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Santa Fe National Forest Land Management Plan

Final Environmental Impact Statement

Volume 1. Chapters 1, 2, and part of 3

Rio Arriba, San Miguel, Sandoval, Santa Fe, Mora, and Los Alamos Counties, New Mexico

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Cover photo: Managing a prescribed fire in a ponderosa pine forest. Photo credit: José Trujillo

Santa Fe National Forest
Land Management Plan
Final Environmental Impact Statement
Rio Arriba, San Miguel, Sandoval, Santa Fe, Mora, and Los Alamos Counties, New Mexico

Lead Agency:	**USDA Forest Service**
Cooperating Agencies:	**East Rio Arriba Soil and Water Conservation District; La Jara Ditch Association; Nacimiento Community Ditch Association; New Mexico Department of Agriculture; New Mexico Economic Development Department; New Mexico Environment Department; New Mexico Forest and Watershed Restoration Institute; New Mexico Department of Game and Fish; New Mexico Energy, Minerals, and Natural Resources Department, State Forestry Division, Las Vegas District and Botany Programs; New Mexico Land Grant Council; Santa Fe – Pojoaque Soil and Water Conservation District; Tierra y Montes Soil and Water Conservation District; and Tesuque Pueblo.**
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Abstract: To comply with the National Forest Management Act and address changes that have occurred during the past 30 years, the Santa Fe National Forest proposed to revise the current land and resource management plan (1987 Forest Plan). This programmatic draft environmental impact statement documents analysis of impacts of four alternatives developed for programmatic management of the 1.6 million acres administered by the Santa Fe National Forest. The analysis displays anticipated progress toward desired conditions as well as potential environmental and social consequences of implementing each alternative. Alternative 1 is the no-action alternative, which is the 1987 Forest Plan, as amended. Alternative 2 is the forest Plan and is reflected in the accompanying Land and Resource Management Plan for the Santa Fe National Forest. This alternative addresses new information that has become available since the 1987 Forest Plan was published and it meets objectives of Federal laws, regulations, and policies. It provides for restoration and diverse ecosystem services. Alternative 3 maximizes natural processes, reducing human uses. Alternative 4 maximizes human uses through timber utilization, access, and facilities maintenance.

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The 2012 Planning Rule is intended to create plans that guide integrated resource management in the plan area, or lands administered by the Santa Fe National Forest (NF), within the context of the broader landscape. It takes an integrated and holistic approach that recognizes the interdependence of ecological processes with social, cultural, and economic systems. The approach uses best available science and local knowledge to inform decisions along the way. Collaboration with stakeholders, including New Mexico's many cultural groups with deep and long-standing ties to the landscape, and transparency of process are key ways the 2012 Planning Rule guides creation of forest plans for the future. The revised Santa Fe National Forest Land Management Plan (known from here on out as the Forest Plan) will consider a wide range of multiple uses on National Forest System (NFS) lands.

1.1 Document Structure

The Forest Service prepared this final environmental impact statement (FEIS) in compliance with the National Environmental Policy Act (NEPA) (P.L. 91-190) and other relevant Federal and State laws and regulations. This FEIS discloses indirect and cumulative environmental impacts that would result from the proposed action (forest Plan) and alternatives. The document is presented in four volumes and organized as follows:

Volume 1:

- **Chapter 1. Purpose of and Need for Action:** Includes information on the needs for change (purpose of and need for the project) and the agency's proposal (alternative 2, the Forest Plan) for achieving that purpose and need. This section also details how the Forest Service involved the public in the development of the draft forest plan and how the public responded.
- **Chapter 2. Alternatives, Including the Proposed Action:** Provides a more detailed description of the Forest Plan (proposed action) as well as alternative methods for addressing needs for change. These alternatives were developed based on significant issues raised by the public and other agencies. This section also provides tables comparing alternatives and their environmental consequences.
- **Chapter 3. Affected Environment and Environmental Consequences:** Describes the physical, biological, social, and economic environments affected by the Forest Plan and the environmental consequences of implementing the Forest Plan and other alternatives. This analysis is organized by resource area. Volume 1 includes analysis for all the resource topics except Socioeconomics and Designated Areas, which are included in Volume 2.

Volume 2:

- **Chapter 3. Affected Environment and Environmental Consequences:** Describes the physical, biological, social, and economic environments affected by the Forest Plan and the environmental consequences of implementing the Forest Plan and other alternatives. This analysis is organized by resource area. Volume 2 includes analysis for Socioeconomics and Designated Areas, all other resource topics are included in Volume 1.
- **List of Preparers.** A brief identification of the individuals involved, their qualifications, and the specific portion of the FEIS they contributed to.

- **List of Agencies, Organizations, and Persons to Whom Copies of the FEIS are Sent.** Any group, organization, agency, or individual that received a copy of the FEIS is identified in this section.
- **Index.** A list of each topic found in the contents, along with the related page numbers where content on that topic appears.
- **Glossary.** Terms and definitions or explanations that are used throughout the document.
- **Literature Cited.** All literature cited in the body of the FEIS is identified in full detail here.
- **Appendices:** Appendices provide more detailed information to support the analysis presented in the FEIS.
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- **Appendices:** Appendices provide more detailed information to support the analysis presented in the EIS.
    - **Appendix O.** Response to Comment [1]

Additional documentation may be found in the project planning record located at the Santa Fe NF Supervisor's Office. Key analysis documents can be found online at: www.fs.usda.gov/goto/santafeforestplan

[1] A full documentation of changes made between the draft and final documents is available in the project record.

1.2 Location

The Santa Fe NF in northern New Mexico was established in 1915, when President Woodrow Wilson signed Executive Order 2160 merging the Jemez and Pecos National Forests. Today, the Santa Fe NF administers approximately 1.6 million acres.[2] The forest is divided into two fairly distinctive sections: the west side centered on the Jemez Mountains and the east side in the Sangre de Cristo Mountains. The city of Santa Fe, the state capital of New Mexico, lies at 7,000 feet elevation in the Rio Grande valley between these two mountain ranges.

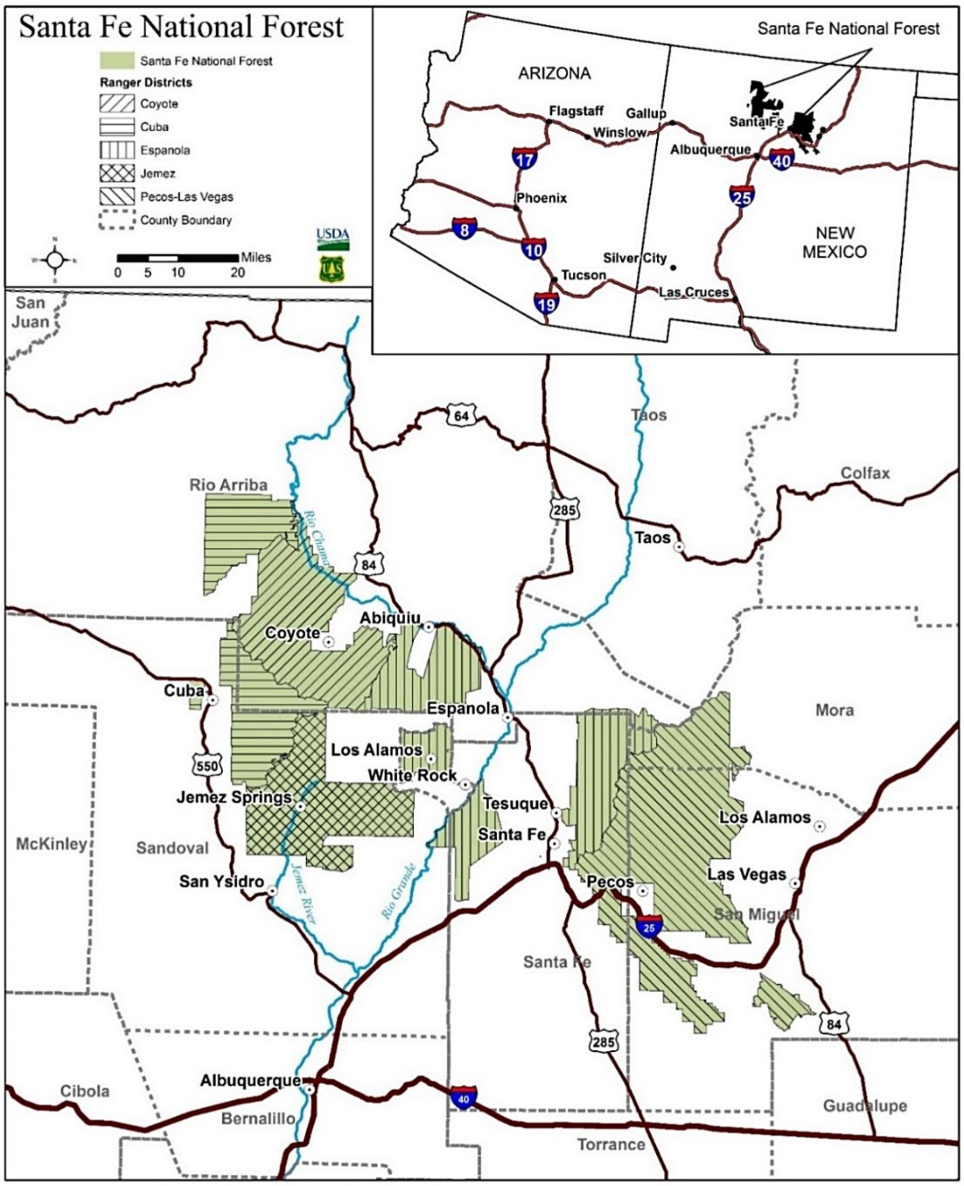

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Figure 1. Vicinity of the Santa Fe NF showing county boundaries, major highways, and major rivers. The inset shows the location of the Santa Fe NF within New Mexico.

[2] Total area within boundary is approximately 1,680,000 acres, which includes 1,545,000 administered by the Santa Fe NF plus 135,000 acres administered by other owners. Data from the Automated Lands Project.

The Santa Fe NF includes portions of seven counties—Rio Arriba, San Miguel, Sandoval, Santa Fe, Mora, Los Alamos, and only 0.2 acre within the Pecos Wilderness in Taos County (figure 1). The forest shares borders with the Carson NF, Bandelier National Monument, Pecos National Historic Park, the Valles Caldera National Preserve, Los Alamos National Laboratories, land administered by the Bureau of Land Management, and various tribes, pueblos, and land grants. The majority (95 percent) of the forest lies within the Rio Grande Watershed. The Santa Fe NF has five ranger districts: Coyote, Cuba, and Jemez on the west side, Pecos/Las Vegas on the east side, and Española spanning both sides. It is one of five national forests in New Mexico.

The forest stretches across mountains, valleys and mesas of the Jemez and Sangre de Cristo mountain ranges. Elevation varies from 5,000 to 13,000 feet, with the summit of Truchas Peak (13,108 feet) within the Pecos Wilderness being the highest point on the east side and Chicoma Mountain (11,561 feet) the highest on the west side.

1.3 Purpose and Needs for Change

The 1987 Land and Resource Management Plan for the Santa Fe NF (1987 Forest Plan), including 17 amendments, is the primary document currently guiding the forest in meeting the mission of the Forest Service and managing its lands to provide for healthy, resilient ecosystems that meet the diverse needs of the American people. The National Forest Management Act of 1976 directs every national forest to revise its forest plan:

- Every 10 to 15 years;
- When conditions or demands in the area covered by the forest plan have changed significantly;
- When changes in agency policies, goals, or objectives would have a significant effect on forest-level programs; and
- When monitoring and evaluation indicate that a revision is necessary.

Over 30 years have passed since the regional forester approved the original forest plan in July 1987. The last 30 years have yielded new scientific information and understanding, and changes in economic, social, and ecological conditions, resulting in a shift in management emphasis from outputs to outcomes. A complete revision of the 1987 Forest Plan is needed to: (1) meet the legal requirements of the National Forest Management Act and the provisions of the 2012 Planning Rule, (2) guide natural resource management activities in the forest for the next 10 to 15 years, and (3) address the needs for change in management direction.

In preparation for forest plan revision, the Santa Fe NF identified guidance in the 1987 Forest Plan that is working, new conditions that need to be addressed, and ongoing challenges that could be better addressed. This preparatory work is documented in the "Assessment Report of Ecological, Social, and Economic Conditions, Trends, and Sustainability" (USDA Forest Service 2016a and 2016b) and the "Findings from the Final Assessment: Twelve Focus Areas and Needs for Change Statements (USDA Forest Service 2016f). The Santa Fe NF identified current ecological and socioeconomic conditions and trends taking place in the forest and associated "needs for change" to be addressed in the Forest Plan. Findings from the Final Assessment resulted in needs for change statements for 12 focus and 10 non-focus resource areas. Those needs for change have been grouped here into five main themes.

1.3.1 Restore Ecosystem Resilience

Resiliency is the ability of an ecosystem to regain structure, composition, and function following disturbance in a timespan that is consistent with the dynamics of the ecosystem. There is a need for plan direction that recognizes the interdependence of resources, provides for management areas that reflect natural features and ecological boundaries, incorporates adaptive management components to better respond to changing environmental conditions, and supports an all-lands approach of working with neighboring land managers to implement projects that improve landscape connectivity across mixed ownerships where natural systems span multiple administrative boundaries. In addition, desired conditions are needed that promote natural disturbance processes that sustain forest carbon sequestration and emphasize silvicultural practices of uneven-aged management in fire-adapted forests and woodlands, and standards and guidelines that limit nonnative species, while encouraging native species.

Fire exclusion and past management activities have limited frequent, low-severity wildfires on the landscape. Wildfire atypical of historic fire regimes has resulted from higher densities of trees, increased fuel loadings, and altered species composition from mature, fire-tolerant species toward shade-tolerant, less fire-resistant species. There is a need for plan direction that recognizes the natural processes of fire and its use as a management tool for vegetation types in the Santa Fe NF and that supports integrated resource objectives.

Grassland, woodland, and shrubland have significantly less grass cover and productivity as a result of the exclusion of wildfire, legacy (historical) grazing from livestock, wildlife grazing, and roads. This lack of cover contributes to reduced ability to carry natural and prescribed fire; reduced water infiltration; accelerated erosion and declining soil productivity, especially during periods of drought; and contributes to a cycle that continues to reduce vegetative cover. In addition, native grasses on much of the landscape have been replaced with nonnative and invasive species that are not as effective in preventing erosion or as productive for forage. There is a need for desired conditions and standards and guidelines that allow for the restoration, conservation, and maintenance of grass productivity and diversity, emphasizing native grasses. Desired conditions that limit and reverse woody species encroachment into grasslands and infill of shrublands, woodlands, and forested systems are also needed.

Riparian systems have been degraded and are at risk across the forest. A variety of land uses (e.g., roads, grazing, recreation), increased water demand (water withdrawal) and climatic changes (e.g., long-term drought have deteriorated these systems. There is a need for desired conditions to restore or maintain characteristic composition and cover of riparian vegetation. There is a need for standards and guidelines that minimize the ecological impacts of multiple uses in riparian areas, and a recognition of their reliance on upland ecological health.

Hundreds of animal, plant, and fungi species rely on habitat within the Santa Fe NF. Some may be restricted only to national forest lands because they are rare or because changing land use patterns outside the forest increase their reliance on habitat within the Santa Fe NF. There is a need for plan direction that supports restoration and maintenance of ecological conditions that contribute to the recovery and conservation of federally listed species (threatened and endangered), maintain viable populations of the species of conservation concern, and maintain common and abundant species. In addition, plan direction for terrestrial and aquatic habitat connectivity for species migration and movement is needed.

1.3.2 Deliver provisioning ecosystem services

Provisioning ecosystem services are the products people obtain from functional ecosystems that they can enjoy or from which they benefit, such as clean air and fresh water.

Both natural and human-caused disturbances have degraded water quality and quantity. As population around the Santa Fe NF increases, the lack of surface water will place a greater demand on groundwater resources, which may further deplete surface flows both in and outside of the forest. There is a need for plan direction to protect stream channels, hydrological function, and condition of water-dependent systems by maintaining and restoring upland and riparian vegetative cover and reducing erosion and sedimentation from disturbed sites (e.g., reclaiming roads) where feasible. There is also a need for plan direction that provides for sustainable groundwater-dependent ecosystems (e.g., seeps and springs, fens, and wetlands) and for the long-term protection of groundwater quality and quantity in the Santa Fe NF. There is a need for plan direction that considers consumptive water uses and water rights because water is over-allocated and will continue to be in high demand.

Soil condition, and soil erosion hazard are directly linked to site productivity and soil resilience, and current soil loss rates exceed natural soil loss rates across the Santa Fe NF. The majority of the Santa Fe NF has a high probability for accelerated erosion due to natural disturbances or management disturbances that expose the soil surface without incorporating erosion control measures. There is a need for plan direction that promotes the maintenance and restoration of soil condition and function (e.g., hydrology, stability, and nutrient cycling) by limiting the amount of exposed soil and by restoring and maintaining sufficient vegetative cover.

Although air quality is generally in good condition, it can be impacted by larger and more severe wildfires and fugitive dust. There is a need for plan direction for air quality in terms of ambient air quality, visibility, and critical loads.

1.3.3 Support Traditional and Cultural Uses

There is a need for plan direction that recognizes the Santa Fe NF's role in contributing to traditional and cultural forest uses and local economies.

The Santa Fe NF includes the locations of thousands of historic properties and traditional cultural properties that are a major source of information regarding the history of human occupation of the plan area and are a way local communities remain connected to their land and their cultural identify. There is a need for plan direction to stabilize, preserve, interpret, and protect historic and sensitive properties such as archaeological sites, historic structures, and traditional cultural properties. There is also a need for plan direction that recognizes the inherent value and preservation of Native American traditional cultural properties and sacred sites, as well as non-Native American traditional cultural properties, while maintaining the anonymity of such sites where appropriate.

There are deep and historic ties between nearby populations and the Santa Fe NF, and the Forest Plan needs to recognize and protect historic and contemporary cultural uses—both economic and non-economic—for tribes as well as traditional communities not considered under tribal relations (e.g., traditional Hispanic and Anglo communities).

Santa Fe NF lands are part of many federally recognized tribes aboriginal or traditional use areas as well as places for contemporary uses including cultural and religious activities. There is a need for management approaches that include opportunities for integrating forest management with tribal needs through shared stewardship to address threats to adjacent tribal resources (e.g., through the Tribal Forest Protection Act of 2004), to meet common objectives identified in tribal and pueblo land management plans, and to use an "all lands" approach to resources management.

Vegetation analyses show that the grassland types commonly used for livestock grazing are losing productivity due to declines in herbaceous ground cover, invasive species, and drought. Other key influences include fractured ownership due to private lands, legal uncertainties about land titles, and endangered species management. There is a need for plan direction that provides opportunities to use adaptive management for the range program that incorporates ecosystem-based desired conditions, with particular emphasis on strategies to address drought and other extreme weather-related events.

The majority of wood products from the forest is in the form of fuelwood and smaller forest products that are significant for traditional and cultural importance as well as economic contributions. Mechanized harvesting of forest products is also an important component to maintaining appropriate vegetative characteristics. There is a need for plan direction that provides for the use of a variety of forest products by commercial, noncommercial, tribal, and land grant users. There is a need for plan direction that allows for flexible size criteria regarding timber extraction to balance desired conditions and the ability to provide economically viable forest products. There is a need for plan direction regarding traditional and alternative energy sources that balances demand with natural resource impacts.

1.3.4 Address Recreation and Multiple Uses

There is a need for plan direction that recognizes the Santa Fe NF's role in contributing to service-based sectors such as recreation and tourism, timber, and other multiple-use related activities and products.

The ability of the Santa Fe NF to provide a meaningful recreation program is at risk, reflecting increasing and changing demands in a resource-constrained management environment. There is a need for plan direction on sustainable recreation management to provide high-quality recreational experiences that are consistent with the forest's social, environmental, and economical resource capacity while balancing changing trends in services and intended use of recreation infrastructure and facilities. Plan direction is also needed to help manage recreation activity impacts to areas sensitive to resource degradation or at risk due to high visitation and to reduce user conflicts.

The qualities that led to the designation of wilderness and wild and scenic rivers contribute to the social sustainability by connecting people to their natural and cultural heritage and providing recreational opportunities. These areas also contribute to ecological sustainability by preserving intact natural systems and their individual components. There is a need for plan direction to identify and evaluate potential additions to the National Wilderness Preservation System and eligibility for inclusion in the National Wild and Scenic Rivers System. In addition, plan direction for designated and recommended wilderness areas is needed to protect and enhance wilderness values and character.

People are drawn to the Santa Fe NF for its diversity of scenic features that contribute to a sense of place and identity. There is a need for plan direction to integrate scenery management into all resource management decisions with the intent of retaining and enhancing scenic resources while integrating with other resources (e.g., restoration, habitat diversity, and timber management).

The Santa Fe NF's ability to maintain its current road system is severely threatened. Of the approximately 6,900 miles of roads on the landscape, 2,200 miles of roads are open to the public for motorized use. The remaining 4,700 miles of roads may be administrative use roads or non-system roads, and most contribute to erosion and sedimentation, reflecting a critical and growing gap in resources for maintenance. There is also infrastructure related to rural and agronomic uses, such as timber harvesting, grazing, and rangeland management. Much of the range infrastructure across the forest is non-functional and in need of maintenance or decommissioning. Non-functional water developments and downed fencing result in cattle seeking water in sensitive riparian areas. Unmaintained and vandalized range improvements can also be hazardous for wildlife. There is a need for plan direction to ensure sustainable infrastructure (roads, recreation and administrative facilities, range improvements, maintenance, etc.) and standards and guidelines that address negative impacts of existing roads.

The Santa Fe NF lands program has increasing demands for services such as managing access to private inholdings, managing encroachments from private landowners, title claims, evolving requests for communication sites, the ever-growing wildland-urban interface area, completing property boundary surveys, and fragmentation. There is a need for plan direction regarding access to private inholdings, including during evaluation of placement of infrastructure, to minimize natural resource damage while ensuring rights of access to private lands are respected. Due to growing demand, plan direction regarding sites for communications infrastructure is needed. Plan direction is also needed to protect existing public access rights and provide for new recreational access opportunities in the forest. Management approaches that support coordination between adjacent landowners and the Forest Service regarding permits, leases, and easements on NFS lands are needed.

1.3.5 Support for All Resources

Overall, there is a need for plan direction that is strategic and identifies desired conditions with objectives for how resources should be managed; eliminates redundancies with existing laws, regulations and policy; removes requirements to prepare additional resource plans; and incorporates the best available scientific information into all plan components.

Monitoring is a critical element of adaptive management, and the plan monitoring program needs to be focused to be effective. Monitoring questions that are relevant to plan components including desired conditions, standards, guidelines, suitability and other strategic goals of the Forest Plan are needed. In addition, monitoring at appropriate scales is needed, including monitoring beyond the Santa Fe NF boundary to compare resources in the forest with their status on a larger context scale or even between neighboring forests.

Relationships and effective partnerships are key to successfully implementing a forest plan that will protect the land and serve the people. Management approaches are needed to both streamline the processes that leverage partners and volunteers and build stronger relationships with the public, including but not limited to State and Federal agencies, cities and counties, tribal governments, recreational and forest user groups, environmental groups, land grant communities and other traditional communities, local communities, youth, and vendors. Management approaches are also needed that will emphasize public education regarding the Santa Fe NF's diverse ecological, social, and economic resources, the multiple-use philosophy, public laws and regulations, and management strategies.

1.4 Proposed Action

The Santa Fe NF proposes to revise its 1987 Land and Resource Management Plan (1987 Forest Plan) to provide strategic, program-level guidance for managing the Santa Fe NF’s resources and uses over the next 10 to 15 years. Proposed changes to the 1987 Forest Plan include incorporating resource desired conditions and geographic areas as well as updating objectives, standards, guidelines, suitability, and monitoring requirements. The Forest Plan changes the description and allocation of the management areas to move the majority of the land toward forestwide desired conditions and adds geographic areas that emphasize management differences across the large landscape. The proposed action (Forest Plan) focuses on the needs for change identified in the assessment and incorporates significant issues raised during the scoping process.

The Forest Plan consists of plan components that guide future project activity and decision making and are the main substance for the document. They include:

- Desired conditions describe the vision for each resource, designated area, management area, or geographic area and form the basis for the types of projects, activities, and uses that occur under the forest plan.
- Objectives focus on tangible targets for achieving desired conditions in some of the highest priority areas that had the biggest need for change. They help guide a long-term program of work for the forest.
- Standards and guidelines provide tangible directions to focus and constrain management actions to move resources toward or keep resources in desired conditions.
- Suitability determinations direct which areas within the NFS lands are suitable for specific multiple uses or activities based on applicable desired conditions.
- Designated areas, management areas, and geographic areas identify parts of the forest that need different management direction than what is provided for forestwide resources. They have their own unique desired conditions.
- Monitoring and evaluation requirements allow us to track management actions to ensure that they are appropriately moving resources toward desired conditions and indicate if future actions, or the forest plan, need modification.

The plan is strategic in nature and does not specifically authorize any projects or activities. Site-specific decisions are made following project-specific proposals and analyses that comply with the forest plan, with additional opportunities for public involvement.

Specific details about the proposed plan are provided in chapter 2.

Comments received during the 90-day comment period were analyzed and informed changes made to the proposed action (the forest Plan) and EIS. Modifications made did not significantly change the proposed action, and consisted largely of editorial and technical corrections and wording clarifications. Some management approaches were added as suggested by commenters, and two plan components were removed – one due to redundancy with another plan component and one to ensure compliance with law, regulation, and policy. Because of the minor nature of modifications, a re-analysis

A summary of changes can be found in appendix A (EIS, Volume 2) and a full accounting of all modifications is available in the project record. Scope of the Analysis

Analysis in this FEIS is limited to the needs for change revision topics listed above and to significant issues (discussed below). Many issues raised during the scoping process are beyond the scope of this plan revision process and are not considered in the FEIS. For example, issues associated with site-specific activities that are addressed by project-level decisions are not addressed. The designation of specific roads, trails, and areas for motorized vehicle travel are not considered during plan revision because these are addressed in the separate environmental analysis for public motorized travel planning in the Santa Fe NF (USDA Forest Service 2012b). Some issues (e.g., budget allocations), although important, are beyond the authority or control of the plan, and will not be addressed in this analysis.

1.5 Decision Framework

This environmental analysis was conducted according to the Council on Environmental Quality's 1978 regulations for implementing the procedural provisions of the NEPA (40 CFR §§1500-1508, as amended). The Council on Environmental Quality issued revised regulations for implementing the procedural provisions of the NEPA, effective September 14, 2020. The revised regulations provide the responsible official the option of conducting an environmental analysis under the 1978 regulations if the process was initiated prior to September 14, 2020 (40 CFR §1506.13, 85 FR 137, p. 43373, July 16, 2020). This EIS was initiated under the 1987 regulations, starting with the Assessment and Scoping processes and up to the beginning of the 90-day comment period on the draft Plan and draft EIS.

The Forest Supervisor of the Santa Fe NF is the responsible official for this project and will make the final decision on the selected alternative for the Forest Plan. The Forest Supervisor will review the proposed action (forest Plan), the other alternatives, and their environmental consequences, then decide which forest plan alternative best addresses the identified needs for change and issues raised during the scoping process, the requirements of the National Forest Management Act (P.L 94-588) and the Multiple-Use Sustained-Yield Act (P.L. 86-517) of 1960, and the diverse needs of forest users and sustainable resource management.

Based on the analysis in this FEIS and subsequent public comments, the responsible official will prepare a final environmental impact statement and identify a selected alternative in a draft record of decision that will be subject to an objection process guided by direction in 36 CFR Subpart B (219.50 to 219.62). A final record of decision and accompanying forest plan will set a course of action for managing the Santa Fe NF for the next 10 to 15 years. Project-level environmental analysis will still need to be completed for specific proposals to implement the forest plan's direction.

1.6 Public Involvement and Collaborative Planning

Our partners and the public have valuable ideas, knowledge, opinions, and needs that can inform and improve management of the Santa Fe NF. To provide meaningful dialogue and collaboration, we have offered a variety of public engagement opportunities throughout the plan revision process.

We raised awareness for plan revision by contacting over 2,000 members of the public through outreach since 2014, by setting up booths at the New Mexico capitol, 12 county fairs, 13 farmers' markets, the Balloon Fiesta, the New Mexico State Fair, the Española Health and Family Day, the Santa Fe High School Volunteer Expo, the Tesuque Pueblo Health and Safety Fair, and the El Camino Real National Historic Trail Grand Opening. Legal notices were posted to the newspaper of record (*The Albuquerque Journal*) announcing official comment periods and the posting of official documents to the *Federal Register*.

- Public Notice of Assessment – March 6, 2014
- Notice of Intent (NOI) – July 3, 2016

- Correction published in Federal Register on July 12, 2016

- Notice of Availability (NOA) – August 9, 2019

Announcements for public meetings were also posted in local newspapers, local libraries, and announced on local news stations serving the communities in and around the Forest.

While revising the forest plan, we hosted or participated in over 250 different meetings with a wide variety of styles and focus groups with over 3,200 participants since December 2013 including:

- In 2014, 16 listening sessions, two public participation workshops, and 15 assessment meetings (including one meeting targeting land grants)
- From 2014 to 2015, 16 additional meetings with various organizations, including the Girl Scouts, on forest plan revision
- In 2015, 13 need-for-change meetings (including two tribal meetings)
- In 2016, 16 wilderness inventory and evaluation meetings, 7 field trips, and 3 open houses. The field trips gave members of the public the opportunity to see resources on the ground and have conversations with Santa Fe NF resource specialists. The open houses are informal opportunities for the public to ask questions and for the staff of the Santa Fe NF to share information about forest plan revision during gaps between formal public meetings.
- In 2017, 11 initial plan components meetings, 5 alternatives and management areas meetings, and seven open houses
- In 2018, 27 open houses before the draft Plan and DEIS release
- In 2019, 11 informal open-house style meetings during the official 90-day public comment period on the draft Plan and DEIS
- Since 2014, 10 targeted public meetings with land grants (including one assessment meeting in 2014), the New Mexico Land Grant Council, and the Northern New Mexico Stockman's Association

Youth outreach since 2014 has included two field trips for 4th grade students, a field trip for community college students through the Students Wildlands Adventure Program in 2017 and 2018, 22 classes taught at local schools (including with Santa Fe High School students through Forest Bound in 2017 and 2018), and working with the Forestry Department at New Mexico Highlands University to tell students about forest planning through forestry classes and encouraging the students to come to Las Vegas public meetings.

Tribal consultation and collaboration have been ongoing since 2013, with the forest staff participating in 73 meetings with tribes that included forest plan revision on the agenda (including two meetings on need-for-change in 2015). The forest plan revision process is a unique opportunity for tribes to influence the long-term vision for the forest and to strengthen the unique government-to-government relationship that the Santa Fe NF maintains with the tribes.

The Santa Fe NF staff held rounds of public meetings on the assessment, need-for-change, wilderness inventory and evaluation, initial plan components, as well as alternatives and management areas. In total, there have been 78 public meetings, 68 of them general meetings, 10 of them technical meetings, and 3 of the general public meetings were targeted for specific groups (twice for tribes and once for land grants). General meetings were held mostly during the evening, started with a presentation and Q&A, then involved breakout working groups to facilitate the writing of public comments. The technical meetings were held during the day, were longer than the general meetings, and covered the same topics, but in more depth. Technical meetings followed a format similar to the general meetings, starting with a presentation and Q&A, followed by breakout working groups to facilitate the writing of public comments.

Since finalizing the assessment and beginning with the need-for-change meetings, we have received 3,237 comments, including 789 on need-for-change; 40 on the notice of intent; 2,009 on the criteria for the wilderness inventory and evaluation; 214 on the wilderness inventory and evaluation; 146 on the initial plan components; and 39 on the alternatives and management areas.

In 2019, during the official 90-day public comment period on the draft Plan and DEIS, the Forest held or attended 30 meetings with federally recognized tribes or pueblos, Cooperating Agencies, local government officials and community groups, and non-profit organizations. Additionally, three Tri-Forest meetings were held collaboratively with the Carson and Cibola NFs, with one for Tribes and Pueblos, one for the general public, and one for Government officials. These meeting were focused on providing information on the documents and aiding the public in writing and submitting comments.

The notice of intent (NOI) to prepare an EIS was published in the *Federal Register* on June 30, 2016. The NOI asked for public comment on the proposal through August 17, 2016; however, the forest considered substantive comments that were received after this date. The 40 NOI comments received were used to modify the proposed plan and develop alternatives.

The notice of availability (NOA) was published in the *Federal Register* on August 9, 2019, initiating the formal 90-day comment period on the DEIS and draft Forest Plan as required by Forest Service National Forest Management Act regulations 36 CFR 219. The Forest received 13,655 comment letters from the public on the documents during this period. Of these comments, 604 letters contained unique and substantially different comments. The remaining 13,051 letters received were form letters.

Eligibility to object to the Forest Supervisor’s decision regarding the proposed action is limited to individuals and organizations that comment on the DEIS or otherwise express an interest in the project during the formal 90-day comment period, or previously made comments during the scoping period (during which the public commented on the NOI and Initial Plan Components; 36 CFR § 219.5).

1.7 Issues

Issues serve to highlight effects, both anticipated and unanticipated, that may occur from the proposed action or alternatives. Addressing the variety of issues identified during the analysis provides opportunities to reduce adverse effects and compare trade-offs for the decision maker and public to understand. Issues were identified from public comments, specifically comments on the NOI, published in the *Federal Register* on June 30, 2016, but additional public comments received since then as well. The public, other agencies, and tribes submitted 40 comments in response to the NOI and initial plan components. Scoping comments were analyzed and divided into 32 initial categories that were then grouped into the 5 categories presented here. We developed alternatives around those issues that involved unresolved conflicts during the iterative development of the proposed plan (see chapter 2 for more information on alternative development). Comments on the draft Plan and DEIS have continued to reflect these issues.

1.7.1 Issue A: Restore Vegetation Resilience

Overall, public comments expressed a desire to restore vegetation composition and structure so that it is in line with historic conditions and has a reduced risk of uncharacteristic wildfires. The Forest Plan focuses on restoring ponderosa pine and mixed conifer-frequent fire vegetation types, which are frequent fire systems most departed from historic conditions that make up almost 50 percent of the Santa Fe NF. Opinions diverged on how vegetation restoration should occur. Some commenters would like to see more prescribed fire, emphasizing use of this natural disturbance. Others were opposed to fire and smoke, and preferred a focus on mechanical treatments and timber harvests that would also provide for a timber industry.

Healthy riparian areas and the water found in them were also identified as important and in need of restoration. Compromised riparian and wetland vegetation is one of the primary contributions of watershed impairment in the Santa Fe NF and improving them is a focus of the Forest Plan. Comments varied in the level of protection for riparian areas versus using them and their water for activities such as recreation and livestock grazing.

Healthy uplands and riparian areas provide wildlife habitat for countless terrestrial and aquatic plant and animal species. These native species not only serve a critical role in the continued ecological function of the land, but also provide a tremendous amount of social services by offering recreational, economic, and subsistence opportunities to the general public. Many public comments expressed a desire for the Santa Fe NF to provide high-quality habitat for many different types of wildlife, such as mammals, game species, birds, native fish, and plants. However, opinions differed on which species are most important and in need of management. Other commenters stressed the need for the plan to account for wildlife connectivity. The Forest Plan seeks to provide guidance that allows for the continued persistence of all native species in the forest, provide for wildlife connectivity, and also provides socioeconomic opportunities where feasible.

1.7.2 Issue B: Deliver Provisioning Ecosystem Services

Provisioning ecosystem services such as clean air and water, healthy soils, and ecosystems resilient to climate change provide the foundation for healthy forests. The value of water was a common theme in the comments received from the Assessment and through scoping and plan development. Impaired or functioning at-risk watersheds are commonly impacted by poor water quality, soil erosion, and runoff from roads or trails. However, commenters diverged on desires to minimize roads and trails to mitigate this impairment. The Forest Plan considers mitigating the most egregious impairments to water quality, while maintaining access and recreation. Other commenters expressed the important role of the forest in mitigating future climate change and the availability for timber and forest products to support economic and rural stability.

1.7.3 Issue C: Support Traditional and Cultural Ways of Life

The lands within the Santa Fe NF have a long history of human use dating back thousands of years. The value of maintaining forest uses for living descendants as a part of their culture, traditional way of life, and rural prosperity was a major theme in comments from scoping and incorporated into the Forest Plan. The forest plan recognizes the importance of access for traditional uses such as collecting forest products (e.g., fuelwood, piñon nuts, herbs), use of sacred sites, maintenance of acequias, and other traditional uses. Some commenters expressed the importance that access is motorized, which is especially important for the elderly, while others appreciated nonmotorized access as it is less obtrusive and provides more privacy. Preference for motorized versus nonmotorized access also can depend on the activity or its specific location.

Livestock grazing is a traditional use that had divergent public comments. Some commented on its importance not only traditionally but also for rural prosperity. The Forest Plan aims to provide healthy forested and non-forested lands that would supply forage for both livestock and wildlife. Other members of the public commented that livestock grazing has negative consequences, is unsustainable, and want to see it reduced.

1.7.4 Issue D: Address Sustainable Recreation

Some areas of the Santa Fe NF have experienced an increased concentration of recreation use over the life of the 1987 Forest Plan. Public comments expressed desires for a variety of recreation opportunities as well as better maintained and new recreation trails. Some commenters focused on promoting specific recreation uses such as motorized recreation, mountain biking, existing nationally designated scenic and historic trails, and primitive backcountry activities. Other commenters expressed concern and recognition that recreation could have impacts on ecological resources and needed to be sustainable on the landscape. The Forest Plan and alternatives aim to address the availability and orientation of recreation opportunities in a sustainable manner.

1.7.5 Issue E: Consider New Wilderness, Protected Areas, and Management Areas

The 2012 Planning Rule requires the forest to evaluate areas for recommended wilderness, and public comments were divided on the desire to see these areas in the Forest Plan. Some wanted to see more land as recommended wilderness, because it would provide for an emphasis on natural processes in remote settings and important corridors for wildlife connectivity. Others disliked that recommended wilderness restricts access and motorized and mechanized use. Similar divergent opinions were expressed regarding the identification of eligible wild and scenic rivers, another 2012 Planning Rule requirement.

Several public comments identified certain areas with unique features or uses and thought these areas should have management different from the forestwide direction. Some of these included protection of ecological resources such as high-quality wetlands or endangered species, while others were about managing for specific uses such as interpretive trails or motorized recreation. On the other hand, there were concerns about limitations on use in these areas. A range of management areas were incorporated into the Forest Plan or alternatives.

1.7.6 Concerns

Not all comments informed issues. We also identified eight concerns during scoping that did not rise to the significance of issues and were outside of the decision on the forest plan. Many of these still informed plan development or the FEIS, but do not have a cause-effect relationship between an alternative and a significant effect in the analysis. These include:

- A desire to be more involved in the planning process
- Specific suggestions for the monitoring plan
- A desire for more integration of partnerships or public education
- Suggestions of methods for analyzing environmental consequences

- Concerns already addressed by law, regulation, and policy
- Concerns related to the 2008 Oil and Gas Leasing EIS and 2018 Supplement
- Concerns related to private lands within or near the Santa Fe NF
- Concerns regarding the list of species of conservation concern

A summary of the NOI comments and how they formed these concerns can be found in the project record. All comments are also cataloged as part of the project record.

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2. Alternatives, Including the Proposed Action

This chapter describes the proposed action (Forest Plan) and other alternatives that satisfy the purpose and need for revision. It also includes a discussion on the development of the alternatives, the significant issues raised from public comments, a description of each alternative considered in detail, and a brief discussion of alternatives eliminated from detailed analysis. The alternatives and a summary of their effects are presented in comparative form, defining the differences between each alternative and providing a clear basis for choice among options by the decision-maker and for the public.

2.1 Alternative Development

All alternatives were developed to address:

- the purpose and need, as described in chapter 1, which includes the need for change;
- changes in socioeconomic or environmental conditions since the 1987 Forest Plan; and
- issues identified from comments received during public scoping of the revision effort and from comments received on initial plan components, alternative themes, and management areas.

Environmental, social, and economic desires do not always coincide to provide a uniform path of action. Besides having separate and unique desired conditions, ways to achieve those desired conditions can also vary. Therefore, we developed the alternatives to encompass the diverse possibilities for managing this landscape and unresolved issues.

In June 2015, the NOI was published in the *Federal Register*. This included the needs for change identified from the Assessment and public comments in fall 2014. These scoping comments received during this period were used to identify an initial set of significant issues that helped drive the development of the initial plan components, alternative themes, and management areas. These preliminary materials were released to the public, cooperating agencies, and forest employees for review and feedback in January and March 2017 as part of an unofficial comment period. Under direction from the forest supervisor, the interdisciplinary team took into account all feedback and used it to refine the draft forest Plan (alternative 2, the proposed action) and alternatives 3 and 4. We continued modifying the alternatives as we received other comments during open houses held throughout 2017 and 2018. In August 2019, the NOA for the draft Plan and DEIS was published in the *Federal Register*, initiating a 90-day comment period. The comments we received during this period were analyzed and informed the final version of the Forest Plan.

We developed alternative 3 to respond to issues regarding placing more emphasis on natural processes. In this alternative, the natural process of fire is the primary restoration tool to move vegetation toward desired conditions. Also, the acres of forest restoration reflect the most frequent fire return intervals and mechanical treatments are deemphasized. This alternative identifies no land as suitable for timber production. This alternative also has the most progress toward watershed and riparian restoration. Human uses are deemphasized with objectives to reduce roads, livestock infrastructure, and recreation sites. Acres for wilderness recommendation, where natural processes occur without human intervention, are increased. Additional management areas focus on protecting areas with special ecological features such as pristine wetlands and endangered species.

We developed alternative 4 in response to issues regarding placing more emphasis on human uses. Mechanical treatments are the primary restoration tool used to move vegetation toward desired condition, and this alternative has the most acres of lands suitable for timber production. Fire is deemphasized. Human uses are emphasized, with objectives for increased road maintenance and potential to add roads, improvements to livestock infrastructure, and increased recreation site maintenance. Several management areas focus on both motorized and nonmotorized recreation. This alternative includes no acres for wilderness recommendation and proposes an area to be removed from designated wilderness.

2.2 Alternatives Considered in Detail

The interdisciplinary team developed four alternatives: alternative 1 (1987 Forest Plan); alternative 2, the proposed action (Forest Plan); alternative 3, where natural processes would be emphasized; and alternative 4, where human uses would be emphasized. These alternatives were developed in response to issues described in chapter 1.

2.2.1 Elements Common to All Alternatives

All four alternatives share a number of features. In particular, they all

- Comply with applicable laws, regulations, and policies (see appendix D of the Forest Plan for a list of the most prevalent);
- Contain plan components including desired conditions, objectives, standards, guidelines, timber suitability, and monitoring. Desired conditions are common across all alternatives and are described in detail in the Forest Plan;
- Include mechanical treatments including thinning and commercial harvests, while offering opportunities for fuelwood collection when projects allow.
- Conserve soil and water resources and do not allow significant or permanent impairment of the productivity of the land;
- Provide protection for riparian areas;
- Maintain air quality that meets or exceeds applicable Federal, State, and local standards and regulations;
- Provide appropriate habitat to support species' viability and critical habitat for threatened and endangered species across the planning area;
- Use a common list of species of conservation concern (SCC). The SCC were selected based on regional guidance, and recommendations from forest and State agency specialists;
- Recognize the value of traditional and cultural uses and their relationship to the Santa Fe NF;
- Protect cultural resources;
- Provide sustained multiple uses, products, and services in an environmentally acceptable manner (including timber, livestock forage, recreation opportunities, and leasable and locatable minerals);
- Restrict geothermal leasing and include the Oil and Gas Leasing Management Area, with plan direction that includes restrictions for oil and gas leasing[3];

[3] The 1987 Forest Plan was amended by the 2008 Oil and Gas Leasing EIS and 2012 supplement, and by the 2018 Geothermal EIS.

- Manage for special qualities of existing designated areas (wilderness; inventoried roadless areas; research natural areas; wild and scenic rivers; Jemez National Recreation Area; wild horse territories; national scenic, historic, and recreation trails; and scenic byways) (figure 2-west and figure 2-east);
- Include the Cañada Bonita proposed research natural area (figure 6-west, figure 8-west, figure 10-west, and figure 12-west); and
- Include 12 eligible wild and scenic rivers (displayed in figures 6, 8, 10, and 12 (both east and west maps)) with plan components developed to maintain their outstandingly remarkable values.

