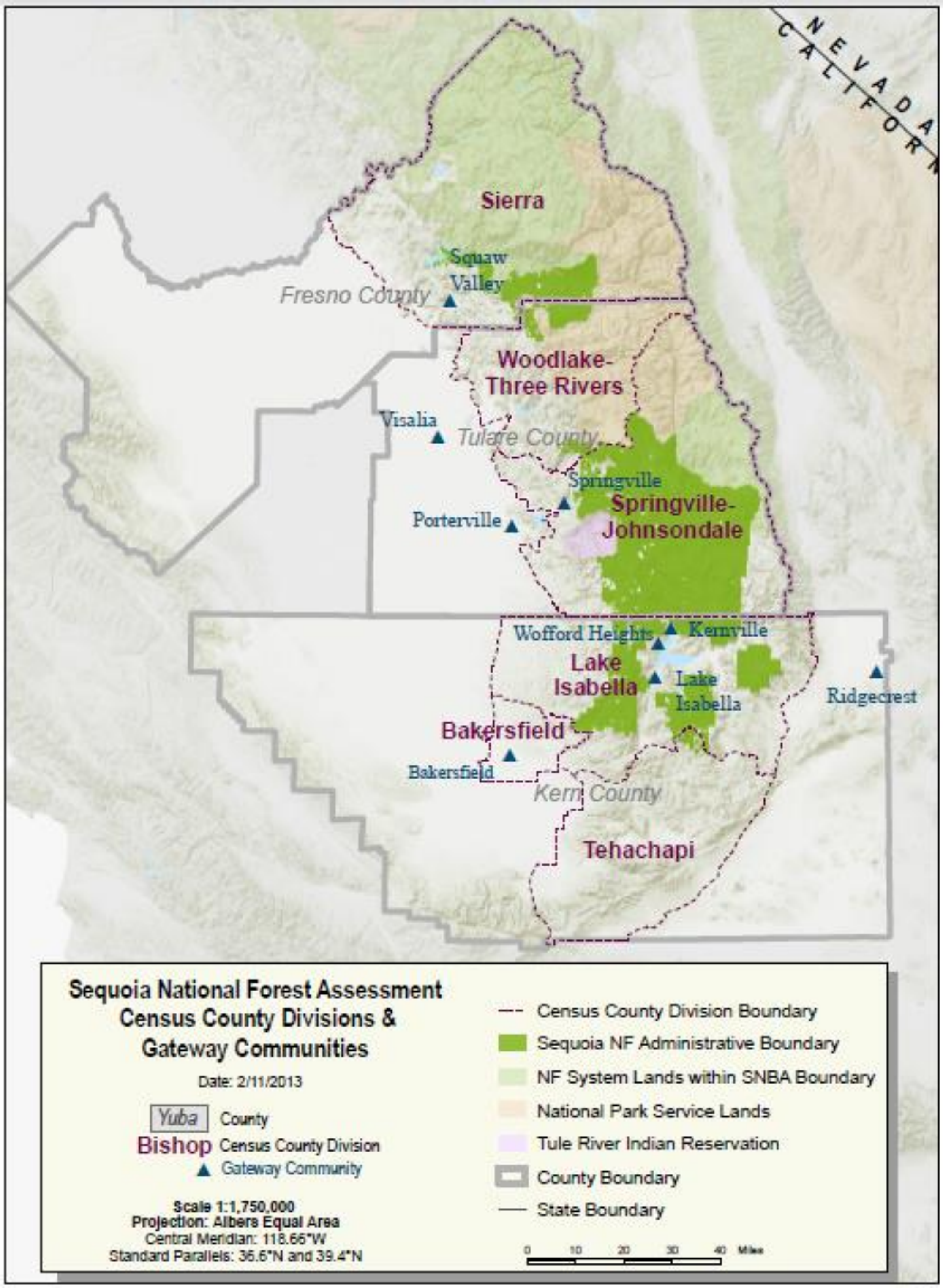

Figure 65. Census county divisions that intersect the Sequoia National Forest administrative boundary

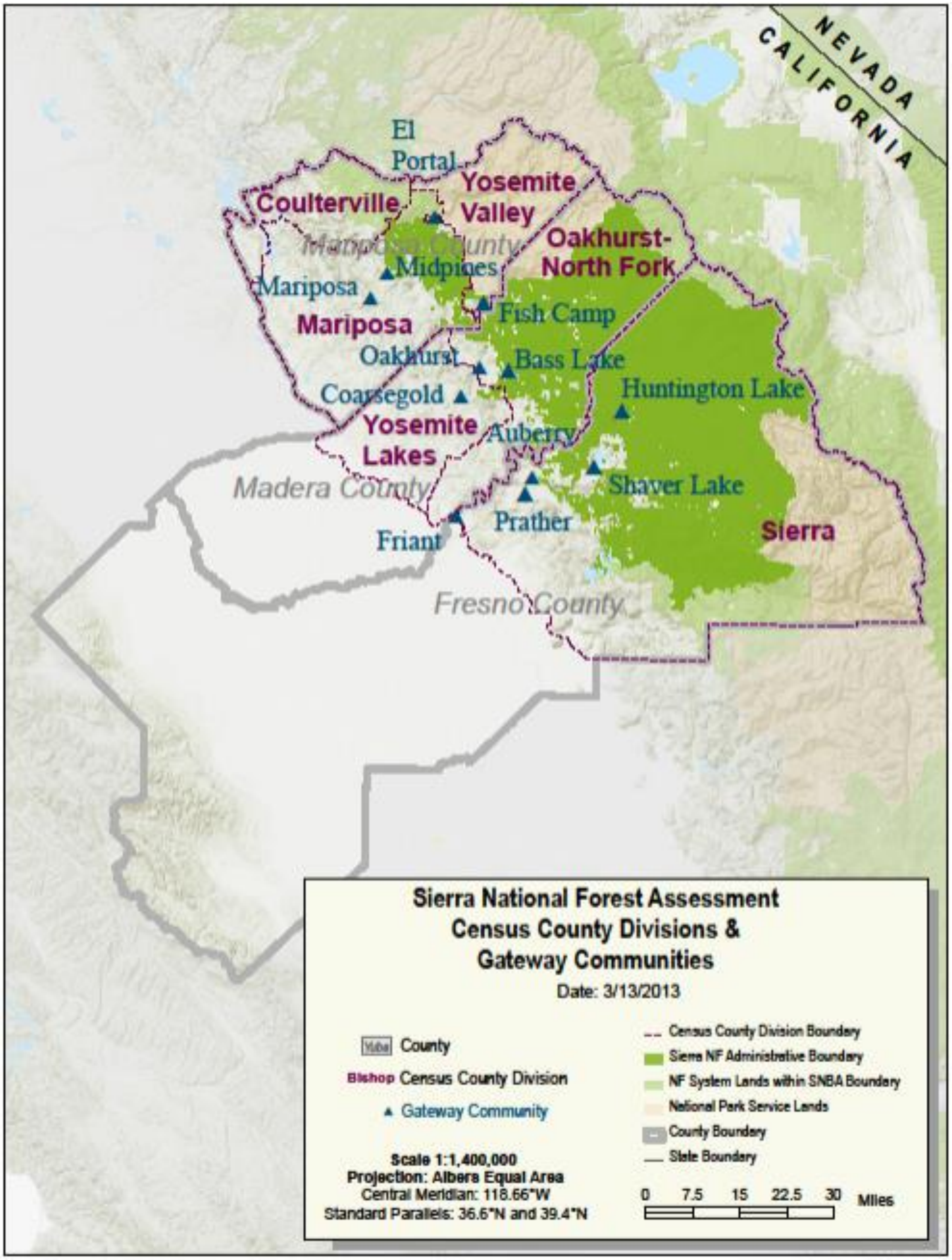

Figure 66. Census county divisions that intersect the Sierra National Forest administrative boundary

Affected Environment

This section describes the social environment of the area relevant to the indicators used in the social impact analysis. More general, comprehensive background information regarding social conditions and trends related to the Sequoia and Sierra National Forests can be found in the national forest assessments.

Values

Values are relatively enduring concepts that people hold and often share within a given society or culture about important life principles, including what is good or bad and desirable or undesirable (Allen et al. 2009). People's values influence how they use national forests and their expectations regarding how National Forest System lands should be managed. The values that people in the Sierra Nevada hold have been passed on through generations. However, values also have been changing over time due to new knowledge, recreation and tourism growth, migration from urban areas, and demographic shifts.

The diverse values that people hold can create complex situations for national forest land management. In addition, many communities outside a national forest's immediate area of influence have an interest in how it is managed, whether they directly use the forests (such as recreation and tourism) or not (such as water demand from urban and agricultural areas, and concern for endangered species) (Long et al. 2014).

Baseline, representative data regarding public values for the Sequoia and Sierra National Forests are unavailable, so it is not possible to describe what values are most important to the public when it comes to managing the Sequoia and Sierra National Forests. However, based on what we heard from stakeholders throughout the revision process, we extracted the broad value categories described below. Because the viewpoints used to establish different value categories came from volunteered stakeholder responses, they are not necessarily representative of the general public. Brown et al. (Brown et al. 2014b) reveal differences in forest values between people who volunteered to participate in a values mapping exercise versus those who were randomly selected to participate. Still, interviews, meetings, and submitted comments often provide the only source of information regarding the forest values that people hold and help us better understand how national forest management decisions may have an impact on those values.

Aesthetic – Manage for the Scenery, Sights, Sounds, and Smells of Nature

As described in the national forest assessments, scenery is a major component of people's recreation experience in the Sequoia and Sierra National Forests; it greatly contributes to their sense of place and connection with the land. Ecosystem stressors, such as excessively dense vegetation conditions, fire return interval conditions susceptible to severe wildfire, and insect and disease outbreaks, continue to diminish valued scenery attributes, particularly socially valued large trees and diverse vegetation.

Biodiversity – Protect Animal and Plant Species and Their Habitat

The diverse landscapes of the Sequoia and Sierra National Forests provide a rich array of ecosystems and habitat types that support hundreds of wildlife, fish, and plant species. These species contribute to the lifestyles, cultures, and traditions of many national forest users through activities such as hunting, fishing, plant gathering, and nature viewing. People also have expressed concern regarding adequate protection of habitat for species that are "at-risk," as described in "At-Risk Species."

Cultural – Protect Forest Uses that Help Maintain Traditions and Cultures

Native American culture is inextricably connected to the land. Many Native Americans participate in traditional activities that carry on family and tribal traditions, provide sustenance for families, and continue a spiritual connection to the land and to animal and plant resources (McAvoy et al. 2004). Tribal members have expressed concern about continued use of and access to areas in the Sequoia and Sierra National Forests that support their cultural traditions.

Learning – Support Opportunities to Learn About the Environment, History, and People

The Sequoia and Sierra National Forests foster people's connection to nature and each other through education and interpretation. People have expressed a desire to increase outreach, education, and interpretation efforts, particularly related to issues such as fire, invasive species, cultural resources, tribal histories and uses, and recreation etiquette and impacts.

Recreation – Maintain and Enhance a Diverse Set of Recreation Activities

Outdoor recreation is a large part of the culture and lifestyle in the Sierra Nevada. It is one of the main ways that residents and visitors connect to the land and enjoy the natural world. Recreational trends and the mix of outdoor activities chosen by the public evolve over time, and these demands influence National Forest System lands and management decisions (United States Department of Agriculture 2012f). Because everyone recreates in the Sequoia and Sierra National Forests in a wide variety of ways, people also have expressed a wide range of concerns regarding potential impacts on their preferred recreation activities. In addition, many people would like to see more opportunities in these forests for the types of recreation activities in which they participate.

Well-being – Promote and Protect Human Health and Safety

The Sequoia and Sierra National Forests contribute to the well-being of human populations in a variety of ways, including basic life necessities such as clean air and water, physical and mental health benefits, and protection from the spread of fire into communities. People are concerned about the impacts of national forest management decisions on their health and safety, particularly in regard to climate change and expected increases in the occurrence and severity of drought and fire. Many stakeholders are concerned with impacts on water supply, including downstream agricultural and urban communities.

Stakeholders have expressed concerns regarding health impacts associated with increased prescribed fire and wildfire managed to meet resource objectives. People are concerned these actions would result in prolonged days of smoke exposure, affecting human health, people's ability to recreate and go about daily activities, and tourism. In addition, people have expressed safety concerns about using prescribed fire or wildfire managed to meet resource objectives near communities, particularly where fuels loads are high. People have raised concerns regarding impacts on access for fire suppression activities and public evacuation routes in the CWPZ.

Civil Rights

The Forest Service invited all members of the public to participate in the plan revision process. The main public notices and meetings held by both forests are listed below. No specific information concerning respondents' race, sex, national origin, or age was collected from public comments or meetings.

- On December 26, 2013, the *Federal Register* published the Forest Service's notice to initiate a plan revision for the Sequoia and Sierra National Forests. The public was also notified in the newspapers of record for the Sequoia and Sierra National Forests: the *Porterville Recorder* and *Fresno Bee*, respectively.

- In January 2014, the Forest Service held public meetings in Bakersfield and Fresno on the preliminary need to change, desired conditions, and forest roles and contributions. Based on sign-in records, 26 people attended the meeting in Bakersfield, and 93 people attended in Fresno.
- In June 2014, the Forest Service held public meetings in Lake Isabella and Fresno on the updated need to change, desired conditions, wilderness inventory, and timber suitability. Based on sign-in records, 30 people attended the meeting in Lake Isabella, and 122 people attended in Fresno.
- The notice of intent to prepare an environmental impact statement for the revised forest plans was published in the *Federal Register* on August 29, 2014. The scoping comment period concerning the proposed action in the notice of intent ended on September 29, 2014. The public was also notified in the newspapers of record for the Sequoia and Sierra National Forests. The notice of intent and supporting documents were available to the public in the Forest Service project website. The Forest Service accepted scoping comments through the project website, email, hard copy, or fax.
- In September 2014, the Forest Service held public meetings in Porterville and Fresno to answer questions about the notice of intent and proposed action and to receive scoping comments. Based on sign-in records, 29 people attended the meeting in Porterville, and 79 people attended in Fresno. During the scoping period, we received more than 7,200 separate public comment letters or emails from tribes, Federal agencies, state agencies, county governments and agencies, local agencies and organizations, and other groups and individuals.
- In November 2014, the Forest Service held public meetings in Porterville and Fresno on scoping issues and the conceptual range of alternatives. Based on sign-in records, 20 people attended the meeting in Porterville, and 36 people attended in Fresno.