In addition, progress toward desired conditions and objectives, and the effectiveness of standards and guidelines are evaluated by a monitoring plan that provides continual feedback and evaluation.

2.2.2 Elements Common to Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 also share a number of features. In particular, they all

- Emphasize vegetation treatments in frequent-fire forested systems (ponderosa pine and mixed conifer-frequent fire) that are highly departed from the vegetative desired conditions and historic fire regimes. They also emphasize restoration of highly departed non-forested vegetation types (juniper grass, piñon juniper grass, Colorado Plateau Great Basin grassland, sagebrush shrubland, and montane subalpine grassland) with treatments such as mechanical treatments, prescribed or naturally ignited wildfires, seeding, or other techniques;
- Include restoration treatments in riparian areas, and those benefitting water resources are emphasized, including treatments such as stream channel and habitat restoration, watershed restoration, and invasive species removal;
- Provide direction on invasive species management in multiple ERUs and for the benefit of native and at-risk species;
- Increase direction on soil and soil crust protection, maintenance, and restoration, e.g., after vegetation treatment projects or human activity;
- Increase guidance on fostering relationships and developing opportunities to leverage partnerships and collaboration and enhance communication;
- Recognize and support traditional communities and uses of federally recognized tribes and rural historic communities;
- Emphasize sustainable recreation and increase guidance on implementing a sustainable recreation program;
- Use the scenic integrity objective system to manage for varying levels of scenery across the forest;
- Limit the numbers and acres of management areas to those areas of the forest that require specific management direction beyond that provided by forestwide plan components;
- Provide management direction for recommended wilderness;
- Incorporate 7 geographic areas (figure 4) that further focus forestwide goals and direction based upon the unique character and needs of the diverse forest and surrounding communities.

A crosswalk comparison between alternative 1 (the 1987 Forest Plan) and alternative 2 (the Plan) can be found in appendix M (located in the FEIS, Volume 3).

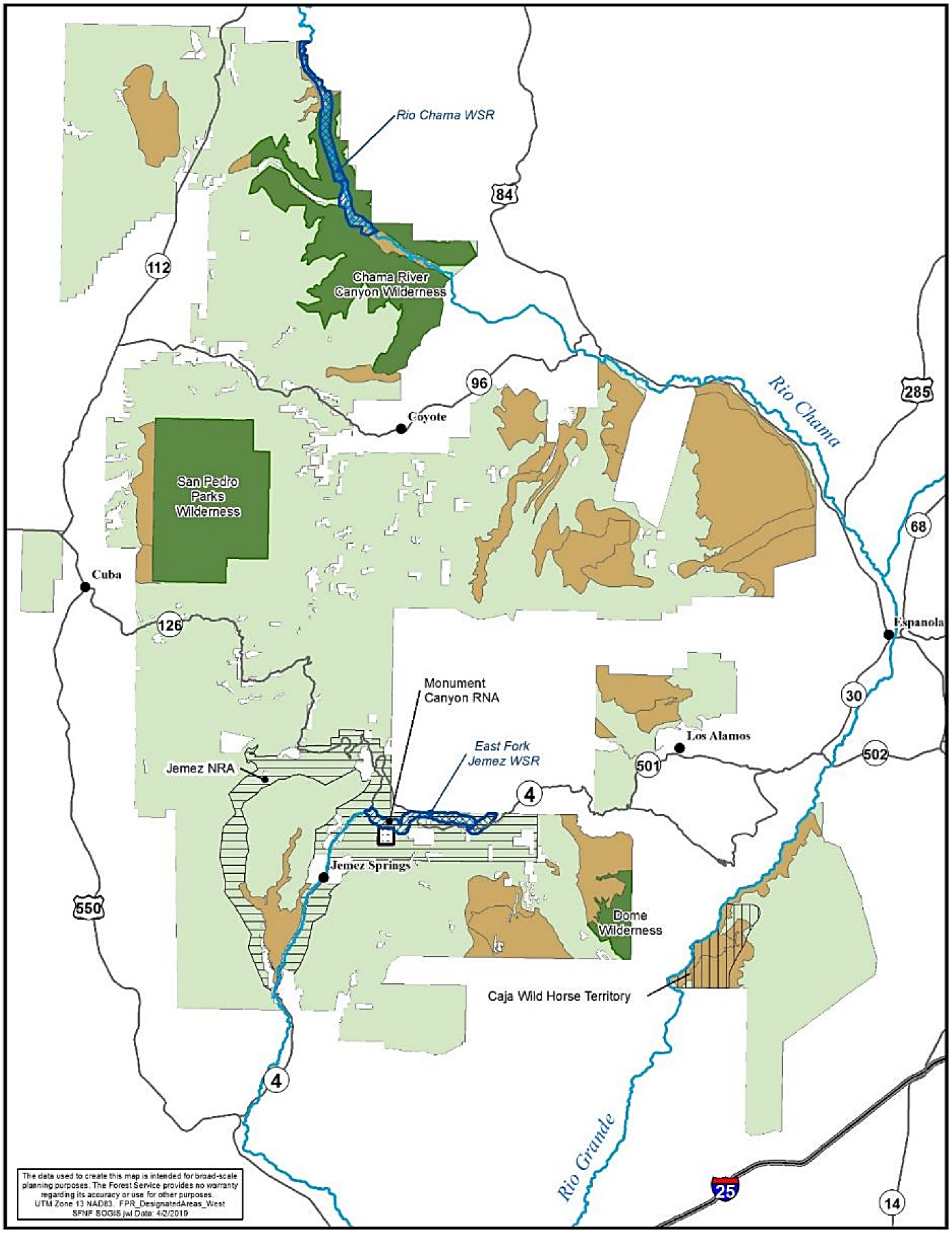

Figure 2-west. Designated areas common to all alternatives for the western half of the Santa Fe NF, from Cuba to Española. For legend see figure 2-east.

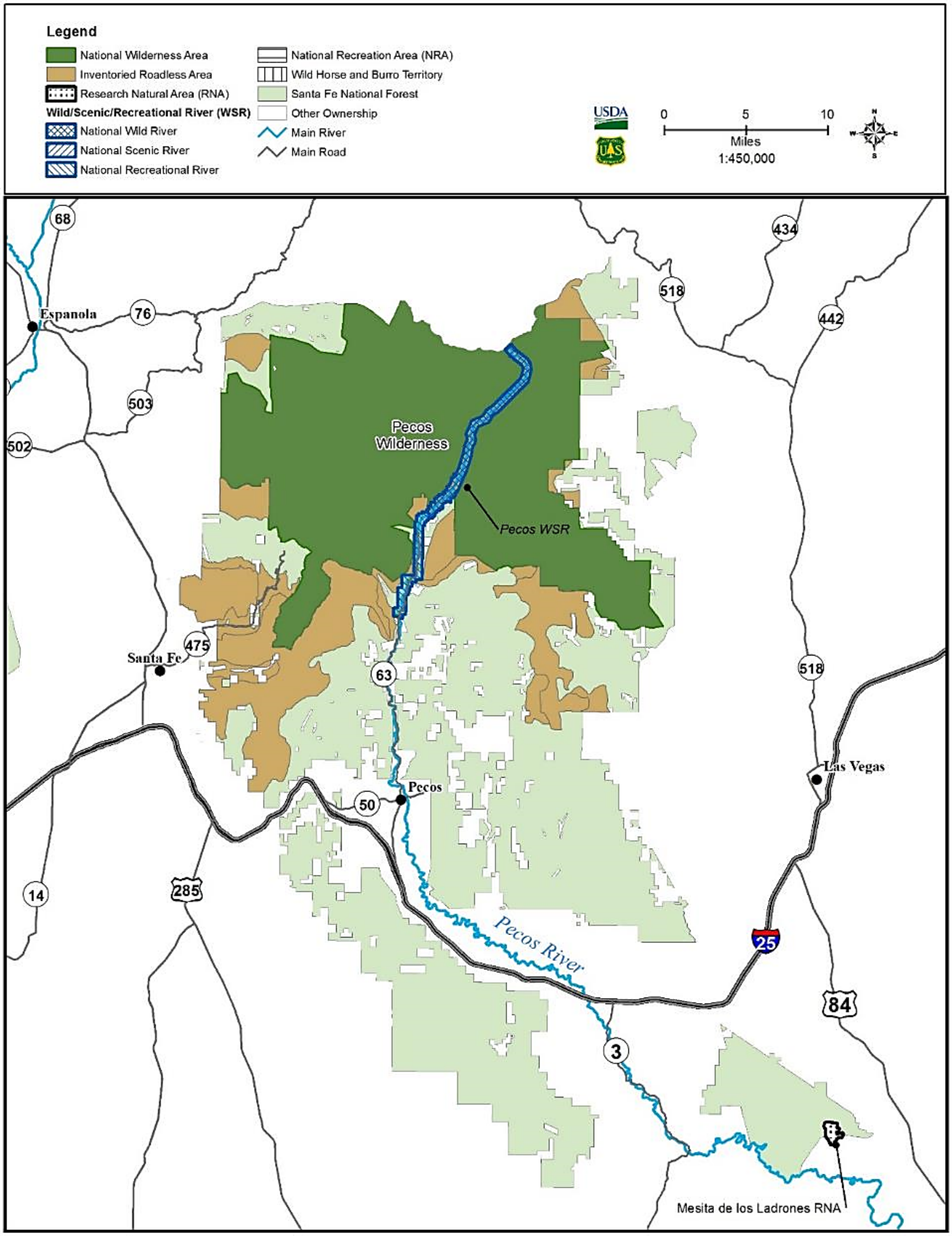

Figure 2-east. Designated areas common to all alternatives on the eastern half of the Santa Fe NF, from Española to Las Vegas

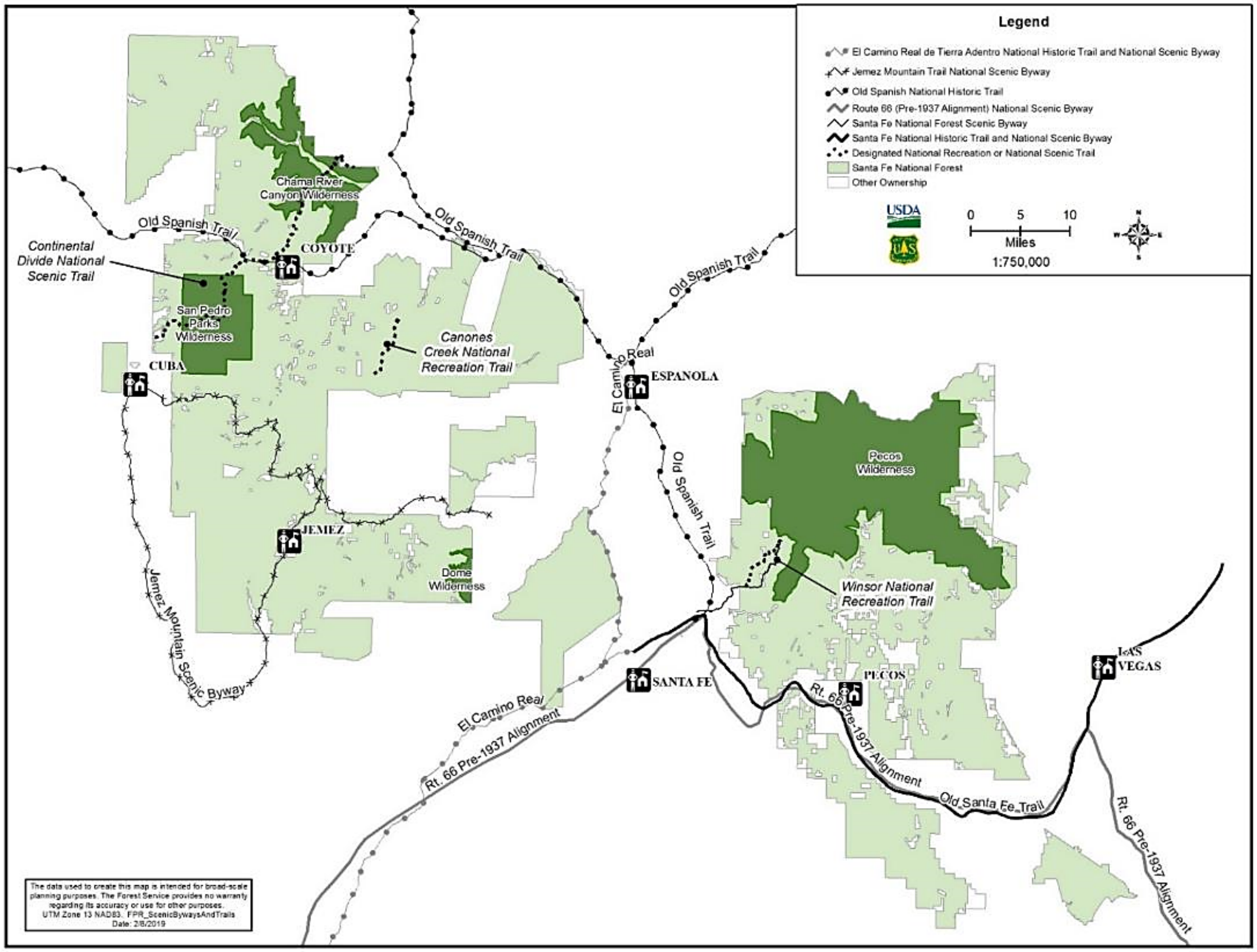

Figure 3. Designated national trails and national scenic byways common to all alternatives for the Santa Fe NF.
National historic trails, particularly the El Camino Real NHT and Old Spanish NHT, have multiple alignments. Some of the alignments pass through the Santa Fe NF and are shown in this map. However, not all alignments may be indicated here for ease of viewing this map. Please see the National Park Service for information and maps regarding all alignments related to NHT.

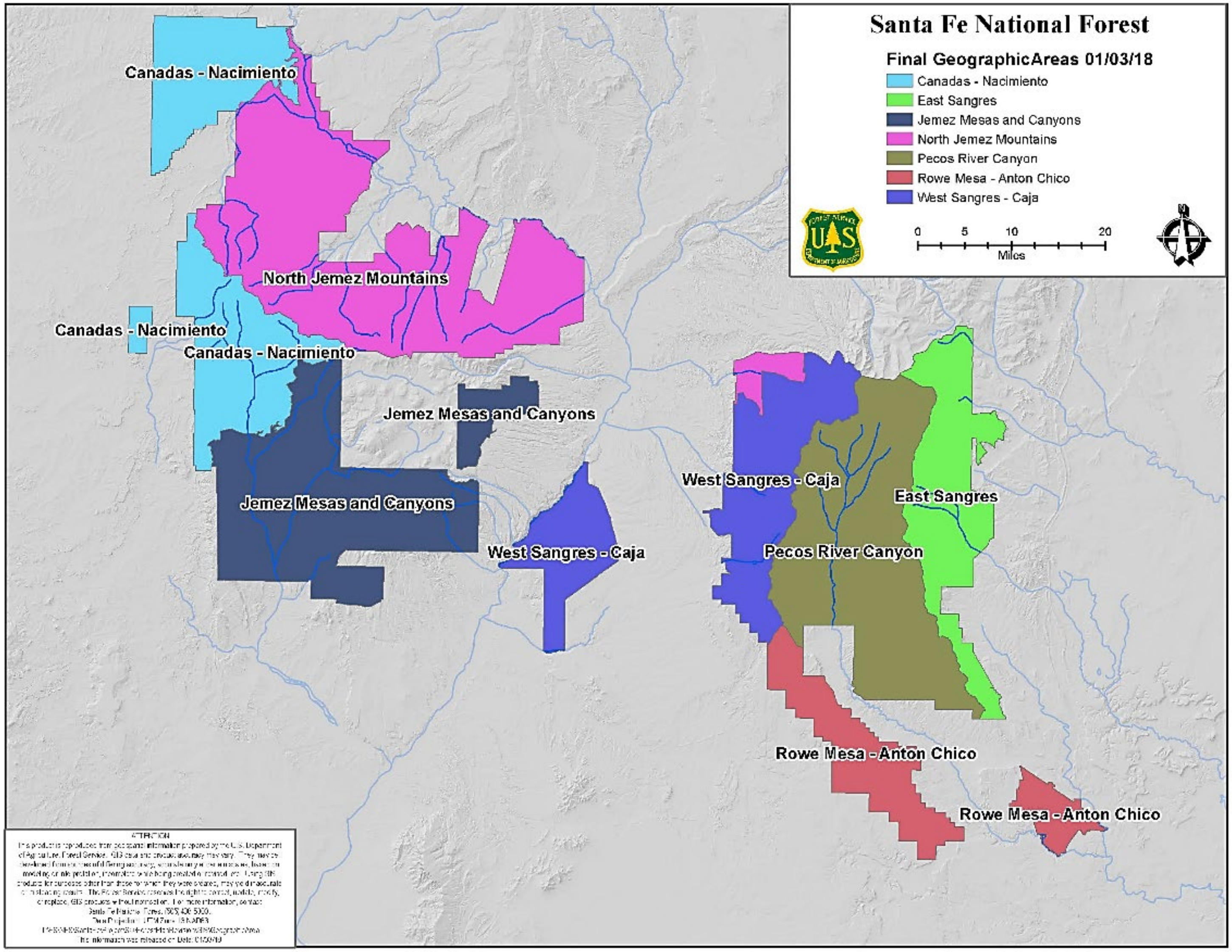

Figure 4. Geographic areas in the Santa Fe NF

2.2.3 Alternative 1 – 1987 Forest Plan

Under the no-action alternative; the 1987 Forest Plan, as amended, would continue to guide management of the Santa Fe NF. Alternative 1 emphasizes timber management over restoration and includes specific direction on fire suppression. Riparian areas and activities on the road system are also emphasized. Direction for managing uses like recreation and traditional and cultural uses is included but minimal. The forest would also remain divided into the current 20 management areas that cover the entire forest.

2.2.3.1 Issue A: Restore vegetation resilience

Alternative 1 has no objectives for treating vegetation. Current management uses mechanical treatments and wildfire (prescribed and natural ignitions) to restore forest health, reduce the risk of fire to communities, encourage wood products industries, and support local communities' forest product gathering for economic and traditional uses.

Most management areas have suppression objectives and maximum acre limits for high- and low-intensity fires and flame lengths. Plan direction is different for each management area, but some examples from Management Area A include:

- The suppression objective is to control 90 percent of the high-intensity (greater than 4-foot flame length) wildfires at 75 acres or less. Maximum loss from high-intensity fires is 1,350 acres in this management area per decade.
- The suppression objective for low-intensity (less than 4-foot flame length) wildfires is to protect plantations less than 40 years old.

A standard promotes naturally ignited wildfires, but only in designated wilderness:

- In wilderness allow wildfire to play a natural role.

There are no specific objectives for terrestrial wildlife habitat improvement. A guideline promotes removing obstructions to wildlife passage and connectivity:

- Allotment fence management will meet wildlife standards to allow easy migration and passage.

This alternative includes no objectives for riparian restoration, but does include in-depth guidelines that describe how riparian areas should be managed for ground cover, shade, bank cover, streambed sedimentation, plant composition, plant structure, and crown cover. There are also no objectives for improving aquatic habitat in general. However, there is plan direction specific to Rio Grande cutthroat trout habitat:

- Continue activities to improve Rio Grande cutthroat habitat with the objective of securing the species. Develop Rio Grande cutthroat trout fisheries within selected areas identified in conjunction with the New Mexico Department of Game and Fish.

2.2.3.2 Issue B: Deliver provisioning ecosystem services

The 1987 Forest Plan includes plan direction to improve watershed health. Most of this direction focuses on the road system, as roads can have substantial impacts to water and watershed health. Plan direction includes:

- Work toward improving unsatisfactory watershed condition to a satisfactory state in those areas that can be cost effectively improved. This should be accomplished through a combination of structural methods and management strategies, such as road closures, satisfactory allotment plans, or off-road vehicle restrictions.
- Accomplish 100 acres (approximately 66 miles) of road obliteration each year for the first two decades. Priorities for road obliteration will be based on the following criteria:
    - ♦ damage to the riparian ecosystem
    - ♦ unacceptable resource damage
    - ♦ management area emphasis of low optimum open road density or protection of sensitive soils.
- Emphasize reconstruction and rehabilitation of existing roads over new road construction.
- The Plan proposes to construct 9.5 miles per year and reconstruct 71.5 miles per year, improving the drainage and surface of major access roads.
- Close or obliterate unnecessary roads.
- Avoid location of temporary roads on unstable or sensitive soils, steep slopes, and watercourses. Revegetation should be accomplished as soon as temporary use is completed, using site-adapted seed mixtures and planting during moist seasons.

2.2.3.3 Issue C: Support traditional and cultural ways of life

Alternative 1 includes no standards or guidelines that address traditional and cultural uses of the Santa Fe NF. The 2012 Travel Management EIS amended the 1987 Forest Plan, limiting motorized access across the forest to designated routes (USDA Forest Service 2012b). Road decommissioning objectives discussed in issue B are substantial, but countered by objectives for additional road construction and reconstruction. In this plan, motorized access for traditional and cultural uses (which could include non-public access roads) would be constantly in flux with roads being added and removed every year.

The current plan aims to maintain the current level of livestock grazing. However, with the absence of specific objectives for improving vegetation, including forage, this can be difficult. Also, the absence of objectives for range infrastructure maintenance and improvements can impact both grazing numbers and ecological sustainability.

2.2.3.4 Issue D: Address sustainable recreation

The plan allows for flexible levels of recreation site maintenance. Certain developed recreation sites are specified to be managed for standard service level, while others are identified to be managed at a less than standard level. There is an emphasis on maintained trails and potentially expanding the trail system. Although plan direction can point to the concept of sustainable recreation, the concept is not specifically mentioned nor are there specific objectives that would help achieve it.

- All trails will be maintained at the standard service level. This will include condition surveys, work to correct deficient conditions, and a maintenance log as described in FSH 2309.18. Maintenance will be geared to meeting management area objectives and will be prioritized by the following needs.
    - ♦ correct unsafe conditions

- ♦ correct resource and trail damage
- ♦ restore trail to planned design standards.

- The trail system will be significantly improved through an increase in maintenance as well as 16 miles per year of construction and reconstruction.

2.2.3.5 Issue E: Consider new wilderness, protected areas, and management areas

This alternative includes two polygons of recommended wilderness (figure 5) totaling 1,853 acres. The Grace Tract and Enchanted Lakes recommended wilderness areas are in the northeastern corner of the forest and adjacent to the Pecos Wilderness. Both are also inventoried roadless areas (IRA) .

Aside from the forestwide direction, the entire forest is also divided into management areas (figure 6-west and figure 6-east), each with its own set of plan components based on the area's emphasis table 1). Most management areas have multiple emphases, which can result in no specific emphasis occurring in those areas. Some acres of the forest also have overlapping management areas.

Table 1. Management areas and their emphasis in the 1987 Forest Plan

Management Area	Emphasis	Acres
A	Emphasis is on timber management and enhancement of wildlife habitat diversity consistent with other resource needs.	270,342
B	Emphasis is on wildlife habitat improvement and key habitat protection. Grazing and timber management activities occur where compatible with the primary emphasis.	61,888
C	Emphasis is on enhancement of visual quality and developed recreation, while protecting essential wildlife habitat. Grazing and timber management occur where compatible with the primary emphasis.	89,819
D	Emphasis is on visual quality and developed recreation. Grazing and timber management occur where compatible with the primary emphasis.	53,038
E	Emphasis is on dispersed recreation, visual enhancement, timber, and firewood production.	119,833
F	Designated wild and scenic rivers. Emphasis is on protecting the free-flowing nature and outstandingly remarkable values of these rivers.	8,050
G	Emphasis is on key wildlife habitat, forage production, and firewood production with dispersed recreation.	226,992
H	Designated wilderness. Emphasis is on preservation and enhancement of wilderness values.	292,329
H/F	Designated wilderness and wild and scenic river. Emphasis is on preservation and enhancement of wilderness values and protecting the free-flowing nature and outstandingly remarkable value of these rivers.	7,291
I	Cultural resource emphasis that focuses on active management including protection, stabilization, interpretation, evaluation, and opportunities for research. *not shown in figure 6-west and figure 6-east	37,920
J	Gallinas Creek Watershed where the emphasis is on water quality maintenance or enhancement and sustained water yield.	17,148
K	Primary emphasis is on prediction of sensitive species, ecosystems, and fragile soils.	65,181

Management Area	Emphasis	Acres
L	Emphasis is on providing semiprimitive-nonmotorized recreation with other uses where compatible, although no roading will occur.	100,684
M	Designated and proposed research natural areas managed to provide opportunities for non-disruptive research.	1,440
N	Managed to protect and enhance essential wildlife habitat.	19,275
O	Santa Fe Watershed where the management emphasis is on quality water production.	15,000
P	Emphasis is on cultural resource location, inventory, and nomination with dispersed recreation opportunities, visual enhancement, and timber management.	30,557
Q	Emphasis is on cultural resource location, inventory, and nomination with dispersed recreation opportunities, visual enhancement, and timber management.	17,108
R	Emphasis is on cultural resource location, inventory, and nomination with wildlife habitat improvement timber management activities.	145,021
S	Emphasis is on cultural resource location, inventory, and nomination with key wildlife protection, forage production, and firewood production.	40,528
X	Designated Jemez National Recreation Area.	53,817

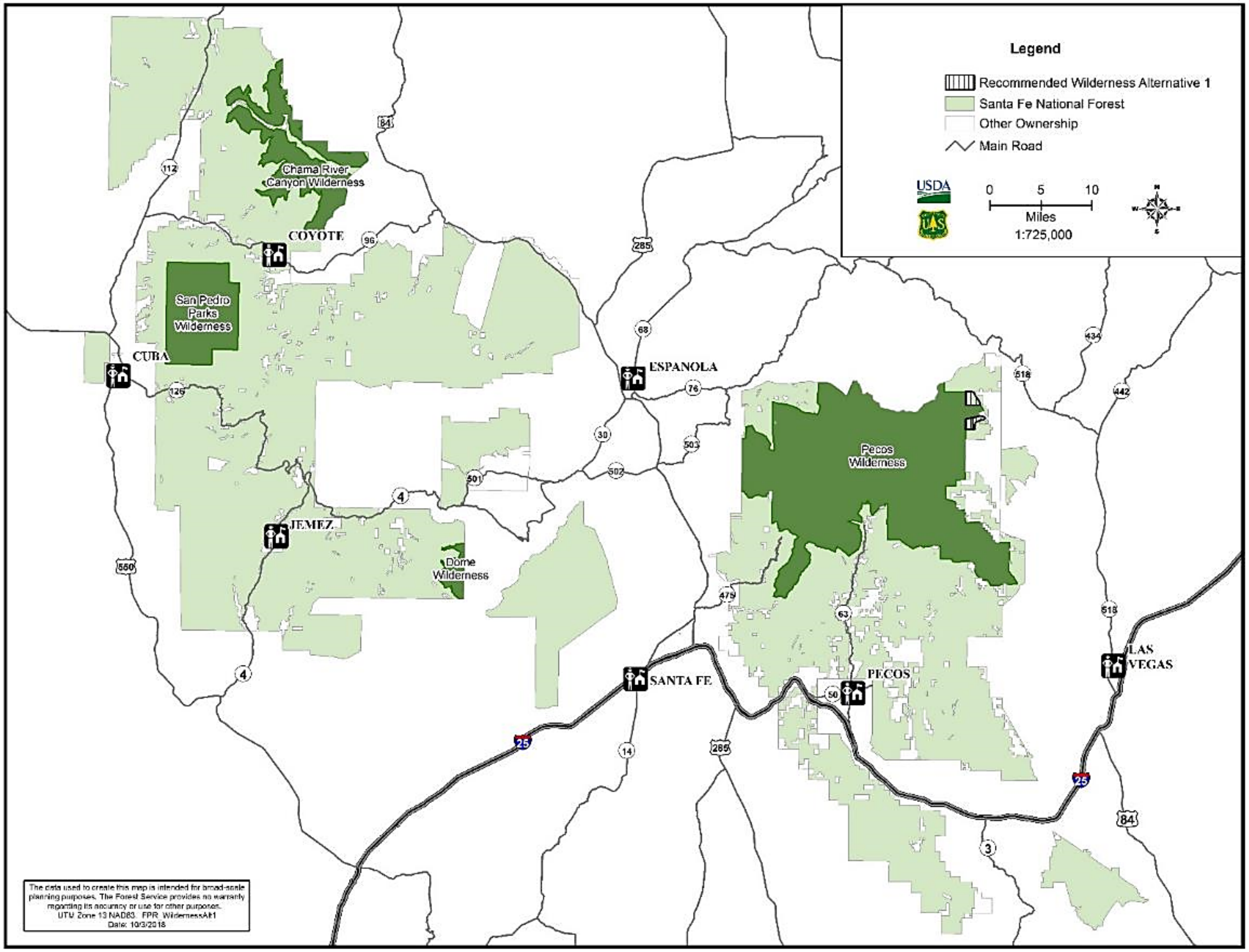

Figure 5. Recommended wilderness in the Santa Fe NF, alternative 1

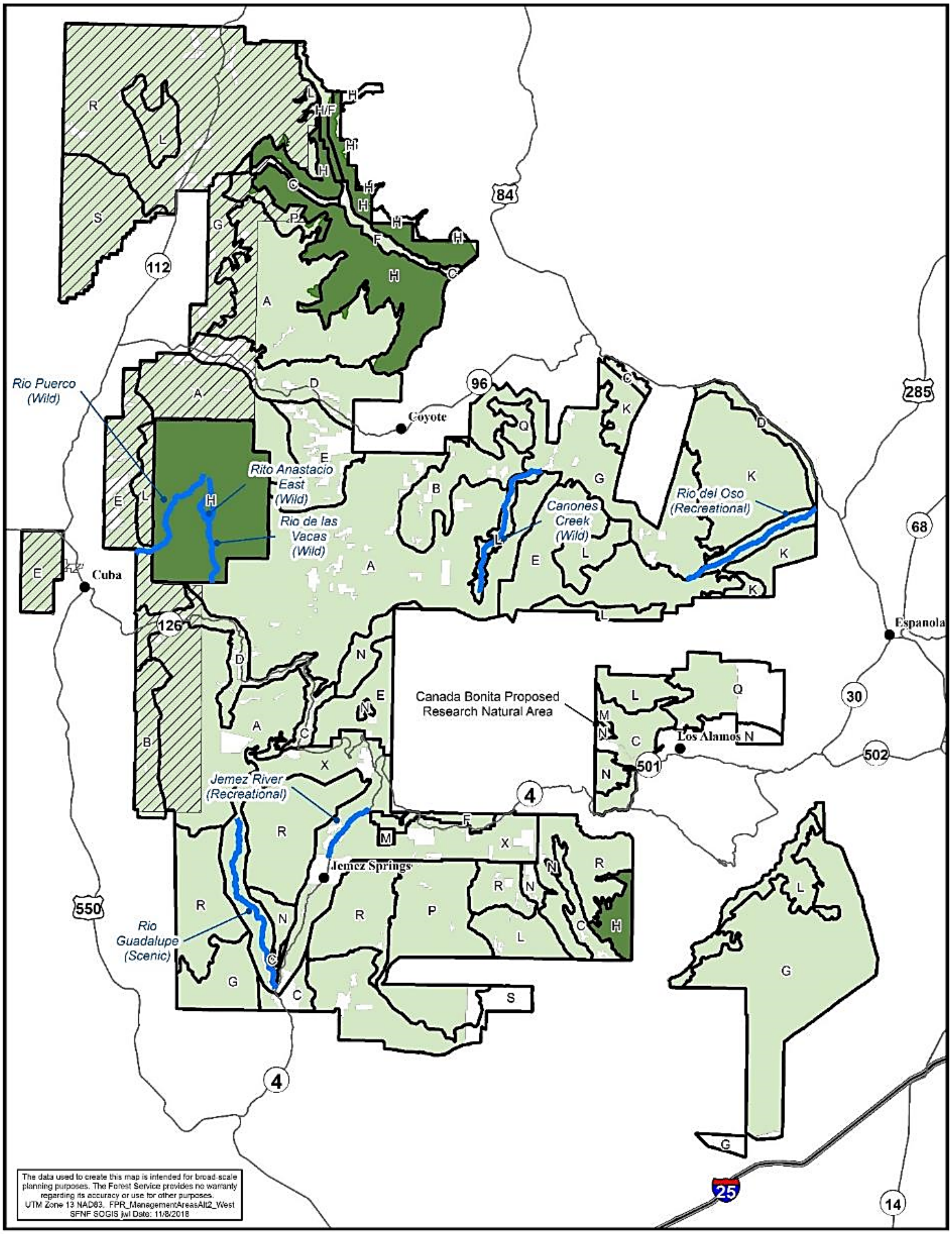

Figure 6-west. Alternative 1 management areas for the western half of the Santa Fe NF, from Cuba to Española. For legend see figure 6-east.

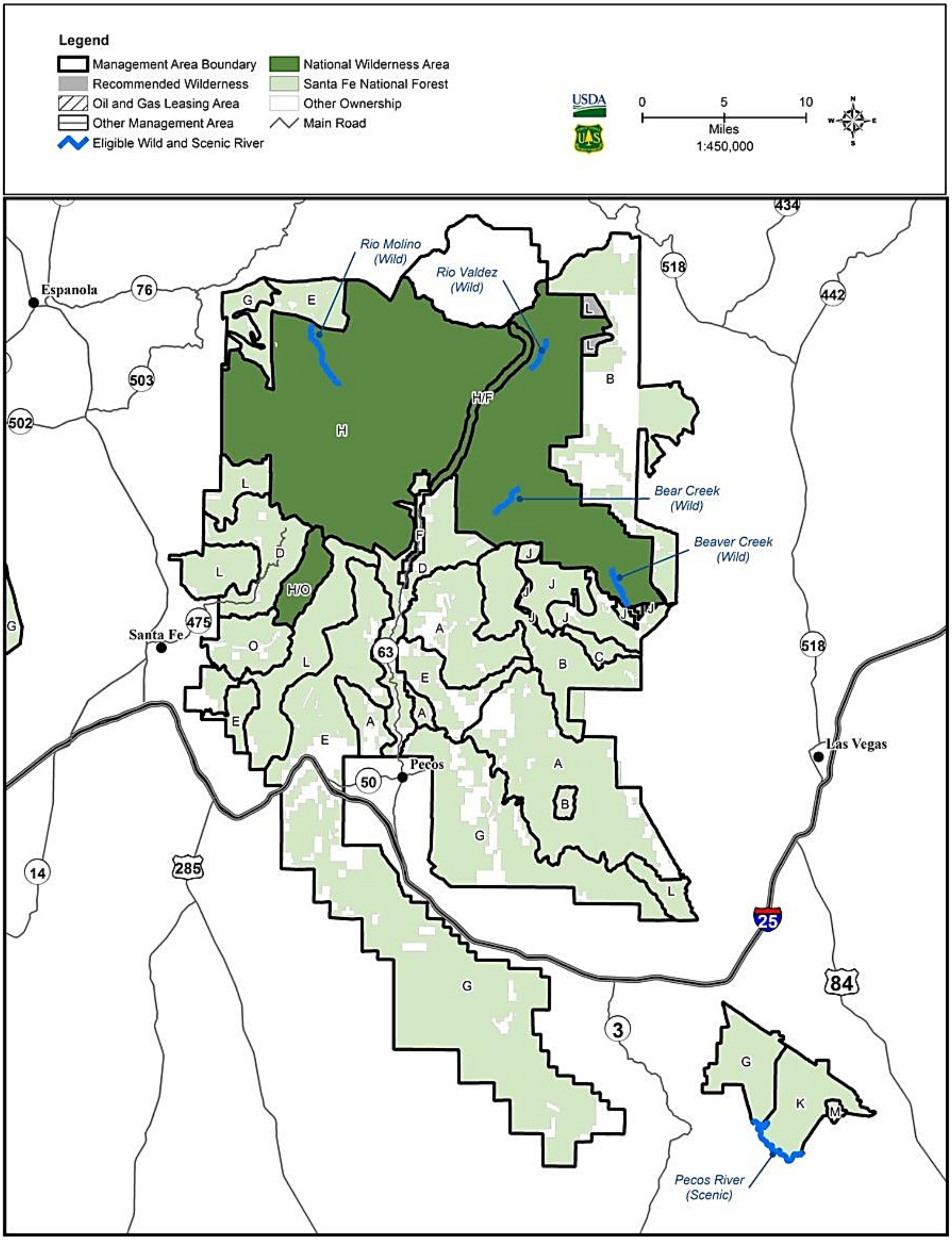

Figure 6-east. Alternative 1 management areas for the eastern half of the Santa Fe NF, from Española to Las Vegas

2.2.4 Alternative 2 – The Proposed Action

Alternative 2 is the proposed action outlined in the forest Plan and focuses on healthy ecological function that supports multiple uses. The interdisciplinary team developed this alternative iteratively with the public to address the needs for change and issues identified in chapter 1. It is designed to address needs for restored forested and non-forested vegetation, incorporating natural wildfires, maintained or improved wildlife terrestrial and aquatic habitat, improved riparian management zones, watershed health, improved rangeland forage and infrastructure, sustainable recreation, and desires for recommended wilderness and other special areas. This alternative maintains current levels of use while improving infrastructure and increasing the level of restoring ecological health. Alternative 2 is the environmentally-preferred alternative because it is expected to improve ecological conditions across the forest in the long term.

There are many plan components in alternatives 2, 3, and 4 where the majority of the language is similar across two or all three alternatives. Therefore, parts of plan components that change between the three action alternatives are in **bold**, to better highlight the differences.

2.2.4.1 Issue A: Restore vegetation resilience

The proposed action, alternative 2, uses a mix of mechanical treatments and wildfire, both prescribed and naturally ignited, to move toward vegetative desired conditions. Objectives are for a 10-year period and include acre ranges specified for mechanical treatments and fire by forested and non-forested vegetation types as follows:

Vegetation ERU	Mechanical Treatment (acres)	Prescribed Fire and Naturally Ignited Wildfire (acres)
Mixed conifer with frequent fire (MCD)	**10,000–80,000**	**50,000–200,000**
Ponderosa pine (PPF)	**15,000–100,000**	**150,000–250,000**
Non-forested*	**2,500–50,000**	**3,800–50,000**

* Juniper grass (JUG), piñon-juniper grass (PJG), Colorado Plateau Great Basin grassland (CPGB), and sagebrush shrubland (SAGE)

In addition, guidelines promote naturally ignited wildfires:

- Naturally occurring fires should be allowed to perform their natural ecological role to meet multiple resource objectives and facilitate progress toward desired conditions.
- Wildfire (naturally ignited fire) should only be suppressed when outside the natural range of variability or where necessary to protect life, investments, and valuable resources.

Improved vegetation leads to improved terrestrial wildlife habitat and connectivity. This integration is recognized with the following objective for terrestrial wildlife habitat improvement:

- Restore or enhance at least **50,000** acres of terrestrial wildlife habitat during each 10-year period of the life of the plan. This may be done in conjunction with objectives for treatments in the vegetation section.

The following standard and guideline also promote wildlife connectivity:

- New or reconstructed fencing must allow for wildlife passage, except where specifically intended to exclude wildlife (such as elk exclosure fence) or to protect human health and safety, while maintaining its effectiveness for livestock management.

- Infrastructure (e.g., fences, roads) should be designed, modified, or removed to minimize impacts on wildlife movement and improve habitat connectivity.

Beyond treatments to restore forested vegetation, the proposed action also emphasizes restoring composition and structure in riparian vegetation, and improving aquatic habitat. Objectives include:

- Within the riparian management zone, move toward desired conditions for vegetation types that are outside of or trending away from their natural range of variability by restoring the composition and structure of 15 miles of stream every 10 years. Actions that could improve riparian areas would be site-specific, but could include several of the following: removing invasive plant species, stabilizing stream channels, planting native species, promoting natural revegetation of bare ground, and redirecting other uses (e.g., providing other watering sources, closing areas to camping).
- Complete aquatic restoration on priority projects that restore 30 miles of aquatic habitat (e.g., increasing pool quantity, providing stream cover, removing or installing fish barriers, restoring beaver populations, and treating invasive aquatic species, etc.) every 10 years to benefit aquatic species.
- Every 10 years restore native fish species to 20 miles of streams where nonnative fish are absent and where natural or human-made fish barriers exist.

2.2.4.2 Issue B: Deliver provisioning ecosystem services

Alternative 2 has a series of objectives to move watersheds toward desired conditions. Work would focus on maintaining functioning watersheds and improving impaired or functioning-at-risk watersheds. Treatments to restore forested vegetation as described in issue A would improve watershed condition. In addition, in this alternative there is an emphasis on maintaining or decommissioning roads and treating invasive species. Objectives include:

- Maintain “properly functioning” and improve at least **two** “impaired” or “functioning at-risk” watersheds (Watershed Classification Framework) every 10 years using the objectives from Vegetation ERUs, Aquatic Species, Water Resources, and Riparian Management Zones and Wetland Ecosystems.
- Over 10 years, improve watershed function by **decommissioning or mitigating impacts (e.g., maintenance, improvements, reroutes) on at least 100 miles of route** (e.g., system roads, unauthorized routes, trails) to the point of restoring hydrologic and ecological function.
- Eradicate or suppress invasive plant species on at least **600** acres annually.

In addition, guidelines ensure that roads are not added to the system.

- Decommissioning of roads at the project level should be based on resource needs.
- Temporary roads that support ecosystem restoration activities, fuels management, or other short-term projects should be closed and rehabilitated (restored to more natural vegetative conditions) upon project completion to protect watershed condition, minimize wildlife disturbance, and prevent illegal motorized use.

Finally, a guideline ensures that the byproduct from forest thinning is treated in a way to protect soils:

- Burn pile composition should contain a mixture of fuel sizes. Large woody fuels, over 8.9 inches in diameter, should be limited to less than 40 percent of the composition of the pile to prevent adverse impacts to the soil.

2.2.4.3 Issue C: Support traditional and cultural ways of life

Although the majority of plan direction associated with this issue is common to alternatives 2, 3, and 4; motorized access to the forest for traditional uses may vary across alternatives based on direction for roads as discussed in issue B. The option to mitigate road impacts (resurfacing) instead of decommissioning them can help maintain motorized access for traditional and cultural uses while maintaining many areas that can only be accessed through non-motorized means can be less obtrusive and allow for more privacy.

Alternative 2 is focused on maintaining the current level of livestock grazing in the forest while improving conditions of the range resource. Objectives for vegetation activities in forested and non-forested vegetation types described in issue A would increase grass and forb abundance, providing increased forage for livestock grazing. Alternative 2 also provides an objective for improving the range infrastructure:

- Annually **remove, improve or reconstruct at least 5 percent** of the forest's range infrastructure that is no longer necessary or in poor or non-functional condition.

A guideline also improves the ability to manage livestock on the allotments, especially in light of temporary impacts from vegetation work in issue A.

- Vacant or understocked allotments should be made available to permitted livestock for pasture during times or events when other active allotments are unavailable and require ecosystem recovery as a result of natural disturbances (e.g., wildfire) or management activities (e.g., vegetation restoration treatments).

2.2.4.4 Issue D: Address sustainable recreation

This alternative includes a mix of developed and dispersed recreation similar to what currently occurs in the forest. Alternative 2 would improve maintenance of recreation infrastructure that exists in the forest. Objectives for maintaining infrastructure, such as developed recreation sites and trails, would contribute toward sustainable recreation by better meeting the needs of visitors and reducing ecological damage. Increasing recreation infrastructure would be unlikely under this alternative.

Objectives addressing recreation infrastructure include

- At **two** developed recreation sites, accomplish at least **75 percent of deferred maintenance projects** every 3 years.
- Maintain (clear, repair tread, brush, or improve drainage) at least **25** percent of system trails every 3 years.
- Verify and correct proper signage and cartographic accuracy for at least **25** percent of system trails every 3 years.
- Undertake sustainably designed capital improvements (such as alteration, expansion, or new construction) on at least **1** mile of poorly designed or maintained trail every 3 years. The mile may be contiguous or non-contiguous.

Areas receiving significant dispersed use, especially camping, would be managed to reduce adverse impacts through a guideline that addresses managing adverse impacts from dispersed camping sites. This guideline states that:

- Dispersed camping sites should be **closed, rehabilitated, or otherwise mitigated** when:
  - ♦ site conditions are no longer consistent with the area's scenic integrity objective,
  - ♦ there are persistent user conflicts, or
  - ♦ unacceptable environmental damage is occurring (e.g., large areas of denuded vegetation, eroded streambanks, piles of campfire ash, human waste impacting natural water features).