Beyond these general public notifications and meetings, “Environmental Justice” describes additional efforts the forests made to reach out to more diverse audiences.

The Forest Service received no comments that indicated concerns about discrimination based on race, sex, national origin, age, or disabilities during the plan revision process for the Sequoia and Sierra National Forests. The forests offered accommodations and provided paper copies of forest plan revision materials to people who requested them due to disabilities or other reasons. All web-based materials were developed to be accessible for people with disabilities as required by section 508 of the Rehabilitation Act.

Some senior citizens expressed a desire for meetings closer to home to avoid long drives at night. We also heard this from members of the public from rural, mountain communities. Meeting locations and times were based on the availability of meeting space and trying to find centralized locations and times that accommodate the greatest possible attendance. The Forest Service adjusted meetings to end earlier over the course of the plan revision process. Forest staffs were also available to answer questions or provide information to those people who could not attend the meetings.

Some comments received during scoping suggest concerns regarding potentially disparate impacts from the proposed action and are further examined in "Environmental Consequences." These include the following:

- Concerns that new wilderness recommendations would result in road and trail closures that would impact seniors, children, and people with disabilities who rely on motorized or mechanized travel to access the national forest
- Concerns that new wilderness recommendations would add areas predominantly used by white males and that exclude minorities and women
- Concerns that prohibiting bicycles on the Pacific Coast Trail would impact people with disabilities who can bike but not walk for long distances
- Concerns with health impacts of wildfire smoke on seniors, children, and people with health problems

Environmental Justice

Of the six census county divisions that make up the Sequoia National Forest's area of influence, the Woodlake-Three Rivers CCD in Tulare County and the Bakersfield CCD in Kern County have minority populations over 50 percent (Table 149), mostly accounted for by people who identified as Hispanic/Latino. In addition, a relatively large proportion of the population around the Tule River Indian Reservation and South Lake identified as American Indian or/Alaska Native. Although not within the Sequoia National Forest's immediate area of influence, about 60 percent of the population in the Visalia-Porterville metro area are estimated to be part of a minority population, almost entirely accounted for by people who identified as Hispanic/Latino.

None of the six census county divisions that make up the Sequoia National Forest's area of influence have substantially greater percentages of people who are below poverty compared with county levels (Table 149). However, certain areas within or near the following places have relatively large low-income populations compared with county levels: Woodlake, Wofford Heights, South Lake, Tehachapi, Bakersfield, and the Visalia-Porterville metro area.

Table 149. Percentage of minority populations and people living below the poverty level in the area of influence for the Sequoia National Forest

Area	Minority Population	People Below Poverty Level
Fresno County	67%	23%
Sierra CCD	24%	10%
Tulare County	60%	24%
Woodlake-Three Rivers CCD	60%	21%
Springville-Johnsondale CCD	41%	13%
Kern County	49%	21%
Lake Isabella CCD	15%	22%
Bakersfield CCD	63%	24%
Tehachapi CCD	31%	13%

None of the six census county divisions that make up the Sierra National Forest's area of influence have minority populations over 50 percent (Table 150). Although not within the Sierra National Forest's immediate area of influence, several areas within or near Fresno, Madera, and Chowchilla have relatively large proportions of their populations who identified as minorities, particularly people who identified as Hispanic/Latino, Asian, and black/African American.

None of the six census county divisions that make up the Sierra National Forest's area of influence have substantially greater percentages of people who are below poverty compared with county levels (Table 150). However, certain areas within or near the following places have relatively large low-income populations compared with county levels: Coulterville, Mariposa, Fresno, Madera, and Chowchilla.

Table 150. Percentage of minority populations and people living below the poverty level in the area of influence for the Sierra National Forest

Area	Minority Population	People Below Poverty Level
Mariposa County	**17%**	**14%**
Coulterville CCD	14%	16%
Mariposa CCD	17%	14%
Yosemite Valley CCD	26%	17%
Madera County	**61%**	**20%**
Oakhurst-North Fork CCD	16%	11%
Yosemite Lakes CCD	19%	7%
Fresno County	**67%**	**23%**
Sierra CCD	24%	10%

Meaningful involvement in the decisionmaking processes is an important part of environmental justice considerations. This includes reaching out to potential environmental justice communities and inviting them to participate in the plan revision process, so we can better understand their concerns.

Efforts have been made to engage tribes early and throughout the plan revision process. In fall 2012, prior to the official start of the plan revision, the Center for Collaborative Policy conducted informational interviews with 31 tribal members representing 14 tribes and tribal organizations associated with the Sequoia and Sierra National Forests. The purpose of the interviews was to better understand tribal concerns that may be relevant to national forest planning, better understand how to improve tribal consultation and involvement, and develop recommendations for tribal involvement during the plan revision process. A Tribal Collaboration and Communication Plan was developed from the results of these interviews to inform how the Sequoia and Sierra National Forests would interact with tribes during the plan revision process.

The Sierra and Sequoia National Forests have been hosting quarterly tribal forums since 2008 for information sharing between the forests and tribes. Tribal forums have helped meet the needs of tribes and national forest leadership by allowing everyone the opportunity to meet at annual forecasted dates and times to discuss topics of mutual interest, including forest plan revision.

The Forest Service has held tribal forums specific to the plan revision in both forests as described below:

- In January 2014, we held tribal forums in Bakersfield and Clovis on the preliminary need to change, desired conditions, and forest roles and contributions. At least 28 tribal representatives attended these forums.
- In June 2014, we held tribal forums in Kernville and Fresno on the updated need to change, desired conditions, wilderness inventory, and timber suitability. At least 26 tribal representatives attended these forums.
- In September 2014, we held tribal forums in Porterville and Fresno on the notice of intent and proposed action. At least 31 tribal representatives attended these forums.
- In November 2014, we held a tribal forum in Prather on scoping issues and the conceptual range of alternatives. Approximately 15 tribal representatives attended.

In addition to the meetings above, both forests have had several meetings with individual tribes and tribal groups throughout the process. These meetings have included forest plan revision as an agenda topic.

In their work and interactions with tribes and tribal organizations, both national forests have gained a better understanding of tribal interests and concerns related to the plan revision. Broad categories of concern include protection of and access to sacred sites, gathering areas, and ceremonial areas; traditional land uses and management, including the role of fire on the landscape; tribal economies; traditional knowledge and education; conflict between recreation uses and traditional tribal activities; and overall forest resilience and sustainability. Further discussion of tribal interests and concerns can be found in "Tribal Relations and Uses."

Aside from tribal communities, limited information is available regarding how minority and low-income populations use and interact with the Sequoia and Sierra National Forests.

National and regional information about how minority populations recreate can provide some insights regarding potential uses of the Sequoia and Sierra National Forests. Despite a U.S. population that is becoming increasingly ethnically diverse, minority populations are still underrepresented in outdoor recreation (Cordell 2012). Based on national outdoor recreation trends (Mahler 2012), running is the most popular outdoor recreation activity among African Americans, Asian/Pacific Islanders, and Hispanics. Biking is the second most popular activity among African Americans and Asian/Pacific Islanders, while fishing is the second most popular activity among Hispanics. Studies have found that Latinos are primarily day-use visitors, recreate in larger groups, prefer developed sites with amenities and facilities, and often spend extended periods at picnic sites cooking several meals throughout the day (Chavez 2012). Studies on four national forests in southern California show that picnic and/barbecues and playing in streams were among the activities in which Latino visitors usually engaged (Chavez and Olson. 2008).

In addition to general public notification, the forests have been trying to find new ways to reach out to more diverse audiences to better understand their concerns and how they use these forests.

The Sequoia National Forest has been working to translate more materials into Spanish and managed a Latino Awareness booth at a local festival, sharing information about fire awareness, forest plan revision, and environmental restoration.

The Forest Service's Central California Consortium based in Clovis, California, has worked on various efforts over the past several years to engage diverse youth and underserved communities in national forest planning. The Central California Consortium is a minority outreach and recruitment program serving the greater San Joaquin Valley. They aim to not only create jobs for underserved communities, but to educate the public on natural resources issues and encourage diverse communities to enjoy public lands. This has resulted in participation by diverse high school and college students in plan revision meetings in the Sierra National Forest and efforts to translate plan revision meeting announcements into Spanish. The forests aim to continue to build on these efforts and develop relationships with groups that tend to be underrepresented in meetings and as national forest users.

Continuing to build on this outreach work can help increase diversity in participants in future efforts, particularly projects and activities developed under the revised plans. During this plan revision effort, we have developed a better understanding of where potential environmental justice communities may be located. Forests have started to do some work on identifying trusted community contacts who can help provide a bridge between the forests and these communities. This information can further assist in developing outreach efforts when we are developing projects in certain areas.

Environmental Consequences to Social Conditions (All Alternatives)

Values

Aesthetic – Manage for the Scenery, Sights, Sounds, and Smells of Nature

Scenery is closely tied to vegetation and fire management as described under "Sustainable Recreation." The alternatives differ in terms of ecological restoration objectives, which define the rate at which we aim to move vegetation toward desired conditions. As vegetation and fire return intervals across more landscapes are restored toward their natural range of variation, the degree to which valued scenic attributes can be sustained through time is also expected to increase. In the short term, however, some people may perceive restoration activities as having a negative impact on scenery.

Long-term sustainability of scenic character would be at greater risk under alternative A compared with alternatives B or D. Alternative A would continue to use the existing Visual Management System for managing scenery; it does not include evaluating the sustainability of scenic character as part of project planning. As described in "Terrestrial Ecosystems," alternative A would provide limited treatments across ecological zones.

Alternative B would better align with aesthetic values in the long term compared with alternatives A, C, and E, but worse than alternative D. It would include evaluating sustainability of scenic character as part of project planning. The Forest Service expects alternative B would better integrate management across resources compared with alternative A, particularly in places that are of high recreation importance and where protection of scenic character is especially critical. This alternative would provide more potential for increasing ecological restoration opportunities across ecological zones than alternatives A, C, and E.

Similar to alternatives B and D, alternatives C and E would include evaluating sustainability of scenic character as part of project planning. However, this alternative would be more restrictive in terms of ecological restoration opportunities compared with all other alternatives. Therefore, long-term sustainability of scenic character would likely be at greatest risk under alternative C compared with all other alternatives.

Similar to alternatives B, C, and E, alternative D would include evaluating sustainability of scenic character as part of project planning. The Forest Service would expect it to better integrate management across resources compared with alternative A. Compared with all other alternatives, the Forest Service would expect alternative D to best align with aesthetic values in the long term, because it would provide the most potential for increasing ecological restoration opportunities across ecological zones.

Biodiversity – Protect Animal and Plant Species and Their Habitat

Fishing, hunting, plant collection, and nature viewing are important activities to people who use the Sequoia and Sierra National Forests. The Forest Service is responsible for managing wildlife habitats on National Forest System lands whereas the California Department of Fish and Wildlife manages individual species.

As described in "Aquatics and Riparian Ecosystems," the slow pace of restoration of habitats for aquatic at-risk species under alternative A would result in a continuing risk of a downward trend for aquatic species diversity. The goal to increase restoration of aquatic habitats under alternatives B, C, D, and E would be expected to address species' needs and improve aquatic biodiversity compared with alternative A. While there are different tradeoffs between short-term consequences of restoration and the long-term risk of intense wildfire among the alternatives B, C, D, and E, over the long term, they would be expected to have similar effects on aquatics species diversity.

As described in "At-risk Plant Species," because broad-scale restoration of ecosystem structure and function would be more limited under alternative A, there could be long-term negative effects on federally listed plant species under this alternative compared with the other alternatives. In comparison with alternatives B, C, D, and E, alternative A would provide the least ecological conditions necessary to conserve candidate species and to maintain or restore their habitats in the plan area, which would contribute to preventing them from being federally listed.

Alternative A would consider fewer rare plants in the project planning process, as compared with alternatives B, C, D, and E. Each of the four alternatives would provide for ecological conditions necessary for the viability of at-risk plant species. However, alternative B would provide the most long-term benefits to the habitat extent and quality of species of conservation concern. Alternative B also would have the most beneficial short- and long-term effects for whitebark pine.

Ecological restoration and use of wildfire primarily to meet resource objectives would be limited under alternative A, providing for less opportunity to create habitat heterogeneity that is needed for many of the hunted and viewable wildlife species. Alternative B would continue to provide for large tree and forest canopy cover, as with alternative A, but with additional emphasis to increase the amount of forest restoration treatments to create greater habitat resiliency and heterogeneity. The Forest Service expects consequences to many hunted and viewable species would be mixed under alternatives C and E; there would be some benefits due to less disturbance, but also less benefit from more limited habitat restoration opportunities compared with alternatives B and D.

According to the fire-climate scenario predictions, there would be a higher likelihood of large, high-intensity fires with implementation of alternatives C and E (Westerling et al. 2015), which could have a long-term, negative impact on the distribution and sustainability of habitat. Alternative D would have the greatest increase in the pace and scale of ecological restoration of all alternatives; it would provide the most areas with increased vegetation resilience and heterogeneity, which would generally benefit hunted and viewable species. The Forest Service would expect the increased pace and scale of mechanical thinning and use of strategic treatments along ridgetops under alternative D to produce greater forage for herbivores. The increased restoration of fire as an ecological process also would provide more sustainable forage. This influx of forage also could help bolster predator populations, such as mountain lions, bobcats, coyotes, and other viewable wildlife species.

Cultural – Protect Forest Uses that Help Maintain Traditions and Cultures

All alternatives contribute to the cultural connections that people have with the Sequoia and Sierra National Forests through the various uses and activities that the forests provide.

Alternative A would not provide the level of integration of tribal interests and values into project considerations that alternatives B, C, D, and E would provide. Alternative A only would include existing designated wilderness and would not recommend new areas for inclusion in the National Wilderness Preservation System, allowing the same level of tribal access to areas traditionally used by tribes and that may have been part of the wilderness evaluation.

Compared with alternative A, alternatives B, C, D, and E would provide a greater level of integration of tribal interests and values into project considerations, due to the addition of new plan components that would be included in each alternative. The increased opportunities for ecological restoration under alternative B would be expected to benefit tribal interests by incorporating traditional ecological knowledge, traditional management practices, and tribal involvement into restoration projects. By working with tribes, the Forest Service would expect more ecological restoration activities to lead to more opportunities that benefit habitats and resources used for traditional purposes. Alternatives B, C, and E would recommend new areas for inclusion in the National Wilderness Preservation System. As described in “Tribal Relations and Uses,” while many tribal activities could still occur within areas recommended for wilderness, some activities such as gathering and ceremonial uses could be restricted or more difficult if areas are managed as wilderness.

Due to the limited opportunities for ecological restoration under alternatives C and E, areas and resources of tribal interest would be at greatest risk to large, high-intensity wildfire under these alternatives. Alternative C would recommend the most new areas for inclusion in the National Wilderness Preservation System across both forests, which could lead to the most restrictions on traditional tribal uses.

The increased opportunities for ecological restoration under alternative D would be expected to benefit tribal interests by incorporating traditional ecological knowledge, traditional management practices, and tribal involvement into restoration projects. By working with tribes, the Forest Service would expect more ecological restoration activities to lead to more opportunities that benefit habitats and resources used for traditional purposes. Because alternative D would provide the most ecological restoration activities, there could be greater risks of inadvertently impacting tribal resources, traditional cultural properties, and sacred sites. However, the Forest Service would expect to mitigate this through close coordination with tribes. Alternative D would not recommend new areas for inclusion in the National Wilderness Preservation System, allowing for the same level of tribal access to areas traditionally used by tribes and that may have been part of the wilderness evaluation.

Learning – Support Opportunities to Learn About the Environment, History, and People

Under alternative A, forests would continue to provide opportunities for people to learn about the environment and the history of the land and its people. However, more opportunities would be expected under alternatives B, C, D, and E because of added plan direction related to volunteering, interpretation, partnerships, and stewardship. New plan direction would emphasize the delivery of effective messaging regarding natural and cultural resources, climate change, land stewardship, responsible recreation use, and Native American heritage and culture, as well as communicating regularly with the public about Forest Service projects, management activities, and volunteer and partnership opportunities. This would include consideration of the diverse backgrounds and needs of visitors in developing communication materials.

In addition, alternatives B, C, D, and E would include an objective to generate cultural resources products, providing for more cultural learning opportunities. This objective would not vary across alternatives B, C, D, and E and does not exist in current forest plans under alternative A.

Across alternatives B, C, D, and E, there would be an increased emphasis on partnerships. Partnerships not only help us do our work but also create opportunities for learning. While emphasis on partnerships across these alternatives is basically the same, the focus of the partnerships may vary across them. For example, there would be more opportunities for partnerships around primitive recreation under alternatives C and E compared with developed recreation under alternative D.

There also would be an increased emphasis on working with tribes under alternatives B, C, D, and E compared with alternative A. An important aspect of this coordination would be finding opportunities for increased learning and understanding between the agency and tribes as we carry out projects and activities. Another important aspect would include incorporating traditional ecological knowledge, traditional management practices, and tribal involvement into restoration projects. This could not only improve land management decisions but also promote transmission of traditions and knowledge to younger generations.

Recreation – Maintain and Enhance a Diverse Set of Recreation Activities

The Forest Service expects demand for outdoor recreation opportunities to increase, while the types of recreation activities and experiences that people seek would continue to shift. With expected stable or declining agency budgets in the future, the Forest Service would need to rely on volunteers and partners to continue to provide a set of recreation opportunities that meet the need of a growing and changing public. Over the past 15 years, there have been significant declines nationally in programs that contribute to providing recreation opportunities as financial and human resources have been shifted to wildfire management (United States Department of Agriculture 2015f). This has resulted in the agency being unable to more fully implement sustainable recreation, heritage, volunteer services, wilderness, and wild and scenic rivers programs to provide consistent, quality recreation opportunities to the public. The reductions in funding and staff also have impacted the agency’s ability to work with partners and volunteers, as well as to manage permits needed by outfitters, guides, and other recreation-focused small business to provide recreation opportunities on National Forest System lands.

Alternatives B, C, D, and E would better emphasize sustainable recreation concepts and integrated resource management compared with alternative A. In addition, these alternatives would emphasize increasing the sustainability of recreation through stewardship and partnership opportunities with local communities, engaging diverse populations, and targeting highest-priority recreation needs to help focus limited resources. However, the types of recreation opportunities emphasized would vary across alternatives.

The threat of large, high-intensity fire would be greater under alternative A compared with alternatives B or D due to limited ecological restoration treatments and a limited ability to use wildfire to restore and maintain landscapes. As a result, the Forest Service would expect recreation opportunities and access to be more at risk under alternative A, increasing the potential for closures, displacement, and associated overcrowding in the long term. The deferred maintenance backlog would continue to grow, further increasing the potential for site and infrastructure closures. Under alternative B, the Forest Service would expect the strategic treatment of fuels and the treatment of focus landscapes to improve the sustainability of recreation infrastructure and limit losses and damage due to wildfire, allowing more recreation resources to go toward reducing the deferred maintenance backlog over the long term.

Alternative D would include more opportunities for ecological restoration than alternative B, further decreasing the risk to recreation opportunities from high-intensity wildfires and reducing the potential for closures and displacement over the long term. It also would further reduce the deferred maintenance backlog compared with alternative B. Additionally, alternative D could have the greatest potential to reduce overcrowding compared with other alternatives because it would best address the growing demand for developed recreation opportunities. Under alternatives C and E, restoration would be most limited, and recreation opportunities would be at greatest risk of negative impacts from high-intensity wildfire. As a result, alternatives C and E would have the most potential for increasing overcrowding due to closures and displacement. Under alternatives C and E, the deferred maintenance backlog would increase more than under all other alternatives due to their focus on dispersed and undeveloped recreation and more limited opportunities for fuels treatments.

Well-being – Promote and Protect Human Health and Safety

National forest management may influence several aspects of human and community well-being. This analysis focuses on health and safety related to wildfire. These aspects of well-being highlight the main differences expected to occur across alternatives for this value category. As described in “Affected Environment,” these are some of the most important areas of concern that stakeholders raised regarding human and community well-being. Wildfires are growing larger, becoming more destructive, and occurring more frequently outside the traditional fire season due to vegetation buildup from years of suppression, climate change, and drought. Large, high-intensity wildfires have the potential to negatively affect stream and watershed quality, reduce air quality with increased smoke, and destroy nearby homes and communities.

As described in “Fire Management,” managing fires more holistically, rather than trying to emphasize suppression only, is the most effective and efficient way to reduce fuels, reduce impacts on resources and communities, and restore and maintain landscapes. Not enough resources are available to reduce fuels with mechanical or prescribed fire treatments alone on enough areas to effectively reduce the risk to communities. As a result, alternatives B and D would best address safety concerns regarding the direct impacts of wildfire. These both would use a four-zone approach to categorize risk, remove many of the uncertainties on the location and source of potential damages, and benefit highly valued resources and assets. This would allow for more use of wildfire to meet resource objectives and the ability to meet overall restoration goals, which ultimately would reduce risks to communities.

The greater amounts of ecological restoration and the enhancement of strategic fire management features under alternatives B and D, compared with alternatives A, C, and E, further would contribute to reducing fire risk to communities and allowing for more opportunities for implementing large, prescribed fires or managing wildfire to meet resource objectives. More ecological restoration treatments under alternative D than under alternative B would be expected to further reduce fire risk to communities.

Under all alternatives, there would be continued coordination with local partners and communities for protection and prevention in high wildfire risk areas to enhance the effectiveness of initial response. All alternatives prioritize fuel reduction treatments around communities. However, alternatives A, C, and E would not account for the likelihood of fires to spread from adjacent areas that contribute to the risk to communities or infrastructure. Because risk-based zones would not be used under alternative A, opportunities for using wildfire to restore and maintain landscapes would be greatly limited. Additionally, mechanical fuels treatments would be more limited under alternative A than alternatives B and D.

As described in “Fire Management,” smoke management opportunities are limited during large wildfires and can result in serious air quality impacts, disrupting the lives of residents and adversely impacting human health. The level of smoke emissions from large wildfires is expected to double over the next half a century, given current vegetation conditions and trends in climate and fire ignitions. Under alternative A, there would generally be a continuation of current trends in large wildfires that produce large smoke emissions. Alternative A would not contribute to altering current trends or improving the long-term sustainability of air quality benefits that these forests provide to people.

Under alternatives B and D, there would be more prescribed fire, thinning, and in some areas wildfires managed to meet resource objectives. All these restoration activities would reduce potential emissions from large, undesirable wildfires. There would be increased smoke emissions from prescribed fires, but the Forest Service generally plans prescribed fires under favorable conditions for smoke dispersion to limit human health impacts, impacts on transportation corridors, and smoke-sensitive populations. Emissions from prescribed fire can be managed more effectively than those of wildfire to reduce the short-term impacts on air quality.

Alternatives B, C, D, and E would contribute to reducing current trends in large, uncharacteristic wildfires that adversely affect the long-term sustainability of air quality. However, under alternative C, there would be less mechanical thinning proposed than under alternatives B and D. As a result, prescribed fires would have a greater quantity of smoke associated with restoration activities because more fuels would be available to burn. In addition, the ability of alternative C to alter current trends would depend on the extent to which larger, landscape-prescribed burning would occur.

Civil Rights

The Sequoia and Sierra National Forests are open to all groups for activities allowed under existing laws, regulations, and policies. This will not change under any alternative. Specific concerns described in “Affected Environment” that the public raised during the public scoping period are discussed further below.

The concerns expressed were that potential wilderness recommendations would result in road and trail closures that would impact seniors, children, and people with disabilities who rely on motorized or mechanized travel to access the national forests. Changes to the trail and road system are project-level decisions and are not part of the plan revision process. While motorized and mechanized travel are considered unsuitable in recommended wilderness areas, current, authorized uses of roads and trails would not change under any alternative.

Unless restricted by law or regulation, the plan alone cannot prohibit public uses without a closure order from the responsible official. To prohibit a use, the responsible official needs to analyze the effects of a proposed closure and issue a project decision. Without a closure order, public uses may continue even if the uses are not considered suitable on the lands where they occur. Plan components can, however, bar the Forest Service from authorizing such uses, for example, when they would be conducted as an event requiring a special use authorization.

Proposed changes to roads and trails within recommended wilderness areas would need to be analyzed at the project level for adverse and disproportionate impacts on seniors, children, and people with disabilities.

The final wilderness concerns raised were that new wilderness recommendations would add areas predominantly used by white males and that exclude minorities and women. All areas in the national forests, including recommended wilderness, are open to all members of the public. Based on the latest National Visitor Use Monitoring data for each national forest, people from culturally diverse backgrounds are generally underrepresented as visitors to the Sequoia and Sierra National Forests. The vast majority of visitors are white, non-Hispanic, and male.

The Forest Service recognizes the demographic shifts that are occurring locally and regionally. It is working to better understand how and why people do and do not visit national forests, as well as outreach to underrepresented populations. Research has shown that people from culturally diverse backgrounds may not be visiting national forests for a variety of reasons, including comfort and safety, accessibility, strong and positive connections, and lack of information (Roberts et al. 2009). Under alternatives B, C, D, and E, we have plan components to consider diverse backgrounds in designing communication and interpretive messages, and to actively engage urban populations, youth, and underserved communities in educational and community outreach programs. In general, there is more emphasis within plan components on connecting people with nature.

In addition to concerns related to wilderness, members of the public expressed concerns that prohibiting bicycles on the Pacific Crest National Scenic Trail would impact people with disabilities who can bike but not walk for long distances. No changes regarding bicycle use on the Pacific Crest National Scenic Trail are being made under the current forest plan revision process. Regional Order 88-4 currently prohibits using or possessing bicycles on the Pacific Crest National Scenic Trail along the entire length of the trail.

People also expressed other concerns regarding potential health impacts of wildfire smoke on more vulnerable populations, including seniors, children, and people with health problems. While most healthy adults and children are expected to recover quickly from smoke exposure and not have long-term consequences, certain sensitive populations may experience more severe short-term and chronic symptoms, including people with respiratory problems, the elderly, and children (California Air Response Planning Alliance 2008). As described above and in “Fire Management,” the level of smoke emissions from large wildfires is expected to double over the next half a century, given current vegetation conditions and trends in climate and fire ignitions.

No alternative offers both short-term and long-term improvements to air resource indicators. Restoration treatments would slow the progress of increasing wildfire emissions. As a result, alternative D would have the highest short-term emissions from treatments followed by alternatives B and C. In the long term, alternative D would result in the greatest reduction in emissions from wildfires followed by alternatives B, C, E, and lastly A. Alternatives B, C, D, and

E also would include goals to help the public reduce smoke exposure through early notification and outreach efforts and participation in interagency collaborative smoke management. In addition, alternatives B, C, D, and E would include a guideline to identify mitigation actions for smoke-sensitive areas when managing wildfires and prescribed burns.

Environmental Justice

Because we do not have good data on how low-income populations use the Sequoia and Sierra National Forests, it is difficult to examine how the alternatives may impact them. As described above in "Economic Conditions," the counties bordering the Sequoia and Sierra National Forests have higher unemployment, lower earnings, and lower per capita income compared with California as a whole. They are likely more vulnerable to national forest management changes that affect key economic sectors, as well as the impacts of large, high-intensity wildfires. While there is no indication that any alternative disproportionately impacts low-income populations, the alternatives have varying effects on improving economic conditions locally and creating more resilient landscapes.

As described in "Economics," over the long term, alternatives B and D would be likely to have beneficial effects on economic conditions in local communities when compared with alternative A. As such, the Forest Service would not expect these alternatives to exacerbate the poverty rate or disproportionately worsen the economic well-being of low-income individuals over the long term. Alternatives C and E would be likely to have some beneficial effects when compared with alternative A, but with losses in the forest products and biomass industries. We would expect alternative A to have overall adverse effects on economic conditions in local communities. It will be important to better understand how low-income populations use the Sequoia and Sierra National Forests and how management actions impact them. This may be particularly true for projects that occur near key places where relatively large proportions of the population are low-income, as described in "Affected Environment."

Native American tribes have integral connections to the Sequoia and Sierra National Forests that cross an array of social institutions, including family, government, economy, education, and religion. Areas across these forests play a key role in defining these institutions. As a result, all aspects of national forest management are generally of great interest to tribes. As described in "Tribal Relations and Uses," alternative C is the only alternative that could result in an incremental loss of sites or diminished access to resources used by tribes over time due to the high risk of large, high-intensity wildfires. In addition, alternative C would include new recommended wilderness areas in both forests, potentially impacting tribal access to and use of culturally important areas.