2.2.4.5 Issue E: Consider new wilderness protected areas and management areas

This alternative includes five polygons of recommended wilderness (figure 7) totaling 25,868 acres. These recommended wilderness areas exhibit high wilderness characteristics, no untenable management trade-offs, support from stakeholders, and enhance existing wilderness areas. The Grace Tract area is the same as alternative 1. The Enchanted Lakes area differs from alternative 1 with the eastern half (427 acres) eliminated because it has lower wilderness characteristics and the polygon extended south (480 acres) to take advantage of land acquired since the 1987 Forest Plan. Three additional polygons are added in alternative 2: Thompson Peak borders the existing Pecos Wilderness, Dark Canyon is north of the existing Rio Chama Canyon Wilderness and adjacent to a BLM Wilderness Study Area, and White Rock Canyon is across the Rio Grande from existing wilderness in Bandelier National Park.

Two additional management areas are proposed (figure 8-west and figure 8-east). The Caja del Rio Wildlife and Cultural Interpretive Area lies west of the city of Santa Fe and east of White Canyon recommended wilderness area. This area has important value for its areas of cultural significance, wildlife habitat along the Rio Grande that provides for wildlife connectivity, and relative remote recreation opportunities. Plan direction aims to preserve these characteristics by creating interpretive materials and limiting future development.

The Forest Plan also includes four cultural interpretive management areas: Nogales Cliff House, Rattlesnake Ridge, Tsipinuouinge, and Poshuouinge (figure 8-west and figure 8-east). These sites already receive visitation and management direction is designed to help manage this recreational use, while protecting the cultural sites.

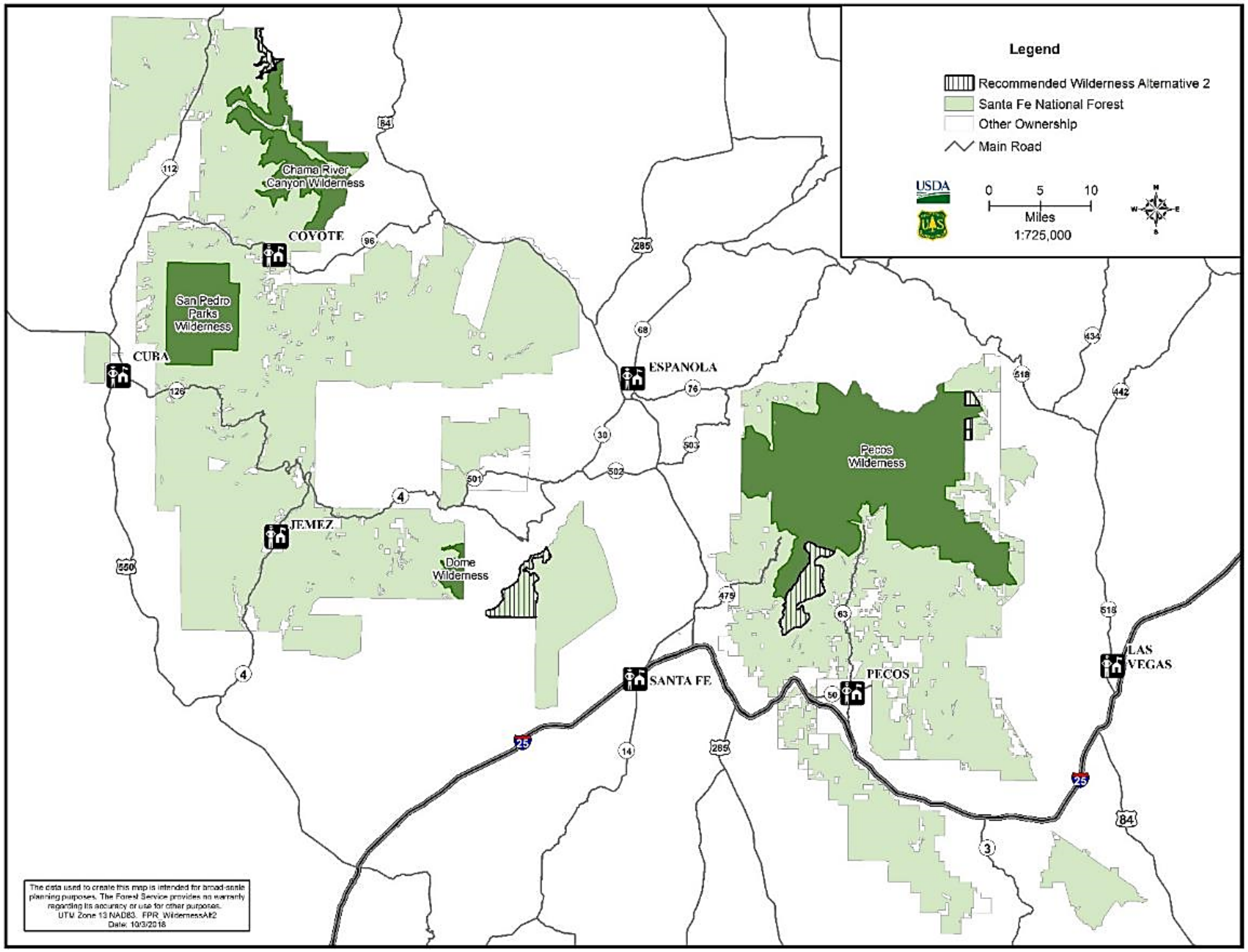

Figure 7. Recommended wilderness in the Santa Fe NF, alternative 2

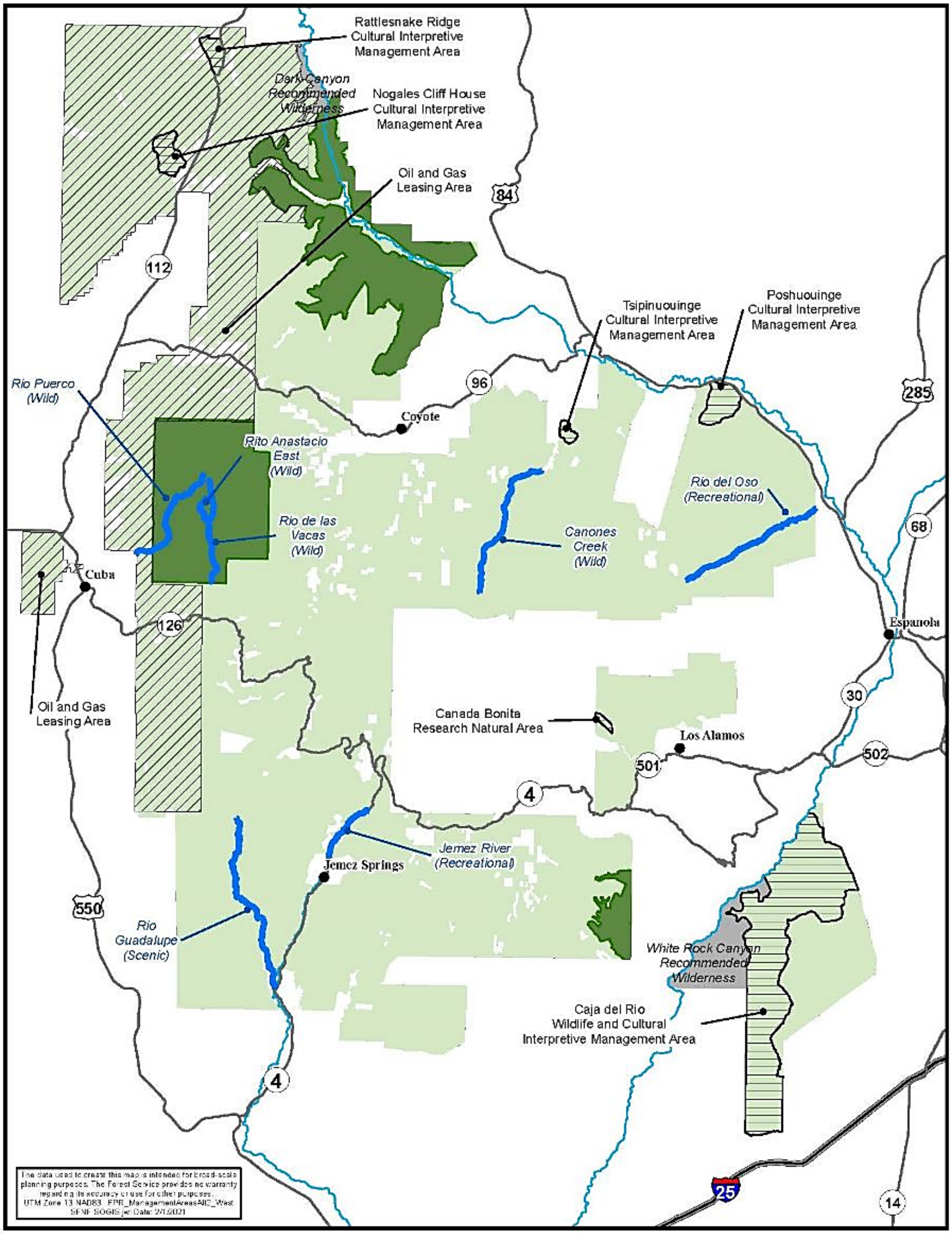

Figure 8-west. Alternative 2 management areas for the western half of the Santa Fe NF, from Cuba to Española. For legend see figure 8-east.

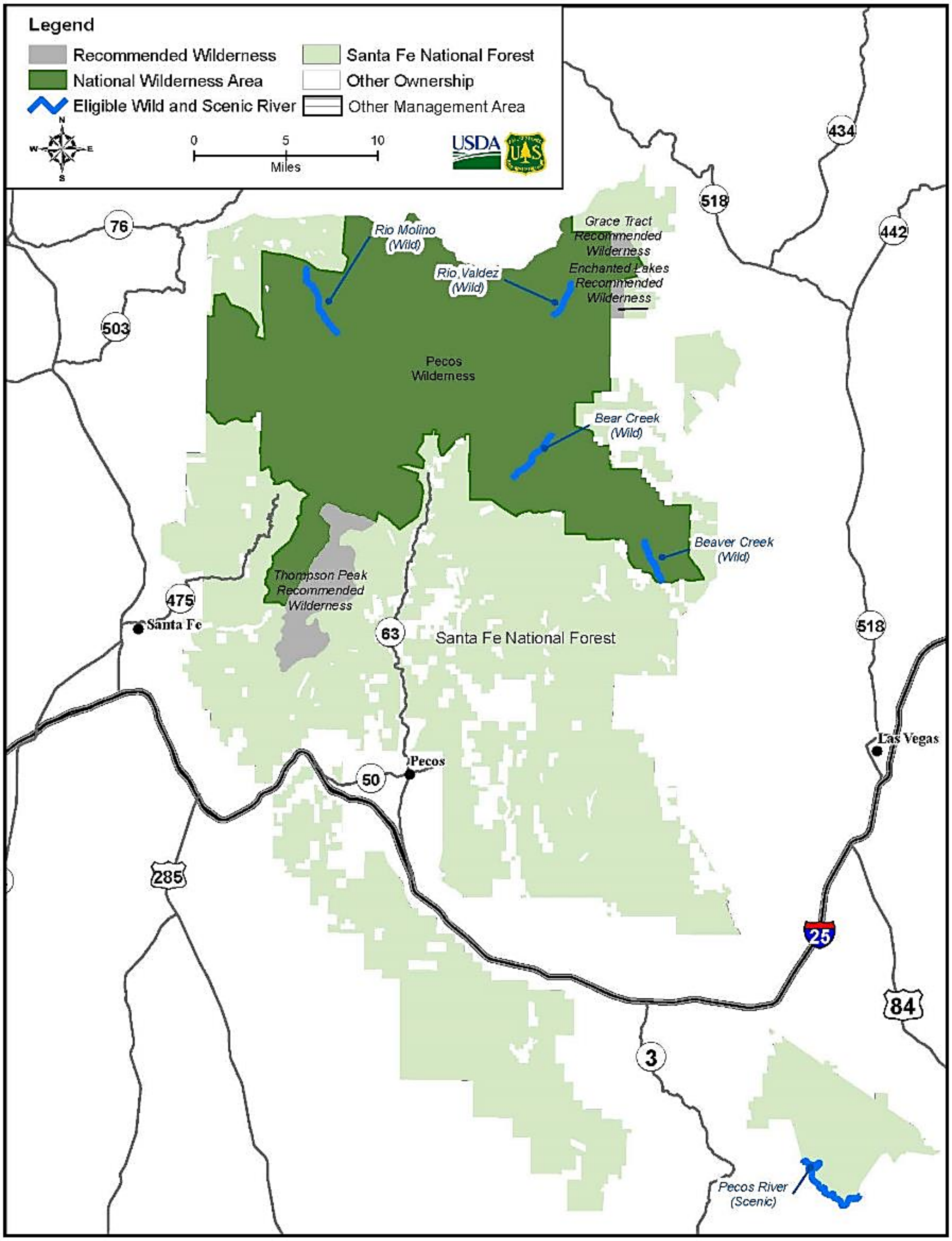

Figure 8-east. Alternative 2 management areas for the eastern half of the Santa Fe NF, from Española to Las Vegas

2.2.5 Alternative 3 – Natural Processes Emphasis

Alternative 3 responds to public comments that forest management should emphasize natural processes. This alternative has an emphasis on natural processes. This includes heavier reliance on fire to move vegetation toward desired conditions, incorporating natural wildfires (i.e., lightning start); and improving wildlife terrestrial habitat, aquatic habitat, riparian management zones, and watershed health. This alternative also includes reductions in amenities or infrastructure (e.g., range infrastructure, trail signage, roads) for human uses, such as recreation and livestock grazing, although it does not actually limit those uses.

2.2.5.1 Issue A: Watershed and vegetation restorations

Alternative 3 predominantly uses prescribed fire and naturally ignited wildfires to move toward vegetative desired conditions. It also increases the acres treated, aiming to meet the low and mid-fire frequency return intervals for vegetation types that are not meeting desired conditions. Mechanical treatments would only be used in limited situations to prepare locations to facilitate fire such as for containment line preparation, to protect structures and facilities within and adjacent to the project area, cultural sites, and in areas that can provide fuelwood for local communities.

Objectives are for a 10-year period and include acre ranges specified for mechanical treatments and fire by forested and non-forested vegetation types as follows:

Vegetation ERU	Mechanical Treatment (acres)	Prescribed Fire and Naturally Ignited Wildfire (acres)
Mixed conifer with frequent fire (MCD)	**20,000**	**100,000–800,000**
Ponderosa pine (PPF)	**22,000**	**250,000–900,000**
Non-forested*	**400**	**75,000–170,000**

* Juniper grass (JUG), piñon-juniper grass (PJG), Colorado Plateau Great Basin grassland (CPGB), and sagebrush shrubland (SAGE)

Similar to alternative 2, this alternative includes the guideline promoting allowing naturally ignited wildfires to burn. However, the guideline that directs suppressing naturally ignited fire in certain situations (when outside the natural range of variability or where necessary to protect life, investments, and valuable resources) is removed as it does not meet the alternative theme of promoting natural processes.

An additional guideline, unique to this alternative, emphasizes that mechanical treatments should only be used for limited purposes.

- Mechanical treatments should only be used in limited situations to prepare locations to facilitate fire such as for containment line preparation, to protect structures and facilities within and adjacent to the project area, cultural sites, and in areas that can provide fuelwood for local communities.

Increased objectives for vegetation restoration should lead to improved vegetation and terrestrial wildlife habitat and connectivity. The objective for improved wildlife habitat is doubled to reflect this increased habitat restoration.

- Restore or enhance at least **100,000** acres of terrestrial wildlife habitat during each 10-year period of the life of the plan. This may be done in conjunction with objectives for treatments in the vegetation section.

Alternative 3 includes the same guideline to promote wildlife connectivity as is found in alternative 2. However, the standard differs from alternative 2, because the portion of this standard that concerns livestock fences is removed to further promote connectivity and because livestock grazing is not a natural process.

- New or reconstructed fencing must allow for wildlife passage, except where specifically intended to exclude wildlife (such as elk exclosure fence) or to protect human health and safety. **Removed "while maintaining its effectiveness for livestock management"**

Alternative 3 also doubles objectives for restoring composition and structure in riparian vegetation and improving aquatic habitat.

- Within the riparian management zone, move toward desired conditions for vegetation types that are outside of or trending away from their natural range of variability by restoring the composition and structure of **30** miles of stream every 10 years. Actions that could improve riparian areas would be site-specific, but could include several of the following: removing invasive plant species, stabilizing stream channels, planting native species, promoting natural revegetation of bare ground, and redirecting other uses (e.g., providing other watering sources or closing areas to camping).
- Complete aquatic restoration on priority projects that restore **60** miles of aquatic habitat (e.g., increasing pool quantity, providing stream cover, removing or installing fish barriers, restoring beaver populations, treating invasive aquatic species, etc.) every 10 years to benefit aquatic species.
- Every 10 years restore native fish species to **40** miles of streams where nonnative fish are absent and where natural or human-made fish barriers exist.

2.2.5.2 Issue B: Deliver provisioning ecosystem services

Emphasizing a return to natural processes, this alternative also seeks to accelerate restoration of watersheds. Objectives to move watersheds toward desired conditions are more than doubled in this alternative. In addition, because roads are not part of natural processes, the objective doubles the amount of road decommissioning and removes the option to mitigate impacts and leave the road open. Finally, this alternative halves the acres of invasive plant species treatments. Although invasive plants are not part of natural processes, treating them with herbicides was more out of alignment with the theme of this alternative than their presence on the landscape.

- Maintain "properly functioning" and improve at least **five** "impaired" or "functioning at-risk" watersheds (Watershed Classification Framework) every 10 years using the objectives from Vegetation ERUs, Aquatic Species, Water Resources, and Riparian Management Zones and Wetland Ecosystems.
- Over 10 years, improve watershed function by **decommissioning 250 miles** of route (system roads, unauthorized routes, and trails) to the point of restoring hydrologic and ecological function.
- Eradicate or suppress invasive plant species on at least **300** acres annually.

Alternative 3 includes the same guidelines to ensure that roads are not added to the system that are in alternative 2, but also includes a guideline to further reduce roads throughout the forest.

- **Construction of permanent or temporary roads should be avoided unless authorized and necessary to achieve a valid permitted activity or for a management action that would**

help meet ecological desired conditions. Roads should be constructed and maintained at the lowest maintenance level needed for their intended purpose. Maintenance and reconstruction should be allowed on existing roads and trails.

The guideline in alternative 2 that ensures that the byproduct from mechanical treatments is treated in a way to protect soils is also in alternative 3, although any mechanical treatments byproduct would be minimal.

2.2.5.3 Issue C: Support traditional and cultural ways of life

Motorized access could be reduced under this alternative because of direction to reduce roads as discussed in issue B. The level of road decommissioning in this alternative would reduce motorized access for traditional and cultural uses. However, with a decrease in motorized access also comes an increase in non-motorized, which could increase privacy and confidentiality for cultural activities.

Objectives for increasing acres of vegetation activities in forested and non-forested vegetation types as described in issue A would also increase grass and forb abundance, providing more forage for livestock grazing than alternative 2. However, since range infrastructure is not part of natural processes, alternative 3 includes some direction that eliminates range infrastructure and could limit the capacity in the forest through reductions in permits. This alternative does not include any language on the number of cattle that could be allowed under permits. The objective is modified to only include removing range infrastructure, and does not include improving or reconstructing the infrastructure in the alternative.

- Annually **remove at least 5 percent** of the forest's range infrastructure that is no longer necessary.

The guideline regarding vacant and understock allotments is also modified in a way that could decrease permitted grazing numbers in this alternative.

- Vacant or understocked allotments should **not** be made available for permitted livestock grazing. **Permits waived without preference should be left vacant and not restocked, when there is limited interest.**

2.2.5.4 Issue D: Address sustainable recreation

Alternative 3 emphasizes minimizing recreation infrastructure, especially if it is causing ecological damages, to promote proper functioning of natural processes and ecological health. Developed site maintenance would be limited to reducing the direct environmental effects caused by the sites. This could eventually lead to site closure in some cases. Objectives in alternative 2 that increase maintenance and infrastructure for trails are omitted in this alternative. The only recreation objective is:

- **Mitigate ecological damages occurring at two developed recreation sites every three years. This could include, but is not limited to, revegetating riparian areas close to or within developed recreation sites, closing sites temporarily, adding measures that protect wildlife (e.g., bear-safe garbage cans, bear-safe storage containers for campers, screening pipe openings to prevent wildlife entrapment), relocating sites to accomplish other restoration objectives (riparian), and, possibly limiting expansion or use of sites.**

This alternative would trend more to dispersed recreation use over time, as the absence of developed sites for recreation would be more in line with an emphasis on natural processes. The guideline for addressing resource impacts from dispersed camping is modified from alternative 2 so that areas receiving significant impacts from dispersed camping would be closed and rehabilitated. The option to mitigate these damages is eliminated from this alternative.

- Dispersed camping sites should be closed and rehabilitated when:
  - ♦ site conditions are no longer consistent with the area's scenic integrity objective,
  - ♦ there are persistent user conflicts, or
  - ♦ unacceptable environmental damage is occurring (e.g., large areas of denuded vegetation, eroded streambanks, piles of campfire ash, human waste impacting natural water features).

2.2.5.5 Issue E: Consider new wilderness, protected areas, and management areas

Alternative 3 includes 42 polygons of recommended wilderness (figure 9) totaling 270,130 acres. These recommended wilderness areas exhibit the highest wilderness characteristics or have at least some wilderness characteristics and are currently managed as roadless areas (IRAs). This is the largest amount of recommended wilderness proposed of all alternatives, representing almost 17.5 percent of the forest, and meets public desires for large increases in wilderness areas. Since allowing natural processes to be a driver is an emphasis in wilderness areas, this increase is in line with the theme of alternative 3. This level of wilderness also improves wildlife connectivity, which is discussed in issue A.

Alternative 3 would also include the Caja Del Rio Management Area (figure 10-west), because its management emphasizes more wild and natural processes and uses that don't impede those natural processes. The footprint of this management area is smaller in alternative 3 than in alternative 2, because a larger portion of it is in the recommended wilderness management areas that border the Rio Grande. Alternative 3 would not include the cultural interpretive management areas, because interpretive trails go against the natural process emphasis of this alternative.

The Wetland Jewels Management Areas (figure 10-east) are included in alternative 3. These 12 drainages across the Santa Fe NF contain wetland complexes that provide ecological functions important for terrestrial and aquatic habitat. The desired condition would be for the protection of these key ecosystems providing resiliency with a changing climate. These areas would serve as the pillar of watershed health to ensure watershed protection and resilience across the forest.

This alternative also includes the Calaveras Management Area (figure 10-west), which seeks to preserve some of the last undisturbed ponderosa pine and mixed conifer systems in the forest. This old growth provides important habitat for many species in the forest, including several listed species (Mexican spotted owl, New Mexico meadow jumping mouse, and Jemez Mountain salamander). These habitat conditions are unique in the forest and make it vital to manage to prevent loss.

In alternative 3, the Holy Ghost Canyon Management Area (figure 10-east) is a drainage in the Pecos River Watershed in the southern Sangre de Christo Mountains. The Holy Ghost ipomopsis, a federally listed endangered plant, is endemic to this canyon. In addition, the canyon hosts several recreation opportunities, including a campground, trail to access the nearby Pecos Wilderness, and recreation residences. Minimizing the impacts of recreation to allow for the persistence and possible expansion of this endangered species fits the emphasis on natural processes in this alternative.

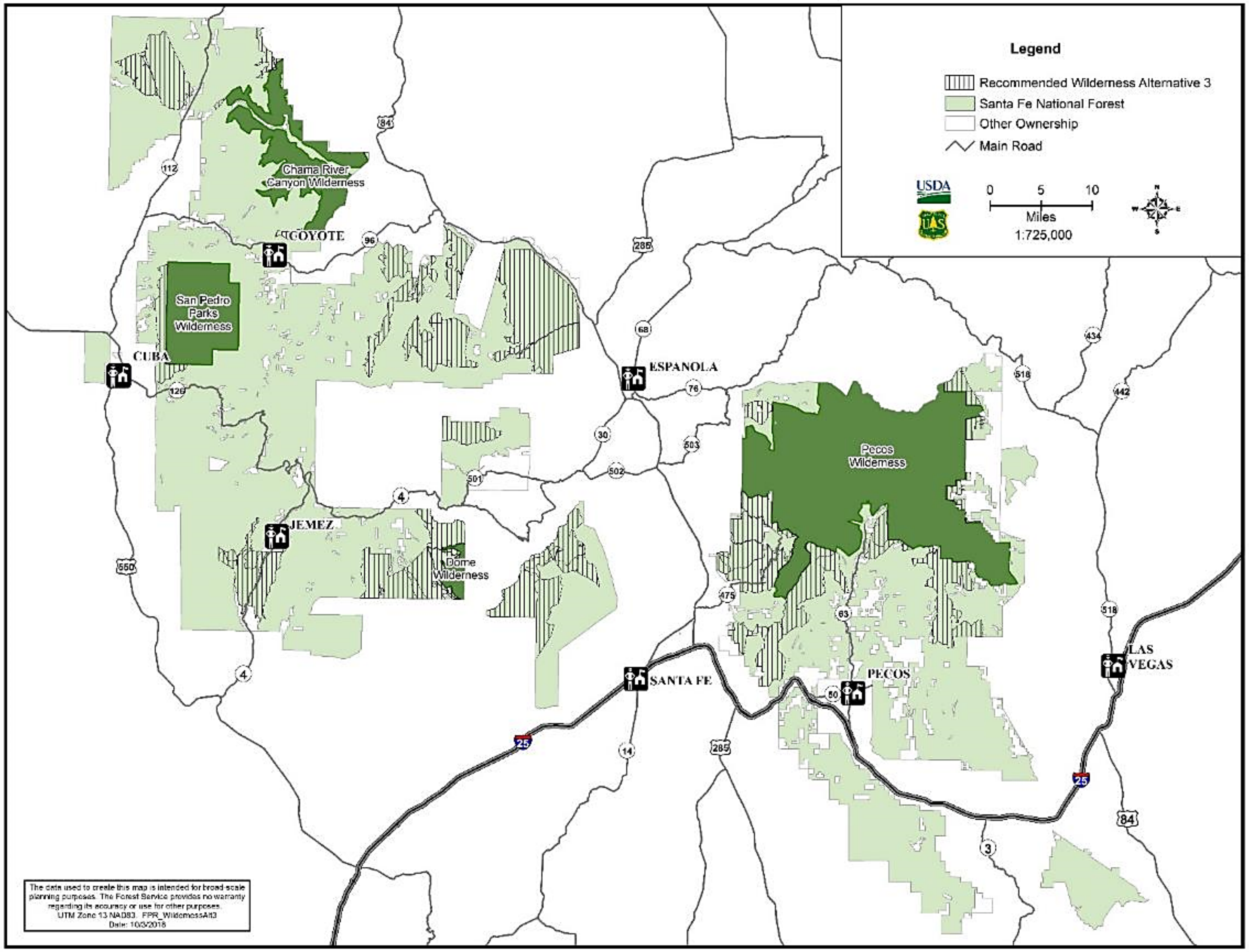

Figure 9. Recommended wilderness in the Santa Fe NF, alternative 3

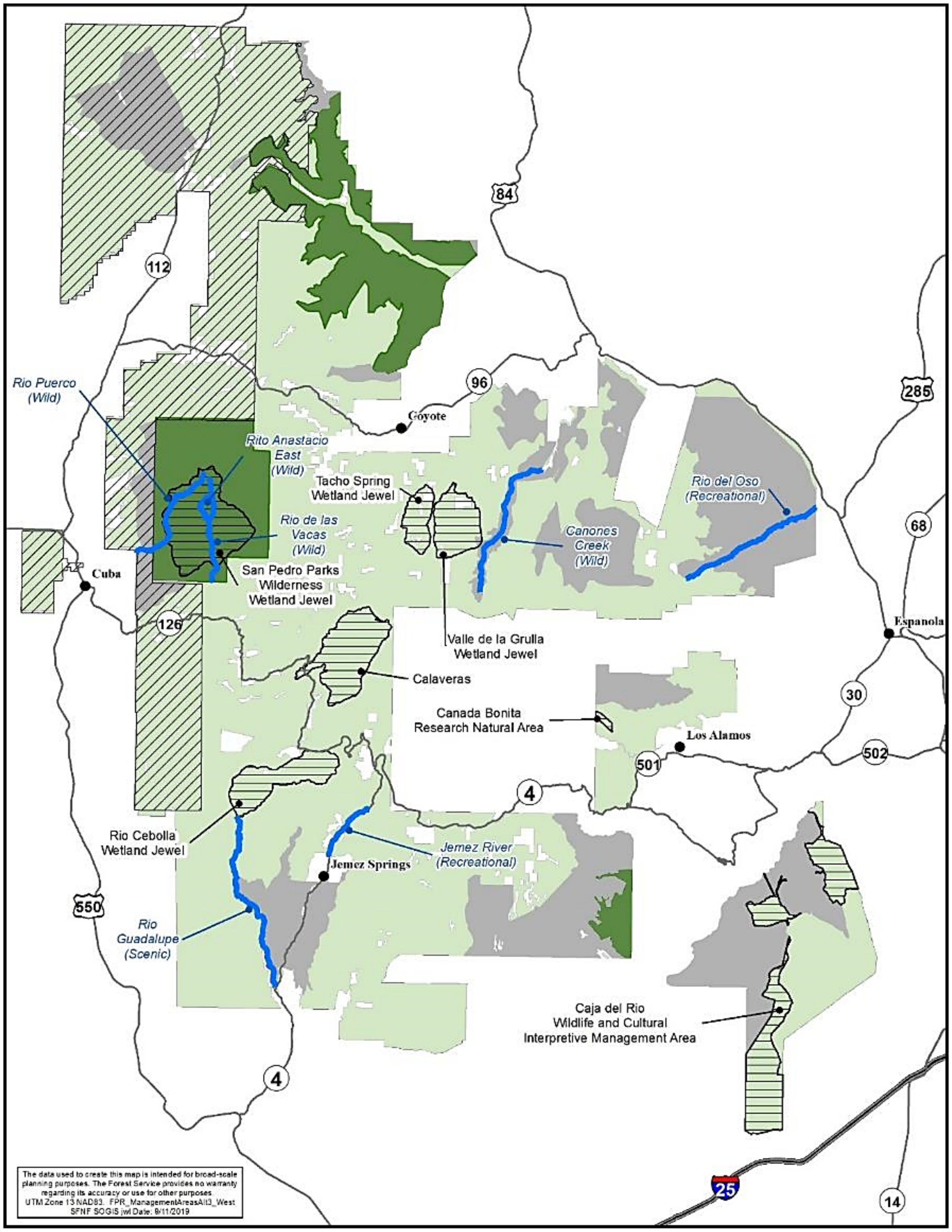

Figure 10-west. Alternative 3 management areas for the western half of the Santa Fe NF, from Cuba to Española. For legend see figure 10-east.

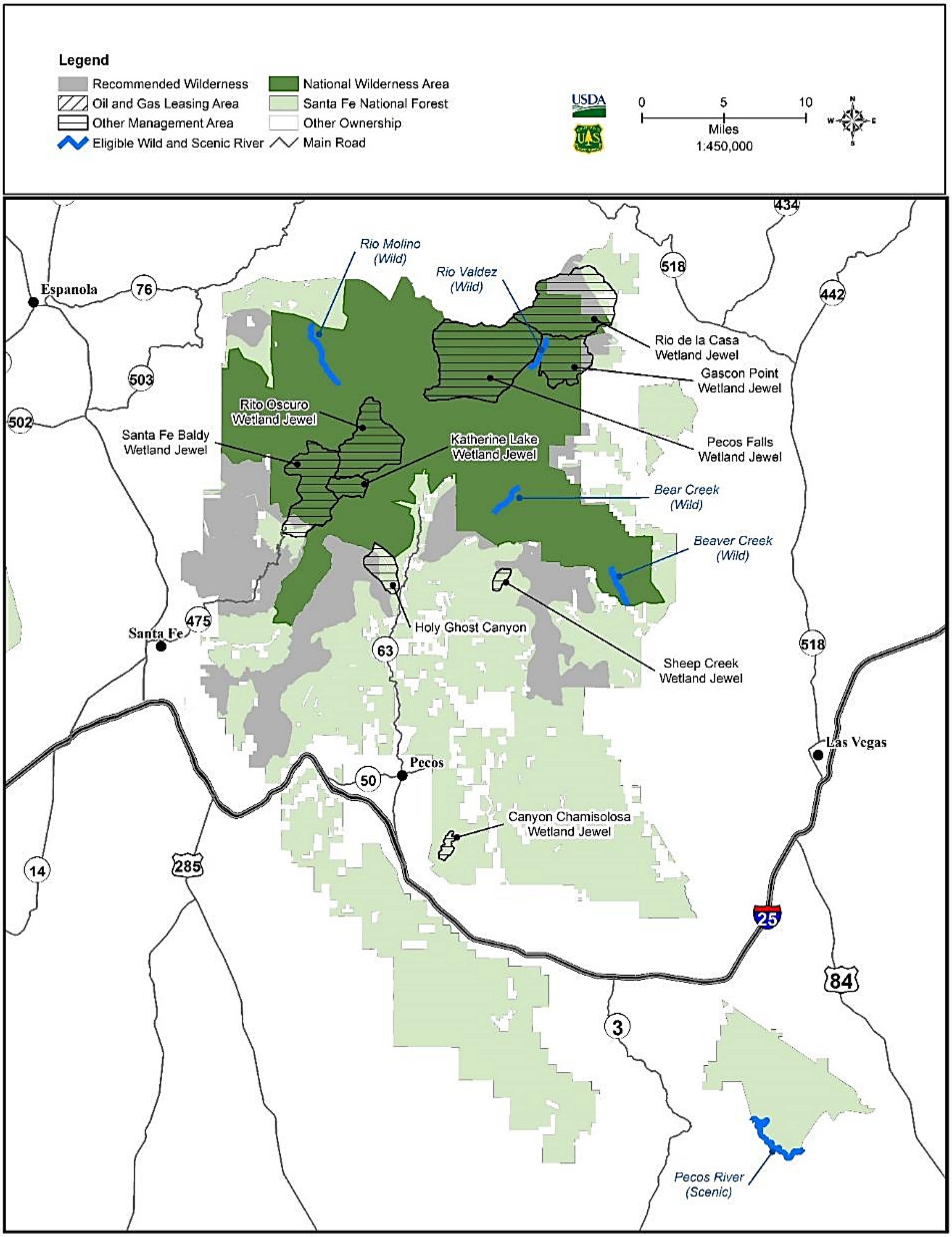

Figure 10-east. Alternative 3 management areas in the eastern half of the Santa Fe NF, from Española to Las Vegas

2.2.6 Alternative 4 - Human Uses Emphasis

Alternative 4 responds to public comments that forest management should emphasize the multiple uses that occur across the forest. This includes heavier reliance on mechanical treatments to move vegetation toward desired conditions, and increased amenities or infrastructure (e.g., roads, range infrastructure, trail signage, and developed campsites) for human uses.

2.2.6.1 Issue A: Watershed and vegetation restorations

Alternative 4 emphasizes utilization of forest products by using mechanical treatments over fire to move toward vegetative desired conditions. This addresses public comments that expressed concerns about smoke, effects to air quality, and escaped wildfires. It also addresses desires for increased use of woody materials in the forest. Only limited amounts of fire would be used from natural ignitions and handling products that cannot otherwise be used.

Objectives are for a 10-year period and include acre ranges specified for mechanical treatments and fire by forested and non-forested vegetation types as follows:

Vegetation ERU	Mechanical Treatment (acres)	Prescribed Fire and Naturally Ignited Wildfire (acres)
Mixed conifer with frequent fire (MCD)	100,000–300,000	25,000
Ponderosa pine (PPF)	80,000–230,000	23,000
Non-forested*	75,000–170,000	12,400

* Juniper grass (JUG), piñon-juniper grass (PJG), Colorado Plateau Great Basin grassland (CPGB), and sagebrush shrubland (SAGE)

The guideline promoting naturally ignited fires to burn is removed from this alternative. The guideline that directs suppressing naturally ignited fires is modified to emphasize fire suppression and reduce fire consumption of fuels so that they can be sold or used.

- Wildfire (naturally ignited fire) should **[removed "only"]** be suppressed when outside the natural range of variability or where necessary to protect life, investments, and valuable resources.

An additional guideline, unique to this alternative, is included to further limit fire:

- **Activity fuels, or byproducts of mechanical treatments and harvests should not be handled through prescribed fire, but should be handled through other means (e.g., chip and grind (mastication), lop and scatter, off-forest removal).**

As in the other alternatives, objectives for vegetation restoration would lead to improved wildlife terrestrial and wildlife habitat and connectivity. However, improved wildlife habitat does not go with the theme of this alternative and the objective is removed.

The standard that directs that fencing must allow for wildlife passage is deleted from this alternative. The guideline about infrastructure effects on wildlife connectivity is modified to delete "removing the infrastructure" as an option to promote wildlife connectivity. In this alternative, this sort of infrastructure is important to emphasizing human uses, and therefore, removing it is not in line with the alternative theme.

- Infrastructure (e.g., fences, roads) should be designed or modified **(deleted "removed")** to minimize impact on wildlife movement and improve habitat connectivity.

The objective in alternative 4 for improving riparian areas and aquatic habitat focuses on invasive plants. People are attracted to the waterways in the forest, and with increased visitation comes increased spread of weeds. Therefore, this alternative emphasizes that specific risk with invasive species management objectives:

- **Control (initial suppression and maintenance) invasive plant species on at least two stream reaches every year, with an objective of 10 miles treated every 10 years to prevent the regrowth, establishment, or spread of treated or other invasive species. Invasive species include nonnative (e.g., nonnative, invasive) species that could disrupt ecological function, cause economic or environmental harm, or harm human, animal, or plant health.**

2.2.6.2 Issue B: Deliver provisioning ecosystem services

The emphasis in alternative 4 is on increasing human uses more than restoring watershed health, so the objective for watershed improvement is removed. Human uses are accommodated through maintaining routes instead of decommissioning them. As discussed in issue A, increased use is likely to lead to increased spread of weeds, so in this alternative the objective for weed treatment has more than double the acres than in alternative 2.

- Over 10 years, improve watershed function by **maintaining** 100 miles of route (e.g., system roads, trails) to the point of restoring hydrologic and ecological function.
- Eradicate or suppress invasive plant species on at least **1,500** acres annually.

Contrary to alternatives 2 and 3, this alternative eliminates the guideline that emphasizes road decommissioning and instead includes guidelines that promote adding roads to the system.

- **When an area is highly used and inaccessible by motorized means, but important for multiple uses (range, forestry, traditional uses, recreation), existing routes to accommodate this use should be added to the MVUM.**
- **Temporary roads should be considered for inclusion into the system to support multiple-use activities and access to the forest as an alternative for decommissioning.**

Since fire is not emphasized in this alternative, the guideline that limits burn pile size to protect soils is removed.

2.2.6.3 Issue C: Support traditional and cultural ways of life

Current motorized access across the forest would increase because direction to decommission roads is replaced with maintaining roads and possibly expanding the road system. This would increase motorized access for traditional and cultural uses but also decrease non-motorized access.

As with alternatives 2 and 3, alternative 4 includes objectives for restoration activities that would improve grass and forb production. An emphasis is placed on maintaining existing range infrastructure. Improved forage condition and infrastructure necessary for managing livestock could allow for increased levels of livestock grazing over the course of the plan although this alternative does not include any language on the number of cattle that would be allowed under permits.

- Annually **improve or reconstruct** at least 5 percent of the forest's range infrastructure that is in poor or non-functional condition.

The guideline regarding vacant or understocked allotments is also modified in a way that could increase permitted grazing numbers in this alternative.

- Vacant or understocked allotments should be made available for permitted livestock grazing. **(Removed restrictions of when this should be considered)**

2.2.6.4 Issue D: Address sustainable recreation

Alternative 4 increases maintenance of recreation infrastructure and offer the possibility of accommodating more use. Objectives for maintaining developed recreation sites and trails are doubled or almost doubled. The increased maintenance should provide increased user satisfaction with the recreation opportunities and limit the need to close or rehabilitate sites that are contributing to the degradation of other resources. Plan components would include:

- At **4** developed recreation sites, accomplish at least 75 percent of deferred maintenance projects every 3 years.
- Maintain (e.g., clear, repair tread, brush, and improve drainage) at least **40** percent of system trails every 3 years.
- Verify and correct proper signage and cartographic accuracy for at least **40** percent of system trails every 3 years.
- Undertake sustainably designed capital improvements (e.g., alteration, expansion, or new construction) on at least **2** miles of poorly designed or maintained trail every 3 years. The miles may be contiguous or non-contiguous.

Developed recreation receives much of the emphasis in this alternative, but dispersed recreation would be managed to reduce environmental impacts in concentrated areas. This alternative also considers adding additional trails and expanding or creating new developed sites to meet user demands and in response to trends in recreation visitation to certain areas.

- Dispersed camping sites should **not be closed, but should be rehabilitated or otherwise mitigated** when:
  - ♦ site conditions are no longer consistent with the area’s scenic integrity objective,
  - ♦ there are persistent user conflicts, or
  - ♦ unacceptable environmental damage is occurring (e.g., large areas of denuded vegetation, eroded streambanks, piles of campfire ash, human waste impacting natural water features).
- **To prevent accumulation of deferred maintenance, all annual recreation site maintenance should be performed to ensure serviceability and repair failures during the year in which they occur.**
- **New trails should be constructed to increase system connectivity, accommodate recreation demand, and reduce user conflict.**
- **Existing developed recreation sites should be expanded or new sites should be added to the system when existing sites can no longer accommodate the volume of visitors or meet visitor desires for camping (e.g., group camping, car camping, etc.).**

2.2.6.5 Issue E: Consider new wilderness, protected areas, and management areas

Alternative 4 proposes no recommended wilderness from the evaluation process. In fact, this alternative analyzes recommending to Congress that 68 acres are removed from San Pedro Parks Wilderness (figure 11). This recommendation would help resolve conflicts between uses in the area that pre-date the Wilderness designation, specifically maintenance of an acequia and continuation of stocking fish in a reservoir to support popular and culturally important recreational fishing.

Several management areas promote different types of human use in alternative 4. The cultural interpretive management areas (figure 12-west) that are in alternative 2 are also in alternative 4 as they provide interpretive recreational opportunities to visit sites, which is a component of human use.

Two motorized recreation management areas (figure 12-east) would be considered in alternative 4. This management area is composed of two separate areas located in the Española and Jemez Ranger Districts. These areas already have an existing road network used by an assortment of motorized recreation visitors and plan direction promotes adding to create a motorized route network.

Three urban recreation management areas (figure 12-west and figure 12-east) consist of land west of Los Alamos and two areas east of Santa Fe. These areas have high recreation value because of their proximity to these cities and the variety of non-motorized recreation opportunities available. The emphasis in these management areas is to promote non-motorized forms of recreation and possibly increase the trail network. Vegetation would support natural levels of fire that do not have negative impacts on these recreation opportunities.