Alternative D would provide the most opportunities to restore sites and resources important to tribes and to reduce the threats from large, high-intensity wildfires due to the increased amount of vegetation management treatments. At the same time, alternative D would require additional coordination to protect these sites and resources due to the increased amount of mechanical treatments. All alternatives would address minimizing impacts on tribes at specific locations during project planning; alternatives B, C, D, and E would include specific new plan direction to incorporate opportunities to improve sites and resources important to tribes during project planning.

There is limited information regarding the use of the Sequoia and Sierra National Forests by other minority populations. Currently, people from culturally diverse backgrounds are still underrepresented as national forest visitors according to the Forest Service National Visitor Use Monitoring data. This may be due to language barriers, lack of information, or other constraints (Roberts et al. 2009). Based on the lack of information about how minority groups use the national forests, it is difficult to determine how the alternatives could impact them. However, there is no indication that the alternatives would be expected to disproportionately and adversely impact minority populations.

Based on general observation at public meetings, there has been limited involvement by minority populations, aside from tribes, during the plan revision effort. In order to have more involvement from culturally diverse stakeholders in processes such as a plan revision, a relationship first needs to exist between the forests and minority populations to provide a foundation to work from and build on. During the plan revision process, the Sequoia and Sierra National Forests have pursued efforts to start building those relationships and to outreach in new ways that may be more effective at reaching minority populations.

Cumulative Effects

Other federally managed lands in the area, including lands managed by the National Park Service and the BLM, support the diversity of values that people hold for the natural landscapes in the southern Sierra Nevada. Restoration efforts across all lands would be important to sustaining these landscapes and how they contribute to people's lives. As described in "Terrestrial Ecosystems," under all alternatives, the impacts of climate change and increased probability of large, high-intensity fires may override the beneficial impacts of restoration treatments, particularly in the near term while projects are being planned and implemented. There is uncertainty as to when or where large, high-intensity fires or severe drought may occur. The role that the Sequoia and Sierra National Forests will play in the future in supporting certain values may change over time as the landscape changes. In addition, demographic, cultural, and societal changes will continue to influence how people use their national forests and what is important to them in terms of forest management.

Analytical Conclusions

Alternative A would not contribute to sustaining a diverse set of forest-related values in the long term as much as alternatives B and D. Current trends of increasing fire activity, drought, and insect outbreaks pose the greatest threat to many of the values people have related to the Sequoia and Sierra National Forests because these values are heavily dependent on resilient ecosystems that can support a variety of uses and needs in the long term. Because ecological restoration treatments would be limited under alternative A, values are more at risk to negative impacts over the long term.

Alternative B would effectively support a diverse set of forest-related values in the long term. Alternative B would provide for increased ecological restoration over the planning period compared with alternatives A and C, though less when compared with alternative D. As a result, alternative B effectively would move forest conditions closer to ecosystem desired conditions and fire-resilient landscapes, though not as quickly as alternative D. By moving toward these desired conditions, aesthetic, biodiversity, cultural, economic, learning, recreation, and well-being values would be sustained over the long term. In terms of biodiversity values, alternative B would be expected to provide more long-term benefit for habitat for plant species of conservation concern than all other alternatives.

Similar to alternative A, alternative C would not contribute to sustaining a diverse set of forest-related values in the long term as much as alternatives B and D because ecological restoration treatments also would be limited under alternative C. Values would be more at risk to negative impacts over the long term. Biodiversity and learning value sets under alternative C would be better aligned than continuing with current management direction under alternative A.

Alternative D would best support a diverse set of forest-related values in the long term compared with all other alternatives. Alternative D would provide for the greatest amount of ecological restoration over the planning period, moving us closer than other alternatives to ecosystem desired conditions and fire-resilient landscapes. As a result, alternative D would best align with sustaining aesthetic, cultural, economic, learning, recreation, and well-being values over the long term.

Alignment with biodiversity values would be somewhat mixed. Alternative D would best align with values related to hunting and viewing terrestrial wildlife. Alternatives B, C, and D would provide similar alignment with values related to aquatic species. Alternatives D and C would provide more long-term benefits to habitat for plant species of conservation concern than alternative A, but less than alternative B.

Management direction under all alternatives would not be expected to adversely or disproportionately impact protected groups. In addition, alternatives B, C, and D would include plan components to improve communication with and outreach to more diverse audiences and often underrepresented populations. These alternatives also would include plan components to increase connections between the forests and people in general. Through this effort, we have heard concerns in particular related to impacts on seniors, children, and people with disabilities. Future projects will need to evaluate whether there may be adverse and disproportionate impacts on these and other protected groups. It will be important to continue to learn about how these groups use the national forests and potential impacts of the forests on them.

The Forest Service would expect alternative E to have effects similar to those under alternative C. The exception would be the additional areas recommended for wilderness; these would be included under alternative C and not included under alternative E.

Other Required Disclosures

Unavoidable Adverse Effects

The revised forest plans provide a programmatic framework that guide site-specific actions but do not authorize, fund, or carry out any project or activity. Therefore, decisions made in each land management plan do not cause, or have the potential to result in, actual irreversible or irretrievable commitments of resources (see next section). Application of land management plan standards and guidelines during future project and activity decisionmaking would provide resource protection measures and limit the extent and duration of adverse environmental impacts. For a discussion of the types of consequences expected from future activities, see the discussion of cumulative effects for each topic area in chapter 3.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time, such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line right-of-way or road or that are subject to high-severity fire that kills mature trees.

The revised plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carry out any project or activity. Because the land management plan does not authorize or mandate any site-specific project or activity (including ground-disturbing actions), none of the alternatives cause an irreversible or irretrievable commitment of resources.

Short-term Uses and Long-term Productivity

The National Environmental Policy Act requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by Congress, this includes using "all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans" (NEPA, section 101). Short-term uses are those that generally occur for a finite time period. Long-term productivity refers to the ability of the land to produce a continuous supply of a resource.

The change in the programmatic management of the Sequoia and Sierra National Forests under alternatives B, C, or D would not jeopardize the short-term or long-term productivity of the lands and resources of the national forests. Discussion of short- and long-term effects is included in the analysis of the environmental consequence in this chapter.

Laws Requiring Consultation

The regulations for implementing the National Environmental Policy Act at 40 CFR 1502.25(a) direct "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with . . . other environmental review laws and executive orders." As a proposed Federal project, the revised plan decisions are subject to compliance with other Federal and state laws. Determinations and decisions made in the revised plans have been evaluated in the context of relevant laws and executive orders. Throughout the development of the revised plans, there has been collaboration with various state and Federal agencies. The Forest Service has taken the following actions to document and ensure compliance with laws that require consultation and/or concurrence with other Federal agencies.

- Endangered Species Act, Section 7: Consultation with the U.S. Department of the Interior, Fish and Wildlife Service, regarding federally listed threatened, endangered, and proposed species, and designated and proposed critical habitat is in progress. A biological assessment for federally listed species will be prepared and submitted to the U.S. Fish and Wildlife Service for formal consultation as required by the Endangered Species Act. Forest plan revision is considered a "framework programmatic decision" that does not result in "take" of listed species or habitats (50 CFR Part 402).
- National Historic Preservation Act: Section 106 of the National Historic Preservation Act mandates consultation with the California State Historic Preservation Officers. The document titled "Programmatic Agreement Among the USDA Forest Service, Pacific Southwest Region (Region 5), California State Historic Preservation Officer, Nevada State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding the Processes for Compliance with Section 106 of the National Historic Preservation Act for Management of Historic Properties by the National Forests of the Pacific Southwest Region" was executed in December 2012. This programmatic agreement prescribes the manner in which the Pacific Southwest Region and the State Historic Preservation Officer shall cooperatively implement this programmatic agreement in California and portions of Nevada. It is intended to ensure the national forests in the region organize their programs to

operate efficiently and effectively in accordance with the intent and requirements of the National Historic Preservation Act and that the Pacific Southwest Region integrates its historic preservation planning and management decisions with other policy and program requirements. The programmatic agreement streamlines the National Historic Preservation Act section 106 process by eliminating case-by-case consultation with the State Historic Preservation Officer on undertakings for which there is no or little potential to affect historic properties and for undertakings that either culminate in no historic properties affected or no historic properties adversely affected with approved standard protection measures (36 CFR 800.4(d)(1) and 800.5(d)(1)).

- Government-to-government consultation was completed with American Indian tribes who have aboriginal territory within the lands now part of the Sequoia and Sierra National Forests, as required by the National Historic Preservation Act, Executive Orders 13007 and 13175, and the programmatic agreement cited above.

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Chapter 4
Preparers, Consultation, and Coordination

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Chapter 4.
Preparers, Consultation, and Coordination

Preparers and Contributors

The following individuals and Forest Service staff groups contributed to developing this environmental impact statement. A steering committee guided the plan revision process, and it was comprised of the Forest Supervisors of the Sequoia and Sierra National Forests; the Regional Office Directors of Ecosystem Planning, Ecosystem Management, and Public Services; and a representative from the Forest Service Office of General Council.

Responsible Officials

Teresa Benson, Forest Supervisor for the Sequoia National Forest; Dean Gould, Forest Supervisor for the Sierra National Forest.

Interdisciplinary Team Members

The following staff members were primary contributors to the RDEIS. Many other staff in the Forest Service and regional office provided input, advice, and assistance throughout the process.

Name	Title and DEIS Contribution	Education and Experience
Forest Service		
Colvin, Chris	Recreation Planner (Core Team: Recreational Support)	• MEM Environmental Management, Yale University • BA, Integrative Biology, University of California, Berkeley • 1 year with the Forest Service, 6 years with the National Park Service
Fairweather, Mary Lou	Biologist Planner (Core Team: RDEIS and Co-author and editor of animal and plant species of conservation concern documents)	• MS, Plant Pathology, University of Arizona • BS, Biology, Fort Lewis College • 30 years with Forest Service, 26 as a Forest Pathologist
Faulkner, Shawna	GIS Analyst (Spatial Analysis, Python Programming, Cartography)	• BS, Botany, Humboldt State University • MS, Natural Resources, University of Idaho • 1 year with the Forest Service
Flowe, Thomas	GIS Analyst (Spatial Analysis, Python Programming, Cartography)	• BS, Natural Resource Recreation, Virginia Tech • MS, Natural Resource Stewardship: Spatial Information Systems • 7 years with the Forest Service, 1 year with the National Park Service
Hamedani, Fariba	Planning Team Lead	• MS, Environmental Management, University of Maryland • BA, Biology, Johns Hopkins University • 1 year with Forest Service, 7 years with the BLM

Name	Title and DEIS Contribution	Education and Experience
Hemphill, Nina	Acting Forest Planner, Program Manager Fish, Aquatic Ecology, Watersheds and Hydrology (Core Team RDEIS; and Author: Aquatic and Riparian Ecosystems and Aquatic SCC)	• PhD, Aquatic Ecology, UC Santa Barbara • MA, Aquatic Ecology, University of Pennsylvania • 7 years with the Forest Service, 10 years with the Department of the Interior • 40 years experience in aquatic ecology
Lin, Sonja	Regional Strategic Planner (review and guidance on plan development and implementation of the 2012 Planning Rule; author: Social Conditions)	• MS and MPA, Forest Resources—Social Science, University of Washington • BS, Fisheries, Wildlife, and Conservation Biology, University of Minnesota • 9 years with the Forest Service
Lo Porto, Tasha	Regional Public Engagement Strategic Planner	• BS, Conservation and Resource Studies—Environmental Policy, University of California, Berkeley • BA, Political Science, University of California, Berkeley • 10 years with the Forest Service
Metcalfe, Mark	U.S. Forest Service Pacific Southwest and Pacific Northwest Economist (Author: Economic Conditions)	• PhD, Economics, North Carolina State University • MS, Statistics, North Carolina State University • MS, Natural Resource Economics, University of Maine • BA, Geography, Boston University • 26 years experience in natural resource and environmental economics
Meyer, Marc	Southern Sierra Province Ecologist (Core Team and Co-Author: Agents of Change and Terrestrial Ecosystems sections)	• PhD, Ecology, University of California Davis • MS and BA, Environmental Biology, California State University Northridge • Certified Senior Ecologist, Ecological Society of America • 13 years with the Forest Service
Nick, Andrea	Air Quality Specialist (Extended Team and Co-Author: Air Quality)	• BA Geography, California State University San Bernardino • MA Geography, California State University Northridge • MA Natural Resources (in progress), Utah State University • 8 years with the Forest Service
Regelbrugge, Jon	Forester (Core Team: Co-Author Forest Products and Management)	• BS Forest Resource Management, Virginia Polytechnic Institute and State University • MS Forest Ecology and Silviculture, Virginia Polytechnic Institute and State University • 30 years with the Forest Service
Stein, Valerie	Enterprise Program, Wildlife Biologist (Extended Team and Co-Author for Animal Species of Conservation Concern Documentation)	• MS Botany (plant-animal interactions), University of Hawaii at Mānoa • BA Biology (ecological emphasis), State University of New York • 10 years with the Forest Service, 12 years with various other agencies

Name	Title and DEIS Contribution	Education and Experience
Stratton, Susan	Regional Heritage Program Leader/Regional Archaeologist (Extended Team and Author: Cultural Resources and SHPO Consultation)	• PhD, Anthropology, University of New Mexico • MS, Anthropology, University of Wisconsin Madison • BSNS, Wildlife Ecology, University of Wisconsin Madison • BS, Biology/Chemistry, University of Wisconsin Whitewater • 4 years with the Forest Service • 8 years with the California Office of Historic Preservation
Striplin, Randy	Regional Fuels Planner (Core Team: Fire Fuels Management)	• MS, Biology/Certified Wildland Fire Ecologist • 15 years with the Forest Service
Tapia, Judi	Planning Staff Officer/Business Manager, Sierra National Forest (Forest Planner)	• BS, Biochemistry, University of California Davis • 10 years with the Forest Service • 9 years with the Bureau of Reclamation
Vandersande, Matthew	Regional Monitoring Planner (review and guidance on Plan Monitoring Program)	• DEnv (Doctorate of Environmental Science and Engineering), University of California Los Angeles • MS, Soil, Water, and Environmental Sciences, University of Arizona • BS, Environmental and Resource Sciences, University of California Davis • 3 years with Forest Service
Yasuda, Don	Regional Analyst (Core Team: Endangered Species Consultation)	• BS, Wildlife and Fisheries Biology, University of California Davis • Certified Wildlife Biologist, 19 years • 30 years with the Forest Service
York, Judy	Writer-Editor (Writer-Editor for DEIS and Draft Forest Plans)	• BS, Wildlife Resources, University of Idaho • MS, Natural Resources Communications, University of Idaho • 27 years with the Forest Service
Young, Tiffany	Enterprise Program, Wildlife Biologist (Extended Team and Co-Author for Animal Species of Conservation Concern Documentation)	• BS, Wildlife Biology • BS Fisheries Biology, emphasis in Terrestrial and Aquatic Conservation Biology, Oregon State University • Associates of Science, emphasis Psychology, Community College of Southern Nevada • 20 years with the Forest Service
Third Party EIS Preparers (EMPSi)		
King, John	Program Manager	• MS, Environmental Engineering, Northwestern University • BA, Biology, University of Rochester • 25 years of experience as an environmental scientist
Chipman, Lindsay	Wildlife Biologist, Persistence Analysis	• PhD, Oceanography, Florida State University • MS, Oceanography, Florida State University • BS, Physics, College of William and Mary • 8 year of biological analysis experience