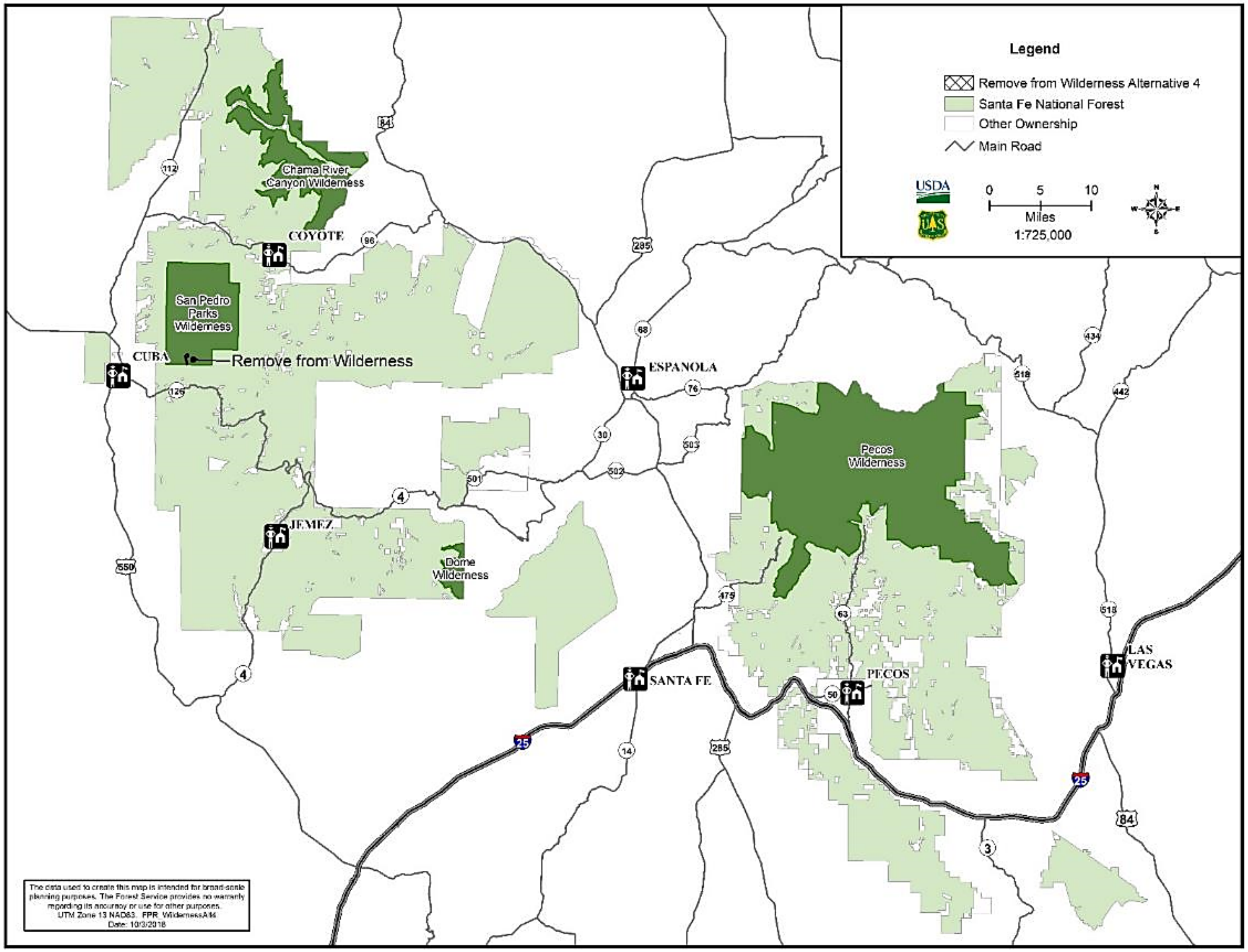

Figure 11. Recommended wilderness in the Santa Fe NF, alternative 4

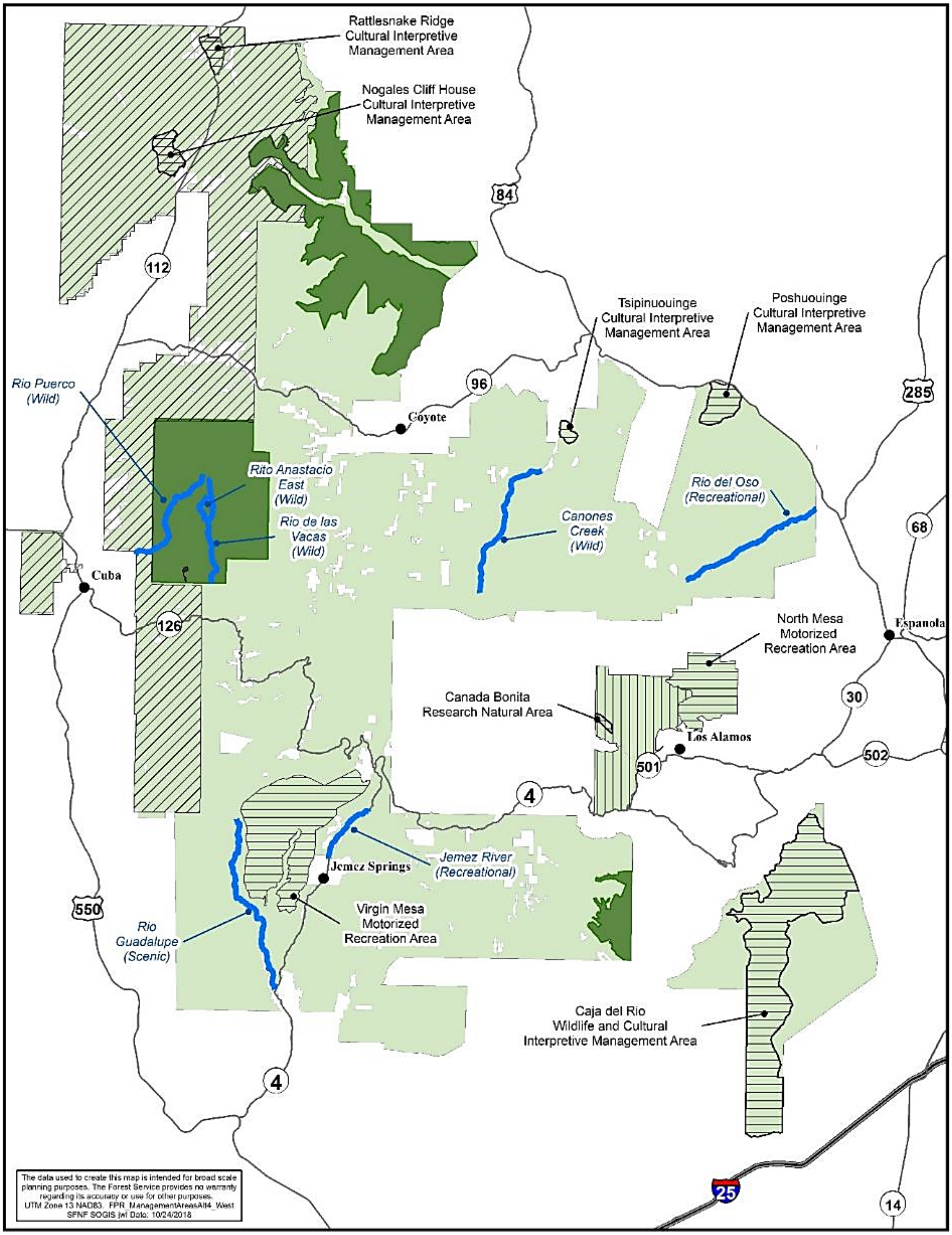

Figure 12-west. Alternative 4 management areas for the western half of the Santa Fe NF, from Cuba to Española. For legend see figure 12-east.

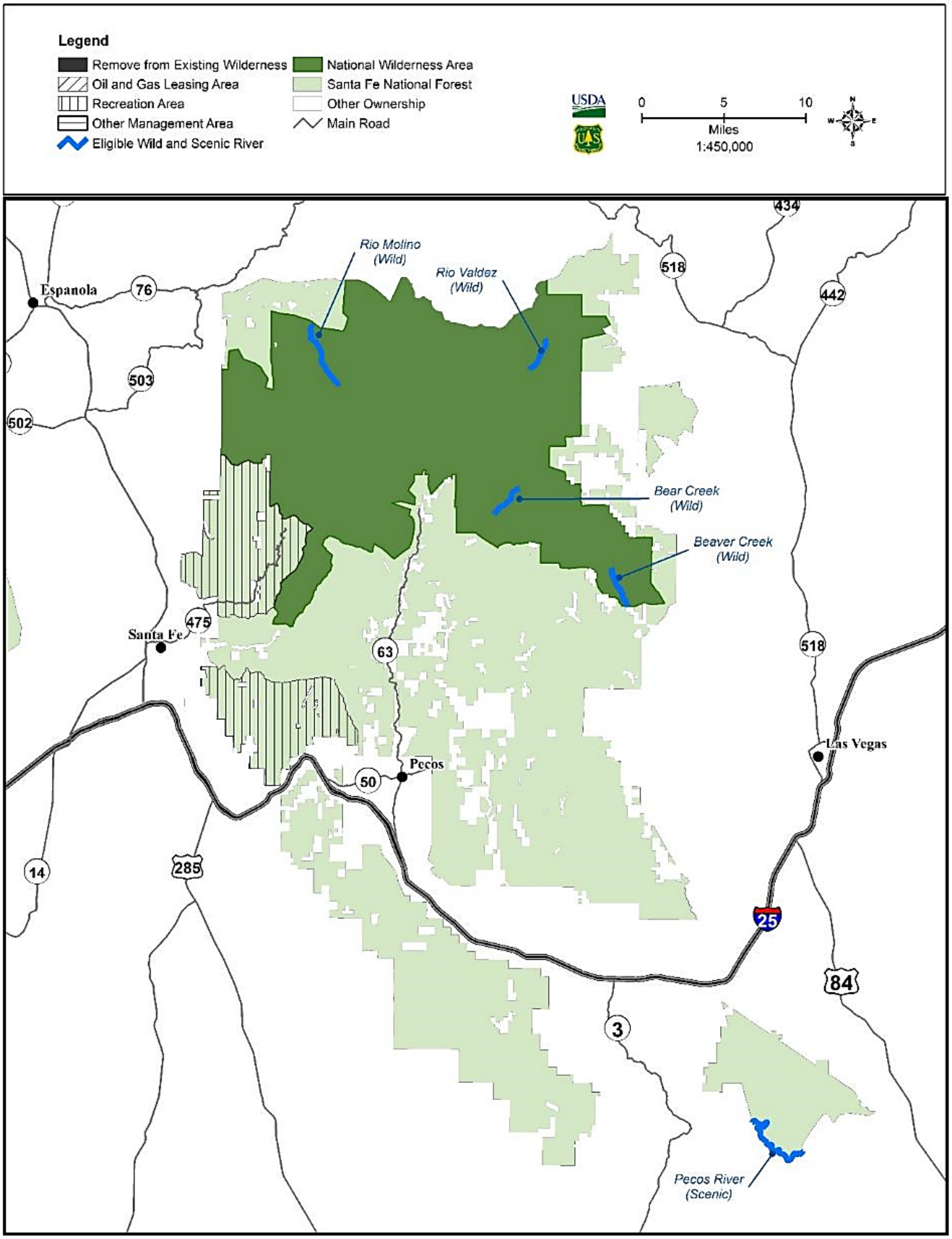

Figure 12-east. Alternative 4 management areas in the eastern half of the Santa Fe NF, from Española to Las Vegas

2.3 Alternatives Considered but Eliminated from Detailed Study

The NEPA requires Federal agencies to rigorously explore and objectively evaluate all 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 in response to the initial plan components and alternative themes in January and March 2017, provided suggestions for alternative methods for achieving the purpose and need. Some of these alternatives are outside the scope of revising the forest plan; already decided by higher law, regulation or policy; duplicative of the alternatives considered in detail, or determined to have components that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered but dismissed from detailed consideration for reasons summarized below

2.3.1 Alternatives with no or restricted livestock grazing

A no-grazing alternative would not meet legal direction that forests will be managed using multiple-use and sustained-yield principles per the National Forest Management Act and Multiple-Use Sustained-Yield Act. This alternative also would not allow the attainment of the desired condition for livestock grazing to contribute to the long-term socioeconomic diversity, stability, and cultural identity of local communities. Therefore, a no grazing alternative is inconsistent with existing laws, Forest Service policy and direction, as well as the purpose and need of revising the forest plan.

Under all alternatives the rangelands management and livestock grazing program has multiple mechanisms to evaluate, review, and adapt management as needed to effectively protect resources and respond to changing conditions. Stocking decisions regarding the amount of livestock grazing authorized for each grazing allotment are considered as part of project-level analysis (NEPA) and beyond the scope of this programmatic analysis for the forest plan. Project-level analysis would cover changes to authorized grazing through term grazing permits (subject to forestwide standards and guidelines); allotment management plans; and annual operating instructions. In addition, the alternatives include a range of options on how to deal with vacant and understocked allotments that could increase or decrease grazing numbers. Based on the above, a restricted grazing alternative is not considered necessary as well as not legally compliant.

2.3.2 Alternative to include as recommended wilderness either all lands in the wilderness inventory or all lands with any wilderness characteristics

We considered but did not include an alternative based on the comment to include all inventory areas as recommended wilderness. There is no requirement in the 2012 Planning Rule for all lands included in the inventory and subsequent evaluation to be carried forward in an alternative (FSH 1909.12, Ch 70.73). The planning rule requires that the responsible official shall identify which specific areas, or portions thereof, from the evaluation to carry forward as recommended wilderness in one or more alternatives to be analyzed for effects.

After completion of the inventory and the evaluation to determine what areas have wilderness characteristics, the responsible official selected only those areas that had high wilderness characteristics or were roadless areas with wilderness characteristics to be considered for analysis. These areas were then considered for how they best met the intent of each alternative.

Requests for new wilderness areas, such as those included in the Pecos Wilderness expansion, were submitted. These areas were considered in light of the evaluation and the themes of each alternative (appendix J). Alternatives 2 and 3 incorporate portions of these external proposals. Other portions were dismissed from detailed consideration because they did not meet any alternative's criteria for recommended wilderness.

2.3.3 Alternative to identify 1,000-foot-wide utility corridor management areas

We received a comment suggesting that we include utility corridor management areas that would be "linear areas approximately 1,000 feet wide to accommodate existing utility facilities and related access for maintenance and repair, and to accommodate co-location of new utilities." This alternative was considered but not analyzed in detail.

The forest pan has desired conditions that all utility infrastructure has minimal impact on natural resources. Authorizations of standardized and very large utility corridors are unlikely to meet these requirements for a large portion of the Santa Fe NF. Additionally, project- and site-specific needs for utility corridor widths are analyzed and determined as part of the permitting process.

2.3.4 Alternative that designates 20 percent of ecosystems as recommended wilderness areas

We received a comment suggesting that we include 20 percent of all ecosystems in the Santa Fe NF that are "underrepresented" (less than 20 percent) in all wilderness throughout the United States as potential recommended wilderness to "adequately protect ecosystem integrity and diversity."

This was considered as an alternative, but not analyzed in detail. Protecting ecosystem integrity and diversity is addressed through other plan components and we did not agree that recommendation as wilderness is always the best management tool for this protection. The plan components for all vegetation in the forest plan are designed to protect ecosystem integrity and diversity as required by the 2012 Planning Rule.

2.3.5 Alternative to incorporate the Southern Rockies Lynx management direction into the forest plan.

Comments suggested incorporating management direction from the Southern Rockies Lynx Amendment regarding lynx linkage areas into the forest plan.

Canada lynx is not typically found in the Santa Fe NF, since the forest naturally lacks the physical and biological features necessary to sustain a population (USDI Fish and Wildlife Service 2014). Resident lynx populations have never been documented on the Santa Fe NF (Frey and Yates 1996). In 1999, Canada lynx were reintroduced into southern Colorado, and on occasion an individual lynx may roam out of Colorado into the Santa Fe NF in New Mexico. As Canada lynx is not known to den or breed in the forest, lynx analysis units have not been established in the Santa Fe NF, and the U.S. Fish and Wildlife Service (USFWS) has not recommended the Forest Service do so. Since this species is a federally listed species, the Endangered Species Act requires consultation with the USFWS during the NEPA analysis process for any management activities that may affect lynx or its habitat.

2.3.6 A water focus alternative

Multiple commenters wanted a water alternative that focuses on watershed and acequia protection or watershed management areas. An additional comment requested management areas prioritized for water protection be called "Wetland Jewels."

While we did not outline a specific, single water alternative in this forest plan revision process, the protection of watershed resources and maintaining acequias is written into all alternatives. We incorporated the Wetland Jewels in alternative 3, because they are consistent with the emphasis on natural processes.

2.3.7 A wildlife movement and connectivity focus alternative

One comment letter requested a greater focus on wildlife movement and connectivity. In particular, the commenter identified the Caja del Rio plateau as an area that was important for wildlife connectivity.

While a specific, single wildlife connectivity alternative was not outlined in this forest plan revision process, the draft forest plan and alternatives provide for a range of wildlife connectivity. The specific plan components in the Forest Plan that address wildlife connectivity can be found in Appendix E, Section C. Varying amounts of the Caja del Rio plateau are considered as a cultural and wildlife interpretive area as part of the Forest Plan and range of alternatives.

2.3.8 A climate change and carbon sequestration focused alternative

Although none of the alternatives is specifically designated as a climate change alternative, all alternatives incorporated climate change into the resource analyses and pinpointed desired conditions and management objectives that increase the ecological resiliency of the Santa Fe NF to predicted changes in climate. For example, the vegetation management practices outlined under all alternatives are capable of reducing drought stress and the risk of uncharacteristic fire, both of which are consequences of changing temperature and precipitation regimes, combined with uncharacteristically dense and fuel-laden forests. Management to maximize carbon sequestration over other ecosystem services is not a goal of the Plan. As with climate change in general, the Plan manages for overall ecosystem function and resiliency, which implies inherent levels of carbon sequestration. The Forest Service is required to design new facilities that reduce energy usage to reduce greenhouse gas emissions. Management practices outlined in the Forest Plan are also designed to allow for the flexibility to address changing conditions over time.

2.3.9 A fifth alternative that focuses on balancing restoration and utilization

One commenter suggested that aspects of each of the alternatives could be reformulated into an alternative emphasizing the balance of restoration and utilization, while not expanding designated management areas. There was concern that the format of the four alternatives set up a dichotomy between values, and that the best alternative would be a combination of the four alternatives rather than any single alternative.

We believe that the concept of balancing ecological health, including using restoration, and utilization of the forest is the emphasis of alternative 2, which provides some combination of the four alternatives. Limited resources such as budget, personnel, time, and conflicting uses (e.g., wilderness and non-wilderness in the same area) would make it impossible to incorporate all the objectives from alternatives 2, 3, and 4 into a single alternative. The alternatives examine reasonable direction, given the issues raised during scoping and existing resources for the Santa Fe NF. In addition, anything analyzed within the range of alternatives can be included in the decision, which would allow for some mixing of alternatives for the final plan.

2.3.10 An alternative with a management area focus

At the technical public meeting on alternative themes and management areas (March 2017), there was a proposal to include an alternative that used management areas to identify different management focuses across the landscape. This alternative would mix guidance from alternatives 2, 3, and 4 for different areas across the landscape, emphasizing unique landscapes in the forest and that certain parcels need different guidance from others. The premise of this alternative was also based on giving land managers flexibility to choose different guidance based on each area's specific needs, uses, and risks.

The concept of dividing the forest into management areas, each with its own tailored plan direction, is part of the 1987 Forest Plan, and therefore, considered as part of alternative 1. The 1987 Forest Plan includes 20 management areas each with a management emphasis, such as water quality and yield or protection of cultural resources. In addition, each management area has its own set of plan components in addition to the forestwide plan components. The need to simplify management direction across the forest and the artificial boundaries imposed by these management areas was identified as part of the Needs for Change. In addition, plan direction for alternatives 2, 3, and 4 is written to allow for the flexibility to choose management actions (objectives) as they are appropriate to specific locations across the forest. In addition, project-specific NEPA analysis is used to determine which types of activities are appropriate in various locations in the forest. Therefore, the management area concept proposed here is redundant not only with alternative 1 (USDA Forest Service 2010), but also project-specific NEPA analysis.

2.3.11 An alternative focused on road decommissioning and restoration

During the 90-day public comment period on the Plan and FEIS, commenters expressed support for a fifth alternative that includes direction for higher rates and scales of road decommissioning and restoration than is detailed in any of the alternatives that were presented in the FEIS.

Road impacts and mitigations are analyzed under all alternatives. The alternatives examine reasonable direction given the issues raised during scoping and existing resources for the Santa Fe NF. The Forest's management is constrained by the Multiple-Use Sustained-Yield Act (MUSYA), which requires that we support the both the ecological and the socioeconomic uses of the forest. Access to the forest is an important aspect of such uses as recreation and traditional community uses (e.g., gathering fuelwood).

Any future transportation system changes would be covered under a separate NEPA analysis.

In addition, the 2012 Planning Rule provides direction that the planning process, plan components, and other plan content should be within the Agency's authority and the fiscal capability of the unit (§ 219.1(g)). Forest budgets (that affect expenditures and salaries) are distributed by an act of Congress and may fluctuate over the life of the management plan, but are not dictated by the management plan or alternatives. Road restoration, decommissioning, and maintenance are some of the most expensive work on the forest. This budgetary strain, in addition to limits on personnel, time, and access would make it unreasonable to increase road management objectives beyond those analyzed under alternative 3.

2.4 Comparison of Effects of Alternatives

This section provides a summary of the effects of implementing each alternative. Table 2 through table 5 display each resource's objectives as well as the effects for each resource's indicators for each alternative. Table 6 displays which management areas are present in each alternative. A full description of the effects for each resource by alternative can be found in chapter 3.

Table 2. Comparison of plan objectives for vegetation management and associated effects across four alternatives.

The magnitude of the effects each alternative has on species changes with the plan components of each alternative. Unless otherwise stated, time lines for effects are the life the plan (10 to 15 years). For each resource, the effects referred to are summarized in the "Related Effects" cell for each resource. For more details on effects, see chapter 3.

Indicators of Effects		Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Forested ERUs-Mixed Conifer Frequent Fire (MCD) and Ponderosa Pine Forest (PPF)					
Treatment objectives (avg. acres; see Appendix C, Table C-5)	MCD	3,257 mechanical 1,249 fire (prescribed and natural ignitions)	4,500 mechanical 12,500 fire (prescribed and natural ignitions)	2,000 mechanical, 45,000 fire (prescribed and natural ignitions)	12,500 mechanical 2,500 fire (prescribed and natural ignitions)
	PPF	3,461 mechanical, 1,671 fire (prescribed and natural ignitions)	5,750 mechanical 20,000 fire (prescribed and natural ignitions)	2,200 mechanical, 57,500 fire (prescribed and natural ignitions)	15,500 mechanical, 2,300 fire (prescribed and natural ignitions)
	Related Effects (Mechanical Treatment) -- *Beneficial*: reduce competition or remove diseased trees; provide local economic benefit; improve habitat conditions; reduce hazardous fuel loadings and uncharacteristic fire risk *Adverse:* soil compaction, soil disturbance and erosion; noise pollution; degraded water quality; introduction or spread of invasive species; reopen or develop roads, fragmenting landscapes.				
Fire		Least beneficial effects and most adverse effects. Least reduction of uncharacteristic fire.	2nd most beneficial effects. Most reduction in uncharacteristic fire	Most beneficial effects and 2nd most adverse effects. 2nd least reduction of uncharacteristic fire.	2nd least beneficial and least adverse effects. 2nd most reduction in uncharacteristic fire
		Related Effects (Fire Treatment)--*Beneficial*: Create habitat mosaics, vegetation diversity, habitat connectivity, and migration corridors; create growing space in the understory; create old-growth forest characteristics; reduces fuel loads and reinstates more natural fire regime, increasing wildland-urban interface (WUI) safety, and protecting infrastructures, habitat, and recreation opportunities. ***Adverse*:** Reduces air quality; if severe can negatively impacts soils, degrade water quality, and increase erosion. *Fire Too frequent*: Plants killed before they mature, or before sufficient seed set to ensure population recovery. *Fire Too infrequent*: Plants die without ever releasing their seeds; species composition shift to favor uncharacteristic combinations; biomass accumulates to uncharacteristic levels. *Uncharacteristic or Large, High-severity fire*: Complete canopy and ground cover removal, adversely affecting watersheds and water resources; degraded air and water quality; adverse human health impacts; increased erosion; excessive soil heating (leading to soil burn and hydrophobicity, and altering microbial or fungal colonies); interrupted nutrient cycling.			

Indicators of Effects		Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Forested ERUs-Mixed Conifer Frequent Fire (MCD) and Ponderosa Pine Forest (PPF)					
Seral State[4]		2nd least improvement toward appropriate seral state.	2nd greatest improvement toward appropriate seral state.	Least improvement toward appropriate seral state; most initial improvement.	Least improvement toward appropriate seral state.
		Related Effects--Densely stocked stands create understory conditions unsupportive of ground cover diversity and abundance, increase risk of uncharacteristic fire. *Appropriate seral state* restores stand structure, composition, and function to ERU's, increasing ecosystem resilience and increasing habitat diversity.			
Canopy & Ground Cover[2]		Least canopy improvement. Understory conditions remain impaired.	2nd greatest canopy improvement. Improves understory conditions	2nd least canopy improvement, but greatest initial improvements	Most canopy improvement, ground cover most adversely affected
		Related Effects -- *Canopy openness improvement to < 30%* aids understory plant communities important in restoring fire regimes; sustains forest compositions, structure, processes and functions; and increases quality and availability of forage**.** *Ground cover and understory improvement* prevents erosion, sustains site productivity, encourage natural processes (e.g., natural fire regimes), provides species diversity, and creates habitat.			
Old Growth & Associated Components	**No. Snags > 8" dbh/ acre**	MCD: Least improvement; PPF: 2nd least improvement	2nd most improvement	MCD: Most improvement PPF: Least improvement	MCD: 2nd least improvement PPF: Most improvement
	No. Snags > 18" dbh/ acre	MCD: 2nd least improvement PPF: Most improvement	MCD: 2nd most improvement PPF: Least improvement	MCD: Most improvement PPF: 2nd most improvement	MCD and PPF: Least improvement
	Tons of CWD/acre	Least improvement	2nd most improvement	Most improvement	2nd least improvement
	Acres contributing to old growth forest	MCD: Highest PPF: 2nd Lowest	MCD: 2nd lowest PPF: 2nd highest	MCD and PPF: Lowest	MCD: 2nd highest PPF: Highest
	Related Effects—*Snags* create habitat diversity, structural complexity, habitat for at-risk species*. Coarse woody debris (CWD)* protects against erosion and mechanical disturbances, protects seedlings from livestock and sun damage, provides habitat, supports hydrologic function, interrupts air flow, can increase severity of soil heating during fire. *Old growth components* in stands contribute to structural diversity, increase the heterogeneity of landscapes, and provide refugia for threatened or endangered species.				

[4] After 50 years

Non-Forested ERUs-Juniper Grasslands (JUG), Piñon-Juniper Grasslands (PJG), Sagebrush Shrublands (SAGE), Colorado Plateau/Great Basin Grassland (CPGB), Montane Subalpine Grassland (MSG)					
Indicators of Effects		**Alternative 1 (1987 Forest Plan)**	**Alternative 2 (Forest Plan)**	**Alternative 3**	**Alternative 4**
Vegetation treatment objectives (avg. acres)	**JUG, PJG, CPGB, MSG, SAGE**	313 mechanical, 553 fire	2,475 mechanical, 4,725 fire	15 mechanical, 12,750 fire	9,000 mechanical, 800 fire
	GAMB, PJO, PJS	228 mechanical, 982 fire	no objectives	no objectives	no objectives
	Related Effects--Reestablish ground cover diversity of native species, reduce erosion potential, maintain or improve water quality, boost site potential, and promote the return of natural fire regimes, reduce tree encroachment, improve grassland structure, and promote grazing.				
Seral State (JUG & PJG)[5]		Least improvement	2nd most improvement	2nd least improvement	Most improvement
		Related Effects--Without *improvement toward* historic disturbances, natural seral state shifts often lead to tree encroachment on grasslands, which alters species compositions, increases canopy cover, and changes grass and forb productivity**.**			
Canopy and Ground Cover		Least canopy and ground cover improvement	2nd least canopy improvement, most ground over improvement overall	2nd greatest canopy improvement. Most ground cover improvement absent severe fire	Most canopy improvement, 2nd least ground cover improvement
		Related Effects—*Grassland canopy openness improvement to < 10%* aids understory and ground cover plant communities important in restoring fire regimes; sustains forest compositions, structure, processes, and functions; and increases quality and availability of forage. *Ground cover improvement* prevents erosion, sustains site productivity, encourage natural processes (e.g., natural fire regimes), provides species diversity, and creates habitat.			
Old Growth & Associated Components		Least improvement	Most improvement	3rd most improvement	2nd most improvement.
		Related Effects-See Forested ERUs			

[5] After 50 years

Table 3. Comparison of effects to wildlife, fish, and plants species in the forest among four alternatives.

The magnitude of the effects each alternative has on species changes with the plan components of each alternative. Unless otherwise stated, time lines for effects are the life the plan (10 to 15 years).

Indicators of Effects		Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Habitat Ratings 3 = best, 2 = moderate, 1 =worst	**Habitat Availability**	No Change			
	Habitat Quality	AT, JUG, MCW, PJO, PJS, PJG, SFF : 2 + MSG, SAGE: 1.5 CPGB, MCD, PPF: 1 RIP: 1	CPGB, JUG, MCD, MSG, PPF, PJG, SAGE: 2+ RIP: 2	CPGB: 2 MSG, SAGE: 2.5 JUG, PJG: 3 MCD, PPF: 1 RIP: 2	same as 1-- Negative effects of human use negates habitat; quality gains
		Related Effects—*Availability* of habitat increases species' resiliency, decreases impacts of long-term population fluctuations, enhances movement. *Quality habitat* meets life-cycle, food, and breeding needs, without which species populations may decline.			
Wildlife Habitat Connectivity 2 = best, 1 = moderate, 0 = poor (see Section 3.5.2.3)		0.33—2nd least improvement in connectivity	1.67--2nd most improvement in connectivity	2.0—Most improvement in connectivity	0.16--Least improvement in connectivity
		Related Effects--Manmade features (facilities/infrastructure, roads, fencing, utilities/rights-or-way) may decrease connectivity, which can decrease species viability. *In-reference vegetative conditions* improve wildlife connectivity.			
At-Risk Wildlife-Summary		Some species may see minimal gains, uncertain if all will persist	Thoroughly addresses primary issues and threats - expected to increase species' viability	Addresses issues and threats-may have negative impacts to some species due to fire (alternative 3) or increased human activity (alternative 4)	Some species may see minimal gains, uncertain if all will persist
At-Risk Wildlife – Issues with Degraded Ecological Conditions	**Highly Departed Seral State-Upland**	Most departed - will not increase species' viability	Most in-reference -- increase species' viability	2nd most in-reference -- increase species' viability but introduce risks (fire)	2nd most departed -- increase species viability but introduce risks (mechanical)
		Related Effects--*Departed*: At-risk species' needs for nesting, denning, foraging, open ground or canopies for germination would not be met--may lead to population declines. *In-Reference*: increased likelihood of plant species finding favorable growing conditions; decrease fuel load and threat of fire that could eliminate species from the landscape; decrease invasive encroachment.			

<table>
<tr><th colspan="2">Indicators of Effects</th><th>Alternative 1 (1987 Forest Plan)</th><th>Alternative 2 (Forest Plan)</th><th>Alternative 3</th><th>Alternative 4</th></tr>
<tr><td rowspan="2">At-Risk Wildlife – Issues with Degraded Ecological Conditions (continued)</td><td rowspan="2">Highly Departed Seral State-Riparian</td><td>Least improvement</td><td>2nd most improvement</td><td>Most improvement</td><td>2nd least improvement</td></tr>
<tr><td colspan="4">Related Effects—Departed: species unable to forage, find protect cover, or move about their habitat as needed to increase species’ viability; negatively impact soil and water characteristics (may cause declines in aquatic species). Improvement toward in-reference species can forage, find cover, or move about as needed.</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Highly Departed CWD</td><td>Least improvement</td><td>2nd most improvement</td><td>Most improvement</td><td>2nd least improvement</td></tr>
<tr><td colspan="4">Related Effects--Undersupply may result in lack of prey items or foraging areas; excess may create unfavorable soil conditions; Improvement toward in-reference conditions provides cover and foraging areas and needed soil and water characteristics; decrease uncharacteristic fire.</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Highly Departed Snag Density</td><td>No negative impacts, but no density maintenance</td><td colspan="3">Ensure species’ viability with density maintenance direction</td></tr>
<tr><td colspan="4">Related Effects—With appropriate snags densities bird species can find appropriate nesting and foraging sites, increasing viability.</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Uncharacteristic Fire</td><td>Not likely to decrease related effects</td><td>Most likely to decrease related effects</td><td colspan="2">2nd most likely to decrease related effects—increase fire effects (alternative 3) or mechanical and human activity effects (alternative 4)</td></tr>
<tr><td colspan="4">Related Effects – Soil conditions (pH, moisture level, nutrients) negatively impacted, subsequently decrease the viability of at-risk species within those soils.</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Invasive Vegetation Encroachment</td><td>Least reduction</td><td>2nd highest reduction</td><td>2nd least reduction</td><td>Greatest reduction</td></tr>
<tr><td colspan="4">Related Effects—Reduced encroachment: Native vegetation required for nesting and foraging is not be diminished or replaced by invasive plant communities; at-risk plant communities do not have to compete with invasive plants communities.</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Disconnected Flood Plains (Wet Soils)</td><td>Least improvement</td><td>2nd greatest improvement</td><td>Greatest improvement</td><td>2nd least improvement</td></tr>
<tr><td colspan="4">Related Effects—Improvement toward connected floodplains increases foraging and nesting areas for at-risk mammals; ensure wetland soil conditions required by some at-risk plant species; maintain native wetland plant communities that provides ecological conditions required by at-risk fish species.</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Limited or Specific Soil Conditions</td><td>Least improvement</td><td>Greatest improvement</td><td>2nd greatest improvement</td><td>3rd greatest improvement</td></tr>
<tr><td colspan="4">Related Effects—Species conditions improve if specific soil-types are protected from degradation due to ground-disturbing activities and long lasting, high-intensity fire.</td></tr>
</table>

Indicators of Effects		**Alternative 1 (1987 Forest Plan)**	**Alternative 2 (Forest Plan)**	**Alternative 3**	**Alternative 4**
At-Risk Wildlife – Issues with Degraded Ecological Conditions (continued)	**Specific Ecological Features or Conditions**	Least condition/needs maintenance	Greatest condition/needs maintenance	2nd greatest condition/needs maintenance	2nd least condition/needs maintenance
		Related Effects-- Species with specific habitat conditions or needs (nesting requirements, water conditions, aspen glades, specific soil) may experience population decline if those needs or conditions *are not maintained* in the forest.			
At-Risk Species – Threats from Human or Forest Activities	**Nonnative Predation (Aquatic)**	Least reduction	Greatest reduction -- (alternative 3 more effective than alternative 2)		Same as 1
		Related Effects-Management actions (e.g., fish barriers and removing invasive aquatic specie) *eliminate or reduce impacts*.			
	Ground/Soil Disturbance (Roads and Trails)	Least disturbance reduction	Greatest disturbance reduction		Same as 1
	Intrusive Human Activity (Recreation Disturbance)	2nd least disturbance reduction	Greatest disturbance reduction — alternative 3 has higher magnitude of effect than alternative 2		Least disturbance reduction
		Related Effects--*Human activity that disturbs* breeding, nesting, or foraging of, or tramples on, at-risk species decreases survival and reproduction due to abandonment, expended energies finding suitable replacement sites, and direct mortality.			
	Unnatural Disease (Introduced or Spread)	2nd least reduction	Greatest reduction		Least reduction—similar to 1, but larger scale
	Mortality/ Altered Behavior from Human-made Features	Least reduction	Greatest reduction		2nd least reduction
	Chemical Applications (e.g., Pesticides)	Least reduction of impacts	Greatest reduction of impacts	2nd least reduction of impacts	Similar to 2

Table 4. Comparison of the forest resources and uses among the four alternatives.

The magnitude of the effects each alternative has on forest resources and uses changes with the plan components of each alternative. Unless otherwise stated, timelines for effects are the life the plan (10 to 15 years).

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Riparian Management Zones				
Vegetation Structure and Composition	Indicators trend away from beneficial effects	Indicators trend toward beneficial effects, moderate short-term adverse effects	Indicators trend toward beneficial effects, least adverse effects	Indicators trend toward beneficial effects, most adverse effects
	Related Effects--*Beneficial*: reduce woody species, increase hydrologic connectivity, rehabilitate geomorphic and biological processes; invasive species treatment promotes recovery of native vegetation; increased infiltration, water storage and retention; restored hydrographs; decreased channel aggradation, and improved water quality; urban water supply is less expensive to clean to standard; increased baseflows during the dry periods of the year; improved fisheries. *Adverse*: methods for restoring structure and composition may affect water and soil quality and inhibit native vegetation recovery.			
Proper Functioning Condition (PFC)	2nd least improvement	2nd greatest improvement	Greatest improvement	Least improvement
	Related Effects—*Improvement toward PFCs* provides clean water, regulated water temperature, water and sediment storage, nutrient cycling, and good habitat.			
Water Resources				
Restoration Treatment Objectives	No objectives	--Improve 2 watersheds --15 miles of stream and riparian restoration --30 miles of aquatic habitat restoration, --600 acres of invasive species removal	--Improve 5 watersheds --30 miles of riparian and stream channel restoration --60 miles of aquatic habitat restoration --300 acres of invasive species removal	1,500 acres invasive species removal
	Related Effects--*Long-term benefits of restoration*: Rehabilitating geomorphic and biological processes, maintaining ground cover, reducing erosion and sedimentation, minimizing road impacts, maintaining water storage capacity *Short-term adverse effects of restoration*: Ground disturbance (erosion, sedimentation), burned and hydrophobic soil conditions, alteration of stream channel geometry, pesticide or herbicide contamination, alteration in shade structure and water temperature conditions.			

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Motorized Route Density (MRD), Recreation, and Grazing Impacts	--Greatest MRD effects (lack of implementation) --Most recreation effects (no mitigation objectives) --Most grazing effects	--2nd least MRD effects --2nd least recreation effects --2nd least grazing effects	--Least MRD effects --Least recreation effects --Least grazing effects	--Greatest MRD effects (expanded road system) --Most recreation effects (expanded recreation system) --2nd most grazing effects
	Related Effects—*MRD effects:* Disrupt water infiltration, cause erosion and sedimentation, alter water temperatures, alter timing and magnitude of peak flows at lower elevations (significant consequences to agriculture and urban development). *Recreation effects:* Repetitive, heavy recreation use close to water bodies; construction of recreation infrastructure; and dispersed recreation close to water bodies adversely affect hydrologic processes and water quality through soil compaction and water pollution. *Grazing effects*: Adversely affects hydrologic processes and water quality, especially where animals are concentrated within riparian areas.			
Watersheds				
Watershed Proper Functioning Condition (PFC)	Least improvement toward PFC	Most improvement toward PFC	2nd most improvement toward PFC	2nd least improvement toward PFC
	Related Effects –*Watersheds in PFC* capture precipitation, storing it for release during drier periods, and clean water by filtering it through soil and vegetation.			
Soil Resources				
Soil Condition (resistance to erosion, water infiltration, nutrient recycling) and Soil Crusts	Conditions trend away from satisfactory; importance of protecting soil crusts is unrecognized.	Grasslands, woodlands, open forest and riparian ERU conditions move toward satisfactory. Soil crust protection encouraged.	Woodlands, juniper grass, and some forests ERU conditions move away from satisfactory. CPGB moves toward satisfactory conditions. Soil crust protection encouraged.	ERUs sensitive to machinery (CPGB and PJG) likely to move away from satisfactory conditions; forest, woodland, and juniper grass ERUs likely to move toward satisfactory conditions. Soil crust protection encouraged.
	Related Effects--*Satisfactory soil condition* provides resistance to soil erosion, and enhance nutrient cycling and water infiltration; lack of effective vegetative ground cover and organic matter reduce soil function, negatively impacting soil condition. *Healthy soil crusts* maintain soil productivity, soil organism diversity, soil stability, and beneficial plant growing conditions; and can be adversely affected by ground-disturbing projects.			

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Vegetative Ground Cover	2nd least beneficial	Most beneficial	2nd most beneficial; exception of potential adverse fire effects	Least beneficial; exception of beneficial recreation mitigation effects
	Related Effects—*Adverse*: Cover may be altered by vegetation treatments, roads, recreation, grazing, and special uses. *Fires* may adversely affect soil physical, chemical, and biological properties; *roads* are the dominant source of erosion and sediment in forests and may spread invasive plant species that degrade soil condition; *recreation* results in erosion, compaction, and loss of vegetative ground cover; *grazing* reduces soil hydrologic function in highly compacted areas where cattle congregate and walk in trails, and reduces soil stability from loss of ground cover wherever over-utilization of available forage occurs. ***Beneficial****:* Sufficient herbaceous material (e.g. through vegetation treatment and restoration, road/recreation/grazing mitigation) protect soils.			
Air Quality				
Initial emissions from active fire (prescribed and wild)	2nd lowest: 12,522 tons PM 2.5, 2.1 million tons CO_2 [6]	2nd highest: 49,898 tons PM 2.5, 8.5 million tons CO_2 [3] –	Highest: 140,158 tons PM 2.5, 23.8 million tons CO_2[3]	Lowest: 7,812 tons PM 2.5, 1.3 million tons CO_2[3]
	Related Effects--Fine particulate matter (PM 2.5) significantly impacts the health and well-being of sensitive populations; smoke from wildland fires may travel large distances, impairing local and regional visibility and degrading air quality far from their point of origin (uncharacteristic wildfire may increase ambient concentrations of criteria pollutants beyond the National Ambient Air Quality Standards).			
Potential Carbon Sequestration	2nd least	2nd highest, moderately uncertain	Greatest, least uncertainty	Least, greatest uncertainty
	Related Effects--Thinning and prescribed fire may release C in the short term, but focus growth and future C storage on more resilient, lower risk trees that are more stable C sinks in the long-term, and avoid severe fires that can be C sources for decades.			
Traditional Communities and Uses				
Access and Resources Procurement	2nd greatest access; 2nd lowest resource output	2nd least access; 2nd greatest resource output	Least access; lowest resource output	Greatest access; greatest resource output
	Related Effects--*Acquisition of Forest products* sustain continued cultural and traditional uses. *Reduced roadways* may negatively affect lifeways of tribes and historic communities by increasing the difficulty of forest access. *Increased access* combined with vegetative management that provides for the sustainability of resources of concern to tribes and rural historic communities positively affects the lifeways of those communities.			

[6] Average emissions over 10 years

Indicators of Effects	**Alternative 1 (1987 Forest Plan)**	**Alternative 2 (Forest Plan)**	**Alternative 3**	**Alternative 4**
Confidentiality, Privacy, and Communication	Limited recognition—least supplementation of existing laws and regulations, lack of additional protections	Recognizes the importance of and provides for confidentiality, and conditions under which communication is enhanced.		Increased adverse effects of activity and access. Faster project analysis and implementation pace may exceed community capacity to respond to communications.
	Related Effects--Lack of additional protections to confidentiality and privacy surrounding traditional and cultural practices could degrade experiences or expose practices to unwarranted users of the forest. *Increased activity in, and access to, the forest* (e.g., visitation, recreation, mechanized activities) may adversely affect traditional practices through breaches in privacy. *Enhance communication* helps direct and focus management practices on public lands to provide for the greatest good, and strengthens relationships, improving collaboration and protecting shared interests.			
Preservation and Protection of Traditional Resources	Least emphasis	Most emphasis		Similar emphasis as alternatives 2 and 3, but higher human use may degrade sites more
Cultural Resources and Archaeology				
Effects Associated with management activities	Least overall adverse treatment (fire and mechanical) effects; 2nd highest risk of adverse uncharacteristic fire effects; second greatest effects from vehicles	2nd least overall adverse treatment (fire and mechanical) effects. Lowest risk of adverse uncharacteristic fire effects; second least adverse effects from vehicles	Least effect from mechanical treatments; greatest fire (treatment and uncharacteristic) effects; least adverse effects from vehicles	Greatest adverse effects from mechanical treatments; 2nd lowest risk of adverse fire (treatment and uncharacteristic) effects; greatest adverse effects from vehicles
	Related Effects-*Adverse mechanical treatment effects*: compact ground in and around sites, disturb artifact distributions or arrangements, may alter artifacts' physical properties and degrade undiscovered sites. *Adverse uncharacteristic fire and fire treatment effects*: alter cultural resources' chemical or physical properties; consume artifacts; promote faster decomposition; affect potential for dating artifacts; damage ground cover and vegetation protecting sites and artifacts; wildfire suppression can damage sites and artifacts – magnitude of all effects increases with severity of fire. *Adverse effects from vehicles:* reduction of cultural deposits, displacement and damage to artifacts, loss of soil and vegetation.			
Visitation or Access	2nd greatest potential effects	2nd least potential effects	Least potential effects	Greatest potential effects
	Related Effects-Looting and vandalism; redistribution of artifacts; livestock and vehicle damage.			

Indicators of Effects		Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Forest Products					
Acres of Timber Suitability		326,779 suitable acres	356,716 suitable acres	0 suitable acres	357,011 suitable acres
		Related Effects--Suitable timber landbase can increase revenue to local and regional communities; the creation or expansion of timber-related industries (particularly utilizing small-diameter stems) helps the Forest reduce overstocked conditions, increases Forest health, and provides an alternative to pile and burn methods used to remove woody residues, which output smoke.			
Sustainable Yield Limit (SYL)		70.6 million cubic feet (MMCF) or 303.4 million board feet (MMBF) per decade over the next 20 years			
Projected Wood and Timber Sale Quantities (PWSQ, PTSQ)	Quantities (first decade)	PTSQ: 16.3 MMCF, 55.0 MMBF, 325,490 Tons PWSQ: 20.2 MMCF, 325,491 Tons	PTSQ: 43.7 MMCF, 145.8 MMBF, 659,446 Tons PWSQ: 52.8 MMCF, 659,449 Tons	PTSQ: 22.1 MMCF, 74 MMBF, 335,462.0 Tons PWSQ: 25.09 MMCF, 335,462.9 Tons	PTSQ: 138.2 MMCF, 461.5 MMBF, 2,087,689 Tons PWSQ: 176.4 MMCF, 2,087,701 Tons
	Sustainability	Sustainable quantities, provides beneficial effects, but not to the scale of alt. 2	Sustainable quantities, provides beneficial effects	Sustainable quantities, provides beneficial effects, but not to the scale of alt. 2	May be unsustainable (average quantities > SYL); beneficial effects may be short-term, adverse effects may occur
	Related Effects--*Beneficial:* support traditional and cultural uses and local economies, create industry opportunity. Timber harvests and vegetation management activities may increase the availability of some forest products (e.g. fuelwood), and may enhance ecological function. *Adverse:* Negative ecological impacts can occur from product removal, particularly when heavy machinery is used (see Vegetation, Soils-Related Effects), roads are created or reopened, or too many forest products are removed.				
Rangeland and Grazing					
Range Condition		2nd least improvement-gradual decline of range condition overall, but sustains 2nd highest level of	Most improvement	2nd most improvement absent severe fire	Least improvement--benefits short lived without fire treatments, mechanical treatments reduce herbaceous ground cover
		Related Effects—*Declines in range condition* degrade biotic conditions through reductions of herbaceous ground cover and increased bare soil, soil compaction or reduced stability, degraded water quality, and decrease livestock grazing capacity**.** *Improved range condition* restores soil stability and condition, hydrologic function, and biotic communities; and increases provisions of high-quality grazing lands.			

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Average Animal Unit Months (AUM)	78,920 (2nd highest)	Highest potential for AUM as a result of restoration effects on forage --temporary declines due to restoration lead to long-term increases	Lowest potential for AUM as a result of restoration effects on forage.	2nd lowest potential for AUM as a result of restoration effects on forage --short-term increases leads to long-term decreases in forage.
	Related Effects--*Increasing the number of AUMs* can lead to positive socio-economic impacts**.** *Short-term reductions in AUMs* allows forage plants time to recover, increases herbaceous establishment, leads to higher quality and more abundant forage, and over time increases the forest's capacity to support increased AUMs. *Restoration effect on forage include* low intensity fire following mechanical treatments improves soil condition, species richness, and herbaceous cover boosts the productivity of the land for quality forage. Increased growth and diversity of understory grasses encourages a return to more natural cycles of fire, helping maintain improved rangeland conditions over time.			
Range Infrastructure Conditions and Treatments	No directives to fix degraded range infrastructure; abandoned fences and loose wire removed. Backlogs remain.	Most improvement (equal to alternative 4)--remove, improve, or reconstruct 5% of poor and non-functional infrastructure annually	Least improvement --Unnecessary fencing removed	Most improvement (equal to alternative 2)--improve or reconstruct 5% of poor and non-functional infrastructure annually
	Related Effects--*Damaged infrastructure*: unfettered distribution of livestock, permits livestock access to sensitive areas degrading habitat quality and water resources. *Improved/Maintained range infrastructure:* reduced-impact grazing through cattle distribution; removing unnecessary fencing increases landscapes natural condition and visual quality, removes hazardous material, and eases wildlife passage.			

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Recreation				
Recreation Management	None	--75% deferred maintenance at 2 developed recreation sites --trail maintenance on ≥25% system trails --improvements on ≥ 1 mile poorly designed trail[7]	--Mitigate ecological damage at 2 developed recreation sites[4] --Close or rehabilitate dispersed sites causing ecological damage	--75% deferred maintenance at 4 developed recreation sites --trail maintenance on ≥40% system trails --improve ≥ 2 miles of poorly designed trail[4]

[7] Every 3 years

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Recreation				
Recreation Opportunities	Diverse ROS classes, but inconsistent with social, environmental, and economic resource capacity of forest --Least effects of vegetation management --Greatest effects of roads --2nd least effect of wilderness	Improved management with more consideration of changing use trends --2nd greatest effects of vegetation management --2nd least effects of roads --2nd greatest effect from wilderness	Shift focus to Primitive ROS class, regardless of use trends or visitor desire --Greatest effects of fire treatments --Least effect of roads --Greatest effects of wilderness	Shift focus to more developed ROS, regardless of use trends or visitor desire --Greatest effects of mechanical treatments --2nd greatest effects of roads --No effects from wilderness; most recreation-based management areas
	Related Effects-*Vegetation treatments* may alter Recreation Opportunity Spectrum (ROS) class, affecting recreational experiences positively or negatively; more, better-maintained *roads* improve access to recreation opportunities, and adversely impact wildlife and streams, adversely affecting recreation like fishing or hunting (which may benefit from road decommissioning) and encourage prohibited or discouraged actions-e.g. motorized use in non-motorized areas-that adversely impact other recreation opportunities. *Designated areas* improve unique recreational experiences-some areas have a recreation focus, others emphasize specific types of recreation. *Wilderness* results in expanded opportunities for primitive, non-motorized, and unconfined type of recreation; expanded opportunities for solitude; and expands areas where natural resources are more protected from long-term damage that can result from intense recreation use.			
Sustainable Recreation	Least sustainable	2nd most sustainable	Most sustainable	2nd least sustainable
	Related Effects-Sustainable recreation ensure the natural resources that make recreating desirable and enjoyable do not suffer from long-term damage as a result of recreation uses and that recreation infrastructure can be maintained. It also aims to build a community of stewards and improve relationships and Forest Service relevancy.			

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Recreation				
Use Conflicts	User conflict identified but often not addressed	More flexibility to address conflicts; emphasis on partnerships may increase education capacity and awareness of multiple uses. Use of management areas reduces user conflict (the most in alternative 3, with alternatives 2 and 4 similar).		
Roads and Infrastructure				
Motor Vehicle Use Map (MVUM) miles	2,200 miles of route on the MVUM			
Motorized Access	2nd most potential for increasing miles on the MVUM.	2nd least potential for increasing miles on the MVUM.	Least likely to have additions to the MVUM.	Most likely to have additions to the MVUM.
	Related Effects-Increases user access and satisfaction, supports multiple use (recreation, hunting, fishing, sightseeing), bring revenue to surrounding communities via increased visitation, increases rancher access to livestock, facilitates Forest management and restoration, eases access for firefighters, and facilitates access to forest products.			
Ecological Effects	2nd greatest adverse ecological effects due to roads.	Beneficial ecological effects are more pronounced in 3 than 2 due to a stronger emphasis on road decommissioning.		Greatest adverse ecological effects due to roads. Least likely to have effects related to road decommissioning.
	Related Effects---*Adverse ecological effects of roads***:** habitat fragmentation; invasive species dispersal; altered water runoff and drainage patterns; restricted movement for wildlife, erosion of soils. *Beneficial ecological effects of decommissioning roads*: increases wildlife habitat connectivity, reduces dumping, reduces sedimentation and impacts to plants and archaeological sites, decreases vandalism and theft of archaeological sites, and lessens noise disturbance.			
Indicators of Effects	**Alternative 1 (1987 Forest Plan)**	**Alternative 2 (Forest Plan)**	**Alternative 3**	**Alternative 4**
Lands and Realty				
Access and Management	Public and administrative access are priorities; strict adherence to list of proposed Land and Water Conservation Fund Recreation Acquisition Composites restricts ability to work with community needs.	"Access reciprocity" is required when easements are granted, resulting in access through private lands for public and administrative purposes. Efforts are made to consolidate land ownership within the forest boundary and establish new rights-of-way to simplify management activities and streamline public access; the need to acquire rights-of-way is reduced by land consolidation. Identify criteria for acquisition or exchange without listing specific areas, thus allowing for determinations to be made based on current community and forest needs.		
	Related Effects-Meeting the needs of local communities for forest access reduces user conflict and enhances public satisfaction. Increased access and landbase consolidation enhances maintenance, fire management and restoration, and ease of public use.			

Indicators of Effects	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Ecological Effects	Most construction permits issued and adverse effects.	Reduced adverse effects--fewer permits and rights-of-way issued and infrastructure consolidation provides for a more contiguous landbase		
	Related Effects-*Adverse Effects*: fragments habitat; alters vegetation and soil; creates noise pollution; could increase the risk of uncharacteristic fire and associated adverse ecological effects.			
Energy and Minerals				
Leasable Minerals	2008 Oil and Gas Leasing EIS and 2012 supplement to the 1987 Forest Plan apply; Geothermal leasing is prohibited in the geothermal study area in the Jemez, Cuba, Espanola, and Coyote Ranger Districts; 0.945 mile of the Rio Puerco within the Oil and Gas Leasing Management Area are managed as an eligible WSR. Production of oil and gas are expected to decline but will continue.		Same as alternatives 1 and 2, with addition of 7,038 acres recommended wilderness in the Oil and Gas Leasing Management Area	Same as alternatives 1 and 2
Salable Minerals	332,405 additional acres of no activity; 84,034 additional acres of limited activity--2nd most withdrawn acres	25,868 additional acres of restrictions --2nd least withdrawn acres	270,130 additional acres of restrictions --Most withdrawn acers	No additional acres of restrictions --Least withdrawn acres
Locatable Minerals	No additional acres withdrawn--2nd least potential withdrawn acres	25,868 acres -- 2nd most potential withdrawn acres	270,130 acres -- Most potential withdrawn acres	No additional withdrawn acres and 68 added acres—least potential withdrawn acres
Renewable Energy	Construction of commercial-scale solar, wind, or hydroelectric facilities is unlikely. Forest products – including firewood permits – continue to be made available. Levels of activity around this energy source and supplies of fuelwood are expected to remain constant and have negligible effect on wood products forestwide.			
All Mineral Resources	**Related Effects--** *Adverse effects*: increased traffic conflicts with other users on forest roads, changes to surface water flow paths and quantities, the loss of vegetation, soil disturbance and compaction, wildlife displacement and habitat fragmentation, decreased air quality due to dust and vehicle emissions, increased noise, increased risk of human-caused fires, and decrease in recreational opportunities. Extractive mineral activities that alter the landscape would most likely encumber other uses and ecological processes on NFS lands for the foreseeable future. ***Beneficial effects:*** meeting the requests of the public for the minerals, increasing national energy security, providing local employment, supporting Federal and state programs through royalties paid, and providing a tax base for the state and county.			
Scenic Resources				
Scenic Integrity Objective (SIO) Allocations	Most land in VQO equivalent to low-very low SIO—natural appearing scenery not emphasized	Most land in high SIO--increased emphasis on natural appearing scenery	Most land in very high SIO—increased emphasis on natural appearing scenery	Same as alternative 2

Indicators of Effects	**Alternative 1 (1987 Forest Plan)**	**Alternative 2 (Forest Plan)**	**Alternative 3**	**Alternative 4**
	Related Effects--*"Very high, "high", and "moderate" SIOs:* relatively natural-appearing landscapes; *"low" and "very low" SIOs:* more modified landscapes often considered less scenic and visually appealing, reduce forest visitors quality of experiences and satisfaction.			
Effects of Resource Management	No directions that differentiate short and long-term scenic effects; move away from desired conditions.	Project-level scenery impacts mitigated; short-term impacts can be inconsistent with SIOs when SIOs are achieved over the long-term; move toward desired conditions	Project-level scenery impacts would be mitigated. Move toward desired conditions.	
	Related Effects-Forest management activities and uses may adversely or beneficially impact scenic. *Vegetation management activities* may disrupt scenic quality and sense of place in the short term, but may move landscapes toward improved scenic character and increase the resilience of scenic attributes in the long-term. *Grazing and rangeland management* could positively or negatively affect scenic resources, depending on forest users' mindset. *Recreation and Roads* damage natural resources, negatively affecting scenic resources, but also provide scenic viewing opportunities.			
Socio-economics				
Recreation; Timber and Forest Products; Grazing; Minerals	≈1,209 jobs and ≈$42.8 million labor income	≈1,187 jobs and $42.4 million labor income	≈ 1,090 jobs and $39.8 million labor income	≈ 1,273 jobs and $45.7 million labor income
	Related Effects--Resource programs contributes jobs, income, and raw materials to the local and national economy; increased visitations benefits local economies; opportunities to graze livestock, benefit area ranchers; increase in employment and labor income generated from forest product removal may cultivate the growth of forest products industries.			
Quality of Life: Well-being; Health and Safety; Traditional, Cultural, and Spiritual Values	Least overall quality of life contributions	Most quality of life contributions—most long-term contributions to well-being, most contributions to health and safety	2nd least overall quality of life contributions—most contributions due to traditional, cultural, and spiritual values.	2nd most overall quality of life contributions—most short-term contributions to well-being and health and safety
	Related Effects—Increased incomes and employment, ecosystem resiliency, ability to express and practices social values, and freedom of choice and ability to express opinions all contribute to community and individual well-being; decreased fire risk and increased water quality protections benefit health and safety, and recreation opportunities allow for mental and physical health; species protections, maintenance and protection of open spaces and cultural sites, protection of cultural and religious values, and open communication with communities all contribute to supporting traditional, cultural, and spiritual values.			

Table 5. Comparison of the forest designated areas among the four alternatives

Management Areas		**Alternative 1 (1987 Forest Plan)**	**Alternative 2 (Forest Plan)**	**Alternative 3**	**Alternative 4**
Designated Areas					
Wilderness	**Designated**	291,669 acres			
	Recommended	1,853 acres (0.12% forest) – 2nd least beneficial and adverse effects	25,868 acres (1.67% forest) – 2nd greatest beneficial and adverse effects	270,130 acres (17.5% forest)-- Greatest beneficial and adverse effects	Removes 68 acres – Least beneficial and adverse effects
	Related Effects-*Beneficial***:** Maintain and protect solitude and high-quality primitive recreation experiences. Decrease adverse effects of motorized and mechanized activities, including user exposure and conflict. Maintain traditional and cultural uses (e.g. grazing, acequia management, spiritual inspiration), provide economic opportunities from primitive recreation, and provide ecosystem services (e.g., protect water resources, species habitat, air quality, etc.). Protect wildlife and habitat and enhance connectivity. Natural ecological processes and disturbance are the primary forces affecting the composition, structure, and patterns of vegetation. *Adverse:* Potential for motorized and mechanized user activities are eliminated – may impact future community forest use and access; concentrate mechanized activities (e.g. biking) to other forest areas, which may lead to increased adverse impacts due to these uses on other forest areas.				
Wild and Scenic Rivers	**Designated**	3 rivers, 44.9 miles			
	Eligible	12 rivers, 74.23 miles			
	Related Effects-*Beneficial Effects:* Protect water quality, scenic integrity, and areas of cultural or historic significance; and improve riparian habitats and species' health and diversity. *Adverse Effects*: constrain river activities to protect free-flow, outstandingly remarkable values, and maintain preliminary river; constrain management of other resources in the WSR corridor to minimize adverse effects to outstandingly remarkable values. *Local communities affected through*: possible activity and resource management restraints when needed to protect outstandingly remarkable values, increased public interest and awareness that may generate economic revenue, increased visitation and associated adverse ecological and social effects.				
Inventoried Roadless Area		55 IRAs, 241,400 acres			
		Related Effects--Protect roadless character; continue to be reference areas to measure the effects of development on other parts of the landscape and a variety of ecosystem services such as undisturbed landscapes important to biological diversity, clean drinking water, opportunities for dispersed outdoor recreation, reference areas for study and research, and high scenic quality			
Research Natural Area	**Established**	Monument Canyon (640 acres), Mesita de los Ladrones (500 acres)			
	Proposed	Cañada Bonita (300 acres)			
	Related Effects-- Protect and maintain natural conditions to conduct non-manipulative research and foster education.				

Management Areas		**Alternative 1 (1987 Forest Plan)**	**Alternative 2 (Forest Plan)**	**Alternative 3**	**Alternative 4**
Nationally Designated Trails	**National Recreation Trail (NRT)**	Cañones Creek NRT, Winsor NRT			
	National Scenic Trail	Continental Divide National Scenic Trail			
	National Historic Trail (NHT)	El Camino Real de Tierra Adentro NHT, Santa Fe NHT, Old Spanish NHT			
	Related Effects-Provide opportunities to view natural features and scenery, recreational opportunities in a variety of ROS settings, and public use and enjoyment of historic routes and associated historic remnants.				
Jemez National Recreation Area		48,300 acres NFS land			
		Related Effects--Provides cultural and supporting ecosystems services through diverse recreation opportunities, high-quality scenery and outstanding scenic features, and habitat; and economic and social benefits to communities and long-time inhabitants of the region.			
Scenic Byways		5 scenic byways: Route 66 (pre-1937 alignment) National Scenic Byway; El Camino Real National Scenic Byway; Jemez Mountain Trail National Scenic Byway; Santa Fe Trail National Scenic Byway; and Santa Fe NF Scenic Byway			
		Related Effects-Protect scenic byway intrinsic qualities: archaeological, cultural, historic, natural, recreational, or scenic; provide opportunities to drive for pleasure and view natural features and scenery, and tourism and economic benefits for the region and communities they traverse. See Scenery and Vegetation			
Wild Horse Territories (WHT)		4 WHTs and 1 wild burro territory; only Caja del Rio WHT is managed for a horse population > 0			
		Related Effects--Provide social and cultural ecosystem services, e.g., benefits to local communities and others who have an emotional attachment to wild horses as cultural symbols; protect and preserve cultural traditions and values surrounding wild horses.			

Table 6. Comparison of the forest management areas among the four alternatives by acres (unless otherwise noted). This table excludes the forestwide management areas from alternative 1, which are not present in any of the action alternatives and can be viewed in table 1.

Management Areas	Alternative 1 (1987 Forest Plan)	Alternative 2 (Forest Plan)	Alternative 3	Alternative 4
Great Santa Fe Recreation Area	0	0	0	24,208
Motorized Recreation Area	0	0	0	30,274
Holy Ghost Canyon	0	0	2,442	0
Calaveras	0	0	10,397	0
Wetland Jewels	0	0	75,615	0
Oil and Gas Leasing Area	208,831[8]	208,831	208,831	208,831
Poshuouinge Cultural Interpretive Area	0	2,768	0	2,768
Nogales Cliff House Cultural Interpretive Area	0	2,166	0	2,166
Rattlesnake Ridge Cultural Interpretive Area	0	1,369	0	1,369
Tsipinuouinge Cultural Management Area	0	609	0	609
Caja del Rio Cultural Interpretive/ Biological Management Area	0	35,247	16,696	0
Cañada Bonita Proposed Research Natural Area	300	300	300	300
Recommended Wilderness Management Areas	1,853	25,868	270,130	- 68
Eligible Wild and Scenic Rivers	74.23 miles	74.23 miles	74.23 miles	74.23 miles

[8] Plan components for this management area are present in alternative 1, but it is not termed a management area.

3. Affected Environment and Environmental Consequences

This chapter summarizes the physical, biological, social, and economic environments of the planning area and the environmental consequences that may occur by implementing each alternative in that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in chapter 2. More detailed information, including methodology, assumptions, and effects analysis are available in appendices B through E and in the administrative records of the plan revision process and the National Environmental Policy Act review.

The forest plan provides a programmatic framework that guides site-specific actions, but does not authorize, fund, or carry out any project or activity. Because the forest plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions), there can be no direct effects. However, there may be implications, or long-term environmental consequences of managing the Santa Fe NF under this programmatic framework. Those environmental consequences are described in this chapter. Consequences are based on predicted implementing activities and are meant to compare alternatives on a programmatic level, rather than provide exact measurements of effects.

3.1 Analysis Methodology

Effects indicators were chosen for each resource as ways to measure the impacts of plan direction in each alternative. The need for change was used to help identify indicators for each resource. Each resource also analyzed drivers and stressors. Sometimes these were common to many resources, such as climate change or drought, other times they were unique to an indicator, such as the energy market for the minerals resource. Drivers and stressors are outside the influence of the alternatives, that is, their effects would occur regardless of which alternative is chosen, so their analysis is not included in the environmental consequences. Detailed information on analysis methodology used for some resources, typically those with more quantitative processes, can be found in appendix B.

3.1.1 Assumptions Common to All Resources

The following assumptions were common to all resources in these analyses:

- No direct environmental effects will result from the administrative action of developing or revising the forest plan. Proposed actions will not be approved or otherwise authorized based on the content of the forest plan; however, they must be consistent with plan components, which include desired conditions, objectives, standards, guidelines, designation of management areas, suitability determinations, and monitoring requirements.
- Components of the forest plan reflect current Federal, State, and local laws and regulations, and USDA and Forest Service policy.
- Effects analyses are applicable for the expected life of the forest plan, which is estimated to be from 10 to 15 years, unless otherwise noted in chapter 3.
- Individual proposed actions are not evaluated in this environmental impact statement nor are they defined by specific location, design, and extent. Rather, the effects described are generic and are used to compare the relative effects of alternatives on a forestwide basis.

- Monitoring during the life of the plan will be used to measure the continued applicability of plan components and the need for future amendments.
- There may be minor, but acceptable discrepancies between the surveyed acres from the Santa Fe NF administrative boundary and the GIS layer used to delineate ERU boundaries.
- Models have inherent shortcomings but provide a relevant basis to compare alternatives and examine potential future trends based on curated inputs.
- Funding levels would be similar to the past 5 years.
- Some plan objectives are stated as ranges. The actual accomplishment over the specified time period would be based on environmental conditions, budget, staffing, and partnerships.

For additional resource-specific assumptions, please see the individual resource of interest within this document.

3.1.2 Effects Citations

For this chapter, we developed effects citations to reduce redundancy in writing, increase awareness and understanding for the reader, and to quickly pinpoint specific effects within analyses. In any given resource, the first time an effect is cited it is written in bold, italic font and is given a letter indicating the resource area and a sequential number in superscript (***effect statement*** ^{E1}). Each time the effect is applicable henceforth in the document, it is cited using the letter and number combination following the related statement ***(E1)***. Further, more than one effect may be applicable to a given statement. When this occurs, multiple cited effects are noted using dashes ***(E1-4)*** indicating all included effects (1, 2, 3, and 4) apply, or are separated by commas ***(E1, 4)*** indicating only effects 1 and 4 apply.

We purposely wrote the majority of effects within the citations without a degree of magnitude. Typically, an effect is cited and is tied to a magnitude dependent on the alternative and the variable in question. For instance, in the forest products section, a main difference among alternatives is the change in acreage of land suited for timber production. A magnitude is tied to the applicable effects in this instance (e.g., *Alternative 4 has the highest quantity of acres suitable for timber production at 323,242 acres **(FP 2-5)***). From this example, the reader can assume that effects ***FP2-5*** would have the highest magnitude of influence under this alternative.

All effects citations are compiled in a table divided by resource areas for quick reference (appendix G).

3.2 Vegetation Communities and Fuels

The Santa Fe NF contains a broad range of ecosystems divided across gradients of moisture and elevation, including grasslands, shrublands, woodlands, forests, and alpine tundra. Plant and animal species depend on these ecosystems to sustain life and diversity, especially within the aquatic and riparian systems (discussed in a separate section) that contain some of the most threatened ecosystems in the arid Southwest. The geographic location, climate, and elevational gradients found in the Santa Fe NF allow for several important ecological and biological features relative to other national forests in the Southwestern Region of the Forest Service (Region 3), and among other major landowners in Arizona and New Mexico. For example, the Santa Fe NF manages more high-elevation vegetation types (spruce-fir forests, mixed-conifer forests, montane grasslands, ponderosa pine forests, and sub-alpine grasslands) than other major landowners in the Southwest, with elevations ranging from 5,300 feet to 13,103 feet at the summit of Truchas Peak in the Pecos Wilderness. Furthermore, the Santa Fe NF contains the largest proportion of mixed conifer forests (32 percent) across the Southwestern Region. These exceptional areas of ecological and biological distinction allow for significant opportunities to manage and conserve these vegetation systems in ways that promote biodiversity and resiliency into the future. Thus, the primary goal of this forest plan with respect to vegetation, is to manage the forest for ecological integrity and sustainability, while providing for the social and economic needs of human communities that depend on the forest.

3.2.1 Ecological Response Units (ERUs)

The ecosystem types found across the Santa Fe NF were categorized and mapped using the Ecological Response Unit framework (Wahlberg et al. 2014), where ecological response units (ERUs) are based on biophysical themes that represent the range of conditions (e.g., dominant species, vegetation associations, soils, landscape features, climate, geology, etc.) that prevail under natural disturbance regimes (e.g., fire, insects and disease, herbivory, etc.). Each ERU has specific seral stages that describe smaller units of vegetation conditions and succession (e.g., dominance of post-disturbance species, closed canopy conditions), which are influenced by both natural processes and management. The Santa Fe NF is primarily composed of 16 terrestrial (upland; table 7) and 6 riparian ERUs (not shown; see the Riparian section). The terrestrial ERUs represent 97.3 percent of all forest acres, while the other 2.7 percent of forest acres are found within riparian ecosystems.

Table 7. Distribution of all terrestrial ERUs found in the Santa Fe NF

Ecological Response Unit (ERU)	Abbreviation	System Type	Acres	% of Forest
Mixed conifer-frequent fire	(MCD)	Forest	429,966.60	25.58%
Ponderosa pine forest	(PPF)	Forest	403,914.57	24.03%
Spruce-fir forest	(SFF)	Forest	250,481.00	14.90%
Piñon-juniper woodland (persistent)	(PJO)	Woodland	231,507.51	13.77%
Juniper grass	(JUG)	Woodland	97,469.57	5.80%
Piñon-juniper grass	(PJG)	Woodland	43,356.23	2.58%
Colorado Plateau Great Basin grassland	(CPGB)	Grassland	41,639.21	2.48%
Mixed conifer with aspen	(MCW)	Forest	40,174.07	2.39%
Sagebrush shrubland	(SAGE)	Shrubland	37,457.19	2.23%
Piñon-juniper sagebrush	(PJS)	Woodland	30,448.68	1.81%
Montane subalpine grassland	(MSG)	Grassland	17,707.32	1.05%
Alpine and tundra	(ALP)	Shrubland/Mixed	5,015.00	0.30%
Bristlecone pine*	(BP)	Forest	2,784.00	0.17%
Gambel oak shrubland*	(GAMB)	Shrubland	1,716.00	0.10%
Mixed-grass prairie*	(MGP)	Grassland	1,147.00	0.07%
Shortgrass prairie*	(SGP)	Grassland	91.00	0.01%
Total Acres			**1,634,874.95**	

* These ERUs are not discussed in depth within this plan. Individually, they represent less than 1 percent each, and in total comprise less than 2 percent of forest acres, so are not priority targets of direct management efforts over the duration of the plan. Although alpine tundra also represents less than 1 percent of the forest, it was added to the plan based on expressed interest of forest users.

3.2.2 Analysis, Methods, and Assumptions

3.2.2.1 Analysis and Methods

The analyses for vegetation use state-and-transition (STM) modeling that treats the various stages of vegetation composition and structure as (seral) states that are connected by transitions. These transitions are triggered either by vegetation development over time (i.e., growth and succession) or disturbance regimes. Projected trends in the movement of vegetation within ERUs between states (or transitions) were derived using the Vegetation Dynamics Development Tool (VDDT).

The VDDT is a software program that provides an STM modeling framework to examine the role of various transition agents, as described above, as well as the effects of management actions that alter vegetative communities (ESSA Technologies Ltd. 2007). STM modeling was completed for the ponderosa pine forest, mixed conifer-frequent fire, pinyon juniper grassland, and juniper grass ERUs. STM modeling was not implemented for the montane subalpine grassland, Colorado Plateau/Great Basin grassland, and sagebrush shrubland ERUs because the STM models were not yet developed for the Santa Fe to analyze these grassland systems. Instead, general qualitative trends were analyzed for these ERUs using the best available science, local records, and expert opinion. These approaches allowed for the quantitative comparison of the effects of vegetation management treatments under each alternative designed to guide plan objectives.

The projected changes to vegetation derived from analyses were given a departure rating based on the degree to which they differed from desired conditions (table 8).

Table 8. Scales of departure for vegetation analysis

Departure	Range (%)
Low	0–33%
Moderate	33–66%
High	66–100%

VDDT modeling was also used to compare the percentage of closed-canopy states of certain vegetation types in the Forest as a proxy for canopy cover by alternative using vegetation treatment objectives (acres) as inputs (EIS, Appendix B). VDDT is not spatially explicit and does not model opening size, but it does contain three descriptive density classes: openings, open forest states, and closed forest states. In VDDT modeling, openings have canopy cover less than 10 percent, “open” states have canopy cover between 10 and 30 percent, and “closed” states have canopy cover greater than 30 percent.

Forest vegetation specialists used LANDFIRE (2010) and TNC (2007) models based off of a historic reference period to determine the degree of departure of fire regimes, including fire frequency and severity and calibrated the models using local data where possible. Research considers the historic reference period to be prior to European-American settlement (Fulé et al. 1997, Swetnam et al. 1999), when extensive land-use patterns changed with the introduction of grazing, fire suppression, and forest fragmentation (Covington and Moore 1994a; Covington and Moore 1994b; Swetnam and Baisan 1996). These fire regime departure ratings help build a greater picture of ERU condition in the planning area when compared with the departure ratings determined by VDDT models (described briefly above). Ultimately, these departure ratings help prioritize which ERUs are the most departed from the historical reference condition, so that focused treatments would be directed where they will be the most effective at restoring ecosystem function (table 9).

Table 9. Degree of seral state departure from reference conditions for selected ERUs*

System	ERU Code	ERU Name	Departure	Departure Index
Forest	PPF	Ponderosa pine forest	High	97
Grassland	CPGB	Colorado Plateau/Great Basin	High	93
Forest	MCD	Mixed conifer-frequent fire	High	74
Grassland	MSG	Montane subalpine grassland	Moderate	60
Forest	SFF	Spruce-fir forest	Moderate	54
Forest	MCW	Mixed conifer with aspen	Moderate	47
Woodland	PJS	Piñon juniper sagebrush	Moderate	46
Woodland	PJG	Piñon juniper grass	Moderate	45
Woodland	JUG	Juniper grass	Moderate	45
Shrubland	SAGE	Sagebrush shrubland	Moderate	41
Woodland	PJO	Piñon juniper woodland (persistent)	Low	28
Shrubland	ALP	Alpine and tundra	Low	20

*Departure in this table based on VDDT modeling

The bristlecone pine, Gambel oak shrubland, mixed-grass prairie, and shortgrass prairie ERUs were not included in the vegetation analysis (table 7), because they each cover less than 1 percent of the total acres in the Santa Fe NF. Since they are relatively rare within the forest, these ERUs are not further discussed in this document.

3.2.2.2 Assumptions

The analyses described above included certain assumptions:

- Plan objectives are achievable considering time, budget, planning timelines, etc., and are applicable to the lifespan of the forest plan (10 to 15) years. All objectives abide by current laws and policies.
- There may be minor, but acceptable discrepancies between the surveyed acres from the Santa Fe NF administrative boundary and the GIS layer used to delineate ERU boundaries.
- The “Interagency Prescribed Fire: Planning and Implementation Procedures Guide” continues to provide clear direction regarding the use of planned ignitions (USDA 2008a and USDOI 2008).
- Acres treated using fire or mechanical methods have improved departure due to the treatments altering the structure and composition of vegetation or fuel loads and move vegetation toward desired conditions.
- Treatment acres using wildland fire assume a portion of the acres treated will be accomplished through unplanned ignitions. These wildland fires will be managed to contribute movement toward desired conditions and protect important resources.
- Actual acres treated under each alternative depends upon resource availability, NEPA analysis, weather conditions, socio-political factors, or other unpredictable factors.
- There is no surrogate for the application of fire in frequent fire ecosystems. It is critical to ecological restoration. Low-severity fire causes mortality in less than 25 percent of dominant overstory, moderate-severity fire causes mortality in 25 to 75 percent, and high-severity fire causes mortality in over 75 percent of the dominant overstory.

- Reference and desired conditions represent identical conditions, except where areas of wildland-urban interface necessitate certain vegetation structure, composition, and fuel loadings to protect communities and reduce the risk of wildfire.
- For each ERU, the closer their ecological composition, structure, and processes are to their reference conditions (having low departure indices versus high departure indices), the more properly each ERU is functioning, and the more secure dependent species (plants and animals) are within the associated habitats.
- Drivers and stressors promote recurring disturbances in the forest at large. While these factors would be influenced on a local scale due to vegetation treatments or fire, predicting their effects (given localized management) on a large scale or over the long term is difficult. For this reason, they are not included as indicators of forest conditions, but mentioned in the effects analysis when effects can be predicted on a localized scale with a degree of certainty (e.g., the spread of cheatgrass in invaded grasslands following fire or insect infestations in areas of widespread canopy mortality following high-severity fire).
- Management areas and designated areas are discussed when an ERU comprises over 20 percent of their land area, as area percentages less than 20 percent are expected to have minimal effects on or impacts to a given area.

3.2.2.3 Vegetation Resource Indicators

Resource indicators represent key ecosystem characteristics that are components of ecological conditions that sustain ecological integrity. They are factors of the composition, structure, or function of an ecosystem. Resource indicators chosen based on the availability of information, historic reference data (LANDFIRE 2010), and relevance to key issues were analyzed for several ERUs using VDDT models (described above in the Analysis section). However, some indicators were not applicable to certain ERUs, such as snag density in grassland ERUs. Below, we illustrate how each selected indicator would impart information needed to assess the effects of management for three vegetation focus areas (table 10) before describing each indicator in detail.

Table 10. Key vegetation focus areas, key ecosystem characteristics, and resource indicator used in the ERU effects analysis

Vegetation focus area	Key ecosystem characteristics	Resource Indicators used in the effects analysis
1. Restore frequent fire ecosystems	Seral state diversity, patch size, fire regime	Seral state departure, fire return intervals, fire severity
2. Improve grasslands and herbaceous cover	Ground cover, species composition, fire regime	Canopy cover, fire return intervals, fire severity
3. Restore ecosystem resiliency	Seral state diversity, fire regime, patch size, species composition, ecosystem health and wildlife attributes	Fire return intervals, fire severity, seral state departure, canopy cover, and coarse woody debris, snags, and old-growth forest components

Seral State Diversity

Seral state proportion is the percentage of an ERU in each seral state (sere) or stage of secondary successional development. Seres describe ecological process of progressive change in a plant community after a stand-initiating disturbance (Hall et al. 1995). Each ERU can manifest in a range of potential overstory vegetative conditions, each representing a unique phase in the overall ecology of the system

(Weisz et al. 2009). By grouping these phases into seral state classes with unique vegetation characteristics (e.g., overstory composition and structure), models can be developed that define transitions among phases. As described above in Analysis and Methods, vegetation specialists modeled the transitions across seral states within individual ERUs over time, to obtain a measure of seral state departure from reference conditions. Seral state departure is the degree to which the current conditions and stages of ecosystem development differ from the historic or desired condition. Many ERUs in the forest currently have moderate to high seral state departure. Forested ERUs typically have a greater stem density and higher canopy cover than was characteristic of historic forests. Both forested and non-forested ERUs have compromised understory structures, and often support plant species compositions that were not characteristic of historic conditions. The addition of nonnative, invasive species has compounded this issue. Non-forest ERUs, particularly grasslands, have departed structures due to encroachment of tree and shrub species, resulting in seral state conditions that were not present historically (see Affected Environment).

Canopy Cover

Canopy cover indicates the degree of space available between dominant vegetation canopies or the proportion of the forest floor covered by the vertical projection of the tree crowns (Jennings et al. 1999). The greater degree of cover, the less light available to infiltrate to the lower vegetation layers. Thus, the degree of canopy cover within ecosystems largely determines the structure and composition of understory vegetation. Understory herbaceous vegetation and grassland vegetation that often prefer open canopy conditions provide habitat, hiding, and thermal cover, nesting sites, and food sources for a myriad of plant and animal species. In addition, these grasses provide the fine fuels that maintain and support the natural fire regimes needed to renew forested, woodland, and grassland ERUs.

Ponderosa pine forests should have more open than closed canopy interspersed with grassy understory vegetation, with conditions maintained by low-intensity, frequent surface fire (Jameson 1967, Laughlin et al. 2005). The grass vegetation component is a major community and ecosystem driver, serving functions such as nitrogen fixation (Kaye and Hart 1998, Nilsson and Wardle 2005). Both mechanical treatments and fire are effective at creating canopy openings, as are other natural disturbances such as wind, ice, insects, and disease. As overstory canopy cover is reduced, there would be an expected increase in understory species diversity, cover, and production, depending on site productivity, condition of the existing understory vegetation and its ability to respond, and the seedbank (Moore and Deiter 1992).

Ground Cover

Ground cover is the combined percent of basal vegetation, bare soil, litter, and rock fragment cover at the plan and local scales. Ground cover is identified as a key ecosystem characteristic, as continuous herbaceous and woody ground cover provides soil stability, reduces overland water flow, fosters infiltration by increasing plant-available water (Davenport et al. 1998, Wilcox et al. 2003), and improves moisture retention. One of the earliest changes to the Southwestern landscape was the reduction of grass cover as a result of the introduction of large numbers of domestic livestock during the early 1800s (Raish and McSweeney 2008). Grazing reduced native plant cover and facilitated the colonization of invasives, altering species composition, and reduced vegetation cover through herbivory and soil compaction, increasing soil temperature and decreasing soil moisture. Although invasives can decline within a few years after grazing is reduced, recovery is incomplete according to Dick-Peddie (121993). Ecologically, the most far reaching, long-term negative effect due to shifts in grass and woody plant abundance is loss of soil, soil productivity, and species diversity.

Old-Growth Components

Old-growth components are a significant part of the diverse ecological web formed by natural forest landscapes and provide unique resources for plants and animals (including people) within the landscape (Franklin et al. 1986). There are varied definitions for old growth, but all contain references to tree size (large trees), varied ages (particularly mature; old), trees in stages of senescence (dying, dead, snags), and varied structural components. Common synonyms for old growth are relic, climax, late-successional, ancient, legacy, primary, primeval, pristine, and virgin. However, these descriptions often fail to address the full breadth of old growth, which is also defined as old stages in early successional forests such as in quaking aspen stands that are successional to climax spruce-fir forests. Thus, the true ecological understanding of old growth lies in a spectrum of temporal and spatial scales, as old growth can occur as individual trees to stands to regions, and across forest types. There are conflicting opinions on whether old growth areas can have evidence of human modification (e.g., cutting), but from an ecosystem standpoint there may be relatively little difference between a truly virgin old-growth forest (rare) and one that has fully recovered over time since human disturbance.

In the Southwest, old growth varies by forest type, given varying tree species compositions, longevities, sizes, densities, and frequencies of natural disturbance (Harmon et al. 1986). In general, the defining old-growth characteristics (required characteristics: old trees, snags and large downed fuels, and structural variability; not required: large trees or age variability) can be divided into forest conditions resulting from three different types of fire severity and frequency:

1. forests distinguished by frequent, low-severity fires that result in fine-scale groups of trees interspersed within a grass/forb/shrub matrix--ponderosa pine and dry mixed conifer are frequent fire forests (e.g., ponderosa pine, dry mixed conifer);
2. forests distinguished by an infrequent mixed-severity fire regime (e.g., wet mixed conifer, spruce-fir, and piñon-juniper woodland); and
3. forests distinguished by a very infrequent high-severity fire regime (e.g., upper subalpine spruce-fir).

Old-growth areas in frequent-fire ecosystems tend to be less dense and have fewer logs on the forest floor than in infrequent fire ecosystems. Tree canopies cover about 30 to 70 percent (depending on forest type and site quality) of an area with grass/forb/shrub interspaces comprising the remainder. Old trees exist in these frequent-fire ecosystems because they have adapted to withstand single large or repeated fire events (Kaufmann et al. 2007). In contrast, in infrequent fire systems, old-growth overstory is dominated by large, old trees with multiple layers of younger, smaller trees beneath the canopy. Due to long periods of time between disturbances, ground fuels build up to high levels.

Snags

Ecologically, a dead tree is as important to the forest ecosystem as a live one (Franklin et al. 1987). Dead trees, called snags, provide key ecological functions that influence the ecosystem through trophic relations; species interactions; soil aeration; primary cavity and burrow excavation; and dispersal of fungi, lichens, seeds, fruits, plants, and invertebrates (Marcot 2002). Snags also provide important habitat for many species, such as Mexican spotted owls and other cavity nesters. Additionally, snags play a role in forest succession as they produce coarse woody debris when they fall, providing cover and foraging sites for terrestrial small mammals (Bull et al. 1997, Payer and Harrison 2003).

Coarse Woody Debris

Coarse woody debris, defined as dead woody material 3 inches and greater in diameter, is created naturally when branches senesce, trees die, become snags, and fall to the forest floor, or are created as byproducts of mechanical treatments. The amount of fuel on the forest floor (litter and coarse woody debris) has a pronounced effect on fire hazard, moisture relations, forage production, and the general health of coniferous forests. Outside of their effect on fire, coarse woody debris also performs a number of important ecosystem services including soil stabilization and moisture retention, and wildlife habitat.

Patch Size

Patches are contiguous areas in which the vegetation composition and structural state are relatively homogeneous within a specific area and differ from their surroundings. Patches can be composed of randomly arranged trees, shrubs, or grasslands; groupings of trees and shrubs; and would be even- or uneven-aged. Typically, patches range in size from 1 to 1,000 acres, depending on the ERU and site-specific conditions (e.g., aspect, site potential). Vegetation patterns, including patch size and distribution, reflect the cumulative and interactive effects of disturbance regimes (e.g., insects, disease, fire, etc.), biophysical environments (e.g., topography, soils, climate), and successional processes (Baker 1989, Keane et al. 1998). For example, natural large dense patches of trees as in spruce-fir forests are indicative of a low-frequency and high-severity fire regime.

Patch size is also an important element of wildlife habitat. Each wildlife species has its own patch size preference, and these preferences vary by species (Bender et al. 1998). For these reasons, and also for reasons of wildfire behavior, current landscape distribution of patches should resemble the distribution under reference conditions—the conditions to which wildlife species adapted—to best accommodate the varying preferences of all wildlife species and simultaneously mimic historic fire behavior. The ability for species to move throughout a landscape is also important for ecological integrity. Species that are wide-ranging are able to maintain genetic diversity and sustainability in the face of changes to their population or environment. While connected landscapes allow other species to migrate in the face of climate change or other pressures.

Fire and Fuels

Fire Frequency

Fire frequency, expressed as the fire return interval, is the number of fire events that occur at a specified point or within an identified area during a specified time period. Since historical written records of fire are often incomplete, alternative methods of identifying fire frequencies have been developed to aid in understanding the long-term interactions between fire and climate. As we go back in time, fire history can reliably be determined for portions of the landscape where some sort of fire indicators is recorded. These records originate from the wood of trees (dendrochronology-based fire scar analysis), from stand structure (age distribution of stands where fire can be assumed to be the dominant disturbance factor), from charcoal deposits gathered from soils, lakes, or bog sediments (sediment charcoal analysis), or can be inferred from vegetation changes over extended time periods (pollen records from packrat middens). While each of these methods has its limitations, approaches using dendrochronology or sediment charcoal and pollen data can provide excellent insights into trends in vegetation, fire, and fire-climate interactions over hundreds to thousands of years. They also provide perspectives on variability and drivers of fire regimes and describe fire-climate-vegetation interactions (Gavin et al. 2007, Allen et al. 2008).

Fire Severity

Fire severity is broadly defined as the degree of ecosystem change induced by fire (Ryan and Noste 1985). Fire severity has been described by the degree of tree mortality (Agee 1993); or the degree to which fires consume organic biomass on and within the soil (Neary et al. 2005), change in color of ash and soil (Ryan and Noste 1985), or a combination of these fire effects. Three broad categories of fire severity have been identified based on the physical characteristics of fire and the fire adaptations of vegetation: low, moderate (mixed), and high-severity (Agee 1993). For describing fire regimes, severity is typically defined based upon degree of mortality in overstory vegetation even where the dominant overstory is shrubs (shrublands) or grasses (grasslands). Low-severity fires typically remove less than 25 percent of overstory vegetation, moderate-severity fires remove between 25 and 75 percent of overstory vegetation, and high-severity fires remove over 75 percent of the overstory vegetation, often leading to “stand replacement.” A combination of fire severities is typical of most fire regimes.