Name	Title and DEIS Contribution	Education and Experience
Cordle, Amy	Technical Editor	• BS, Civil Engineering, Virginia Polytechnic Institute and State University • 20 years of experience in environmental analysis and NEPA • 10 years of experience in technical editing
Morta, Dan	Biologist, Persistence Analysis	• MS, Botany, University of Canterbury • BS, Biology • 7 years of biological analysis experience
Murdock, Kim	Technical Editor	• MBA, University of Denver • BS, University of Colorado • 11 years of experience in technical editing
Prohaska, Holly	NEPA/Forest Planner	• MS, Environmental Management, University of San Francisco • BA, Marine Science/Biology, University of San Diego • 17 years of experience in land use planning and NEPA
Schad, Cindy	Lead Formatter	• BFA, Creative Writing, Emerson College • 25 years of experience as a word processor, 7 of 508 compliance
Spellmeyer, Andy	Wildlife Biologist, Persistence Analysis	• MS, Biology • BS, Biology • 5 years of experience as a wildlife biologist and NEPA specialist
Remp, Julie	Wildlife Biologist (Extended Team and Co-Author: Wildlife, Aquatic and Plant Species	• BS, Wildlife and Conservation Biology, University of California Davis • 12 years in biological resource management
Rice, Kevin	NEPA/Forest Planner	• BS, Environmental Science, Northern Arizona University • 9 years of Forest Service NEPA experience
Varney, Randy	Technical Editor	• MA, Technical and Professional Writing, San Francisco State University • BA, Technical and Professional Writing, San Francisco State University • 22 years of experience in technical editing
Whitehead, Tom	Senior Hydrogeologist (Author Water Quality, Water Quantity, and Watershed Condition)	• MS, Hydrology, University of Arizona • BS, Geology, California State University Hayward • BA, Anthropology, San Francisco State University • 23 years California Certified Hydrogeologist; 32 years environmental consulting
Zaccherio, Meredith	Wildlife Biologist, Persistence Analysis	• MA, Biology, Boston University • BS, Biology, SUNY Binghamton • 13 years of experience as a biological resource specialist for NEPA documents

Support to the Interdisciplinary Team

The staffs of the Sequoia and Sierra National Forests Supervisor's Office and Ranger Districts and the Pacific Southwest Regional Office reviewed and had input on the development of the RDEIS. Staff from the Sequoia and Sierra National Forests, the Pacific Southwest Regional Office, and the Pacific Southwest Region Remote Sensing Laboratory provided additional GIS support. Many other staff and contractors have contributed support to the development of the proposed forest plans and the draft environmental impact statement and are not listed.

Sequoia National Forest

Steve Anderson, Wildlife Biologist

Jeff Cordes, Wildlife Biologist

Alicia Embry, Forest Public Affairs Officer

Annette Fredette, Environmental Coordinator (currently Coconino Forest Planning Team Lead)

Robin Galloway, Western Divide District Wildlife Biologist

Paul Gibbs, Deputy Forest Fire Management Officer

Heidi Hosler, Forest GIS Coordinator

Carol Hallacy, Hume Lake District Recreation Officer

Emilie Lang, Forest Wildlife Biologist

Fletcher Linton, Forest Botanist

Tricia Maki, Kern River District Recreation Officer

Karen Miller, Forest Recreation and Lands Officer (Archaeology)

Chris Sanders, Western Divide District Recreation Officer

Brent Skaggs, Forest Fire Chief

Jim Whitfield, Forest Ecosystem Management

Barbara Johnston, Forest Resource Specialist

Sierra National Forest

Jody Nickerson, Forest Recreation Officer and Wilderness Manager

Antonio Cabrera, Forest Engineer

Danny Lee, GIS Coordinator

Joanna Clines, Forest Botanist

Aimee Cox, Rangeland Management Specialist, Bass Lake Ranger District

Kellen Takenaka, Forest Soil Scientist

Alex Olow, Acting Forest Public Affairs Liaison

Meredith Hollowell, High Sierra Ranger District Recreation Officer

Pablo Gonzalez, Forest Road Manager

Jeff Irwin, Forest Archaeologist and Tribal Liaison

Jeanette Williams, Natural Resources Staff Officer

Mike Price, Forest Timber Management Officer

Joshua Courter, High Sierra Ranger District Hydrologist

Cesar Sanchez, Forest Landscape Architect

Denise Tolmie, former Fuels Planning Officer (currently Bass Lake District Ranger)

Ann Roberts, Forest Terrestrial and Aquatics Biologist

Dan Tune, Forest Fuels Planner

Ramiro Rojas, Assistant Regional Silviculturist (formerly High Sierra Ranger District Silviculturist)

Pacific Southwest Region of the Forest Service

David Bakke, Pesticide-Use Specialist, Invasive Plants Program Manager

Thomas Flowe, GIS Analyst

Tom Frolli, Regional Range Program Manager

MaryBeth Hennessy, Deputy Director, Ecosystem Planning

Laura Hierholzer, Regional Environmental Coordinator

Crispin Holland, Acting Regional Rangeland Program Manager (detailed)

Trini Juarez, Landscape Architect

Patti Krueger, Regional Threatened and Endangered Species Coordinator

Denise Tolmie, Fire Management Specialist

Jamie Tripp, Regional Fuels Operation Specialist

Consultation and Coordination

The Forest Service consulted with tribes; Federal, State, and local agencies; groups and individuals during development of this environmental impact statement. Tribes, agencies, and others who provided comments during the scoping period are indicated with an asterisk.

Tribes and Tribal Organizations

The Forest Service consulted with the following tribes and tribal organizations or associations:

American Indian Council of Mariposa

Antelope Valley Indian Community

Big Sandy Rancheria

Chaushilha Yokuts

Cold Springs Rancheria

Council for the Interpretation of Native Peoples

Dumna Wo-Wah Tribal Government

Dunlap Band of Mono Indians

Haslett Basin Traditional Committee

Kawaiisu Tribal Council

Kern River Paiute Council

Kern Valley Indian Community

Kern Valley Indian Council

Kitanemuk & Yowlumne Tejon Indians

Monache Inter-Tribal Association

Mono Nation

North Fork Mono Tribe

North Fork Rancheria

Picayune Rancheria of Chukchansi Indians

Sierra Mono Museum

Sierra Nevada Native American Coalition

Southern Sierra Miwuk Nation

Table Mountain Rancheria

Tachi-Yokuts- Santa Rosa

Tejon Indian Tribe

Tubatulabel Tribe of Kern Valley

Tule River Indian Tribe

Wukchuni Tribal Council

Wuksachi Tribe

Yurok Tribe

Federal, State, County, and Local Agencies and Organizations

The Forest Service consulted with numerous Federal, State, county, and local agencies and organizations in developing the revised plan and this environmental impact statement. Complete mailing lists for the scoping periods are available in the planning record.

Federal Agencies and Representatives

The U.S. Environmental Protection Agency is a cooperating agency for both national forests.

National Park Service, Sequoia and Kings Canyon National Parks

National Park Service, Yosemite National Park

U.S. Army Corp of Engineers

U.S. Department of Transportation, Federal Highways Administration

USDA, Natural Resource Conservation Service

USDA, Pacific Southwest Research Station

USDA, Pacific Southwest Research Station, Redwood Science Lab

USDI, Bureau of Land Management

USDI, Bureau of Reclamation

USDI, Office of Environmental Policy and Compliance

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

U.S. Geological Survey

U.S. Navy, Naval Air Station Lemoore

U.S. Navy, Naval Facilities Engineering Command Southwest Division

U.S. Representative 4th District

U.S. Representative 8th District

U.S. Representative 20nd District

U.S. Representative 21nd District

U.S. Representative 22nd District

U.S. Representative 23rd District

U.S. Senator, Kamala Harris

U.S. Senator, Dianne Feinstein

State Agencies

California Air Resources Board

California Department of Fish and Wildlife

California Department of Forestry and Fire Protection

California Department of Justice

California Department of Parks and Recreation, Office of Historic Preservation

California Department of Transportation

California Regional Water Quality Control Board

California Assemblymember 32nd District

California Assemblymember 34th District

California Governor

California Senator 14th District

California Senator 16th District

California Senator 18th District

County Governments and Agencies

Fresno County Board of Supervisors

Fresno County Department of Public Works

Kern County Air Pollution Control District

Kern County Board of Supervisors

Kern County Board of Trade

Kern County Fire Department

Kern County Parks and Recreation

Kern County Planning Department

Madera County Board of Supervisors

Mariposa County Board of Supervisors
Tulare County Board of Supervisors
Tulare County Office of Education
Tulare County Parks & Recreation
Tulare County Planning Department
Tulare County Resource Management Agency
Tuolumne County Board of Supervisors

Local Agencies and Organizations

Apple Valley Town Hall
Bakersfield City Council
Bakersfield College Library
Bakersfield Convention and Visitors Bureau
Carlton College, Gould Library
College of the Sequoias Library
CSU Bakersfield, Walter W. Stiern Library
CSU Fresno, Henry Madden Library
Fresno City College Library
Fresno City Council
Fresno County Public Library
Kings River Conservation District
Kings River Water Association
Kern County Black Chamber of Commerce
Kern County Hispanic Chamber of Commerce
Kern County Library
Kern River Valley Chamber
Kern River Valley Council
Kern River Valley Fire Safe Council
Kern River Watermaster
Kings County Public Library
Lake Isabella Public Library
Merced County Public Library
Midland School
Mojave Desert-Mountain RC&D
Montana State University
Porterville City Library
Porterville City Planning Department
Porterville College Library
Reedley College
Ridgecrest Chamber of Commerce
Ridgecrest Public Library
Rolling Green Utilities
San Joaquin Valley Air Pollution Control District
Shafter-Wasco Irrigation District
Tulare County Library
Tulare Kings Hispanic Chamber of Commerce
University of Arizona
University of California, Berkeley
University of California, San Diego
University of California, Stanislaus
Visalia City Council

Others

Numerous groups and individuals participated in the process through written comments and by attending public meetings. Complete mailing lists are available in the public record.

Some of the groups that provided comment are as follows:

Alliance for Environmental Concerns
American Forest Resource Council
American Lands Access Association
American Whitewater
Back Country Horsemen
Bakersfield Californian
Bakersfield Trailblazers
Bakersfield Yamaha
Baymiller Family Trust
Blue Ribbon Coalition, Inc.
Brechbuehl Timber
The Bristlecone Chapter of the CNPS
Brown-Berry Biological Consulting
Californians for Alternative to Toxics
California Association of 4WD Clubs, Inc.
California Cattlemen's Association
California Equestrian Trails Coalition
California Forestry Association
California Indian Basketweavers Association
California Institute of Technology, Combined Array for Research in Millimeter-wave Astronomy (CARMA)
California Land Management
California Native Plant Society
California Off-Road Vehicle Association
California Trail Users Coalition
California Trout, Inc.
California Wilderness Coalition
CalWild
Camp Max Straus
Camp Nelson Mutual Water Company
Camp San Joaquin
Carver Bowen Ranch
Cedarbrook Cabin Owners
Center for Biological Diversity
Church of Jesus Christ of Latter Day Saints
Concerned Citizens—Piutes
Cyrus Partners
D&B Partnership
The Daily Independent
David Wood Ranches
Dinuba Sentinel
Dowville Tract Association
Dunn School
Eagle Rafting
Equestrian Trails and Lands
Eshom-Kaweah Ranch
Evergreen Helicopter, Inc.
Far Horizons, Inc.
Fresno Bee
Geos Institute
Giant Sequoia National Monument Assn.
Guest Services, Inc.
Hafenfeld Ranch
High Desert Multi Coalition
High Sierra Guide Service
HMS Veterinary Development, Inc.
Hume Lake Christian Camps
Huntington Lake Association
Inland Valley Mountain Bike Association
International Mountain Bicycling Association
John Muir Project
Kern River Courier
Kern River Revitalization
Kern River Tours
Kerncrest Audubon
Kiper & Kiper
Klamath Forest Alliance
KMPH TV Channel 26
Lake Isabella-Bodfish Property Owners Assn.
McGee Creek Pack Station

Mike Berry Guide Service
National Forest Recreation Association
Natural Resources Defense Council
News Review (Ridgecrest)
North American Packgoat Association
Northern California Society of American Foresters
OA Outfitting Inc., KR Outfitter
Off Road Vehicle Watch
Outdoor Alliance
Pacific Crest Trail Association
Pacific Crest Trail Reassessment Initiative
Pacific Gas and Electric
Pacific Rivers Council
Particle Media Group
Pecks Camp
Ponderosa Lodge
Ponderosa Property Owners
Q.A.B. Media
Quaker Meadow Ministries
Recreational Aviation Foundation
R.M. Pyles Boys Camp
Roger Camp Homeowners Association
Sageland Ranch
San Joaquin Houndsmen Club
San Joaquin River Trails Council
Santiago Outfitter Fishing
Sequoia Crest
Sequoia Forest Alliance
Sequoia Forest Keeper
Sequoia Lake Conference of YMCA
Sequoia Snowmobilers
Sierra Club
Sierra Forest Legacy
Sierra Forest Products
Sierra Reader
Snowlands Network
Southern California Edison
Southern Sierra Fat Tire Association
Spanish Radio Group
Stewards of the Sequoia
Stewards of the Sierra
Sugarloaf Community Group
Sugarloaf Mountain Park
Sustainable Forest Action Coalition
Tehachapi Mountain Trails Association
Track and Trail Publications
Trout Unlimited
Tulare County Audubon Society
Tulare County Sportsman
United Church of God
United Trail Maintainers of California
Upper Tule Association, Inc.
Upper Tule News
Visalia Times Delta
West Coast Development Co.
Western Watersheds Project
Whitewater Voyages
WildEarth Guardians
The Wilderness Society
Winter Wildlands Alliance
W. M. Beaty & Associates, Inc.