Fire Regime

Fire regimes describe the natural role that fire plays across a landscape (Agee 1993). A fire regime incorporates fire frequency and severity, as well as fire predictability, size, seasonality, and spatial patterns (Heinselman 1981, Agee 1993). Outside of human influences, vegetation and climate are the dominant drivers of fire regimes, where they directly affect the size, frequency, and severity of fires.

Fire Regime Condition Class

Fire regime condition class (FRCC) describes the patterns of fire seasonality, frequency, size, spatial continuity, intensity, type (crown fire, surface fire, or ground fire), and severity in a particular area or ecosystem (Agee 1994) and can be a tool for assessing a current landscape’s departure from historical (natural) conditions (Hann et al. 2008). The FRCC departure metric can be derived by evaluating the change in the composition and structure of succession classes, fire frequency, and fire severity compared to conditions under the historic disturbance regimes (Barrett et al. 2006; table 11).

Table 11. Fire regime groups used in the current LANDFIRE database adapted from FRCC Guidebook, Version 3.0 (Barrett et al. 2010) and their associated ERUs in the Santa Fe NF

Fire Regime Group[1]	Frequency	Severity	Severity Description	ERUs[2,3]
I	0–35 years	Low / mixed	Generally low-severity fires replacing less than 25 percent of the dominant overstory vegetation; can include mixed-severity fires that replace up to 75 percent of the overstory	MCD, PPF, PJG, JUG
II	0–35 years	Replacement	High-severity fires replacing greater than 75 percent of the dominant overstory vegetation	CPGB, MSG
III	35–200 years	Mixed / low	Generally mixed-severity; can also include low-severity fires	MCD, MCW, PJS, PJO
IV	35–200 years	Replacement	High-severity fires replacing greater than 75 percent of the dominant overstory vegetation	MCW, SFF, SAGE
V	200+ years	Replacement / Any severity	Generally, replacement-severity; can include any severity type in this frequency range	SFF, PJS, PJO

[1]These groups have been modified from earlier versions (Hardy et al. 2001, Schmidt et al. 2002).

[2]See table 7 for ERU abbreviation guide

[3]Forest and woodland ERUs from Reynolds et al. 2013; grassland and shrubland ERUs from Wright and Bailey 1982, Dick-Peddie 1993). Multiple other relevant fire literature sources were also used to determine reference fire regimes of vegetation types in the Santa Fe NF and are included in table 9 on page 32 of USDA FS 2016a.

Three levels of fire regime condition class departure have been identified (table 12; Schmidt et al. 2002). Common causes of departure in the fire regime condition class include advanced succession, fire suppression, timber harvesting, historical livestock grazing, and established exotic species (Schmidt et al. 2002, Stambaugh et al. 2008, Keane et al. 2009).

Managers can use fire regime departure and condition class data to document possible changes to key ecosystem components (Schmidt et al. 2002) including vegetation characteristics, fuel composition and loading, and fire characteristics. They would also use this to derive information about other associated disturbances, such as insect and disease mortality, legacy grazing, and drought to direct land uses and management in a manner that reduces departure and returns these systems closer to their natural fire regimes.

Table 12. Fire regime condition class departure descriptions (Schmidt et al. 2002) and suggested management guidelines

Fire Regime Condition Class	Class Description	Example Management Treatments
FRCC1	Less than 33 percent departure* from the central tendency of the historical range of variability. Fire regimes are within the historical range and the risk of losing key ecosystem components is low. Vegetation attributes (species composition and structure) are intact and functioning within their historical range.	The reintroduction of fire into these areas can help to restore historical fire regimes.
FRCC2	33 to 66 percent departure. Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical frequencies by one or more return intervals (either increased or decreased). This would result in moderate changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been moderately altered from their historical range.	These areas will need moderate levels of restoration treatments including fire, human, or mechanical treatments to restore historic fire regimes.
FRCC3	Greater than 66 percent departure. Fire regimes have been significantly altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals. This would result in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been significantly altered from their historical range.	These areas will likely need high levels of restoration treatments such as the removal of invasive species, human or mechanical treatments before implementing fire to restore natural fire regimes.

Fuels

Fuels include snags and coarse woody debris (described above), as well as smaller diameter woody debris, needles, leaves, grasses, and other flammable materials on the forest floor. Fuels also include ladder fuels, which are shrub or tree species that create vertical connectivity from the forest floor to the dominant canopy layer. The presence of ladder fuels in frequent-fire forests greatly increases the risk of canopy fires occurring, increasing fire severity and often leading to fire spread over larger areas. Fuel moisture is a key component of the flammability of fuels; the drier the fuels are, the greater the likelihood that they will burn when contacted by an ignition source (e.g., lightning, humans).

3.2.2.4 Ecosystem Characteristics Not Considered in Detail

Similarity to Site Potential (ecological status)

Site potential or ecological status is the degree of similarity of the current or existing vegetative plant community composition to the natural community, as described in the Terrestrial Ecosystem Survey of the Santa Fe NF (Miller et al. 1993). The similarity analysis results in an index value that considers all plant species collectively (as opposed to evaluating every species or every plant group). The potential natural community, along with the earliest successional stage, identifies the range of conditions that should prevail in a healthy ecosystem.

Similarity to site potential was not used as resource indicator of future forest condition in this analysis due to the lack of anticipated effects from plan objectives for treatment or any notable differences by alternative during this planning cycle. It is expected that all alternatives will lead to improvement in similarity to site potential, as the desired conditions for vegetation are intended to drive ERUs toward conditions within their natural range of variability. The description is included here to give reference for the mention of similarity to site potential within the Affected Environment section below.

3.2.3 Affected Environment

3.2.3.1 Fire and Fuels

Healthy, resilient landscapes have a greater capacity to survive natural disturbances and large-scale threats to ecological sustainability. This is especially true under shifting and uncertain future environmental conditions, such as those driven by a changing climate and increasing human uses. Through restoring natural fire regimes, forests move closer to desired conditions where structure, species composition, and function return to their natural conditions, building resiliency in the ecosystem. This return to ecosystem health and function, aided by fire, supports a wide range of ecosystem services:

- regenerating grasses to support permitted grazing operations
- enhanced biodiversity
- carbon sequestration in residual trees following fire
- creating a wide range of habitat conditions for wildlife to support recreational wildlife viewing or game hunting
- provide a higher quality timber resource by naturally thinning stands and releasing trees from competition
- enables old-growth development
- may ease accessibility for gathering forest products
- reduction in subsequent or extreme fire risk, protecting life and property near wildland areas

The resiliency of much of the forest is dependent upon fire as a frequent disturbance process, as the structure and function of vegetation are closely intertwined with the role of fire. As such, fire is discussed with vegetation throughout this document. Below we describe fire frequency, severity, and regimes relevant to the Santa Fe NF to provide a base of understanding of this significant driver of the forest's condition.

Fire Frequency

The area encompassed by the Santa Fe NF has had a long-recorded history of fire and anthropogenic influences. According to Allen (2002), the Jemez Mountains exemplify one of the most humanized portions of the prehistoric Southwest. At the time of European settlement in 1598 A.D., the northern Rio Grande valley region was estimated to have a population of about 100,000 people in 100 communities, primarily residing in piñon-juniper and lower ponderosa pine vegetative types, where fire was a natural occurrence. It is probable that human ignitions and human impacts to vegetation enhanced prehistoric fire frequencies in localized areas (Allen 1996, Fish 2006). Detailed temporal and spatial records of past fire activity exist contained in dendrochronological (tree ring) reconstructions of fire history from scarred tree samples, showing clear connections between climate and fire throughout centuries (Swetnam et al. 1999, Allen 2002). Drought is a main driver of large fire events, where fuel moisture greatly influences fire regimes in ponderosa pine and mixed-conifer (Swetnam et al. 1999). Extensive records of fire frequency within the Southwest have identified the natural fire return intervals for many ecological types (see individual ERUs below).

Fire Severity

Fire history and fire modeling in the Santa Fe NF shows fires occurring across the range of severities. The absence of fire across much of the forest for decades to centuries has had mixed effects on vegetative communities. Some areas have responded to fire's absence with increased fuel loads and dense canopy structures that are flammable and highly susceptible to burning with stand-replacing severity, especially under extreme drought conditions (e.g., ponderosa pine, dry mixed conifer). Other areas have also incurred changes in species compositions, ground cover, or fuels, which have lowered their natural capacity to carry fire (e.g., Colorado Plateau Great Basin grasslands, montane subalpine grasslands). Typically, fire severity is a product of fuel loading and moisture, vegetative structure and composition, and climatic variables including relative humidity, wind, and temperature. Areas with high fuel loads and dense vegetative structure are more likely to experience high-severity fire if fuel moisture is sufficiently low. Many of our frequent-fire ecosystems are currently departed from historic conditions, placing them in a high-risk state with increased susceptibility to large-scale, uncharacteristically severe disturbance (see Vegetation-ERUs below). A range of fire severities is typical of many of the fire regimes associated with the vegetation communities comprising the Santa Fe NF (discussed in greater detail by ERU). Large-scale, high-severity patches of fire can have substantial detrimental effects (discussed in Environmental Consequences section), particularly in forest types where that extent and severity is not a part of the natural fire regime (e.g., MCD, PPF). Over smaller, more localized areas mixed- to high-severity patches have beneficial effects. Small patches of mixed- high-severity fire create greater heterogeneity in the landscape by promoting the development of complex early-seral forest conditions (Hutto et al. 2016). Where stand-replacing fire severity is a part of the natural fire regime, it is a crucial component of the ecological processes of those areas, though negative effects still occur alongside the benefits. The intent of the revised Forest plan is to manage vegetative communities in ways that restore the natural processes and the cycles that characterize them, while also providing for human safety and to meet multiple-use needs and ecosystem services.

Fire Regimes

Each ERU in the Santa Fe NF has a natural fire regime that is integral to its ecological functions and processes (table 11; Affected Environment-Vegetation), which have been determined through historical accounts, tree ring studies, and other documented empirical evidence (see: table 9 on page 32 of USDA FS 2016a). Information about past fire regimes can help guide and inform land managers about current and future fire regime characteristics and patterns. This information can also identify historical forest structure characteristics that drive the strategic planning of fire and natural resource management, and aid in assessing risk and ecological conditions (Morgan et al. 2001). Through fire regime and vegetation history research we can illustrate change in disturbance regimes through time, identify knowledge gaps, and learn how climate, topography, vegetation, and land use influence fire regimes. For instance, recent research compiled from data collected within the Santa Fe Watershed, has shown that historically fire occurred every 1 to 10 years in dry conifer forests, typically burning in early summer (Margolis et al. 2020, unpublished report). Further, fire events were observed during years of drought that were preceded by wet years (Margolis et al. 2020, unpublished report), which allow for an increase in fine fuels (e.g., grasses) that dry and senesce during drought conditions.

Fuels

Under historic conditions and natural fire regimes, the predominant fuels in frequent-fire forests, such as dry mixed conifer or ponderosa pine, were understory grasses and forbs, leaf litter or needles, and small amounts of woody debris (Covington and Moore 1994a, Battaglia and Shepperd 2007). These ground fuels were consumed in low-severity ground fires at regular intervals that kept fuel loads at a low level, barred trees from encroaching into grasslands, and encouraged open stand structures in forests (Battaglia and Shepperd 2007). Contemporary dry mixed conifer and ponderosa pine forests have forest floor fuel loadings (combined litter, fermentation, and humus layers) higher than historic conditions supported at an average of 13.6 tons per acre and 13.2 tons per acre, respectively in the Santa Fe NF (Sackett and Hasse 1996). These high fuel loadings are due to the very slow decomposition rates characteristic of the dry southwestern climate, combined with extensive fire suppression, and have led to increased probability for crowning, torching, and spot fires, making suppression difficult (Harrington and Sackett 1992, Brown et al. 2003, Stephens 2004). This severe fire behavior would be increased in areas of heavy mistletoe infestations (Hoffman et al. 2007).

Uncharacteristic Wildfire

After years of fire suppression, the understory and midstory of frequent-fire forests have been colonized by fire sensitive species such as white fir. These trees create dense canopy cover, as they are not self-pruning like many fire-adapted species and form a continuous ladder of fuels from ground to crown. With over-stocked, dense forest stands and excessive forest floor fuel loadings characterizing many areas within the Santa Fe NF, the current risk of uncharacteristically high-severity fire is elevated where these conditions are not within the natural range of variation (NRV) for the ERU. Uncharacteristic wildfires can be described as high-severity fires that burn over large areas or over long durations within vegetation types where this fire behavior or size is divergent from the natural fire regime and can cause resource damage. For example, the occurrence of high-severity fire outside of small or localized areas is uncharacteristic of frequent-fire, low- to mixed-severity regimes (e.g., PPF, MCD); large-scale, stand-replacing fire may also be uncharacteristic within infrequent-fire regimes that include variably sized patches of stand-replacing fire as part of the natural disturbance cycle (e.g., SFF, MCW) based on the patch size of high-severity fire exceeding the NRV. A stand-replacing fire kills all, or nearly all, of the vegetation present on site through the combination of crown fires consuming all photosynthetic material and live buds, and surface fires penetrating the soil with extreme heat. When wildland fire causes extensive ecological damage (and often also negative socio-economic impacts) they are referred to as catastrophic fires. The Santa Fe NF, and surrounding areas, have experienced some instances of catastrophic fire in recent decades, most notably the Cerro Grande (2000) and the Las Conchas (2011) Fires.

3.2.3.2 Vegetation

Vegetative communities within the Santa Fe NF have been shaped over time by natural and human-caused disturbances, management practices, climatic factors, land uses, insects, diseases, and introduced species.

Some of these plant communities have maintained a degree of similarity to their historic conditions, while others have changed significantly over time. Across the forest, departure from reference conditions continues to trend further away from reference conditions. Because of this, forest managers assessed the vegetative communities (ERUs) and determined desired conditions to guide plan objectives, guidelines, and standards within each unique forest, woodland, or grassland system comprising the Santa Fe NF.

The remainder of this section describes the current condition of the predominant terrestrial ERUs in the Santa Fe NF and relates the degree of departure from historic reference conditions based on data in LANDFIRE 2010 calibrated with local data and relevant scientific information. A more detailed description of each ERU can be found in the Ecological Response Units of the Southwestern United States document (Wahlberg et al. 2014) and the Santa Fe NF Forest Plan Assessment Report (USDA Forest Service 2016a).

Forested ERUs

Mixed Conifer Frequent Fire (MCD)

Frequent-fire mixed conifer (dry mixed conifer) is the most extensive and prevalent ERU found in the forest, accounting for 429,967 acres (25.6 percent) of the lands the Santa Fe NF administers. The mixed conifer frequent fire vegetation type spans a variety of semi-mesic environments at elevations between approximately 8,500 and 11,000 feet, situated between ponderosa pine, piñon-oak, or piñon-juniper woodlands at lower elevations and spruce-fir forests above. MCD was historically dominated by ponderosa pine in an uneven-aged open forest structure (less than 30 percent tree cover), with minor occurrence of aspen, Douglas-fir, and southwestern white pine. Aspen in this forest type occurs within dissimilar inclusions and not as a seral stage forest type as with the mixed conifer with aspen (MCW) forest type. More shade-tolerant conifers, such as Douglas fir, white fir, and blue spruce tend to increase in cover during late succession and would not typically achieve dominance under the characteristic historic fire regime (0–35 year return interval; low-mixed severity; table 11). These species could, however, achieve dominance in localized settings where aspect, soils, and other factors limited the spread of surface fire. Understory vegetation is typically composed of forbs, grasses, and shrubs.

Fire exclusion and past management activities including selective logging (“high-grade”), fragmentation (e.g., construction of roads), fire suppression, and intensive historical grazing in dry mixed-conifer forests have contributed to higher stand densities, and altered species composition from mature, large ponderosa pine and Douglas-fir trees to more shade-tolerant, less fire-resistant species such as white fir (Moore et al. 2004, Romme et al. 2009a, Reynolds et al. 2013). Disturbance was more frequent (every 5 to 21 years) before fire exclusion, where adjacent dry forest and woodland types provided ignition sources (Floyd et al. 2009, Romme et al. 2009b). Despite fire management practices shifting focus in the late 20th century to include the use of naturally ignited wildfires and prescribed fires to achieve resource objectives, the area affected by prescribed fire has been relatively small (approximately 2,000 acres per year over the last 15 years, Forest Activity Tracking System database). This represents only 0.33 percent of all MCD and PPF acres found in the forest; allowing tree densities, fuel loadings, and fuel continuity to result in landscape-scale crown fires in many areas. Current fire return intervals are highly departed from reference conditions (86 percent), as is fire severity. Nearly 40 percent of the MCD landscape now results in high-severity fire, and 30 percent occurs at moderate- or mixed-severity. Historically, these two severity categories only accounted for roughly 25 percent of all acres burned in this vegetation type (table 13). Recent research compiled from historical tree-ring data collected from fire-scarred trees within the Santa Fe Watershed, has shown that fire-related mortality due to mixed- to high-severity fire was rare within the study area (comprised of MCD and PPF forest types); the rare occurrences were predominantly documented within the dry mixed conifer forest type (Margolis et al. 2020, unpublished).

Over 70 percent of the MCD landscape in the Santa Fe NF is currently in the large tree, closed-canopy state, a departure from the 5 percent that occurred historically in this seral state when MCD was dominated by open, uneven-aged forests (table 13). Overall, seral state proportions have shifted significantly (74 percent departure) from reference condition proportions. The biggest shift has been from reference conditions of stands comprised of medium-sized trees with varied canopy closure to those characterized by large trees and closed canopies. The areas that have been classified by the models as states H, I, L, and M indicate that large (dominant) trees are present on the landscape, along with many small to mid-diameter stems creating closed conditions meeting the reference state. There have also been reductions in seral state proportions of early successional states including grass/recently burned lands, and aspen deciduous states (table 13).

Outside of changes to tree structure and composition, the reduced frequency of fire within MCD has also contributed to increased patch sizes, which are drastically increased from historic conditions at an average of 247 acres. Snag density for stems (8 to 17.9 inches dbh) has risen to 24 snags per acre, 15 more per acre than the historic average, while larger (over 18inches dbh) snags have remained consistent at 3.5 snags per acre. Coarse woody debris loading is highly departed (78 percent) from reference levels of 15.2 tons per acre at the current average of 69.3 tons per acre within the MCD forest type.

Table 13. Comparison of reference conditions and current (plan scale) conditions for mixed-conifer frequent fire (MCD) in Santa Fe NF, 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A, N, B, F	Non-tree, recently burned, grass, forb, and shrub types	20	10
C	All aspen, deciduous tree mix, and evergreen-deciduous mix tree types	10	5
G	Seedling/sapling and small trees (5 to 9.9 inches), all cover classes	5	11
J, K	Medium trees (10 to 19.9 inches dbh), all cover classes	60	1
H, I, L, M	Large trees (20 inches or larger), closed canopy	5	72
D, E[2]	Large trees (20 inches or larger), open canopy	0	1
	Average patch size in acres	0.02 to 50	247
	Understory Structure and Composition		
	Similarity to site potential (%)	100	67
	Bare Soil (%)	5	7
	Veg. BA (%)	7	7
	Fire		
	Fire Return Interval (years)	5 to 21	152
	Fire Severity (%) Low Moderate High	 75 18 7	 31 29 39

[1] Based on LANDFIRE 2010.

[2] Contemporary landscapes only; historically rare or localized

Ponderosa Pine Forest (PPF)

Note: PPF encompasses the subclasses: ponderosa pine bunchgrass (PPG) and ponderosa pine/evergreen oak (PPE).

Ponderosa pine forest is the second most prevalent ERU found in the Santa Fe NF, where it is dispersed fairly evenly and covers 403,915 acres (24 percent) of the forest. Ponderosa pine forests are found at elevations ranging from 6,000 to 9,000 feet on igneous, metamorphic, and sedimentary parent soils with good aeration and drainage. The dominant species in this system is ponderosa pine, but Gambel oak, piñon pine, one-seed juniper, and Rocky Mountain juniper may also be present. There is typically a shrubby understory mixed with grasses and forbs; however, this type sometimes occurs as savannah with extensive grasslands interspersed between widely spaced clumps or individual trees.

Ponderosa pine forests are adapted to drought during the growing season, and have evolved several mechanisms to tolerate frequent, low-intensity surface fires, such as thick bark and the ability to self-prune. A historical fire regime of frequent, low-severity surface fires (every 4 to 30 years) is widely documented, but there is growing evidence of limited scale areas of historical mixed-severity and high-severity fires, especially for steep slopes in areas of heterogeneous topography (Morgan et al. 2001, Iniguez et al. 2009, Meyer and Frechette 2010). Moreover, changes in the historic fire regime have led to increased fuel loading and continuity across the landscape and have contributed to increased severity and size of crown fires (Fulé et al. 2004, Romme et al. 2009b). As wildfire occurs, more high-severity fires are likely, creating large patch sizes and resulting in lowered site productivity. Severe fires also result in lower cover of native grasses (Armour et al. 1984), reduced herbaceous diversity, and impaired understory conditions; specifically, for the ponderosa pine forest bunchgrass type where herbaceous cover is important in maintaining surface fuels and the natural fire regime.

Despite fire management practices shifting focus in the late 20th century to include the use of naturally ignited wildfires and prescribed fires to lessen wildfire severity and restore more natural fire regimes, the area affected by prescribed fire has been relatively small (approximately 2,000 acres per year over the last 15 years, FACTS). This represents only 0.33 percent of all PPF and MCD acres found in the forest.

At the plan scale, only 3 percent of the Santa Fe NF PPF landscape is similar to reference conditions. Just over 70 percent of the landscape has moved into closed-canopy states, with 60 percent representation in the medium to large tree states, and 11 percent in the small-diameter tree state (table 14). Another 11 percent of PPF in the Santa Fe NF is found in the open canopy, medium to large tree states. The limited remaining proportions are found in early successional states (table 14).

Reference patch sizes were very small in size as a result of the heterogeneous variation in structure and large interspaces. Shifts in overstory structure from historically open canopies to closed canopies, combined with limited disturbance, have resulted in a significant departure (97 percent) within PPF. Currently, patches average 72 acres in size. With limited variation between local zones, snag densities at the plan scale differ slightly from any one local zone, with roughly 1 large-diameter (over 18 inches dbh) snag and 8 smaller-diameter (8.0 to 17.9 inches dbh) snags per acre. Coarse woody debris loading is highly departed (79 percent) from historic reference conditions at 42.3 tons per acre.

Table 14. Comparison of reference conditions and current (plan scale) conditions for ponderosa pine forest (PPF) in Santa Fe NF, 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
J, K	Multi-storied, open canopy with medium to large trees (10 inches dbh)	100	3
A, N[2]	Recently burned, grass, forb, and shrub types	0	3
B, F[2]	Seedling/sapling, all cover classes	0	7
C2	Small trees (5 to 9.9 inches), open canopy	0	5
D, E[2]	Medium to large trees (10 inches or larger dbh), open canopy	0	11
G[2]	Small trees (5 to 9.9 inches dbh), closed canopy	0	11
H, I, L, M[2]	Medium to large trees (10 inches or larger dbh), closed canopy	0	60
	Average patch size in acres	0.02 to 1	72
	Understory Structure and Composition		
	Similarity to site potential (%)	100	63
	Bare Soil (%)	13	13
	Veg. BA (%)	13	9
	Fire		
	Fire Return Interval (years)	4 to 30	203
	Fire Severity (%)		
	Low Moderate High	95 1 4	55 29 16

[1] Based on LANDFIRE 2010.

[2] Contemporary landscapes only; historically rare or localized

Site potential is moderately departed at 37 percent, with invasives like bull thistle, nodding plumeless thistle, and Canada thistle displacing native species. Vegetative ground cover, similarly, is 37 percent departed, given that ground cover for reference conditions (13.4 percent) is higher than the 8.5 percent cover found currently at the plan scale. Though the absence of fire (up to 200-year exclusion in some areas in the Santa Fe NF) is partially responsible for the reductions in desired ground cover and increased tree densities, other disturbances like drought, concentrated recreation, and biological pests (insects such as the bark beetle, dwarf mistletoe, disease, and invasive species) also influence the structure and condition of ponderosa pine forests. Southwestern dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) is the most damaging pathogen in PPF in the Santa Fe NF. The parasitic plant is persistent and chronic, increasing over the past century due to harvesting practices that allowed densely stocked young trees to become established under infected overstory seed trees.

Spruce-Fir Forest (SFF)

Spruce-fir forest is the third largest ERU in the Santa Fe NF, covering 250,481 acres (14.9 percent). Also known as subalpine conifer forests, spruce-fir forests range in elevation from 9,500 to over 11,500 feet, giving it the highest elevation range of any major forest type in the southwestern United States. The spruce-fir forest occurs along gentle to very steep mountain slopes and is comprised almost entirely of Engelmann spruce and corkbark fir (subalpine fir) associations, which dominate the higher-elevations (10,500 to over 11,500 feet) of this forest type. In lower elevations (9,500 to 10,500 feet), spruce-fir forests resemble wet mixed conifer forests with Douglas-fir and quaking aspen. Here, aspen occur as a seral component that may be co-dominant or dominant in the canopy. Common understory species in SFF include spruce-fir fleabane, currants, maple, huckleberry, sedges, and clover. Montane-subalpine grasslands can also be found scattered throughout the spruce-fir forest type.

Important drivers of vegetation dynamics within spruce-fir forests include a diverse disturbance regime that is dominated by wind, insects, fire, climate variation, and human-caused disturbances. Drought and fire infrequently occur and affect the spruce-fir forest on a large scale, while insects, disease, and wind are more frequent disturbances and occur on smaller scales.

Historically, fires in the lower elevations of SFF consisted of small to large crown and surface fires, where fires typically burned with moderate to high severity. Higher elevation spruce-fir forests burned less frequently than the lower elevations, but often with stand-replacing severity. Research provides evidence that stand-replacing fires within spruce-fir forests, which historically occurred in patch sizes of up to 521 hectares (1,287 acres), are within the normal range of variability and often promote aspen regeneration (Margolis et al. 2011). Drought was a major factor in the most recent stand-replacing fire (year 1685) in the spruce-fir forest within the Santa Fe Municipal Watershed (Margolis and Balmat 2009). Fire frequency within SFF in the Santa Fe NF currently occurs approximately every 222 years, fitting within the historical fire regime. However, fire severity has moderate departure from historic conditions, where severity has shifted from predominantly moderate to high severities to a much higher proportion of low severity fire within this forest type (table 15). In SFF, fire regime condition class (FRCC) departure is moderate (level 2), meaning that moderate levels of treatment would be needed to return this system to a natural fire regime in the future.

Outside of fire, windthrow is the second largest disturbance factor in spruce-fir forests (Battaglia and Shepperd 2007); older trees are more susceptible to windthrow than younger trees. Widespread mortality from windthrow can increase fire severity and trigger insect outbreaks (Battaglia and Shepperd 2007). Various sizes and severities of insect outbreaks have been documented in the Santa Fe, but the most notable outbreak event on record originated from high winds in the Jemez Mountains in October 1971. That storm downed numerous spruce trees, which triggered a spruce beetle outbreak that lasted from 1974 to 1977, and covered over 75,000 acres of the Cuba, Coyote, and Española Ranger Districts (Lessard 1976). Periodic bark beetle outbreaks will continue to be a part of the disturbance patterns that shape the spruce-fir forests into the future.

At the plan scale, seral state proportions are fairly similar to historical proportions for early to mid-seral states. Conversely, medium (10.0 to 19.9 inches dbh) and large tree (greater than 20.0 inches dbh) seral states have exhibited a large shift relative to reference conditions (table 15). Historically, the majority of SFF occurred as late seral, large tree states. In contrast, 68 percent of SFF in the Santa Fe NF currently occurs in medium tree states, leaving only 4 percent in the desired late seral, large tree state (table 15). Overall, these seral state transitions are indicative of a moderate departure (54 percent) from desired conditions and have likely been influenced by prolonged drought and other forms of disturbance.

Currently in SFF, understory composition is moderately departed (32 percent), due in part to invasions by Canada thistle and nodding plumeless thistle, while vegetative ground cover and bare soil exhibit low departure from desired conditions. The number of snags per acre has declined, especially in the smaller diameter class (8.0 to 17.9 inches dbh), where snags have decreased to 12 per acre from a 25 snags per acre reference level. Despite the number of snags 18.0 inches or greater in diameter being more prevalent in the forest (5.2 snags per acre), departure from reference conditions is still moderate (42 percent; 9 snags per acre). Additionally, coarse woody debris has increased to 69.9 tons per acre (47 tons per acre reference) in SFF, at least partially due to high site productivity and long fire return intervals (200 to 400 years).

Table 15. Comparison of reference conditions and current (plan scale) conditions for spruce-fir forest (SFF) in Santa Fe NF 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A, K	Non-tree, recently burned, grass, forb, and shrub types	9	6
B, T	All aspen, deciduous tree mix, and evergreen-deciduous mix tree types	13	13
C, G, P, L	Seedling/sapling and small trees (5 to 9.9 inches), all cover classes	20	9
D, M, H, Q	Medium trees (10 to 19.9 inches dbh), all cover classes	14	68
E, N, F, O	Large trees (20 inches or larger), closed canopy	44	4
I, R, J, S	Large trees (20 inches or larger), open canopy[2]	0	0
	Average patch size in acres	200 to 1,000	1,017
	Understory Structure and Composition		
	Similarity to site potential (%)	100	68
	Bare Soil (%)	2	3
	Veg. BA (%)	7	6
	Fire		
	Fire Return Interval (years)	200 to 400	222
	Fire Severity (%)		
	Low Moderate High	0 32 68	34 22 45

[1] Based on LANDFIRE 2010.
[2] Contemporary landscapes only; historically rare or localized.

Mixed Conifer with Aspen (MCW)

Mixed conifer forests with aspen, also referred to as wet mixed conifer, cover 40,174 acres (2.4 percent) within the Santa Fe NF. In the Rocky Mountains and Madrean Provinces, wet mixed-conifer forests may be found at elevations between 9,000 and 11,000 feet, situated between ponderosa pine forests below and spruce-fir forests above. Wet mixed-conifer stands typically occur on moist north and east aspects, lower slopes, and forested valley bottoms. These forests are more common at high elevations, where soils may contain more moisture. MCW stands generally have a dense structure, where dominant and codominant vegetation varies in elevation, moisture availability, and seral stage of the forest patches. Douglas-fir, southwestern white pine, white fir, and Colorado blue spruce occur as dominant and or co-dominant conifer species, limber and ponderosa pines may have a minor presence, and Engelmann spruce and subalpine (corkbark) fir are absent. Quaking aspen is dominant in even-aged stands in areas that have experienced great disturbance. Understory vegetation is composed of a wide variety of shrubs, graminoids, and forbs, depending on soil type, aspect, elevation, disturbance history, and other factors. Disturbances here occur on two general scales: large-scale, infrequent disturbance (fire, drought), and small-scale, frequent disturbances (insect, disease, wind, fire).

MCW is distinguished from dry-mixed conifer (MCD) by less frequent mixed- to high-severity fire, as well as the presence of quaking aspen in a post-disturbance seral state. Currently, in the Santa Fe NF, the majority of MCW acres fall into two state groups, where 58 percent of acres reside within medium tree (10 to 19.9 inches dbh) states and 25 percent of acres occur in aspen or a deciduous-mix state (table 16). Minimal acres were found in large tree, closed-canopy states (less than 1 percent) at the plan scale, which historically accounted for the majority of this ecosystem. This change in states from historic reference conditions represents a moderate departure (50 percent) in structure and seral state conditions.

With 6 percent of acres currently in the grass, forb, or shrub states (A, K), vegetative ground cover is similar to proportions found in the reference condition. Conversely, proportions in the amount of bare soil have doubled from what is expected in referenced conditions (table 16).

Snags in MCW are more abundant on the current landscape than what existed historically (14.0 snags per acre 8 to 17.9 inches dbh; 4 snags per acre larger than 18 inches dbh), with 22 snags per acre in the smaller size class and 5.2 snags per acre in the larger size class. Although snags on the landscape have increased and are a great benefit to wildlife, average patch size in MCW has decreased considerably from 100 to 400 acres to an average of 57 acres, potentially fragmenting corridors and habitat for MCW-dependent species like the Mexican spotted owl that relies on larger patches of continuous forest for all or part of their life-cycle requirements.

Within MCW, coarse woody debris loadings are approaching the high departure category (64 percent) at loadings of 79.1 tons per acre at the plan scale. The large departure in CWD loading (reference is 28.7 tons per acre) occurs despite current fire return intervals in MCW being within the range of natural occurrences (table 16). This outcome is partially a result of the high frequency of fire (24-year cycles) in the northeast zone (Pecos and Las Vegas) that decreased the average to 238 years at the plan scale; without which, the fire return interval would be closer to 531 years. The skewing of severity from the low and moderate categories into the high-severity class (table 16) is likely attributable to prolonged drought and differences in fuel loading within the contemporary composition of this forest type. These factors contribute to the moderate (level 2) FRCC departure within MCW. At this level of departure, moderate levels of treatment would be effective at returning MCW to a natural fire regime.

Table 16. Comparison of reference conditions and current (plan scale) conditions for mixed-conifer with aspen (MCW) in Santa Fe NF, 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A, K	Non-tree, recently burned, grass, forb, and shrub types	7	6
B, T	All aspen, deciduous tree mix, and evergreen-deciduous mix tree types	21	25
C, G, P, L	Seedling/sapling and small trees (5 to 9.9 inches), all cover classes	18	11
D, M, H, Q	Medium trees (10 to 19.9 inches dbh), all cover classes	14	58
E, N, F, O	Large trees (20 inches or larger), closed canopy	40	0
I, R, J, S	Large trees (20 inches or larger), open canopy[2]	0	0
	Average patch size in acres	100 to 400	57
	Understory Structure and Composition		
	Similarity to site potential (%)	100	67
	Bare Soil (%)	2	5
	Veg. BA (%)	9	8
	Fire		
	Fire Return Interval (years)	50 to 500	238
	Fire Severity (%)		
	Low	30	22
	Moderate	36	27
	High	34	51

[1] Based on LANDFIRE 2010.

[2] Contemporary landscapes only; historically rare or localized.

Non-forested ERUs

Piñon-Juniper Grassland (PJG)

Piñon-juniper grassland covers 43,356 acres (2.6 percent) of the Santa Fe NF, generally found at lower elevations (e.g., under 7,500 ft.). PJG is typically found on sites with well-developed, loamy soil characteristics, including gentle upland and transitional valley locations, where soil conditions favor grasses (or other grass-like plants), but can support at least some tree cover. Moreover, some areas have sparse tree cover because of climatic limitations on woody plant growth. Tree species include two-needle piñon, one-seed juniper, Utah juniper, and occasionally alligator juniper. Native understories are made up of predominantly cool season, perennial grasses including mutton grass, squirrel tail, and western wheatgrass alongside both annual and perennial forbs, while shrubs are absent or scarce (less than 1 percent cover) (Miller et al. 1993).

Despite changes across many of the key ecosystem characteristics, specifically the lack of fire, seral state distribution has changed only moderately (44 percent). The majority of the PJG landscape still occurs in open canopy states (55 percent, table 17), unlike many of the other vegetation types found in the Santa Fe NF. Like other vegetation communities, PJG has an overrepresentation in smaller diameter trees, with 60 percent of acres currently in these states (B, C, E, and F). However, from a structural standpoint, the largest departure in seral state proportions is the underrepresentation of open large tree sites (state D), which currently exists on only 5 percent of the PJG landscape. This a vast change from reference conditions where 50 percent of acres were in large tree states (table 17).

The influx of smaller diameter trees has created stands of continuous tree canopies, leading to increases in average patch size (93 percent departure) and horizontal fuel continuity. Within PJG currently, snags per acre are modestly departed (21 percent) and coarse woody debris loadings are highly departed (71 percent) from reference conditions. Coarse woody debris loadings on PJG have reached 12.3 tons per acre, an increase from the 3.5 tons per acre expected based on referenced site conditions.

Changes to the overstory structure of PJG have also affected the diversity, density, and vigor of herbaceous understory plants (38 percent departure), leading to increased dominance of warm season species such as blue gramma, and has supported uncharacteristically high shrub cover. However, despite reductions in vegetative ground cover, PJG has the lowest departure (23 percent) for similarity to site potential of all vegetation types analyzed in the Santa Fe NF.

When alterations to understory vegetation are combined with increased bare soil percentages, these changes may impede fuel continuity in some PJG sites with insufficient understory vegetation to carry surface fire. Currently, the fire return interval is highly departed (97 percent; table 17) with greater than 1,000-year returns. Fire severity has also departed from reference conditions with a much greater proportion of fires occurring with low severity, and marginally less occurring with moderate severity; high-severity proportions are similar to historic levels. These factors have contributed to a moderate departure in FRCC (level 2).

Table 17. Comparison of reference conditions and current (plan scale) conditions for piñon-juniper grasslands in Santa Fe NF 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A	Recently burned, grass, forb, and shrub types	5	16
B, C, E	All seedling/sapling; small trees (5 to 9.9 inches), open canopy	25	50
D	Medium to large trees (10 inches or larger), open canopy	50	5
F	Small trees (5 to 9.9 inches), closed canopy	10	10
G	Medium to large trees (10 inches or larger), closed canopy	10	19
	Average patch size in acres	0.07 to 1	15
	Understory Structure and Composition		
	Similarity to site potential (%)	100	72
	Bare Soil (%)	27	45
	Veg. BA (%)	22	16
	Fire		
	Fire Return Interval (years)	8 to 36	>1,000
	Fire Severity (%)		
	Low	6	28
	Moderate	65	42
	High	29	30

[1] Based on LANDFIRE 2010

Juniper Grassland (JUG)

Roughly 90 percent of all JUG acres are in the central and western half of the Santa Fe NF, accounting for 97,470 acres (5.8 percent) forestwide. JUG is typically found on warmer and drier sites beyond the environmental limits of piñon pine, and just below (and often intergrading with) the piñon-juniper zone (under 7,500 feet in elevation). Generally, these types are most extensive in geographic areas dominated by warm (summer) season or bi-modal precipitation regimes. Overall, JUG sites are less productive for tree growth than the piñon-juniper woodland (PJO) type.

Disturbances (fire, insects, and disease) in JUG typically occur with low severity and high frequency. JUG sites historically have an average fire return interval of 8 to 30 years from low–moderate severity fire (Hauser 2007, Margolis 2014). Within JUG, disturbance patterns create and maintain the uneven-aged, open-canopy structure that is characteristic of this type. Compositionally, trees occur as individuals or in small groups, shrubs are absent or scattered, and understory grasses and forbs alternate with small patches of bare soil. Typically, native understory grasses are perennial species, while forbs consist of both annuals and perennials. The average patch size, according to reference conditions, is less than 1 acre. In the Santa Fe NF, average patch sizes have increased to 16 acres in size (on average), which is a 97 percent departure from reference conditions.

Seral state proportions at the plan scale, which are moderately departed (45 percent), display an overrepresentation in early successional states and late-successional closed sere (seral state G; table 18). The medium to large tree, open seral state that was once dominant (50 percent) on the JUG landscape, is greatly under represented on the current forest landscape (1 percent; table 18). Seedling/sapling and small trees with open canopy seral states (B, C, and E) dominate the current landscape (66 percent) accounting for over half of all acres found in this ecosystem (table 18).

Vegetative ground cover and site potential (44 percent) are moderately departed. Of the woodland types found in the Santa Fe NF, JUG has the most extensive documented occurrences of invasives with 1,560 acres (1.6 percent) infested with bull thistle, Russian olive, salt cedar, or Siberian elm. Yet, unlike other ERUs, alterations in the species composition has not resulted in a noticeable increase in the proportion of bare soil (10 percent departed), despite a moderate reduction in vegetative basal area (41 percent). Decreases in vegetative ground cover can, however, be attributed to increases in woody biomass, including coarse woody debris, which has increased significantly to current levels of 13.7 tons per acre from the 3.0 tons per acre average of reference conditions. Snag densities display low departure at the plan scale, averaging 3 per acre (greater than 8 inches dbh) and 0.6 per acre (greater than 18 inches dbh). The increases in coarse woody debris and snag density are similar to proportional increases observed in other vegetation types, and likewise, can also be linked to the absence of wildland fire. Fire frequency at the plan scale is 831 years on average, which is highly departed (96 percent) from its natural range. However, in the infrequent instances in which fire does occur within JUG, fire severity has remained consistent with natural levels. Lastly, the FRCC of JUG is moderately departed at level 2, though conditions are approaching high FRCC departure.

Table 18. Comparison of reference conditions and current (plan scale) conditions for juniper grasslands in Santa Fe NF 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A	Recently burned, grass, forb, and shrub types	5	0
B, C, E	All seedling/sapling; small trees (5 to 9.9 inches), open canopy	25	66
D	Medium to large trees (10 inches or greater), open canopy	50	1
F	Small trees (5 to 9.9 inches), closed canopy	10	33
G	Medium to large trees (10 inches or greater), closed canopy	10	0
	Average patch size in acres	0.07 to 1	16
	Understory Structure and Composition		
	Similarity to site potential (%)	100	56
	Bare Soil (%)	27	30
	Veg. BA (%)	13	8
	Fire		
	Fire Return Interval (years)	8 to 30	831
	Fire Severity (%) Low Moderate High	 82 12 6	 80 16 3

[1] Based on LANDFIRE 2010

Sagebrush Shrubland (SAGE)

Sagebrush shrubland primarily occurs adjacent to Great Basin grasslands and persistent piñon juniper woodlands (PJO). Occupying 37,457 acres (2.2 percent) of the Santa Fe NF, sagebrush shrubland is primarily found in the northwestern portion of the Santa Fe NF. Sagebrush shrubland sites are usually found on deep, well-drained valley bottom soils between 6,200 and 7,800 feet in elevation, where precipitation ranges between 10 to 18 inches per year. While big sagebrush (*Artesmisia tridentata*) is the dominant species, other shrubs and grasses and forbs are present. Historically, sagebrush shrublands had patchy areas of shrubs with a combination of forbs, bunchgrasses, and bare soil patches interspersed in the understory openings (Boyle and Reeder 2005). Sagebrush shrublands can provide important habitat for large game animals. Unfortunately, the loss and degradation of these systems is widely documented in the West (Saab et al. 1995).

Historically, the majority (55 percent) of SAGE acres were in an open cover shrub state across the landscape. Sagebrush shrublands currently have 26 percent of acres in the open cover shrub state (table 19), characterizing a moderate departure (41 percent) in seral state at the plan scale.

Sagebrush shrublands are, or at least once were, fire-adapted ecosystems. Historically, fire created a mosaic of burned and unburned patches at landscape scales, where some areas burned as frequently as every 12 years in moderate surface fire, and other areas burned with stand-replacing severity every 70 years depending on site moisture (Wright and Bailey 1982, Miller and Tausch 2000). Moreover, some sagebrush shrublands burned over longer fire return intervals (fire regime III; fire return of 35 to 200 years; or 100 to 240 years, Baker 2006). While fire is the principal means of renewal for decadent stands of the dominant or codominant Wyoming big sagebrush (*Artemisia tridentada* var. *wyomingensis*), fire does not stimulate germination (as they are killed by fire), but creates establishment sites with plants emerging from the seedbank or as seed from remnant plants that escaped fire (Howard 1999). Many other shrubs in our contemporary sagebrush shrublands are not adapted to fire, therefore, the appropriateness of fire must be evaluated and based on the site potential, species composition, and site conditions (e.g., presence of exotic species). For example, Baker (2006) recommends that fire should be avoided in areas where cheatgrass (*Bromus tectorum*) is present, though this species is not currently a problem in the Santa Fe NF. Today, sagebrush shrublands in the Santa Fe NF have highly departed fire regimes with greater than 1,000-year return intervals. When fires do occur, they burn with very low severity, due to the lack of a grassy understory component and closed-canopy conditions. SAGE is currently highly departed at FRCC Level 3.

Table 19. Comparison of reference conditions and current (plan scale) conditions for sagebrush shrubland in Santa Fe NF, 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A	Recently burned; All grass and forb types; sparsely vegetated	15	14
B	All closed cover shrub types	30	19
C, D	All open cover shrub types	55	26
E[2]	Tree invaded	0	41
	Average patch size (acres)	152-407	152
	Understory Structure and Composition		
	Similarity to site potential (%)	100	60
	Bare Soil (%)	39	68
	Veg. BA (%)	18	8
	Fire		
	Fire Return Interval (years)	12 to 70	>1,000
	Fire Severity (%) Low Moderate High	 0 24 76	 96 4 0

[1] Based on LANDFIRE 2010.

[2] Contemporary landscapes only; historically rare or localized.

The absence of fire has not significantly affected patch sizes within SAGE, as it has in other vegetation types in the Forest. Here, the average patch size for SAGE is currently 152 acres, fitting just into the low end of the natural range of variability at 152 to 407 acres. Conversely, the lack of a fire disturbance in sagebrush shrublands has led to a significant proportion (41 percent) of the Santa Fe NF SAGE landscape to be invaded by trees and other woody shrub species (State E; table 19). This tree-invaded condition was not a recognized condition state historically when moderate- to high-severity fire recurred frequently. Saab and others (1995) have documented that tree establishment is the result of a combination of causes including historical overgrazing, which limited fine fuel continuity, altered fire regimes, and contributed to nonnative plant invasions into sagebrush habitat. As a result of the increased incursion of nonnatives and trees, sagebrush vegetative basal area has been reduced in comparison to the desired reference conditions (table 20). Furthermore, ground cover analysis indicated that much of this area (68 percent) is now bare ground. Drought and sagebrush disease are also major concerns and can be intensified by pressure from heavy domestic grazing or wild ungulate use (Winward 2004).

Colorado Plateau/Great Basin Grassland (CPGB)

The Colorado Plateau Great Basin grassland ERU covers 41,639 acres (2.5 percent) within the Santa Fe NF. In general, CPGB is found along elevational and temperature gradients above semidesert grasslands and below montane-subalpine grasslands with vegetation coverage consisting of mostly grasses and interspersed shrubs. It occupies cooler and wetter sites than semidesert grasslands. CPGB is typically associated with PJG along the grassland-woodland ecotone in cool climates. Vegetation coverage consists of mostly grasses and interspersed shrubs. Grass species may include, but are not limited to, Indian ricegrass, threeawn, blue grama, fescue, needle and thread grass, spike fescue, muhly, James' galleta, and Sandberg bluegrass. Shrub species may include sagebrush, saltbush, *Ephedra*, snakeweed, winterfat, one-seeded juniper, Utah juniper, and wax currant.

Currently, 61 percent of the CPGB acres within Santa Fe NF occur in a mid-seral state and 37 percent occur in a low-seral, ruderal invaded state, which is highly departed from the reference conditions (table 20).

Changes to seral state distribution and the moderate amount of understory vegetation departure (40 percent), can be attributed to the prolonged absence of fire, overgrazing, and the establishment of exotic species (primarily cheatgrass). The shift in ground cover, both from alterations in site potential toward exotics and moderate increases in the amount of bare soil, have contributed to fire frequencies well outside the natural range of variability.

Historically, CPGB systems were maintained by periodic fires that set back succession to woody species, but a history of fire suppression has allowed the widespread encroachment of shrubs and trees (Humphrey 1958, McPherson et al. 1995). Current fire return intervals average over 1,000 years at the plan scale and have a highly departed FRCC at level 3. Historically, fires in CPGB occurred every 10 to 30 years with low-moderate severity (Wright and Bailey 1982). These periodic, low-moderate severity fires also historically maintained the patch sizes of this ecosystem, which are currently only slightly departed (21 percent) from reference condition averages at the plan scale (table 20) in the absence of periodic fire.

Table 20. Comparison of reference conditions and current (plan scale) conditions for Colorado Plateau/ Great Basin (CPGB) grassland in Santa Fe NF 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A	High seral: perennial grasses, shrub/tree cover less than 10 percent, grass cover greater than 30 percent	70	0
B	Mid-seral; perennial mixed grasses, tree/shrub cover less than 10 percent, grass cover less than 10 percent, includes post-fire plant communities previously high seral	5	61
C	Low-mid seral; perennial mixed grasses, shrub/tree cover 10 percent or greater, grass cover 10 percent or greater	25	2
D, E, F	Low-seral; ruderal/exotic grasses and forbs; Shrub and tree invaded[2]	0	37
	Average patch size (acres)	295 to 513	233
	Understory Structure and Composition		
	Similarity to site potential (%)	100	60
	Bare Soil (%)	31	48
	Veg. BA (%)	26	17
	Fire		
	Fire Return Interval (years)	10 to 30	>1,000
	Fire Severity (%) Low Moderate High	 42 58 0	 69 25 6

[1] Based on LANDFIRE 2010.

[2] Contemporary landscapes only; historically rare or localized.

Montane Subalpine Grassland (MSG)

Montane subalpine grasslands (MSG) occur on 17,707 acres (1.05 percent) within the Santa Fe NF, making it the least represented upland ERU that has been analyzed. MSG occurs at elevations ranging from 8,000 to 11,000 feet in various sized openings within spruce-fir, mixed-conifer, and ponderosa pine forests. Trees may occur along the periphery of the meadows, and some shrubs may also be present. These meadows are seasonally wet, which is closely tied to snowmelt, but they typically do not experience flooding events.

Montane subalpine grasslands support a diverse understory composed of bunchgrasses, perennial and annual forbs, sod-grasses, and sedges. These meadows often have higher herbaceous species richness than adjacent forest. Here, vegetative compositions depend on soil texture, soil moisture, elevation, site exposure (e.g., ridges), and disturbance (Brown 1995). Coop and Givnish (2007) suggest that frequent fire was the single most important factor in maintaining the grassy understory of montane subalpine grasslands, especially on steep, high-elevation slopes. Other major disturbance factors for these ecosystems are climate (low temperature, frost, snowpack) and herbivory (Coop and Givnish 2007).

At the plan scale, seral state proportions are 60 percent departed from reference conditions as adapted from LANDFIRE reference condition models (Smith et al. 2009). The majority of the current departure in vegetation structure is marked by a transition toward an uncharacteristic shrub and tree invaded state, given that 60 percent of MSG acres are now classified as invaded (table 21). The invaded state is a result of reduced fire disturbance, climatic variation, and decreased competitive ability of certain species from over-utilization by large herbivores (Fletcher and Robbie 2004, Zier and Baker 2006, Vankat 2013). Woody species encroachment has fragmented the MSG system (Fletcher and Robbie 2004), reducing current average patch sizes to 53 acres, roughly half the size that existed historically. Therefore, patch size is moderately departed (44 percent) from reference conditions at the plan scale.

The encroachment of trees and the absence of fire has impacted understory compositions and conditions. The percent of bare soil is highly departed (70 percent) from reference conditions, increasing to an average of 14 percent. There has also been a substantial reduction (41 percent departure) in the amount of vegetation basal area within MSG. Existing vegetation species compositions within MSG have been altered significantly (59 percent) by nonnatives and invasives, such as Kentucky bluegrass, leading to moderate departure (59 percent) in similarity to site potential. Primary causes of these changes in the understory include long-term drought intensified by ungulate grazing and human disturbances (road construction, fire suppression and rehabilitation), and concentrated recreation (Vankat 2013).

Table 21. Comparison of reference conditions and current (plan scale) conditions for montane subalpine grasslands in Santa Fe NF, 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A	Low-seral - recently burned; sparsely vegetated; grass cover < 10%	20	1
B, C	Mid and High seral - all grass and forb types; shrub & tree cover < 10%, grass cover >10%	80	39
D[2]	Tree and/or shrub invaded	0	60
	Average patch size (acres)	94 to 122	53
	Understory Structure and Composition		
	Similarity to site potential (%)	100	41
	Bare Soil (%)	4	14
	Veg. BA (%)	52	31
	Fire		
	Fire Return Interval (years)	2 to 22	261
	Fire Severity (%) Low Moderate High	 22 10 68	 70 20 10

[1] Based on LANDFIRE 2010.

[2] Contemporary landscapes only; historically rare or localized.

Montane grasslands are characterized by a historic fire regime of 2- to 22-year fire return intervals (Dick-Peddie 1993, White 2002) with stand-replacing fire severity (over 75 percent mortality). Currently, the fire return interval is highly departed at a frequency of 261 years. Also, in contemporary MSG systems, infrequent fires are occurring at low severities, which does not produce the level of disturbance necessary to thwart encroaching trees or maintain diverse ground cover. These factors have contributed to a high departure in FRCC, currently at level 3, indicating a great risk for losing key ecosystem components within MSG.

Non-forest ERUs without Plan Components

Piñon-Juniper Woodland (PJO)

Persistent piñon-juniper woodlands, which cover 231,508 acres (13.8 percent) of the Santa Fe NF, are found on lower slopes of mountains and in upland, rolling hills at approximately 5,500 to 8,500 feet in elevation. These woodlands range from young to old in age, but are typically found as large, even-aged structured patches. Persistent PJO characteristically has a moderate to dense tree canopy and a sparse understory of perennial grasses, annual and perennial forbs, and shrubs. The canopy is commonly composed of two-needle piñon pine and one-seed juniper, though other areas contain Utah juniper and Rocky Mountain juniper. Woodland development occurs in distinctive phases, ranging from open grass-forb, to mid-aged open canopy, to mature closed canopy. Some PJO on broken or rocky terrain exhibits little to no natural fire, thus, insects and disease may be the only disturbance agents. Mistletoe has also caused gradual tree decline within PJO and has increased susceptibility to beetle infestation and drought.

Overall, at the plan scale, persistent PJO is in low departure, as a result of its long and slow successional pattern and varied dependence on fire to maintain its structural composition. Drought conditions beginning in the late 1990s initiated a bark beetle outbreak from 2002 to 2004 that killed a significant portion of the piñon pine component in some woodlands of central and northern New Mexico (Ryerson 2014). As a result, there are considerably more snags and coarse woody debris than is typical in PJO, where snags are departed from the reference condition of 2 per acre to 9 per acre in the greater than 8-inch diameter class (table 22). Furthermore, coarse woody debris loadings have increased from 4.1 tons per acre to 17.4 tons per acre. In addition to altering fuel loads, increased snags and coarse woody debris contribute to the partial reductions we currently see in vegetative cover. Moreover, understory compositions in PJO have been moderately impacted (36 percent departure) by invasive species such as bull thistle, Russian olive, salt cedar, and Siberian elm.

Despite some fire disturbance in the central (Los Alamos, Caja del Rio) and northeast (Pecos and Las Vegas) zones, the majority of PJO acres have been almost completely devoid of fire. The absence of fire within PJO has precipitated a shift in the fire interval from a 30- to 400-year cycle to over 1,000-year cycles (97 percent departure) and a shift from moderate-high severity to lower fire severity (moderate departure; table 22). Furthermore, FRCC for PJO is moderately departed with the majority of acres (64 percent) exhibiting level 2 departure (see table 12). This shift in fire regime, coupled with grazing and drought has likely influenced the reduction in patch sizes of persistent PJO, which are currently outside of the natural range of variability (table 22).

Table 22. Comparison of reference conditions and current (plan scale) conditions for persistent piñon-juniper woodland (PJO) in Santa Fe NF, 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A	Recently burned, grass, forb, and shrub types	10	14
B, C, E	All seedling/sapling; small trees (5 to 9.9 inches), open canopy	5	30
D	Medium to large trees (10 inches or larger), open canopy	10	7
F	Small trees (5 to 9.9 inches), closed canopy	15	12
G	Medium to large trees (10 inches or larger), closed canopy	60	37
	Average patch size (acres)	50 to 400	29
	Understory Structure and Composition		
	Similarity to site potential (%)	100	64
	Bare Soil (%)	23	32
	Veg. BA (%)	20	13
	Fire		
	Fire Return Interval (years)	30 to 400	>1,000
	Fire Severity (%) Low Moderate High	 0 39 61	 54 33 13

[1] Based on LANDFIRE 2010.

Piñon-Juniper Sagebrush (PJS)

Piñon-juniper sagebrush (PJS) covers 30,449 acres (1.8 percent) of the Santa Fe NF and is concentrated in geographic areas dominated by cold season (winter) precipitation regimes and frigid soils. These systems have a distinct appearance of open woodland canopies interspersed by Colorado Plateau and Great Basin shrub species. Trees occur as individuals, or in smaller clumps that are often even-aged. Tree species composition varies throughout the region; piñon pine is occasionally absent, but one or more juniper species are always present. The understory is dominated by moderate to high density shrubs that are well distributed. Shrubs usually achieve high canopy cover during mature successional phases or where livestock grazing has favored their development over herb species, which are limited and are typically concentrated in canopy openings. Generally, the sparse native understory grass development includes perennial species, while forbs consist of both annuals and perennials.

At the plan scale, the open canopy, seedling/sapling and small tree states (states B, C, and E) are overrepresented (57 percent), while closed canopy, small trees (state F; 5 percent) and mid to late open seral states (4 percent) are underrepresented with respect to historic conditions, which divided seral states into relatively similar proportions (table 23).

Because fire plays a bigger role in maintaining seral state proportions in PJS compared to PJO, it is likely fire exclusion and legacy grazing have had a greater impact on departure in PJS. Fire has been absent in PJS in the Santa Fe NF according to fire records. FRCC is moderately departed overall, with some acres of PJS at level 2 and the majority (76 percent) at level 3 (see table 12). Furthermore, fire exclusion has resulted in a fire return interval that exceeds 1,000 years and is very highly departed from the 50- to 100-year cycles of mixed-severity fire (Gruell et al. 1994) that historically characterized PJS. These historic fires typically removed the shrub layer and killed many of the trees (Allen et al. 2008, Romme et al. 2009b). The absence of fire and other disturbance factors, drought, insects, and disease have contributed to current fuel loadings and quantity of snags across PJS. Coarse woody debris loadings are trending toward high departure (66 percent) with 8.8 tons per acre at the plan scale. Without the disturbance of fire, snag density has declined. At the plan scale, snag density is underrepresented in both the small diameter (over 8 inches dbh) at 3.6 snags per acre (6.0 reference) and large diameter (greater than 18.0 inches dbh; less than 1 snag per acre) snag classes.

Table 23. Comparison of reference conditions and current (plan-scale) conditions for piñon-juniper sagebrush in Santa Fe NF, 2017

State	Description	Reference Condition (%)[1]	Plan Scale (%)
	Overstory Structure and Composition, Seral State Proportion		
A	Recently burned, grass, forb, and shrub types	10	21
B, C, E	All seedling/sapling; small trees (5 to 9.9 inches), open canopy	25	57
D	Medium to large trees (10 inches or larger), open canopy	35	4
F	Small trees (5 to 9.9 inches), closed canopy	20	5
G	Medium to large trees (10 inches or larger), closed canopy	10	13
	Average Patch size (acres)	50-100	16
	Understory Structure and Composition		
	Similarity to site potential (%)	100	54
	Bare Soil (%)	24	41
	Veg. BA (%)	21	13
	Fire		
	Fire Return Interval (years)	50 to 100	>1,000

[1] Based on LANDFIRE 2010

The long-term absence of fire combined with effects of drought, legacy grazing impacts, development of roads or trails, and increased tree density have resulted in decreased grass cover. According to model outputs, ground cover has changed significantly in PJS, with moderate departures in both bare soil (increasing in proportion) and vegetative cover (decreasing in proportion) (table 23). Reduced vegetative cover and increased bare soil has led to the fragmentation of this vegetation type, which currently has average patch sizes of 16 acres (table 23). This is a high (69 percent) departure from the 50- to 200-acre patches characteristic of reference conditions.

Alpine and Tundra (ALP)

The Santa Fe NF has 5,015 acres (0.3 percent of total acres) within the alpine and tundra type classification. Alpine and tundra are typically found on a range of slopes, flat ridges, saddles, and high basins (Wahlberg et al. 2014), and typically occur at elevations over 11,800 feet. on the Santa Fe NF. Alpine and tundra often include barren talus, scree fields, or meadow-like areas characterized by herbaceous species cover and the occasional presence of low-growing shrub or trees. These trees known as krummholz, are typically dwarfed varieties of Englemann spruce and subalpine fir (Dick-Peddie 1993) and cover no more than 10 percent of the tundra area (LANDFIRE 2010). Dominant species include sagebrush (*Artemisia arctica*), sedges (*Carex* spp.), fescue grasses (*Festuca* spp.), Ross's avens (*Geum rossii*), wherry (*Phlox pulvinata*), alpine clover (*Trifolium dasyphyllum*), and other species with rhizomatous roots or taproots (Wahlberg et al. 2014). Ultimately, vegetation within ALP is limited by soil substrates, exposure to high winds, high rates of evapotranspiration, and a short growing season (Dick-Peddie 1993). These fragile systems can be negatively affected by grazing or recreation activities, such as hiking and camping (Monz 2002), which potentially denude the vegetation and expose soil to wind disturbance (Fletcher and Robbie 2004) Conversely, fire is not believed to be a major factor of disturbance to alpine and tundra areas, where it has historically occurred every 100 to 200 years with mixed severity (Wahlberg et al. 2014).

Currently, in the Santa Fe NF, alpine and tundra has a low departure (20 percent) from reference conditions. The gradual encroachment of trees into previously open areas is the biggest diversion from the desired condition, characterizing 20 percent of the acreage included in ALP in the forest (table 24). Future changes in temperature or moisture, may exacerbate the rate of tree encroachment or promote changes in plant composition and structure by increasing plant stress due to a warmer, drier climate.

Other characteristics including site similarity, patch size, and bare soil, were not quantified for ALP during the assessment phase of the plan revision process, due to the small acreage covered by alpine and tundra across the forest. Defining the seral state proportions were determined to be the most important indicator of current conditions for ALP at this time. Also, alpine and tundra is not a fire-adapted ecosystem, so while fire may occur on a rare occasion, the management by fire included in plan alternatives is unlikely to promote movement toward desired conditions.

Table 24. Comparison of reference conditions and current (plan-scale) conditions for alpine tundra overstory in Santa Fe NF, 2017

Seral State	Description	Reference Condition (%)	Plan Scale (%)
A	Recently burned; sparsely vegetated; early development	15	3
B	Herbs, shrubs, and krummholz trees (less than 10 percent cover); late development	85	77
C [2]	Moderate tree encroachment, 10 to 30 percent cover	0	12
C [2]	High tree encroachment over 30 percent	0	7

[1] Based on LANDFIRE 2010.
[2] Contemporary landscapes only; historically rare or localized.

3.2.4 Drivers and Stressors

3.2.4.1 Insects and Disease

Insects and diseases are integral components of forest and woodland ecosystems. They help to shape forest structure and species compositions, not only as disturbance agents, but as significant contributors to ecosystem condition and function. There are numerous positive impacts of insects and diseases on the forest ecosystems. Trees killed by insects and pathogens provide important contributions to ecosystem function when they are at levels within the natural range of variation. Bark beetles and wood boring insects provide forage for wildlife (such as woodpeckers). Dead trees either standing (snags) or down (coarse woody debris), create essential habitats for cavity nesting (owls, bats) and ground-dwelling animals, and provide organic biomass to forest soils. Furthermore, 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 et al. 2013). However, under severe disease infection levels or episodic outbreaks of insects, the effects are more evident and can often be negative. Damage sustained during large outbreaks can be detrimental to forest and woodland environments.

As human activities change forest and woodland ecosystems, the extent and activity of insects and diseases change. Today's pine and mixed conifer forests have greater stem density than the forests of the past, which has made them more susceptible to bark beetle outbreaks and more vulnerable to the spread of dwarf mistletoe. The spatial locations of where dwarf mistletoe is found are similar to historic conditions, but continuity and severity of infestations have increased due to the lack of fire in current forest conditions (Shaw and Agne 2016). In some cases, past harvesting activities have left mistletoe-infected seed trees, likely increasing infestation levels in many regenerating stands. Moreover, past harvesting preferences that reduced the pine component of mixed conifer stands have shifted forest composition to greater dominance by shade-tolerant species that are favored by western spruce budworm, Douglas-fir tussock moth, and root disease. Outbreaks of western spruce budworm, in particular, are probably more extensive in mixed conifer stands simply because host trees are more abundant.

Environmental factors such as drought, wildfires, or vegetation conditions strongly influence behavior of native insects and pathogens. For example, in reference to the bark beetle outbreaks of the mid 2000s in Colorado, Romme et al. (2006) suggest that the combination of drought and hot summers likely stressed the trees and made them more susceptible to bark beetles; the warm summers may have accelerated the growth and reproduction of some bark beetle species (e.g., spruce beetles and piñon Ips); and the mild winters produced very little mortality of beetle larvae. 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. Bark beetles are the leading cause of dying trees, and the recent outbreaks across western North America are the largest and most severe in recorded history (Bentz et al. 2009). The National Insect and Disease Risk Map is a strategic project to assess the potential risk of tree mortality from insects and diseases across the United States over a 15-year time period. These insect and disease risk models evaluate the potential loss of basal area based upon current forest conditions. Future projections estimate that bark beetle and other forest insect activity will increase because of climate changes such as elevated temperatures, frequent drought, and the current high-risk conditions (dense vegetation) of western forests (Bentz et al. 2010).

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 have longer durations, widespread bark beetle-caused mortality may be expected. The resulting rapid loss of trees would affect ecosystem integrity, dramatically altering the structure, composition, and distribution of forests. These changes alter ecological function and decrease the stability and resiliency of forests for the future. After significant bark beetle infestations, forest stands may or may not return to original conditions; and the loss of keystone tree species affects associated wildlife or vegetation. These relationships between subsequent disturbances such as drought and beetle outbreaks were described in Hart et al. (2015), and termed "linked disturbances," which are instances where one disturbance can alter the severity, extent, or occurrence probability of a subsequent disturbance. The authors also reported evidence that climate and forest structure drive beetle outbreaks, but a lack of suitable host trees provides resistance to subsequent infestations (Hart et al. 2015). Thus, vegetation treatments that reduce suitable host trees following severe drought may reduce beetle outbreak potential and increase residual stand vigor.

The primary forest insects and diseases in the region (and in the Santa Fe NF) are native organisms that have been part of the ecosystem and have evolved with their plant hosts over a long period of time. The discussions of bark beetles and mistletoe above are examples of these long evolutionary relationships.

There are also a few introduced (exotic) insects and disease agents in the forest. For example, white pine blister rust has become established and is expected to expand in range over the next few decades. Additionally, the tamarisk leaf beetle, which is a biological control agent introduced to the region to limit the expansion of tamarisk, has started defoliating stands of this invasive plant. If there is a lasting effect of this interaction, it has yet to be determined.

3.2.4.2 Invasive Plant Species

Invasive plants significantly alter plant compositions, landscape structure, and ecosystem functions. Undesirable nonnative and invasive plant species gradually out-compete native plant communities by starving native plants of space, moisture, and nutrients, leading to the loss of biodiversity (Randall 1996). By reducing native plant communities and altering natural ecosystem functions, they are also reducing the abundance and diversity of native wildlife species and microorganisms in those ecosystems. Wildlife habitat is negatively affected by the presence of nonnative and invasive species as palatable forage is lost for grazing species (including livestock), and nesting and foraging cover is decreased for both aquatic and terrestrial species. Nonnative, invasive species also disrupt natural ecosystem processes by causing or contributing to decreased water infiltration, increased soil erosion, decreased water quality, increased soil salinity, and altered fire regimes (Dick-Peddie 1993).

In the Santa Fe NF, the invasive species that pose the greatest potential for habitat degradation are diffuse knapweed (*Centaurea diffusa* Lam.), yellow star-thistle (*Centaurea solstitialis* L.), leafy spurge (*Euphorbia esula* L.), and yellow toadflax (*Linaria vulgaris* Mill.) (White et al. 2015). Other problematic invasives found include cheat grass (*Bromus tectorum* L.), common mullein (*Verbascum thapsus* L.), bull thistle (*Cirsium vulgare* (Savi) Ten.), nodding plumeless thistle (*Carduus nutans* L.), Canada thistle (*Cirsium arvense* (L.) Scop.), Russian olive (*Elaeagnus angustifolia* L.), and Siberian elm (*Ulmus pumila* L.). Invasive species, such as those mentioned above, continue to invade rangelands, forests, and riparian ecosystems throughout the Southwest, as there are numerous vectors to spread them across the landscape (e.g., natural disturbances, humans, animals). Invasive plant species may become better competitors under changing climate and fire regimes, especially in sagebrush, piñon-juniper, and desert ecosystems. This is the beginning of a negative feedback cycle, where increased nonnative plant invasions contribute to increased occurrences of fire, and fire enables nonnative plant invasions. Ultimately, the presence of invasive plant populations limits the potential to effectively restore native plant communities to conditions within the historic range of variability.

3.2.4.3 Climate Change

Although regional climates persist for centuries, they gradually change, and vegetation responds on a similar scale over time (Delcourt and Delcourt 1983). The ecosystems we see today are products of species evolution and migration over time, occurring on a constantly shifting landscape driven by climate. Climates change at a variety of scales. Long-term, persistent trends in temperature and humidity determine the extent and location of various life zones, the elevation at which one biotic community replaces another. Short-term fluctuations, on the order of years to decades, determine drought cycles, fire frequencies, and pulses of tree reproduction. The Southwest Region is strongly influenced by oscillation in the Pacific Ocean-atmosphere system. El Niño years bring increased annual precipitation, but less rain in the summer, and La Niña years bring the opposite (Betancourt et al. 1993).

Climate change is anticipated to have lasting, large-scale impacts to a variety of ecological, social, and economic resources around the Santa Fe NF (Allen et al. 2005). Mean annual temperatures in the planning area have increased in the last several decades, mostly with increased nighttime temperatures. There has been a decrease in the amount of snow at low to mid-elevations, and an increase in year-to-year precipitation variability (wetter wet years and drier dry years) (Allen et al. 2005). At higher elevations, overall snowfall and spring snow-water equivalent (amount of water in snowpack) have remained steady in most southern areas, but snowmelt now occurs earlier in the year. Changes in temperature and in amounts and timing of precipitation have led to earlier peak stream flow rates in most streams, with higher spring flows and lower summer flows (Allen et al. 2005), and will have a major influence on fire across the western United States, especially in mid-elevation forests (Westerling et al. 2006).

The most important determinant of fire severity is fuel condition (Parks et al. 2018a and 2018b), while two other important factors for determining fire regimes are vegetation type (or ERU) and weather or climate patterns. Fire history and dendrochronological studies provide ample evidence of past relationships between fire and climate. That evidence makes it clear that a changing climate will profoundly affect the frequency and severity of fires and change vegetation structure and composition as a response to more severe or prolonged droughts (Westerling et al. 2006, Bowman et al. 2009, Flannigan et al. 2009). Warmer temperatures, more variable precipitation, and increased moisture deficit are likely to stress vegetation, and make high-elevation forests more vulnerable to fire, insects, and disease. Fires will likely be more frequent and widespread. Insects such as western spruce budworm and spruce beetle are likely to proliferate in stressed and weakened trees, and mortality is likely to increase as a result of these outbreaks. However, past spruce budworm outbreaks have been associated with periods of increased moisture (Ryerson et al. 2003), and warmer, more drought-prone conditions could reduce budworm activity and temper the severity of future outbreaks. Root rot is also likely to increase in stressed forests. Increased tree mortality due to extended or severe drought, will change fuel structure and dead fuel loads, further impacting fire frequency and severity. However, for southwestern forests persistent cool season droughts extending 3 or more years may result in fuels being a limiting factor and prohibit large fires, as fires in this region are often associated with cool season moisture and the flush of vegetative growth that follows greater moisture availability (Margolis et al. 2017).

Changes in climate are likely to alter vegetation communities over time which may be amplified by increases in the size and severity of fire. The combination of climate change and subsequent fire also impacts other facets of ecosystems and the provisioning of services they provide, such as biodiversity and carbon storage (Hurteau et al. 2014). The increased burning of forests would result in carbon release, changing western forests from carbon sinks to carbon sources, contributing to increased greenhouse gas emissions (Westerling et al. 2006, Flannigan et al. 2009). Vegetation treatments to reduce the risk of fire can negatively impact carbon stores in the short term through the removal of trees via thinning or prescribed fire treatments, but these effects can be minimized by optimizing areas for thinning treatment where the greatest threats of fire are and applying prescribed fire elsewhere (Krofcheck et al. 2019). By optimizing treatments, the remaining carbon can be stabilized by moderating future wildfire behavior (Hurteau 2017) and may even increase carbon storage under certain climate models particularly if the pace of restoration is quickened (McCauley et al. 2019).

At the forest level, the effects of climate change on vegetation are magnified where vegetation structure and composition are outside the natural range of variation, especially in high-elevation forests that are moderately (e.g., MCW, MCD, PPF) to highly (e.g., ALP, SFF) vulnerable to climate change on a landscape scale. Vulnerability ratings are based off of each ERU's ability to resist non-normal ecological conditions and rank their degree of resilience to these disturbances, where ERUs ranked highly vulnerable have little resistance to non-normal disturbances and less ability to recover following these types of disturbance. Across the forest, 8 percent of all ecosystems are at very high vulnerability risk, 14 percent are at high vulnerability, 54 percent are at moderate vulnerability, and 24 percent are at low vulnerability (CCVA 2015). The ERUs with the highest vulnerability to climate change at the plan unit scale include ALP, PJG, and PJS. On more localized scales, a very high to high vulnerability risk could be expected in the northwest zone (Cuba) in PJG, PJS, and SFF; southwest zone (Coyote, Jemez Springs) in JUG, PJG, PJO, PPF, and SFF; northeast zone (Pecos and Las Vegas) in SFF; southeast zone (Glorietta Mesa, Anton Chico) in CPGB, JUG, PJG, PJO, PPF, and SFF; and central zone (Los Alamos, Caja del Rio) in CPGB, MCD, PJG, PJS, PPF, and SFF (CCVA 2015).

Outside of the impacts that changes in climate could have on vegetation, such as structural and composition changes, type shifts across elevational gradients, increased mortality or predisposition to secondary disturbances like disease or insects, and increased competition pressure from growing invasive species populations, changes in vegetation communities would also affect wildlife, recreation opportunities, and socio-economic factors. For instance, five at-risk species in the forest rely on CPGB or on PJS and PJG, all of which are at very high vulnerability to climate change at various scales. Recreation opportunities could suffer from the loss of SFF areas (such as the forested areas surrounding the Santa Fe Ski Basin), as increased tree mortality would make hiking or riding on popular trails exceedingly dangerous. In wilderness areas, trail maintenance would become increasingly difficult with additional tree mortality. Socio-economic impacts of climate change-affected vegetation in the forest may include reduced availability of forest products needed for heat (fuelwood) or sustenance (piñon nuts), medicinal uses, and cultural traditions or practices. Scenery may also be negatively impacted, resulting in fewer (non-local) visitors to the Santa Fe, bringing less revenue into the area and reducing the need for some existing seasonal or permanent positions.

A large proportion of ERUs are well outside of the natural range of variation and are highly departed from desired conditions. Uncharacteristically dense vegetation has a lower resilience to climate change, fire, insects, and pathogens. Moreover, plant compositions that have shifted toward dominance of less drought- and fire-tolerant species have decreased resilience to climate change. The best way that land managers can align forest conditions to adapt with a changing climate is by reintroducing fire into fire-adapted ecosystems (Allen et al. 2002). Implementing managed fire and other management techniques in highly departed areas now is paramount to shape sustainable and resilient ecosystems for the future in the face of a changing climate.

3.2.5 Environmental Consequences

This section analyzes the environmental consequences of the forest plan treatment objectives outlined by plan alternatives on vegetation within ERUs and in areas of special designations, such as wilderness, wild and scenic rivers, heritage or cultural areas, and proposed management areas. This section examines and compares the four forest plan alternatives: a no-action alternative (alternative 1), which reinstates the 1987 Forest Plan without major revisions; the proposed action (alternative 2), which proposes a mix of treatments; natural processes dominate alternative (alternative 3), which relies on natural processes such as fire; and human uses dominate alternative (alternative 4), which relies on mechanical treatments. Plan alternatives were designed to move the condition of highly departed (and some moderately departed) ERUs toward desired conditions (table 25) to increase ecosystem function and resiliency.

The plan objectives determine the number of treatment acres needed to move departed ERUs toward desired conditions over the 15-year planning cycle (table 25). The table divides treatments into mechanical methods and fire categories; mechanical methods would incorporate mechanized treatments, hand-based treatments, or other methods that are effective for restoration. Restoration activities for some ERUs would require additional planning and adaptive management strategies to determine the appropriate treatment (e.g., reseeding native grasses following a shrub encroachment thinning in grasslands, removing invasive species from invaded areas and planting natives) to move departed areas toward desired conditions.

Table 25. Average treatment acres per year by ERU and alternative

ERU*	Treatment	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
Forested ERUs MCD	Mechanical Fire	2,047 2,258	4,500 12,500	2,000 45,000	12,500 2,500
PPF	Mechanical Fire	2,484 4,572	5,750 20,000	2,200 57,500	15,500 2,300
SFF (no objectives)	Mechanical Fire	325 1,355	-- --	-- --	-- --
Non-forested ERUs restoration focus (JUG, PJG, CPGB, MSG, SAGE)	Mechanical Fire	313 553	2,475 4,725	15 12,750	9,000 800
no objectives (GAMB, PJO, PJS)	Mechanical Fire	228 982	-- --	-- --	-- --
Total combined treatments	(mechanical and fire)	15,117	49,950	119,465	42,600
Total mechanical treatments		5,397	12,725	4,215	37,000
Total fire treatments		9,720	37,225	115,250	5,600

[1]Averages based off of treatment acres in years 2007 to 2017 in alternative 1.

* Note: MCW and ALP do not have treatment objectives and are not included in this table.

3.2.5.1 Effects Common to all Vegetation in Santa Fe NF

Indicator: Seral State

Desired conditions and management emphases in the forest plan aim to restore and maintain a range of ages and size classes of vegetation in a mosaic of habitats across the Santa Fe NF. Seral states of vegetation will naturally shift in all ERUs and under all alternatives without any influence from treatments identified within the forest plan objectives. However, this natural shift in seral state, in the absence of predominant historic disturbances (e.g., fire, humans), often leads to densely stocked conditions (in forests and woodlands) and tree encroachment (in grasslands) that are not representative of the desired mosaic of seral states that is targeted within the desired conditions of the forest plan. ***Stands that are densely stocked create shaded understory conditions that do not support ground cover diversity and abundance*** and often ***increase the risk of uncharacteristic fire by providing vegetative connectivity from the ground to the canopy[V1]. Areas with tree encroachment alter species compositions, increase canopy closure, and lessen grass and forb productivity[V2]. Restoring seral state distributions to within the natural range of variability restores stand structure, composition, and function to ERUs over time, increasing the resiliency of ecosystems to disturbance and creating greater habitat diversity[V3]***.

Indicator: Canopy Cover

Canopy openness influences the establishment of understory plant communities and the grass-forb-shrub interspaces between tree groups, encouraging greater plant diversity and cover in the

understory[V4]. The creation of grass-forb-shrub interspaces between tree groups are important in providing the fuel matrix necessary to restore fire regimes, and sustain forest compositions, structure, processes and functions (Moore et al. 1999)***. Increases in the cover of grasses and forbs within canopy openings, can increase the quality and availability of forage for grazing animals and livestock[V5].*** Canopy cover shifts to include more open conditions based on natural disturbances such as wind, fire, disease, insects, or human influences (e.g., thinning or harvesting) on localized to broad scales depending on the magnitude of disturbance. Canopy cover would also shift to more closed conditions under natural processes like succession. ***If overstory canopy cover moves away from desired conditions (greater than 10 percent in grasslands and greater than 30 percent in forests and woodlands), there would continue to be negative environmental consequences, including departed fire regimes, dense stand structures, and altered species compositions favoring shaded environments[V6].***

Indicator: Ground Cover

The maintenance of adequate ground cover is important to prevent erosion, sustain site productivity, encourage natural processes and cycles, and provide for diverse vegetation. ***Any natural process or human-caused treatment that results in the loss or significant changes to ground cover will have detrimental effects to site potential and vegetative recovery following disturbance. For instance, unsustainable grazing practices, recreation activities, timber harvesting practices, and fire have reduced ground cover of grasses and forbs over time. Reduced ground cover lessens surface fire activity, potentially leading to altered fire return intervals or fire frequency[V7]. Reductions in vegetation ground cover also can trigger increases in erosion rates as isolated bare soil patches become connected, creating networks at broader spatial scales that promote accelerated water runoff and associated erosion and sedimentation*** (Davenport et al. 1998, Reid et al. 1999, Wilcox et al. 2003, Pierson et al. 2008)***[V8]. The reduction of ground cover would also lessen water infiltration into the soil profile which slows vegetative growth[V9]. These changes further promote decreased vegetative cover and increased bare ground, creating a negative feedback cycle. The increased net losses of water and soil feedback serve to reduce the productivity and vigor of vegetation cover, potentially leading to desertification*** (Schlesinger et al. 1990)***[V10]. Furthermore, increased bare soil can also facilitate exotic species introductions*** (Stohlgren et al. 2001)***[V11]***.

Rapid and extensive changes in watershed hydrology often occur when high-severity fires amplify runoff and erosion by reducing vegetation and ground cover across broad areas (Shakesby and Doerr 2006)***[V12]***. The hydrologic effects of such fire-induced surface cover changes are demonstrated by the approximately 100-fold increases in peak runoff observed for 1 to 3 years after large stand-replacing fires in the Jemez Mountains in the Santa Fe NF (Johansen et al. 2001, Veenhuis 2002)***. Once initiated, altered pattern-process relationships of accelerated erosion would persist for decades*** (Wilcox et al. 2003)***, and once desertified through loss of vegetation and soils, semiarid ecosystems would be slow to recover*** (Peters et al. 2006)***[V13]. Soil erosion can irreversibly alter the physical, chemical, and biological properties of the soil and, in turn, alter the kind and amount of vegetation a site can support[V14].*** According to Friedel (1991)***, once grass has been displaced, this alteration may result in conversion to woody vegetation that is difficult to reverse[V15]. Additionally, shifts in understory plant community structure and composition (e.g., loss of grasses and increases in shrubs) away from reference conditions can have detrimental impacts that reduce understory abundance, species diversity, wildlife or avian habitat, and ecosystem function[V16].***

Indicator: Old Growth and Associated Components

Desired conditions in the forest plan stress the importance of retaining old growth and for managing vegetation in ways that support its development over time. Old growth components in stands contribute to structural diversity and increase the heterogeneity of landscapes. Old growth areas typically contain single large or old trees or small groups of large or old trees. These large or old trees with shaggy bark or dead portions with cavities provide nesting habitat for bats and owls. As such, large or old trees provide refugia for some threatened and endangered species. ***Thinning dense stands can benefit old growth development and increase the health and vigor of the residual trees, reducing their susceptibility to disease or insects*[V17]*. Repeated occurrences of low to moderate severity fire can aid in the development of late-successional stages by restricting the regeneration of new seedlings and increasing the availability of resources such as water or nutrients for use by larger, older trees*[V18]*. Mechanical treatments can enhance old growth development by specifically targeting smaller trees for removal before burning to reduce damage to the larger, more valuable trees during fire*[V19]*.***

In addition to large and old trees, old growth areas are characterized by having multiple stages of regeneration and senescence, and a ground cover of diverse plant assemblages. ***Coarse woody debris protects the forest floor and mineral soil from erosion and mechanical disturbances; protects new seedlings from livestock damage; provides key habitat components for many wildlife species; maintains stream ecology; interrupts air flow; and provides shade, which in turn encourages and protects new forest growth*** (Graham et al. 1994)[V20]. Also, in the absence of nitrogen-fixing plants (e.g., *Ceanothus* spp.), coarse woody debris play an important role in facilitating non-symbiotic nitrogen fixation (Larsen et al. 1978). Coarse woody debris also has an effect on fire behavior when moisture is low and conditions are right for burning. ***Coarse woody debris can increase the duration of smoldering combustion, and in turn increase emitted particulate matter, potentially contributing to reduced air quality and visibility in local and regional airsheds*** (Reinhardt et al. 1997)[V21]. ***Prolonged smoldering times of Coarse woody debris can also increase the severity of soil heating*** (Reinhardt et al. 1997), ***negatively impacting microorganisms and soil structure, and potentially cause hydrophobicity or sterilization of the soil*** (Neary et al. 2005)[V22].

Snags are important ecosystem components and are created through natural and human-caused disturbances. Snags contribute to habitat diversity and structural complexity, leading to diversified and dynamic ecosystems. ***Without a sufficient quantity or spatial distribution of snags, habitat for cavity nesters (e.g., bats, owls) is scarce, and there would be insufficient material to replenish coarse woody debris loadings in the future*[V23]*.*** Snags also function as perches for raptors, creating a platform to locate prey while hunting.

Indicator: Patch Size

With a focus on reaching desired conditions, plan objectives for treatments in fire-adapted forest and woodland ERUs in all alternatives would reduce patch sizes from current conditions, which are highly departed with stands that have infilled over time, forming uncharacteristically large patches. ***Reduced patch sizes create greater landscape diversity, providing a wider array of habitat types and cover for many species (e.g., edge species and generalists);*** however, ***habitat fragmentation through reducing patch sizes may result in population declines for some species (particularly interior-obligate species) that prefer large intact tracts*** (Bender et al. 1998) [V24]. By not implementing treatments that reduce patch sizes in infrequent fire ERUs (e.g., MCW, SFF), the potential for a negative impact on wildlife populations should be minimized for all alternatives. ***Reduced patch sizes also increase the health and integrity of residual trees by increasing the distance between trees of the same species, lessening the***

risk for large scale spread of insects or disease [V25]***. Treated areas would have a patchy or clumpy forest structure that would be randomly distributed across the landscape, increasing the forest's resistance to uncharacteristic fire by creating larger interspaces where ladder fuels and trees that could carry canopy fire are absent*** [V26]***.***

On local scales, high variability thinning treatments (patchy distribution of leave trees; not an even spacing) would create immediate alterations in patch size within treated areas. ***By selectively removing overstocked trees, patch sizes can be directly manipulated to the desired levels on a project level basis, resulting in a quick return to desired conditions (e.g., within the treatment area). Returning to desired conditions on a smaller scale basis, would eventually lead to large scale improvements as more treatments are implemented across the landscape, increasing ecosystem function and resiliency*** [V27]***.*** Alternately, fire would be capable of creating a diversity of patch sizes over a larger area than mechanical cutting treatments, as fires of all severities create patches of stand-replacement, though the size of these patches vary (Brown et al. 2008, Collins et al. 2017). As fire is an imprecise tool and often causes delayed mortality, it could not be expected to create patch sizes reflective of desired conditions immediately and may create patch sizes larger than are desired. Instead, to reach desired conditions using fire, periodic (recurring) fires would likely be necessary. ***The implementation of periodic*** (planned ignition) ***fire to drive patch sizes toward desired conditions would also provide further support to the return natural fire regimes within fire-adapted ecosystems, restoring natural processes, functions, and species assemblages on the landscape over time*** [V28]***.*** Overall, prescribed fire has been shown to be less effective at increasing the within-stand heterogeneity than high variability thinning treatments, though both treatments together best altered stand heterogeneity in ways that mimicked conditions present in the historical range of variability (Knapp et al. 2017). Though these effects would be applicable across all alternatives, the magnitude of these associated effects would vary by alternative and are discussed briefly by ERU in the following section.

Indicator: Fire

Plan desired conditions strive to return natural fire regimes to fire-adapted ERUs to restore proper structures and species compositions that will result in increased ecosystem function and resiliency. Plan objectives or standards and guidelines call for the use of planned fire or managed natural fire for resource benefit and to reduce the risk of uncharacteristic fire. Within certain areas in the forest, containment targets for wildfires of certain sizes or severities change (see effects by alternatives for ERUs). Also, under plan standards and guidelines, an archaeologist or para-archaeologist is consulted before creating containment lines in areas of cultural significance to avoid damage to cultural resources or artifacts. Similarly, wildlife biologists are consulted to avoid damage to habitat for species of conservation concern (SCC) or other potentially sensitive terrestrial, aquatic, avian, or plant species.

The majority of ERUs in the Santa Fe NF are fire-adapted, experiencing natural ignitions at varying frequencies and severities that historically maintained vegetative conditions within the natural range of variability (see Fire Regimes). ***If fires are too frequent, plants would be killed before they have matured, or before they have set sufficient seed to ensure population recovery. If fires are too infrequent, plants would mature, senesce, and die, without ever releasing their seeds; or species composition would shift to favor uncharacteristic combinations; or live and dead biomass would simply accumulate to uncharacteristic levels*** [V29]***.*** Fires within the natural range of variability support reaching the desired conditions for fire-adapted vegetation types within the forest plan.