Agencies, Organizations, and Persons Sent Copies of the Draft Environmental Impact Statement

The Forest Service has distributed this draft environmental impact statement or made it electronically available to over 3,300 individuals and groups. Each specifically requested a copy of the document or commented during public involvement opportunities. In addition, we sent copies of the document or, in some cases, made it electronically available to Federal agencies, federally recognized tribes, State and local governments, and organization representatives who asked to be involved in the development of this analysis. Due to the number of people, agencies, and organizations, we have omitted a complete listing from this environmental impact statement, but it is available on request.

Glossary

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Glossary

Active management: Planned, intentional actions in an area that are specifically designed to obtain or move toward a desired objective or result.

Adaptive management: An approach to natural resource management in which decisions are made as part of an ongoing process. Adaptive management involves planning, implementing, monitoring, evaluating, and incorporating new knowledge into management approaches, based on scientific findings and the needs of society. Effects are monitored for the purpose of learning and adjusting future management actions, which improves the efficiency and responsiveness of management.

Administrative site: An area such as a work center, fire lookout, permitted ranch headquarters, seed orchard, communication site, utility corridor, and developed campground; also includes other areas that are occupied or used by the Forest Service during the administration of work associated with national forest lands.

Administrative use: Use by the Forest Service.

Allowable sale quantity (ASQ): The quantity of timber that may be sold from the area of suitable land covered by the land management plan for a period specified by the plan. This ASQ is usually expressed on an annual basis as the "average annual allowable sale quantity." For timber resource planning, the ASQ applies to each decade over the planning horizon and includes only chargeable volume. Consistent with the definition of timber production, ASQ does not include firewood or other nonindustrial wood.

Anchor point: An advantageous location, usually a barrier to fire spread, from which to start building a fire line. An anchor point is used to reduce the chance of firefighters being flanked by fire.

Aspen clone: A genetically identical set of aspen trees all connected by the same root system, as in vegetative reproduction. A clone is a distinct aspen stand, may be a smaller inclusion within a conifer stand, or may cover an entire mountainside as a large stand or patch.

Available forage: That amount of growth of a vigorous and healthy plant that can be used as feed (regardless of what animal is using it) without impairing the plant's long-term health and productivity or other uses, such as riparian filtering. The amount of available forage may be less where there is a need to restore health and vigor of forage plants. That amount may also depend on time of year and plant physiological stage or other conditions such as drought.

Basal area: The common term used to describe the average amount of an area (usually an acre) occupied by tree stems. It is defined as the total cross-sectional area of all stems in a stand measured at breast height and expressed as per unit of land area (typically square feet per acre).

Beneficial use: Any of the various uses that may be made of the water, including domestic water supplies, fisheries and other aquatic life, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics.

Best management practices (BMPs) for water quality: Methods, measures, or practices selected by an agency to meet its nonpoint source control needs. BMPs for water quality include structural and nonstructural controls and operation and maintenance procedures. BMPs for water quality can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (36 CFR 219.19).

Biocultural diversity: In this document, the diversity of plants, animals, insects, fungi, and other natural and cultural resources found across the landscape that provide for the diversity of cultural and traditional uses, knowledge systems, and practices of Native American Tribes.

California spotted owl

Activity center: owl nest or roost.

Protected activity center (PAC): An area established around an occupied California spotted owl site to help ensure successful reproduction and species viability. A protected activity center is approximately 300 acres and includes the best owl nesting and roosting habitat.

Candidate species: Plants and animals for which the U.S. Fish and Wildlife Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act, but for which development of a proposed listing regulation is precluded by other higher priority listing activities.

Canopy: In a forest, the branches from the uppermost layer of trees; on rangeland, the vertical projection downward of the aerial portion of vegetation.

Canopy closure: The percentage of the sky hemisphere obscured by vegetation when viewed from a single point.

Canopy cover: The proportion of the forest floor covered by the vertical projection of the tree crowns (Jennings et al. 1999).

Cavity: The hollow excavated in a tree that is used by birds or mammals for roosting and reproduction.

CCF: Hundred cubic feet.

Class I airshed: An airshed classification where areas require the highest level of protection under the Clean Air Act of 1963. Some national parks and national wilderness areas are included in the category of Class I airsheds.

Class II airshed: An airshed classification representing National Forest System land that is not classified as a Class I airshed. These areas may receive a greater amount of human-caused pollution than Class I areas.

Climate refugia: Locations where taxa survive periods of regionally adverse climate and locations that provide habitats for the long-term persistence of populations. These areas are more buffered against climate change and climate-related disturbances than others. These refugia have resisted climate changes occurring elsewhere, often providing suitable habitat for relict populations of species that were previously more widespread.

Climatic water deficit: Water balance measure that is an estimate of drought stress on plants and quantifies the evaporative demand exceeding available soil moisture for terrestrial vegetation. In Mediterranean climates, increases in climatic water deficit are proportional to the supplemental amount of water needed to maintain current vegetation cover.

Clump: A tight cluster of two or more trees that are generally of similar age and size, have adjacent or interlocking crowns, and share a common root zone.

Coarse woody debris: Woody material, including logs, on the ground greater than 3 inches in diameter; a component of litter. Large, coarse, woody debris is often considered to be downed logs at least 12 inches in diameter and 8 feet in length.

Code of Federal Regulations (CFR): A codification of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the Federal Government.

Complex early seral forests or habitat: A type of early successional forest habitat that develops following a stand-replacing event, such as high severity fire, and contains structural, compositional, or functional elements of ecological complexity or integrity. These elements may include biological legacies, such as large snags, logs, and isolated live trees or tree clusters, as well as patches of young and diverse native shrubs, hardwoods, herbaceous plants, or tree regeneration. Other characteristic elements of complexity in early seral forests are spatial heterogeneity in vegetation structure, diversity in vegetation composition, and variability in such functional processes as nutrient cycling during post-disturbance recovery.

Communications site: An area of National Forest System land used for telecommunications services. It may be limited to a single communications facility, but most often it encompasses more than one facility.

Community wildfire protection plans (CWPP): Plans for at-risk communities that identify and prioritize areas for hazardous fuels treatments. Several communities next to the national forests have developed these plans.

Connectivity: The ecological conditions that exist at several spatial and temporal scales to provide landscape linkages, including to permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long distance range shifts of species, such as in response to climate change.

Conservation agreement or conservation strategy: Plans to remove or reduce threats to candidate and sensitive species of plants and animals so that a listing as threatened or endangered is unnecessary.

Conservation watersheds: A collection of properly functioning watersheds that support populations of fish, other aquatic and riparian-dependent organisms, and State-designated uses of water, while enabling multiple other goods and services to be provided, such as outdoor recreation, timber, forage, and habitats for plants and wildlife (Reeves et al. 2006, United States Department of Agriculture 2008, Reeves et al. 2016). Conservation watersheds allow for connectivity of habitat where appropriate, allow species to shift their distributions in response to climate change, and focus on maintaining high quality habitat.

Consultation:

- An active, affirmative process that (a) identifies issues and seeks input from appropriate American Indian governments, community groups, and individuals; and (b) considers their interests as a necessary and integral part of the Forest Service's decisionmaking process
- The Federal government has a legal obligation to consult with American Indian tribes, in accordance with the Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act, and numerous other executive orders and statutes. This legal responsibility is, through consultation, to consider Indian interests and account for those interests in the decision.
- Also refers to a requirement under Section 7 of the Endangered Species Act for Federal agencies to consult with the U.S. Fish and Wildlife Service with regard to Federal actions that may affect listed threatened and endangered species or critical habitat

Critical aquatic refuge (CAR): Subwatershed, generally ranging between 500 and 50,000 acres, that contains known locations of at-risk species, highly vulnerable populations of native plant or animal species, or localized populations of rare native aquatic- or riparian-dependent plant or animal species.

Critical habitat: For a threatened or endangered species, the specific areas in the geographical area occupied by the species, at the time it is listed and in accordance with the provisions of Section 4 of the Endangered Species Act (16 USC 1533), on which are found those physical or biological features essential to the conservation of the species and that may require special management considerations or protections; and specific areas outside the geographical area occupied by the species at the time it is listed, in accordance with the provisions of Section 4 of the Endangered Species Act, on a determination by the Secretary of the Interior that such areas are essential for conserving the species (16 USC 1532 (3)(5)(A)). Critical habitat is designated through rulemaking by the Secretary of the Interior or Secretary of Commerce (16 USC1533 (a)(3) and (b)(2)).

Cumulative effects or impacts: Cumulative effects or impacts on the environment result from the incremental impact of an action, when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or nonfederal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. "Effects" and "impact" are synonymous (40 CFR 1508.7).

Desired condition: A desired condition is a description of specific social, economic, or ecological characteristics if a plan area, or a portion of it, toward which management of the land and resources should be directed. This description is specific enough to allow progress toward achievement but does not include a completion date.

Developed recreation site: A distinctly defined area where facilities are provided by the Forest Service for concentrated public use, such as campgrounds, picnic areas, and swimming areas.

Diameter at breast height (dbh): The diameter of a forest tree species at the bole (or trunk), typically measured at 4.5 feet above ground level.

Dispersed recreation: Outdoor recreation in which visitors are spread over relatively large areas. Where facilities or developments are provided, they are more for access and protection of the environment than for the comfort or convenience of the visitors.

Disturbance: Any relatively discrete event in time that disrupts ecosystem, watershed, community, or species population structure or function and changes resources, substrate availability, or the physical environment.

Early seral or early successional forest: Vegetation conditions in the early stages of succession following a disturbance that removes forest canopy, such as stand-replacing wildfire or a windstorm, that often contains vigorously growing herbaceous plants, shrubs, and trees and may contain biological legacies, such as snags, logs, residual shrub patches, and isolated live trees or tree clusters.

Ecological integrity: The quality or condition of an ecosystem when its dominant ecological characteristics, such as composition, structure, function, connectivity, and species composition and diversity, occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence.

Ecological restoration: The process of assisting in the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions.

Ecoregion: Ecoregion sections and subsections are units in the National Hierarchy of Ecological Units, ranging in size from 13 million acres (section) down to 10,000 acres (subsection) that describe areas of similar environmental and biological features.

Ecosystem: A spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and elements of the abiotic environment within its boundaries. An ecosystem is commonly described in terms of the following: its composition or the biological elements in the different levels of biological organization, from genes and species to communities and ecosystems; its structure or the organization and physical arrangement of biological elements, such as snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern and connectivity; its function or the ecological processes that sustain composition and structure, such as energy flow, nutrient cycling and retention, soil development and retention, predation and herbivory, and natural disturbances, such as wind, fire, and floods; and its connectivity.

Ecosystem diversity: The variety and relative extent of ecosystem types, including their composition, structure, and processes in all or a part of an area of analysis.

Ecosystem management: The use of an ecological approach to achieve multiple-use management of public lands by blending the needs of people and environmental values in such a way that lands represent diverse, healthy, productive, and sustainable ecosystems.

Ecosystem function (processes): The collective biotic processes of ecosystems and their effects on the physical and chemical conditions of their environment. These processes include nutrient cycling, plant primary production, decomposition, biotic interactions (such as food web interactions), carbon storage, hydrologic cycles, and soil respiration.

Ecosystem services: The benefits that people obtain from ecosystems, as follows: provisioning services, such as clean air and fresh water, energy, food, fuel, forage, wood products or fiber, and minerals; regulating services, such as long-term storage of carbon, climate regulation, water filtration, purification, and storage, soil stabilization, flood and drought control, and disease regulation; supporting services, such as pollination, seed dispersal, soil formation, and nutrient cycling; and cultural services, such as educational, aesthetic, spiritual, and cultural heritage values, recreation experiences, and tourism opportunities.

Ecosystem sustainability: The ability to sustain diversity, productivity, resilience to stress, health, renewability and yield of desired values, resource uses, products, or services from an ecosystem, while maintaining the integrity of the ecosystem over time.

Eligible wild and scenic rivers: River segments that have been identified as eligible for inclusion in the national Wild and Scenic Rivers System under the authority of the Wild and Scenic Rivers Act. The river segment must be free flowing and it must possess one or more outstandingly remarkable scenic, recreational, geological, fish and wildlife, historic, cultural, ecological or other value. See *Wild and scenic rivers*.

Endangered species: Species that the Secretary of the Interior or the Secretary of Commerce has determined is in danger of extinction throughout all or a significant portion of its range. Endangered species are listed at 50 CFR 17.11, 17.12, and 224.101.

Endemic: Species or population that is limited in distribution to a specific geographic area.

Energy corridor: A linear strip of land identified for the present or future location of a utility right-of-way, such as an above or below ground electric transmission line or gas pipeline.

Energy development: Infrastructure associated with providing or transporting energy, such as from biomass power generation, wind turbines, and solar panels.

Environmental impact statement (EIS): A statement of the environmental effects of a proposed action and alternatives to it. It is required for major Federal actions under Section 102 of the National Environmental Policy Act (NEPA) and released to the public and other agencies for comment and review. A DEIS is released to the public and other agencies for review and comment; a final EIS is issued after consideration of public comments. A record of decision is based on the information and analysis in the final EIS.

Environmental justice: To the greatest extent practicable and permitted by law, all populations are provided with the opportunity to comment before decisions are rendered on, are allowed to share in the benefits of, are not excluded from, and are not affected in a disproportionately high and adverse manner by government programs and activities affecting human health or the environment.

Ephemeral stream: Headwater stream channel showing evidence of fluvial processes, such as the erosion of annual organic matter inputs and having defined banks and periodic, seasonal absence of surface water.

Evapotranspiration: Loss of water from the earth's surface through evaporation from the soil and surface water bodies and transpiration by plants.

Expected net value change (eNVC): Calculated as the sum of burn probability and value change (to one or more resources or assets) over a range of wildfire intensity classes, usually flame length. eNVC is a risk-neutral measure of the wildfire risk to resources and assets. It forms the basis for the quantitative wildfire risk assessment process described in this report. If no beneficial effects are under consideration, eNVC can simply be called expected loss. The terms value change, response, and net response are functional synonyms for net value change; all refer to the net effects of positive and negative changes on the value of a resource or asset (RMRS-GTR-315).

Federal reserved water rights (reserved rights): When Congress designates Federal lands for a specific purpose, it also reserves sufficient water to serve the purposes of that designation. These are known as Federal reserved water rights, or simply reserved rights. Reserved rights are implied, meaning that Congress need not expressly state in a bill that it intends to reserve a Federal water right; the right exists whether or not Congress explicitly mentions it.

Federally listed species: Threatened or endangered species listed under the Endangered Species Act, as amended. Candidate and proposed species are those that are being considered for Federal listing.

Fire intensity: The degree of energy and heat released from a fire.

Fire regime: The long-term fire pattern characteristic of an ecosystem, described as a combination of seasonality, the length of time between fires, size, spatial complexity, intensity, severity, and fire type, such as surface fire or active crown fire. There are five classified fire regimes, based on the fire return interval or frequency (average number of years between fires) and severity (amount of replacement of the dominant overstory vegetation) of the fire, as follows:

- **Fire regime I—**0- to 35-year frequency and low (surface fires most common, isolated torching can occur) to mixed severity (less than 75 percent of dominant overstory vegetation replaced)
- **Fire regime II—**0- to 35-year frequency and high severity (greater than 75 percent of dominant overstory vegetation replaced)
- **Fire regime III—**35- to 100+-year frequency and mixed severity
- **Fire regime IV—**35- to 100+-year frequency and high severity
- **Fire regime V—**200+-year frequency and high severity.

Fire regime condition class: A classification of the degree of departure from the natural fire regime. It is based on a relative measure describing the degree of departure from the historical natural fire regime. This departure can result in changes or risks to one or more of the following ecological components: vegetation (species composition, structural stages, stand age, canopy cover, and mosaic pattern across the landscape), fuel composition, fire frequency, severity, and pattern, and other associated disturbances.

- **Condition class 1—**Fire regimes are within the natural (historical) range, and the risk of losing key ecosystem components is low. Vegetation attributes (species composition, structure, and pattern) are intact and functioning within the natural (historical) range.
- **Condition class 2—**Fire regimes have been moderately altered from their natural (historical) range. Risk of losing key ecosystem components is moderate. Fire frequencies have departed from natural frequencies by one or more return intervals (either increased or decreased). This results in moderate changes to fire size, intensity and severity, and landscape patterns. Vegetation and fuel attributes have been moderately altered from their natural (historical) range.
- **Condition class 3—**Fire regimes have been substantially altered from their natural (historical) range. The risk of losing key ecosystem components is high. Fire frequencies have departed from natural frequencies by multiple return intervals. Dramatic changes occur to fire size, intensity, severity, and landscape patterns. Vegetation attributes have been substantially altered from their natural (historical) range.

Fire restoration: The use of fire as a tool for ecological restoration or the reestablishment of natural fire regimes to the landscape within the historical fire return interval for the associated ecosystem.

Fire severity: Degree to which a site has been altered or disrupted by fire; also used to describe the product of fire intensity and residence time. Usually defined by the degree of soil heating or mortality of vegetation. In this document, fire severity refers to vegetation burn severity, unless otherwise specified.

Focus landscape: Defined during project planning, a large area, generally from 40,000 to 100,000 acres, where mechanical thinning and prescribed burning are strategically located to treat enough of the landscape to change potential wildfire behavior and to improve the resilience of vegetation within the landscape. Treatments would focus especially on areas most departed from vegetation desired conditions and where there is negative fire risk to high value resource areas.

Foliar: Pertaining to green tree leaves or needles.

Forest Service Handbook (FSH): Directives that provide detailed instructions on how to proceed with a specialized phase of a program or activity.

Forest Service Manual (FSM): A system of manuals that provides direction for Forest Service activities.

Fragmentation: The breakup of a large continuous land area by reducing and dividing it into smaller patches isolated by areas converted to a different land type. Habitat can be fragmented by natural events or development. It is the opposite of connectivity.

Free-flowing: Water existing or flowing in natural conditions without impoundment, diversion, straightening, riprapping, or other modification of the waterway.

Fine fuels: Fast-drying dead or live fuels, generally characterized by a comparatively high surface area-to-volume ratio; fine fuels are less than 1/4-inch in diameter.

Fuel: Plants, both living and dead, and woody vegetative materials capable of burning.

Fuel load: The dry weight of combustible materials per unit area; usually expressed as tons per acre.

Fuel treatment: Any manipulation or removal of fuels to reduce the likelihood of ignition or to lessen potential damage and resistance to control.

Fugitive dust: Fine particulate matter from windblown soil and dust that becomes airborne.

Geographical information system (GIS): An information processing technology to input, store, manipulate, analyze, and display data; a system of computer maps with corresponding site-specific information that can be combined electronically to provide reports and maps.

Geomorphic: The process of erosion and sediment transport and deposition.

Global climate models (GCMs): Climate models are a mathematical representation of the climate that divide the earth, ocean, and atmosphere into a grid. The values of the predicted variables, such as surface pressure, wind, temperature, humidity, and rainfall, are calculated at each grid point over time to predict their future values. The GCMs used in *Fire-Climate* examined the expected change in large fire size with different future climate and vegetation restoration scenarios; they are as follows:

- **CCSM—**Community Climate System Model
- **GFDL—**Geophysical Fluids Dynamic Laboratory

- **CNRM—**Centre National de Recherches Météorologiques

Government-to-government consultation: The active and continuous process of contacting Tribal leadership, soliciting their participation, involvement, comments, concerns, contributions, and traditional knowledge that will assist the agency in making informed decisions in planning, managing, and decisionmaking actions.

Guideline: A constraint on project and activity decisionmaking that allows for departure from its terms, so long as the purpose of the guideline is met (CFR 219.15(d)(3)). Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements.

Habitat: A place that provides seasonal or year-round food, water, shelter, and other environmental conditions for an organism, community, or population of plants or animals.

Hazard tree removal: The abatement of tree hazards, generally near roads, trails, and facilities. Tree hazards include dead or dying trees, dead parts of live trees, or live trees unstable because of structural defects or other factors that are within striking distance of people or property. Hazard trees can cause property damage, personal injury, or fatality in the event of a failure.

Herbaceous: Grass or forb vegetation.

Herbivory: Loss of vegetation due to consumption by another organism.

Historic range of variation: See *Natural range of variation*.

Home range core area (HRCA): Areas established surrounding each territorial California spotted owl activity center detected after 1986. The core area amounts to 20 percent of the area described by the sum of the average breeding pair home range plus one standard error. For the Sierra National Forest, the home range core area size is 600 acres. Aerial photography is used to delineate the core area. Acreage for the entire core area is identified on national forest lands. Core areas encompass the best available California spotted owl habitat closest to the owl activity center. The acreage in the 300-acre protected activity center counts toward the total home range core area. Core areas are delineated within 1.5 miles of the activity center. When activities are planned next to lands other than national forests, 1.5-mile circular core areas are delineated around California spotted owl activity centers. Using the best available habitat, as described above, any part of the circular core area that lies on national forest lands is designated and managed as a California spotted owl home range core area.

Hydrologic: Refers to the movement, distribution, and quality of water.

Hydrologic function: The behavioral characteristics of a watershed described in terms of ability to sustain favorable conditions of waterflow. Favorable conditions of waterflow are defined in terms of water quality, quantity, and timing.

Hydrologic Unit Code (HUC): The U.S. is divided and subdivided into successively smaller hydrologic units (watersheds), which are identified by unique HUCs. The average size of a 4th level HUC watershed is 1 million acres, 5th level HUC watersheds are around 165,000 acres, and 6th level HUC watersheds are about 21,000 acres.

Hydrophytic vegetation: The sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present.

Instream flow: Seasonal stream flows needed for maintaining aquatic and riparian ecosystems, wildlife, fisheries, and recreation at an acceptable level.

Intermittent stream: A stream that flows only at certain times of the year when it receives water, usually from springs or from a surface source, such as melting snow.

Invasive species: Are alien species whose introduction causes or is likely to cause economic or environmental harm or harm to human health; a species that harms or is likely to cause harm and that is exotic to the ecosystem it has infested. Invasive species infest both aquatic and terrestrial areas and can be identified within any of the following four taxonomic categories: plants, vertebrates, invertebrates, and pathogens.

LANDFIRE (Landscape Fire and Resource Management Planning Tools Project): This is an interagency program producing consistent and comprehensive data describing landscape change, disturbance, vegetation, fuel, and fire regimes across the United States.

Leasable minerals: Coal, oil, gas, oil shale, sodium, phosphate, potassium, geothermal. Leasable minerals also include the hardrock minerals, if they are found on lands that have “acquired” status. Leases are obtained through the Bureau of Land Management to extract these mineral resources.

Litter: Dead, unattached organic material on the soil surface that is effective in protecting it from raindrop splash, sheet, and rill erosion and is at least ½ inch thick. Litter is composed of leaves, needles, cones, and woody vegetation debris, including twigs, branches, and trunks.

Livestock grazing: Foraging by permitted livestock (domestic foraging animals of any kind).

Locatable minerals: In general, the hardrock minerals mined and processed for metals (gold, silver, copper, uranium, and some types of nonmetallic minerals, such as sandstone). Locatable means that they are subject to mining claim under the United States mining laws. Locatable minerals are limited to lands with “reserved public domain” status.

Low-income population: Any readily identifiable group of low-income persons who live in geographic proximity to and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who would be similarly affected by U.S. Department of Agriculture programs or activities. Low-income populations may be identified using data collected, maintained, and analyzed by an agency or from analytical tools, such as the annual statistical poverty thresholds from the Bureau of the Census’ Current Population Reports, Series P-60 on Income and Poverty.

Management practices (vegetation): Silvicultural practices, such as reforestation, prescribed fire, thinning to reduce stand density, and other practices designed to facilitate tree growth and development.

Managing wildfires to meet resource objectives: A strategic choice to use unplanned wildfire starts to achieve resource management objectives and ecological purposes under specific environmental conditions. Such fires are monitored closely to ensure safe conditions for people, property, and other highly valued resources.

Mechanical treatment: For this analysis, mechanical treatments include most vegetation treatments, except fire. They may include mechanical thinning, hand thinning, and other silvicultural treatments.

Mechanized travel/transport: Movement using any contrivance over land, water, or air, having moving parts, that provides a mechanical advantage to the user and that is powered by a living or nonliving power source. This includes sailboats, hang gliders, parachutes, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include skis, snowshoes, rafts, canoes, sleds, travois, or similar primitive devices without moving parts.

Mesic: Sites, patches, or habitats containing a moderate amount of moisture supply that are wetter than xeric sites (see *Xeric*), where sufficient moisture may be available to support optimal plant growth.

Minority: A person who is a member of one or more the following population groups**:** American Indian or Alaskan Native, Asian or Pacific Islander, Black, or Hispanic.

Minority population: Any readily identifiable group of minority persons who live in geographic proximity to, and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who would be similarly affected by U.S. Department of Agriculture programs or activities.

Motorized travel: Movement using machines with a motor, engine, or other nonliving power source. It does not involve a vehicle operated on rails or a wheelchair or mobility device, including one that is battery powered, designed solely for the use by a mobility-impaired person for locomotion and that is suitable for use in an indoor pedestrian area.

National Forest System (NFS): Includes national forests, national grasslands, and the National Tallgrass Prairie.

National Forest System road: A road wholly or partly in or next to and serving the National Forest System that the Forest Service determines is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources. A forest road other than a road that has been authorized by a legally documented right-of-way held by a state, county, or other local public road authority (36 CFR 212.1).

National Forest System trail: A trail wholly or partly in or next to and serving the National Forest System that the Forest Service determines is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources A forest trail other than one that has been authorized by a legally documented right-of-way held by a state, county, or other local public road authority (36 CFR 212.1).

National Wild and Scenic Rivers System: Created by Congress in 1968 (Public Law 90-542; 16 USC 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations.

Natural range of variation (NRV): Spatial and temporal variation in ecosystem characteristics under historical disturbance regimes during a reference period. The reference period considered should be sufficiently long to include the full range of variation produced by the dominant natural disturbance regimes, often several centuries, for such disturbances as fire and flooding, and should also include short-term variation and cycles in climate. NRV is a term used synonymously with the historical range of variation. The NRV is a tool for assessing ecological integrity and does not necessarily constitute a management target or desired condition. The NRV can help identify structural, functional, compositional, and connectivity characteristics, for which plan components may be important for either maintenance or restoration of such ecological conditions.

Nonmotorized travel: Movement not relying on machines with a motor, engine, or other nonliving power source; examples are walking, canoeing, and horseback riding.

Nonpoint source pollution: Affecting water quality from diffuse sources, such as polluted runoff from agricultural areas draining into lakes, wetlands, rivers, and streams. Can be contrasted with point source pollution discharged to a body of water at a single location, such as from a chemical factory or urban runoff from a roadway or storm drain. Nonpoint source pollution may derive from many different sources with no specific solution to rectify the problem, making it difficult to regulate.

Objective: A concise, measurable, and time-specific statement of a desired rate of progress toward a desired condition or conditions. Objectives are based on reasonable foreseeable budgets.

Old forest: Late successional stands in the montane and upper montane zones that are characterized by the presence of large and old trees (generally exceeding 30 to 40 inches in diameter and more than 150 years in age) and contain unique structural features, such as large snags, large logs, and variable tree size classes, that contribute to high structural complexity and heterogeneity. Structural complexity of old forests includes a mixture of individual trees, tree clusters, and canopy openings, with and without shrub or tree regeneration patches, that vary over space and time.

Outstandingly remarkable value: A value that a river or river segment possesses that reflects its unique, rare, or exemplary qualities. In the Wild and Scenic River Act, river values identified include scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Examples of other similar values are botanical, hydrological, paleontological, scientific, or heritage. A river must have at least one outstandingly remarkable value to be eligible for wild and scenic river designation.

Perennial stream: A stream or reach of a channel that flows continuously, or nearly so, throughout the year and whose upper surface is generally lower than the top of the zone of saturation in nearby areas.

Potential operational delineation (POD): Spatial representation of an area that summarizes wildfire risk in a meaningful operational fire management context. Potential operational delineations can follow fine-scale features, such as ridgetops, water bodies, roads, barren areas, elevation changes, or major fuel changes.

Protected activity center: The area that surrounds nests; an area of habitat used for nesting and raising young until they leave the nest.

Patch: A relatively homogeneous area that differs from its surroundings; the basic unit of the landscape that changes and fluctuates. Patches have a definite shape and spatial configuration and can be described compositionally by internal variables, such as number of trees, number of tree species, age of trees, height of trees, or other similar measurements.

Planned ignition: A fire ignited by management actions under certain predetermined conditions to meet plan desired conditions; synonymous with prescribed fire.

Planning period: The life of the plan, generally 10 to 15 years from plan approval. As a general rule, this analysis uses 10 years to define the planning period.

Primitive recreation: The reliance on personal, nonmotorized, or nonmechanized skills to travel and camp in an area, rather than relying on facilities or outside help.

Recreation opportunity spectrum (ROS): Has six distinct classes along a continuum, from primitive and undeveloped to highly modified and developed, as follows:

> **Primitive (P)—**An essentially unmodified natural environment. Interaction between users is very low and evidence of other users is minimal. Essentially free from evidence of human-induced restrictions and controls. Motorized use in the area is generally not permitted. Very high probability of experiencing solitude, closeness to nature, tranquility, self-reliance, and risk.
>
> **Semiprimitive nonmotorized (SPNM):** A predominantly natural or natural-appearing environment. Interaction between users is low, but there is often evidence of other users. The area is managed in such a way that any minimum on-site controls and restrictions are subtle. Motorized use is generally not permitted. High probability of experiencing solitude, closeness to nature, tranquility, self-reliance, and risk.
>
> **Semiprimitive motorized (SPM):** A predominantly natural or natural- appearing environment. Concentration of users is low, but there is often evidence of other users. The area is managed so that minimum on-site controls and restrictions may be present, but they are subtle. Motorized use is generally permitted. Moderate probability of experiencing solitude, closeness to nature, tranquility, self-reliance, and risk.
>
> **Riparian areas:** Occur at interface between aquatic and terrestrial habitats; include terrestrial and aquatic ecosystems that extend into the groundwater, above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water coarse at variable widths.
>
> **Roaded natural (RN):** A predominantly natural-appearing environment with moderate evidence of the sights and sounds of other humans. Such evidences usually harmonize with the natural environment. Interaction between users may be low to moderate but with evidence of other users prevalent. Resource modification and utilization practices are evident but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities. Opportunity to affiliate with other users in developed sites but with some chance for privacy.
>
> **Roaded modified (RM):** Substantially modified natural environment, except for campsites. Roads and management activities may be strongly dominant. There is moderate evidence of other users on roads. Conventional motorized use is provided for in construction standards and facilities design. Opportunity to get away from others, but with easy access.
>
> **Rural (R):** Substantially modified natural environment. Resource modification and utilization practices are to enhance specific recreation activities and to maintain vegetation cover and soil. Sights and sounds of humans are readily evident, and the interaction between users is often moderate to high. A considerable number of facilities are designed for use by a large number of people, and facilities are often provided for special activities. Moderate densities are provided far away from developed sites. Facilities for intensified motorized use and parking are available. Opportunity to observe and affiliate with other users is important, as is convenience of facilities.
>
> **Urban (U):** Characterized by a substantially urbanized environment, although the background may have natural-appearing elements. Resource modification and utilization practices are to enhance specific recreation activities. Vegetation is often exotic and manicured. Sights and sounds of people on-site are predominant. Large numbers of users can be expected, both on-site and in nearby areas. Facilities for highly intensified motor use and parking are available, with mass transit often available to carry people throughout the site. Opportunity to observe and affiliate with other users is very important, as is convenience of facilities.

Reforestation: The natural or artificial reestablishment of an area with forest tree cover.

Research natural area: A physical or biological unit in which current natural conditions is maintained and can be observed. These conditions are ordinarily achieved by allowing natural physical and biological processes to prevail without human intervention. Research natural areas are principally for nonmanipulative research, observation, and study. They are designated to maintain a wide spectrum of high quality representative areas that represent the major forms of variability found in forest, shrublands, grassland, alpine, and natural situations that have scientific interest and importance that, in combination, form a national network of ecological areas for research, education, and maintenance of biological diversity.

Resilience: The ability of an ecosystem and its component parts to absorb, or recover from, the effects of disturbance through preserving, restoring, or improving its essential structures and functions and redundancy of ecological patterns across the landscape.

Restoration: See *Ecological restoration*.

Riparian area: Includes terrestrial and aquatic ecosystems that extend into the groundwater, above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water course at variable widths.

Riparian conservation area: An area of vegetation or forest litter next to stream courses or riparian areas for the purposes of filtering sediment and providing bank stability and shade for fisheries habitat in tree/shrub ecosystems.

Road maintenance: The upkeep of the entire transportation facility, including surface and shoulders, parking and side areas, structures, and such traffic control devices necessary for its safe and efficient use (36 CFR 212.1). This work includes brushing roadside vegetation, felling dangerous trees, blading roads, and cleaning ditches and culvert inlets and outlets.

Sacred sites: Defined in Executive Order 13007 as "any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site."

Scenic integrity objective: In the context of the forest plan, this is equivalent to a goal or desired condition. Scenic integrity describes the state of naturalness or a measure of the degree to which a landscape is visually perceived to be complete. The highest scenic integrity ratings are given to those landscapes that have little or no deviation from the landscape character valued by constituents for its aesthetic quality. Scenic integrity is the state of naturalness or, conversely, the state of disturbance created by human activities or alteration. Scenic integrity is measured in five levels, as follows:

> **Very high—**Landscapes where the valued landscape character is intact with only minute, if any, deviations. The landscape character and sense of place is expressed at the highest possible level.
>
> **High—**Landscapes where the valued character appears unaltered. Deviations may be present but must repeat the form, line, color, texture, and pattern common to the landscape character so completely and at such scale that they are not evident.
>
> **Moderate—**Landscapes where the valued character appears slightly altered. Noticeable deviations must remain visually subordinate to the landscape character being viewed.
>
> **Low—**Landscapes where the valued character appears moderately altered. Deviations begin to dominate the landscape character being viewed, but they borrow valued attributes, such as size, shape, edge effect, pattern of natural openings, vegetation type changes, or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed but should be compatible or complementary to the character within.
>
> **Very Low—**Landscapes where the valued character appears heavily altered. Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes, such as size, shape, edge effect, pattern of natural openings, vegetation type changes or architectural styles in or outside the landscape being viewed. However, deviations must be shaped and blended with the natural terrain so that such elements as unnatural edges, roads, landings, and structures do not dominate the composition.

Scenic character: The combination of the physical, biological, and cultural images that give an area its scenic identity and contribute to its sense of place. Scenic character provides a frame of reference from which to determine scenic attractiveness and to measure scenic integrity.

Scenic stability: Measures the degree to which the scenic character and its scenery attributes can be sustained through time and ecological progression; in other words, it looks at the ecological sustainability of the valued scenic character and its scenery attributes. Because attributes such as rock outcroppings and landforms change relatively little over time, scenic stability focuses on the dominant vegetation scenery attributes. It recognizes the often subtle, incremental changes that can severely diminish or eliminate scenic character.

Scoping period: The time during which a proposed action has been provided to the public for review and comment so that the scope of issues related to the proposed action can be determined.

Seral stage: A particular plant and animal community developmental stage that is transitional between other stages along the continuum of succession or change. Following disturbance, ecological communities often undergo directional change in composition and structure, from early to late seral stages through localized, successional processes. Early seral forest is an example of a seral state that, without disturbance over time, will eventually transition to a subsequent seral state dominated by mid-sized conifers.

Silviculture: The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands, using species silvics to meet the diverse needs and values of landowners and society on a sustainable basis.

Slash: The residue, such as branches or bark, left on the ground after a management activity, such as logging, or natural ecological process, such as a storm or fire.

Snags: Standing dead or partially dead trees (snag topped), often missing many or all limbs or bark. Snags generally 12 inches or larger provide essential wildlife habitat for many species and are important for forest ecosystem function.

Soil productivity: The inherent capacity of the soil to support appropriate site-specific biological resource management objectives, which includes the growth of specified plants, plant communities, or a sequence of plant communities to support multiple land uses.

Special use authorization: A permit, term permit, temporary permit, lease, easement, or other written instrument that grants rights or privileges of occupancy and use, subject to specified terms and conditions, on National Forest System land.

Stand: A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure and growing on a site of sufficiently uniform quality, to be a distinguishable unit, such as mixed, pure, even-aged, and uneven-aged stands.

Standard: A mandatory constraint on project and activity decisionmaking, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements.

Standard terra trails: Trails that have a surface consisting predominantly of the ground and are designed and managed to accommodate use on that surface. They do not include snow or water trails.

Stressors: Agents of change that may directly or indirectly degrade or impair ecosystem composition, structure, or ecological process in a manner that may impair its ecological integrity. Examples are invasive species, loss of connectivity, the disruption of a natural disturbance regime, uncharacteristic wildfire, insect or pathogen outbreaks, air pollution, drought, invasive species, and climate change.

Structure: Both the vertical and horizontal dimensions of a vegetation type or plant community. The horizontal structure refers to spatial patterns of individual and groups of plants and openings, as well as plant size and species composition. The vertical component refers to the layers of vegetation between the forest floor and the top of the canopy. Each vegetation type has its own structure. For example, forests have greater vertical structure than a grassland or woodland, based on the height of the dominant species.

Suitable timberlands: Land to be managed for regulated timber production. Such lands have been determined to meet the following criteria:

- Available for timber production (not withdrawn for wilderness or other official designation by Congress, the Secretary of Agriculture, or Chief of the Forest Service)

- Are physically capable of producing crops of industrial wood without irreversible resource damage to soils productivity or watershed conditions
- Adequate tree restocking within 5 years of final harvest is reasonably assured
- Adequate information exists about responses to timber management activities
- Timber management is cost efficient over the planning horizon in meeting forest objectives that include timber production
- Timber production is consistent with meeting the management requirements and multiple-use objectives specified in the forest plan or plan alternative
- Other management objectives do not limit timber production activities to the point where it is impossible to meet management requirements set forth in 36 CFR 129.27 (per FSH 2409.13, WO Amendment 2409.13-92-1, O Code and Chapter 20).

Suitability of lands: Determined for specific lands in the plan area identified as suitable or not suitable for various uses or activities, based on desired conditions applicable to those lands. The suitability of lands is not identified for every use or activity; every plan must identify those lands that are not suitable for timber production (CFR 219.11).

Sustainability: The capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs. For the purposes of 36 CFR 219, ecological sustainability refers to the capability of ecosystems to maintain ecological integrity; economic sustainability refers to the capability of society to produce and consume or otherwise benefit from goods and services, including contributions to jobs and market and nonmarket benefits; and social sustainability refers to the capability of society to support the network of relationships, traditions, culture, and activities that connect people to the land and to one another and support vibrant communities.

Sustainable recreation: The set of recreation settings and opportunities on the National Forest System that is ecologically, economically, and socially sustainable for present and future generations.

Thinning: An intermediate treatment made to reduce the stand density of trees, primarily to improve growth, enhance forest health, recover potential mortality, emphasize desired tree species, or achieve other restoration objectives. Includes crown thinning (thinning from above, high thinning), free thinning, low thinning (thinning from below), mechanical thinning (geometric thinning), variable-density thinning (thinning to accentuate forest structural heterogeneity and complexity), and selection thinning (dominant thinning). Thinning can be used with both even and uneven-aged management systems.

Timber production: The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use (36 CFR 219.19). Timber production could use even-aged management, with such regeneration methods as clear-cut or shelter-wood harvests, or uneven-aged management using group selection or single tree selection harvests as the regeneration method.

Torching potential: The potential or probability of individual crown fire ignition.

Total maximum daily load (TMDL): A written analysis that determines the maximum amount of a pollutant that a surface water can assimilate (the load) and still attain water quality standards during all conditions. The TMDL allocates the loading capacity of the surface water to point sources and nonpoint sources identified in the watershed, accounting for natural background levels and seasonal variation, with an allocation set aside as a margin of safety.

Traditional cultural properties (TCP): Defined in National Register Bulletin 38 as properties associated "with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community." TCPs can range from structures, mountains, and other landforms to plant gathering locations to communities. These areas are considered historic properties that may be eligible for listing on the National Register of Historic Places.

Travel Management Rule (November 29, 2005, 36 CFR 212.51): Requires that each national forest designate a system of roads, trails, and areas for motor vehicle use by vehicle class and, if appropriate, by time of year. Once the system is designated, the rule prohibits motor vehicle use off the designated system.

Unauthorized road or trail: A road or trail that is not a forest road or trail or a temporary road or trail and that is not included in a forest transportation atlas (36 CFR 212.1, Forest Service Manual 2353.05, and Forest Service Manual 7705).

Uncharacteristic wildfire: Wildfire that exceeds the natural range of variation in fire severity (high severity proportion, high severity patch size) and other fire effects indicators for a specific vegetation type.[56]

Undesirable wildfire: Wildfire that does not meet the desired conditions for a specific vegetation type.

Unplanned ignition: A wildfire.

Vegetation burn severity: The degree of vegetation mortality caused by a fire and the fire severity from the ecological effect of the fire. As used in this EIS, refers to the effect of the fire on the dominant vegetation, which is coniferous trees. Three levels of fire severity are recognized, as follows:

- High severity—Greater than 75 percent of the dominant overstory vegetation (trees) are killed; also referred to as stand-replacement fire.
- Moderate severity—25 to 75 percent of the dominant overstory vegetation (trees) is killed.
- Low severity—Less than 25 percent of the dominant overstory vegetation (trees) is killed.

Watershed: A distinct area bounded peripherally by a divide and draining to a stream or river. Sub-watersheds are an area or ridge of land that is part of the larger watershed.

Watershed condition framework: A national comprehensive and consistent approach for classifying watershed condition, implementing integrated restoration in priority watersheds on national forests and grasslands, and tracking and monitoring outcome-based program accomplishments for performance accountability.

Wild and scenic river: A river designated by Congress as part of the National Wild and Scenic Rivers System that was established in the Wild and Scenic Rivers Act of 1968 (16 USC 1271 (note), 1271–1287) with the following characteristics:

Wild—Those rivers or sections of rivers free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

Scenic—Those rivers or sections of rivers free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Recreational: Those rivers or sections of rivers readily accessible by road or railroad that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Wildland-urban intermix (WUI): Includes those areas of resident populations at imminent risk from wildfire and human developments having special significance. These areas may include critical communications sites, municipal watersheds, high voltage transmission lines, church camps, scout camps, research facilities, and other structures that, if destroyed by fire, would result in hardship to communities. These areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites, regardless of the distance involved (Forest Service Manual 5140.5).

Xeric: Dry sites, patches, or habitats that have limited moisture supply to support biological processes, such as plant growth.

[56] C. C. Hardy. 2005. "Wildland fire hazard and risk: Problems, definitions, and context." *Forest Ecology and Management* 211(1): 73–82.

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