Ecologically, ***fires create a mosaic of habitats across the landscape, leading to structural and compositional diversity in vegetation, where fire-adapted species are promoted, and fire-sensitive***

species are suppressed. These changes result in species compositions more indicative of potential natural vegetation types and historic reference conditions over time[V30]. Areas that burn with lower severity tend to remain relatively dense in structure, while areas that burn with higher severities become increasingly open and create patches of complex early-seral forest conditions important to meet habitat requirements or to meet other requirements for the persistence of many plant and animal species. Fire often reduces small-diameter stems that create dense midstory and understory conditions that prohibit the growth of grasses and forbs in the understory. ***By removing*** these ***dense small-diameter stems and creating growing space in the understory, fire encourages increased response from grasses and (lesser so) forbs.*** Furthermore, ***as fire consumes vegetation and fuels, it releases ash and nutrients into the air and onto the soil, which are important to regenerate grasses, forbs and shrubs, and, in turn, help restore natural fire regimes[V31].***

Fire is also beneficial in the creation of old-growth forest characteristics as it reduces vigorous tree regeneration, allowing for a greater availability of resources to be devoted to larger, fire-resistant stems, which may eventually become old-growth (Binkley et al. 2007)***[V32]***. ***The array of stand density and forest conditions created by fire allows for greater habitat diversity, benefitting wildlife species and encouraging diverse compositions of plants. Having a mosaic of habitat types within burned and unburned areas allows for connectivity and corridors for animal and (sometimes) plant migrations and promotes species diversity and ecosystem health[V33]***.

However, with the increased occurrence of fire, comes the increased chance for negative impacts and potential for increased fire severity, especially in long unburned frequent-fire systems or areas experiencing prolonged drought. ***Fire reduces air quality through the addition of micro particulate matter into the air and causes smoke impacts (e.g., reduced visibility) to communities near the burns[V34]. The particulate matter from smoke emissions is detrimental to human health, especially for the elderly or people with pre-existing respiratory conditions[V35]. Fire, especially high-severity fire, would also negatively impact soils through increased erosion, excessive heating, altering microbes or fungal colonies, and interrupting nutrient cycling by incinerating organic material[V36]. Generally, low- to moderate-severity fires do not result in excessive heat transfer to the soil or cause extensive damage to larger, fire-resistant overstory trees[V37].***

Under highly departed conditions, many areas of the Santa Fe NF such as ponderosa pine and dry mixed conifer forests are at risk for uncharacteristic fire. ***Uncharacteristic, high-severity fires would result in complete canopy and ground cover removal, dramatically affecting watersheds and water resources by altering the important processes of evapotranspiration, interception, surface flow, and subsurface flow*** (Swanson 1981)***[V38]***. Furthermore, the size of patches burned with high-severity fire is important in determining the probability of fire-induced flooding events or debris flows, where increased patch sizes result in increased impacts (Wohl and Pearthree 1991, Cannon and Reneau 2000). Recent large stand-replacing fires in the southwestern United States have produced runoff and erosion events as much as two orders of magnitude greater than found under pre-fire conditions (Veenhuis 2002). ***High-severity fire can degrade water quality 50 kilometers downstream with increased turbidity of runoffs, limited dissolved oxygen levels, and altered pH and conductivity rates*** (Dahm et al. 2015)***[V39]***. However, small or localized patches of high-severity fire increase landscape heterogeneity and can provide for unique habitat requirements for many species that require early-seral stages or edge habitats.

Fuel loadings (coarse woody debris, litter, fine woody debris, and flammable live vegetation) that are too high increase the risk of a site experiencing severe fire behavior[V40]. Vegetation treatments implemented to reduce hazardous fuel loadings, will help to reduce the risk of uncharacteristic fire, especially in the localized areas of treatments. Treating many areas with fuels reduction treatments would provide a greatly reduced risk of extreme fire over a much larger area. This ***reduction in fire risk brings with it the protection of water quality in the highly valued headwater streams of the area***[V41]***. Fuel reductions also increase safety to local citizens whose homes lie within the wildland-urban interface and increase protection of area businesses and infrastructure***[V42]. Furthermore, ***the reduction of forest density and a return to more natural fire regimes, will protect habitat for wildlife, as well as, enhance recreation opportunities and aesthetic conditions, which would be lost if the area burned in a severe fire***[V43].

Mechanical Vegetation Treatments

Mechanical vegetation treatments such as mechanized thinning are used to alter stand structure to conditions that support natural ecosystem compositions, processes, and functions. Mechanical treatments often incorporate machines (e.g., skidders, chainsaws, masticators) capable of cutting down trees, but would also incorporate site preparation, seeding, planting, fencing, bank stabilization, stream channel restoration, invasive species removal, road or trail maintenance, or other treatments deemed necessary for improving ecosystem function and resiliency. ***By implementing restorative treatments ground cover diversity of native species can be reestablished, reducing erosion potential, maintaining or improving water quality, boosting site potential, and promoting the return of natural fire regimes in frequent-fire systems***[V44]***.*** Mechanical treatments or timber harvesting can ***improve the health and vigor of the residual forest by reducing competition for resources or removing diseased trees***[V45]. Mechanical treatments and timber harvesting would also ***provide economic benefit to local industries and surrounding communities***[V46] ***and improve habitat conditions for target wildlife species***[V47]***.***

Under plan guidelines, forms of mechanical treatments performed by hand, instead of using machines, is necessary in wilderness areas or other sensitive areas (e.g., steep slopes or on highly erodible, unstable soils) where mechanized equipment could have detrimental impacts. ***The negative impacts of mechanical treatments, especially of those that use machinery, include soil compaction, soil disturbance and erosion, noise pollution, and the degradation of water quality***[V48]***. Mechanical treatments can also facilitate the introduction or spread of invasive species as they are transported or move from an infected area to non-infected areas***[V49]. ***Mechanical treatments that require the reopening of closed roads, or the development of new roads, disrupt landscape continuity and fracture vegetative communities, negatively impacting vegetative species and wildlife habitat***[V50]***.***

Designated Wilderness

In areas designated as wilderness (management areas H, HO, and HF in the existing forest plan), the applicable laws and policies have the potential to affect the likelihood and implementation of future vegetation treatments. These laws and policies do not change by alternative. The Wilderness Act (1964) establishes that the use of motorized equipment is not compatible with wilderness objectives, and as a result, vegetation cannot be managed through mechanized harvest activities, mitigating negative impacts of mechanized treatments ***(V48-49)***. Moreover, commercial timber production or non-commercial harvesting of timber or other forest products (e.g., firewood, Christmas trees) is not allowable in wilderness areas. Any cutting of fallen trees across trails is implemented using hand saws since chainsaws are not allowed. These cutting restrictions ***retain the untrammeled character that is valued in wilderness areas, increasing the satisfaction of backcountry users by having unaltered viewsheds and by inspiring a feeling of solitude***[V51]***.***

Limited road access in wilderness areas can impede fire suppression activities within designated wilderness areas, though the Wilderness Act allows some prohibitive uses of mechanized equipment for this purpose. In the interest of maintaining firefighter safety, aircraft and motorized equipment are used to suppress wildfire in wilderness areas when necessary. Plan standards and guidelines direct wildfire suppression activities in wilderness areas to suppress fires of high intensity at 2,000 to 5,000 acres, using natural barriers as much as possible. Low-severity fires do not elicit suppression efforts in the wilderness but will be monitored. While many other site-specific factors that can change over time are known to influence the decision to suppress or manage wildfires for resource objectives, the limitations associated with operating in wilderness are expected to decrease the chance of a suppression decision, where within wilderness areas, forest plan desired conditions allow for fire (natural and planned ignitions) to perform its natural ecologic role ***(V18, 30-33)***.

The proposed forest plan, in accordance with current laws and regulations (FSM 2320), ***describes livestock grazing and acequia management as allowable practices in designated wilderness, supporting local economies and cultural and traditional uses*** [V52]. Sustaining productive grazing areas in wilderness areas is driven by natural processes, where disturbances such as wind, insects, disease, or fire open canopy gaps and promote the growth of grasses in the understory ***(V5-6, 31)***. ***Wilderness areas also contribute to clean air and water, quality wildlife habitat, primitive recreation, natural vegetation assemblages and disturbance processes*** [V53].

Wild and Scenic Rivers

The Santa Fe NF has several designated wild and scenic, or recreation rivers (WSR) (management area F in the existing forest plan) including parts of the East Fork of the Jemez River, Pecos River, and the Rio Chama, which predominately flow through PPF (22 percent), MCD (18 percent), and SFF (17 percent) areas. A portion of these rivers flow within areas of designated wilderness (see above). And, additional river segments are eligible for wild and scenic or recreational designation in the future. Consistent with applicable laws and policies, under existing plan guidelines and standards, designated and eligible rivers are required to be managed to retain the "outstandingly remarkable values" that warrant their eligibility or designation as a WSR. Further, law requires the protection of water quality of designated rivers. Management practices would continue according to forest plan objectives, standards, and guidelines for the forest at large or for certain areas within the forest (e.g., wilderness), provided that the free-flowing nature of these waterways is not restricted, scenic integrity is maintained or improved, and that management actions comply with each individual river's comprehensive river management plan. Because management practices are required to maintain the outstandingly remarkable values associated with these WSR areas, minimal effects would be expected from vegetation treatments conducted in surrounding ERUs. The most likely detrimental impacts to WSR areas would occur in the event of an unplanned fire ignition that resulted in uncharacteristic fire behavior ***(V12, 38-39),*** though the duration of the adverse effects may be brief depending on the size, location, and duration of the fire event.

Wild Horse and Burro Areas

The Santa Fe NF has four designated wild horse territories and one wild burro territory (collectively: WHT): the Caja Wild Horse Territory (active), Mesa de las Viegas, Chicoma, and San Diego Wild Horse Territories and the Dome Wild Burro Territory (all inactive). Management of active wild horse and burro territories is guided by individual management plans. Within the existing forest plan and under future forest plans, WHT areas have desired conditions, standards, and guidelines that call for ecologically sound management that provides for adequate forage and range conditions. Any vegetation treatments (under all alternatives) that result in increased ground cover, promote the growth of grasses ***(V5-6, 30-31)***, and build ecosystem resiliency will help support WHT in the forest. As horses and burros are large animals capable of covering long distances, there should be minimal impacts to herds from vegetation treatments or fire.

Inventoried Roadless Areas

Inventoried roadless areas (IRAs) are large, unfragmented, and undeveloped tracts of land that are important to biological diversity and the long-term survival of many at-risk species. They serve as safeguards against the spread of invasive plant species and provide reference areas for study and research. Forest plan desired conditions and guidelines limit timber harvesting and road construction in these areas, thus there should be minimal direct effects. When mechanical treatments are implemented in surrounding areas bordering IRAs, some negative impacts could occur ***(V48-49)***. The lack of road corridors in IRAs could make fire suppression more difficult in the event of wildfire. However, like in wilderness areas, low-intensity fires are permitted to burn for resource benefit ***(V18, 30-33)***, while high-severity fires have forest plan guidelines for suppression at 2,000 to 5,000 acres to minimize ecosystem impacts ***(V12, 38-39)***.

3.2.5.2 Forested ERUs

Effects common to alternatives 2, 3, and 4 for all forested ERUs.

Indicator: Fire

To promote a return to natural fire regimes across the Santa Fe NF, the forest plan includes objectives, guidelines, and desired conditions for the use of planned fire in the most highly departed ERUs, and for managing natural ignitions for resource benefit where applicable in all alternatives. These alternatives in the Forest Plan also have objectives and guidelines to treat highly departed dry conifer forests (dry mixed conifer and ponderosa pine) to reduce the risk of uncharacteristic fire and provide for special treatments within high-risk wildland-urban interface areas. Because these are arid and more xeric sites, ***effects of large patches of moderate- to high-severity fires could result in long-term detrimental impacts to the site and watershed. This includes the alteration of soil condition, hydrological function, and overall productivity of the site[V54]. These fires may also encourage beetle outbreaks that cause additional tree mortality, further degrading stand function and health[V55]***. Moreover, ***stand-replacing fires damage valuable ecosystem components by killing old growth timber and eliminate suitable habitat for species that depend on these stands for survival[V56].***

Some moderate- to high-severity patches eventually become colonized by aspen, forming relatively even aged stands within burned patches, increasing landscape heterogeneity, and shifting seral state distributions toward early states[V57]. High-severity fires have the potential to cause a type conversion from forest to grasslands or shrublands (Guiterman et al. 2017, Walker et al. 2018)***, and reduce site productivity for conifer species for many years or decades[V58]. In areas of extensive damage to the soil, the capacity for the site to support future pine growth is reduced through the loss and degradation of soil, and through the reduced infiltration of water into the soil coupled with increased runoff [V59]. Future pine growth is also limited following widespread tree mortality by the elimination of a viable seed source[V60].*** However, under normal fire conditions, ***the reintroduction of fire across the landscape would result in more fire-created openings, aspen regeneration (in MCD, SFF, MCW), and a reduction in the overabundance of fire-sensitive species such as white fir[V61].***

Mixed Conifer Frequent Fire (MCD)

Alternative 1 – 1987 Forest Plan

In the 1987 Forest Plan, the Santa Fe NF was divided into separate management areas. Though there are not specific objectives for the treatment of MCD in the existing forest plan, each of these management areas has a management emphasis (table 27) and standards and guidelines to follow. A detailed description of each management area can be found in the 1987 Forest Plan. Below, standards and guidelines for management areas are discussed if they have effects on vegetation under alternative 1.

Table 26. Percent of MCD acres in each management area of the 1987 Forest Plan

Management Area	A	B	C	D	E	F	G	H	HF	HO	I*
MCD (%)	64	64	59	46	48	44	0	46	24	97	*in P, Q, R
Management Area	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**X**
MCD (%)	93	0	50	27	73	57	38	12	29	0	44

Table 27. Emphasis for management within each management area of the 1987 Forest Plan

Management Area	Emphasis	Management Area	Emphasis	Management Area	Emphasis
A	Timber- Wildlife	**HO**	Wilderness and Santa Fe Watershed	**Q**	Cultural Resources-Dispersed Recreation-Visual-Timber
B	Wildlife- Timber	**I***	Cultural Resources- *in P, Q, R	**R**	Cultural Resources-Wildlife/Timber
C	Recreation-Visual-T&E Species-Timber	**J**	Gallinas Creek Watershed	**S**	Cultural-Wildlife-Range-Firewood
D	Recreation-Visual-Timber	**K**	Sensitive Soils-Species	**X**	Jemez NRA
E	Dispersed Recreation-Visual-Timber	**L**	Semi-Primitive Non-Motorized Recreation		
F	Wild and Scenic Rivers	**M**	Research Natural Areas		
G	Wildlife-Range-Firewood	**N**	T&E Species Habitat		
H	Wilderness	**O**	Santa Fe Watershed		
HF	Wilderness-Wild and Scenic Rivers	**P**	Cultural Resources-Timber/Wildlife		

Also, alternative 1 would have desired conditions for vegetation that are the same as those defined across all other alternatives.

Indicator: Seral State

Alternative 1 shows the least improvement toward desired conditions, depicting a movement in seral state departure from high (74 percent) to moderate (63 percent) in the first 20 years (figure 13), but becomes more effective than alternative 3 by year 25 and maintains the third highest departure position until year 50. Currently, 309,576 acres in the mixed conifer-frequent fire ERU are in closed, late development states, where the stand density and structure are highly departed from reference conditions. ***These dense conditions place additional stress on trees and increase their susceptibility to large disturbances like uncharacteristic fire or beetle outbreaks[V62].*** Ultimately, this alternative leads to the second highest risk of uncharacteristic fire and associated effects ***(V38-39, 54)***.

The existing forest plan includes standards and guidelines for timber treatments that provide for even-aged and uneven-aged treatments, old-growth retention, and to manage for insects and diseases ***(V17, 19).*** Despite the recent increase in the scale of restoration projects, such as the Southwest Jemez Mountains Project and proposed Greater Santa Fe Fireshed project, currently only about 2 percent of MCD is treated on an annual basis through prescribed fire, thinning, and through the management of wildfires to meet resource objectives (FACTS). Also, these projects would overlap the same landscape footprint, as multiple treatments (e.g., thin and then burn) are typically necessary to moderate the potential fire hazard that results from the current vegetative conditions. Therefore, less than 2 percent of the MCD landscape is treated annually, at which rate it would take 68 years to restore the mixed conifer- frequent fire ecological type alone. This low level of treatment would retain a moderate to highly departed structure of MCD forests, where dense, closed forests would continue to dominate the MCD landscape ***(V62)***, a condition that would not significantly reduce risk for future disturbance events such as uncharacteristic fire (***V38-39, 54-58***) more than any other alternative.

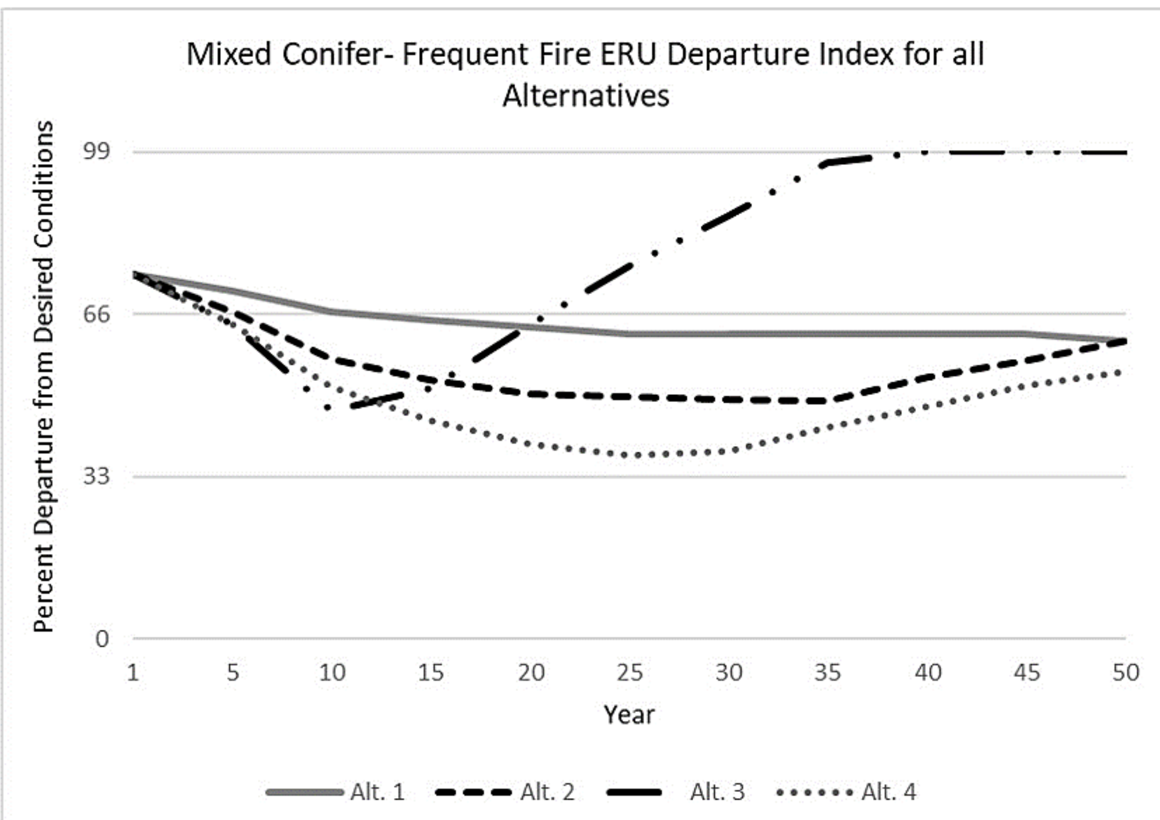

Figure 13. Mixed conifer-frequent fire ERU departure. Departure is based off a nominal classification of low (0-33%), moderate (34-66%), and high (67-100%)

Indicator: Canopy Cover

Alternative 1 shows the least movement toward greater proportions of open-state conditions of all alternatives, with the percentage of closed-canopy states on the landscape at 77 percent after 50 years (figure 14) ***(V4)***. Thus, the understory conditions are likely to remain impaired due to the minimal reduction (11 percent) in closed-canopied states ***(V5)***. This small amount of change would not reap the benefits of grass-forb interspaces (***V6***), as the openings would likely not be sufficient to develop this desired condition of the forest plan.

The existing forest plan (the 1987 Forest Plan; alternative 1) provides standards and guidelines for canopy openings resulting from vegetative treatments to maintain a certain visual aesthetic for forest users. Opening sizes are based on the landscape, distance from roadways or trails, and the speed of travel. ***Canopy openings or vegetation treatments that are obvious near travelling corridors can negatively impact viewsheds and reduce public satisfaction by altering what would have previously appeared to be untouched by human influence[V63].***

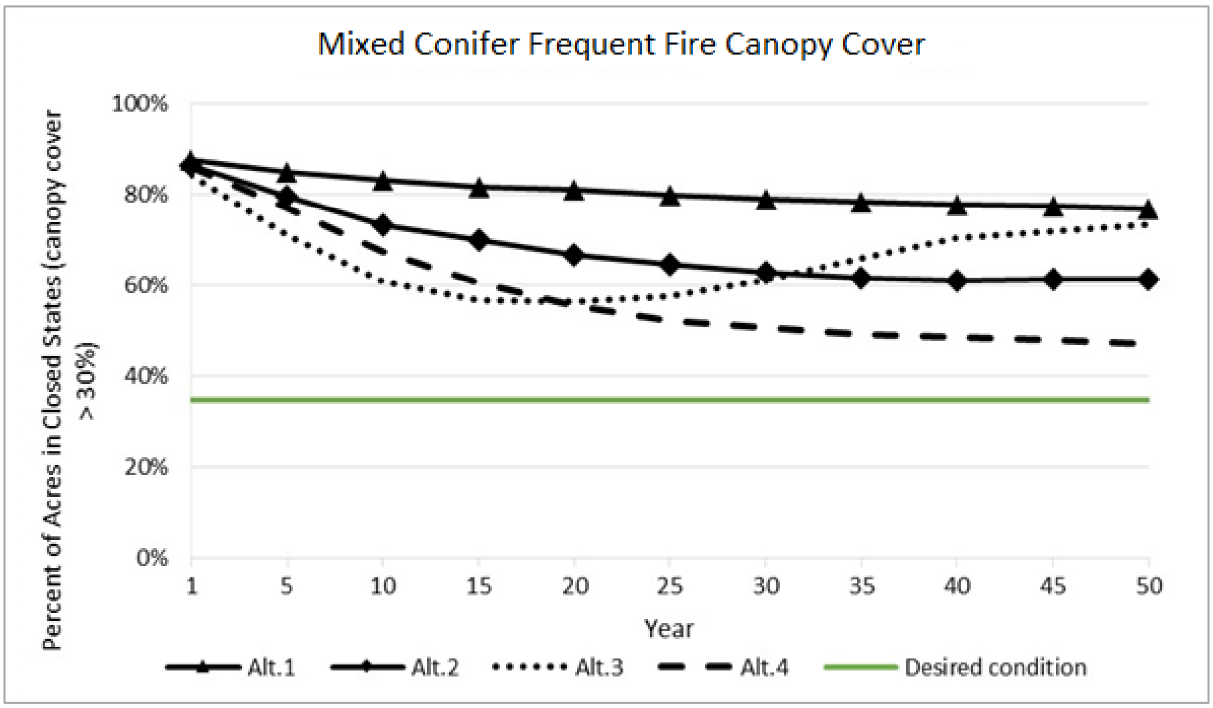

Figure 14. Mixed conifer-frequent fire ERU canopy cover. Closed state conditions are when woody canopy cover exceeds 30 percent (ESSA 2006)

Indicator: Ground Cover

Levels of fire and mechanical treatments used during the existing forest plan are minimal compared to expected levels of the Plan, and thus, are not expected to have significant effects on ground cover. However, the existing forest plan has standards and guidelines for seeding or planting native species, especially those with berries or high aesthetic value. Any seeding of denuded or degraded areas will improve ground cover ***(V44)*** and minimize the negative consequences ***(V7-9, 11, 14-16)***. This is like the language in the Plan, as it also allows for seeding or planting in denuded areas, resulting in a similar magnitude of the listed effects (above), based on the proportion of the land treated. Uncharacteristic fire, should it occur, would have significant effects in the localized area affected by the fire and other areas within the watershed (***V38-39, 54-55***).

Indicator: Old Growth and Associated Components

The existing forest plan has standards and guidelines for using harvesting practices that encourage old growth development. While alternative 1 has the highest proportion of late successional stages, and the greatest number of acres contributing to old-growth components, coarse woody debris levels remain highly departed (table 28). While there are standards and guidelines for snag retention and coarse woody debris levels to provide quality wildlife habitat ***(V20, 23)*** following timber harvests or fuelwood acquisition under the guidance of the existing forest plan, high seral state departure, excess amounts of coarse woody debris, and presence of other surplus fuel (needle litter, low stature living and dead plants) would threaten the development of old-growth forest components and existing large trees, especially in the instance of severe fire (***V22-22, 38***). Additionally, retaining a ***high proportion of stands with highly closed canopies, high stand densities, and stressed conditions, all of which further limit the development and maintenance of old-growth forest components and increases the risk of uncharacteristic fire[V64]***.

Table 28. Old-growth forest components for desired conditions, current conditions, and for all alternatives (at year 50) for the mixed conifer-frequent fire ERU

Ecosystem Characteristic	Desired Conditions	Current Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Number of snags greater than 8 inches dbh per acre	4 to 12	24.2	19.0	16.9	13.8	17.7
Number of snags greater than 18 inches dbh per acre	1 to 5	3.5	6.2	5.9	4.0	6.7
Tons of coarse woody debris per acre	5 to 15	69.3	66.8	54.5	42.0	55.1
Acres contributing to large trees and old-growth forest components	182,736	9,674	117,725	76,491	1,935	95,625

Data from VDDT model output

Indicator: Patch Size

Alternative 1 would reduce patch sizes (moving toward desired conditions) the least of any alternative on a landscape scale due to the low acreages of vegetation treatments expected to be implemented under this alternative, resulting in the fewest positive ***(V25-28)*** and fewest negative effects ***(V24)*** of patch size reduction.

Indicator: Fire

The 1987 Forest Plan included no specific objectives for the use of natural and prescribed fire, though plan standards and guidelines state that prescribed fire can be used for site preparation, fuels reduction, and enhancement of wildlife habitat (***V17-18, 29, 38-33, 61***). Under the 1987 Forest Plan, standards and guidelines state that wildfires are permitted to burn for resource benefit, given certain suppression parameters. These parameters state that wildfires with high intensity are suppressed at 75 acres, while low-intensity fires are suppressed when threatening young tree plantations, or at the discretion of a wildlife biologist. Generally, under alternative 1, fire use would continue to be limited to predominantly natural ignitions in areas far away from resources at risk and to prescribed fire in areas of fuel reduction projects. Without the more frequent use of prescribed fire within many overstocked, fuel-laden MCD stands, this alternative would do little to reduce the risk of uncharacteristic fire and bar against the negative effects of those fires (***V34, 36, 38-39, 54, 58***). The predominant practice of fire suppression under this alternative also would reduce the magnitude of ecological benefits of fire in MCD (***V30-33, 57, 61***) the most of all alternatives.

Alternative 2 – Forest Plan

Alternative 2 proposes to treat up to 28,000 acres (high treatment objective) annually, with nearly 74 percent of treatment acres (on average) allocated to fire and the remainder allocated to mechanical treatments. Research has found that within southwestern frequent-fire ecosystems, a timber management regime of uneven-aged thinning followed with frequent, low-severity understory burning has the potential to restore many ecosystem characteristics and processes to more closely mirror historical conditions (Moore et al. 1999). Moreover, ***the removal of fuels within dense, overstocked areas considerably reduces risks to human property, infrastructure, and life in the event of wildfire[V65].***

Indicator: Seral State

In alternative 2, Plan objectives for mechanically thinning and burning MCD would result in the second greatest improvement toward desired conditions as seral state departure moves from high (74) to moderate (60) after 50 years (figure 13), leaving it slightly less than alternative 1 at this timepoint. However, at 20 years, alternative 2 departure is more than 10 percent lower than alternatives 1 and 3 at 50 percent departure.

At the high level of the acreage range for treatment, it would take only 11 years to treat most closed-late-development states. Therefore, if treatments are implemented toward the high end of the range given in the forest plan objectives, alternative 2 would have a much greater potential to restore acres at a pace necessary to buffer stressors and restore ecosystem resiliency compared to alternative 1 ***(V3, 30)***.

Indicator: Canopy Cover

Alternative 2 shows the second greatest movement toward desired open-state conditions of all alternatives, with a 27 percent reduction in closed states after 50 years (percentage of closed-canopy states at 61 percent) (figure 14). Furthermore, in the first 20 years, the percentage of closed-canopy states are predicted to drop from 86 percent to 67 percent. The second-greatest reduction in closed-states would result in improved understory conditions and create grass-forb-shrub interspaces ***(V5-6)***. The newly opened areas as a result of the combination of fire and mechanical treatments, would gradually develop ***species compositions that are able to promote natural fire regimes into the future[V66].*** In turn, ***the restoration of natural fire regimes would lead to greater habitat diversity, providing a range of conditions complimentary to many wildlife species, and lead to increased site productivity over the long-term [V67].***

Indicator: Ground Cover

Research suggests that restoration experiments in southwestern frequent-fire forests promote a rapid increase in herbaceous production after the removal of many post-settlement trees followed by prescribed burning (Covington et al. 1997). Therefore, using both fire and mechanical treatments has a greater likelihood of restoring desired conditions, such as increased understory grass and forb cover and diversity ***(V5-6)***, gradients of habitats across the landscape from open to closed ***(V33)***, and reduced risk of large, high-severity fire ***(V38-39, 54-56)***, than using just mechanical treatments or fire alone. Alternative 2 has plan objectives for the use of both mechanical and fire treatments that when used in conjunction, would drive the departed MCD areas closer to desired conditions than other alternatives during the life of this forest plan, which rely more heavily on one of the two treatments (alternative 3 or 4) or treat many fewer acres overall (alternative 1).

Indicator: Old Growth and Associated Components

This alternative would provide the most support to developing old-growth forest components out of all alternatives due to the combination of mechanical treatments and fire treatments ***(V17-19)***. The combination of treatments targeting small, dense trees helps to boost the acreage that contributes to large trees or old-growth conditions over current conditions within MCD under alternative 2, though lesser so than alternatives 1 and 4 (table 28).

Coarse woody debris levels would also trend toward desired conditions after 50 years (table 28), providing organic matter inputs into the soil and creating habitat for species like the Jemez Mountain salamander ***(V20)***.

Indicator: Patch Size

Alternative 2 would reduce patch sizes (moving toward desired conditions) the most of any alternative due to the relatively high acreages in objectives for vegetation treatments (fire and cutting) to be implemented under this alternative, resulting in the highest positive ***(V25-28)*** but fewer negative effects ***(V24)*** of patch size reduction than either alternatives 3 or 4. Overall, the combination of fire and high variability thinning treatments would create changes to existing MCD patch sizes on the landscape in a more efficient and direct manner than using either treatment alone (Knapp et al. 2017). In the most highly departed MCD areas, cutting treatments could directly create desired patch sizes that fire could then maintain over time.

Indicator: Fire

The increased occurrence of fire under this alternative would encourage a return to a more natural fire regime and have associated effects ***(V30-32)***, much more effectively than alternatives 1 and 4, but at a slower rate than alternative 3. Compared to alternative 3, this alternative's use of treatments before planned fire ignitions would help to moderate fire behavior, reduce negative fire impacts ***(V12, 34, 36, 38-39, 54)***, more deliberately move toward the forest plan desired conditions, and reduce risk to wildland-urban interface areas. Following mechanical treatments in alternative 2, the residual fuels would be reduced on site through the process of piling and burning, before broadcast burning the site using low-severity prescribed fire. This method significantly reduces fuel loading and, at least in the short term, greatly reduces the risk of uncharacteristic fire (***V38-39, 54, 58, 67***), more so than other alternatives.

Alternative 3– Natural Forces Emphasis

This alternative proposes the highest average treatment objective acres (up to 80,000 acres) using fire and the lowest percentage of acres treated mechanically (2 percent; 2,000 acres) on an annual basis. Mechanical treatments in this alternative would primarily focus on resource protection and safety, by treating areas in the wildland-urban interface.

Indicator: Seral State

Compared with all other alternatives, alternative 3 would show the least improvement in seral state departure, and remain highly departed after 50 years (figure 13) with multiple associated effects ***(V1, 7, 16).*** However, in the first 10 years, which would be within the intended lifespan of the forest plan, this alternative shows the greatest initial reduction in seral state departure moving MCD from 74 to 46 percent. This trend plainly illustrates the importance of returning fire to this fire-adapted ERU as a means to drive seral state departure toward the desired conditions outlined in the forest plan. By doing so, structure and composition of MCD would begin to resemble reference conditions and enhance resiliency to future disturbances ***(V3, 30-32)***. The reversal of departure improvement that begins after year 10 illustrates the need for additional treatments to help maintain the lower levels of seral state departure reached by the return of fire, to thin the areas dense in early successional seral states and promote structural and age class diversity.

Indicator: Canopy Cover

Alternative 3 would yield the second least improvement in open conditions, with the percentage of closed-canopy states estimated at 74 percent after 50 years (figure 14). However, initially this alternative promotes the greatest increases in canopy openings and would create large interspaces across the burned landscape ***(V4-5, 30-31)***.

Indicator: Ground Cover

The predominance of fire in this alternative would likely lead to reduced ground cover initially following fire events, exposing a greater proportion of bare mineral soil than the other alternatives, which incorporate fewer acres of fire through the combustion of vegetative ground cover and woody fuels (***V7-15***). Response of vegetative ground cover would be dependent on the frequency and severity of the fires (***V29***).

Indicator: Old Growth and Associated Components

It remains unknown what the effects of the fire treatments in alternative 3 would have on old-growth development. On one hand, alternative 3 could result in a reduction in the development of late-successional stages, as a result of more acres burning into early successional stages or uncharacteristic shrub/grass/seedling sapling states (see table 13), which can increase future fire severity, damaging the residual older trees. Because of this, old-growth development would be expected to be lessened under this alternative. Moreover, by damaging large, older trees, this alternative could provide less old-growth habitat for the health and function of species that depend on these areas. Conversely, low-severity fire can benefit old-growth development ***(V32-33)***. Thus, the effects of this alternative on old-growth development are largely dependent on the frequency and severity of fire.

Coarse woody debris is the lowest of any alternative, but remain well over the amount desired from reference conditions (table 28), which would have the most positive ***(V25-26),*** but also the greatest potential for negative ***(V21-22)*** impacts given the amount of fire proposed under this alternative. Snag density is also closest to reference conditions in alternative 3, due to the increased presence and frequency of fire.

Indicator: Patch Size

Due to the prevalence of fire, which has been largely absent from many fire-adapted ecosystems for several decades, alternative 3 would increase landscape heterogeneity and reduce patch sizes in MCD over the lifespan of the forest plan. Though this alternative would have effects similar to the other alternatives ***(V24-26, 28)***, the wide-ranging introduction of fire into areas that have not seen fire in decades ***without mechanically pre-treating areas with heavy fuel loads increases the potential for additional negative effects, such as the creation of patch sizes much larger than desired, increased tree mortality and regeneration difficulties, all of which temporarily degrade site quality and potential for the land to support multiple uses [V68].***

Indicator: Fire

This alternative is expected to have the second least improvement in risk of uncharacteristic fire. Without some mechanical treatments (e.g., initial entry) incorporated into this alternative in dense, high-risk stands, the effectiveness of solely using fire to improve conditions would be limited. For instance, early experiments to reintroduce fire in contemporary southwestern frequent-fire forests failed, as many old-growth pine trees were killed, and post-settlement poles and saplings were not thinned by prescribed burning as originally intended (Sackett et al. 1996). Moreover, ***the implementation of fire over large***

areas without the use of mechanical treatments as a pre-treatment could raise fire severity*, *resulting in the reduction of old growth*[V69]**, type conversion to non-forest conditions ***(V54, 58), or other negative impacts to the ecosystem ***(V34, 36, 38-39)*** particularly in areas also impacted by prolonged drought. Like alternative 1, the understory conditions (species composition and community structure) are likely to remain impaired ***(V5, 8-15)***, as large amounts of fire would increase proportions of bare ground, at least initially and may promote the regeneration of woody species instead of the desired grasses and forbs ***(V8-9, 14-16)***. Without improvements in the mixed conifer-frequent fire bunchgrass type, the maintenance of surface fuels that support natural fire regimes would be challenging ***(V7)***.

Alternative 4 – Human Uses Emphasis

Alternative 4 proposes to treat up to 22,500 acres (high treatment objective) annually, primarily using mechanical methods.

Indicator: Seral State

Based on the high treatment objective, it would take only 14 years to treat most at-risk areas (closed-late-development states). Models predicted that alternative 4 would reach the lowest seral state departure after 50 years, but would still be moderately departed and only slightly lower than alternatives 1 and 2 (figure 13). Seral state departure reaches and maintains the lowest levels of departure by year 15, showing that this alternative, with its reliance on mechanical treatments, can directly alter stand structures in highly departed areas and enforce change over the lifespan of the Forest Plan. The reduction in seral state departure would have numerous benefits to the forest ecosystem ***(V3)***.

Indicator: Canopy Cover

While alternative 4 would produce the most open conditions (lowest percentage of closed-canopied states) (figure 14), understory plant herbaceous diversity and cover would still be impaired in areas ***(V7-8)***, due the lack of fire that provides nutrient turnover, regenerates herbaceous cover, and provides a fuel matrix necessary to carry surface fire ***(V5)***. Snag density and coarse woody debris loadings are very high under this alternative, likely as a direct result of mechanical treatment and the lack of follow-up burning ***(V29, 40)***.

Indicator: Ground Cover

This alternative would implement the greatest amount of mechanical treatments out of all alternatives. The predominance and high use rates of these mechanical treatments would cause elevated ground disturbance, potentially reducing site productivity and negatively impacting ground cover recovery following treatment at a higher level than compared to the other alternatives ***(V7-8, 14)***. Without the use of fire in combination with mechanical treatments, the grass-forb-shrub component could suffer (***V29, 31***). Furthermore, residual fuels left untreated, scattered, or treated with mastication could increase the risk of intense soil heating and ground cover or soil loss from wildfire ***(21-22, 36, 38)***.

Indicator: Old Growth and Associated Components

Alternative 4 would not readily promote the development of late-successional stages, since fire is an important process in maintaining the interspaces and understory diversity that characterizes old-growth forest (***V17, 31***). Fire also helps create snags and balance levels of coarse woody debris ***(V20)***. Therefore, the lack of fire in this alternative would do little to promote the development of many old-growth forest components, though any existing old growth would be better protected from fire under this alternative (***V19***) than alternatives that incorporate minimal thinning (alternatives 1 and 3). By mechanically thinning small, vigorously growing trees surrounding larger, older trees, we could increase available resources and decrease stressors to the older tree ***(V17)***. In this manner, thinning may also increase the value of timber through reduced stressors and protection from fire.

Indicator: Patch Size

Alternative 4 would reduce patch sizes in MCD toward desired conditions and increase stand heterogeneity on a landscape scale due to the high acreages of mechanical vegetation treatments. However, with the minimal incorporation of fire under this alternative, repetitive thinning treatments would be needed over time to maintain desired patch sizes, as regeneration would quickly infill the understories on many treated sites. This factor makes this alternative result in the fewer positive ***(V25-27)*** and higher negative effects ***(V24)*** of patch size reduction than alternative 2, as the area of land is more highly fragmented, but natural fire regimes are not restored. On smaller, more localized scales, this alternative would initially reduce patch sizes the closest to desired conditions most readily of any alternative due to the high objective acres for cutting treatments.

Indicator: Fire

Fire would be minimally incorporated into the forest plan objectives for this alternative. Therefore, the effects of fire would be limited to wildland-urban interface areas, and to areas in which unplanned ignitions (wildfire) occur. This alternative would largely reduce the benefits (***V18, 30-33***) and the negative consequences of fire (***V38-39, 54-58***) by using mechanical treatments to alter stand structure and treat fuels in ways that lessen the risk of uncharacteristic fire. The risk of uncharacteristic fire is expected to be lower than other alternatives, except alternative 2. However, the lack of fire would also necessitate additional treatments to remove fuels created through thinning ***(V40)*** and challenge the regeneration of the desired grass-forb component in the newly opened understory ***(V31)*** more than other alternatives that incorporate more acres of fire.

Ponderosa Pine Forest (PPF)

Alternative 1 – 1987 Forest Plan

In the 1987 Forest Plan, the Santa Fe NF was divided into separate management areas. Though there are no specific forest plan objectives for treating PPF in the existing forest plan, each of these management areas haves a management emphasis (table 29) and standards and guidelines to follow. A detailed description of each management area can be found in the 1987 Forest Plan. Desired conditions for vegetation are the same as those defined across all other alternatives.

Below, standards and guidelines for management areas are discussed if they have effects on vegetation under alternative 1.

Table 29. Percentage of PPF acres in each management area of the 1987 Forest Plan

Management Area	A	B	C	D	E	F	G	H	HF	HO	I*
PPF (%)	30	28	20	32	47	20	27	26	55	3	
Management Area	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**X**
PPF (%)	7	9	36	18	4	43	57	58	59	37	34

See table 27 for brief description of management areas.

Indicator: Seral State

Alternative 1 promotes slight movement toward desired conditions, as seral state departure shifts within the high departure category from 97 percent to 72 percent after 50 years, making it the second least effective method of reducing seral state departure across the analysis timespan (figure 15). Currently, nearly 70 percent or 282,740 acres in the ponderosa pine forest ERU are in closed, late-development states (V1, 23) (see table 14, Affected Environment). The existing forest plan includes standards and guidelines for timber treatments that provide for even-aged and uneven-aged treatments, old-growth retention, and to manage for insects and diseases (V17, 19). At the proposed rate of treatment for alternative 1, it would take 81 years to treat these highly departed areas, much longer than the expected lifespan of the forest plan.

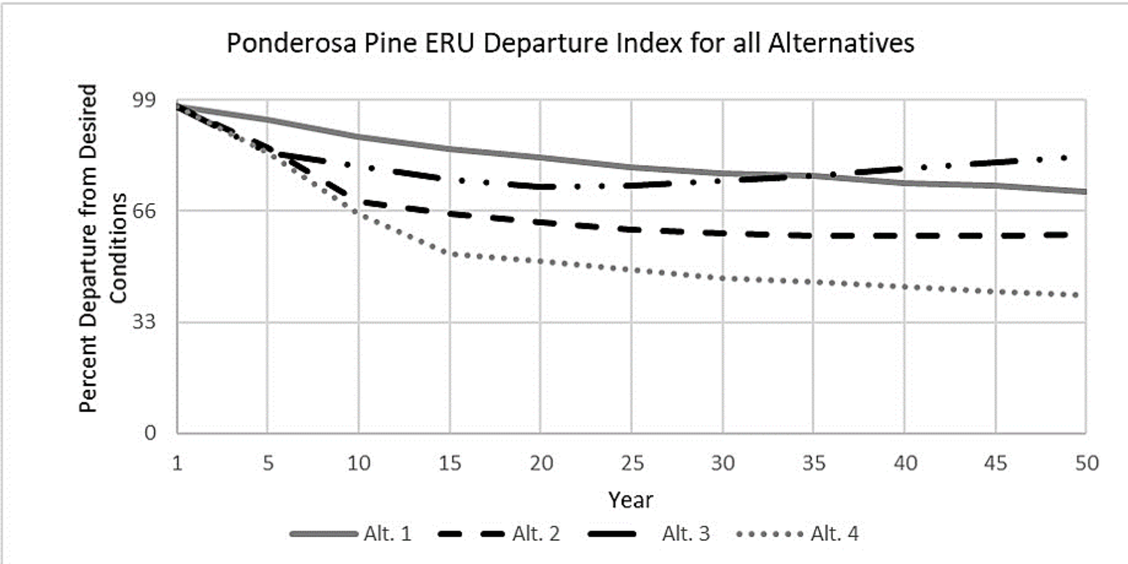

Figure 15. Ponderosa pine forest ERU seral state departure. Departure is based off a nominal classification of low (0-33%), moderate (34-66%), and high (67-100%).

Indicator: Canopy Cover and Ground Cover

The existing forest plan provides standards and guidelines for canopy openings resulting from vegetative treatments to maintain a certain visual aesthetic for forest users. The opening sizes are based on the landscape, distance from roadways or trails, and the speed of travel ***(V63)***. Due to the limited number of acres included for treatment, alternative 1 retains the highest percentage of acres in closed canopy states (61 percent) compared to other alternatives after 50 years (figure 16). Remaining under high canopy cover, understory conditions (species composition, and community structure) would continue to be impaired ***(V5, 7-8, 14-16)*** the most compared to all other alternatives or the second most (ahead of only alternative 3) depending on the frequency and severity of wildfire.

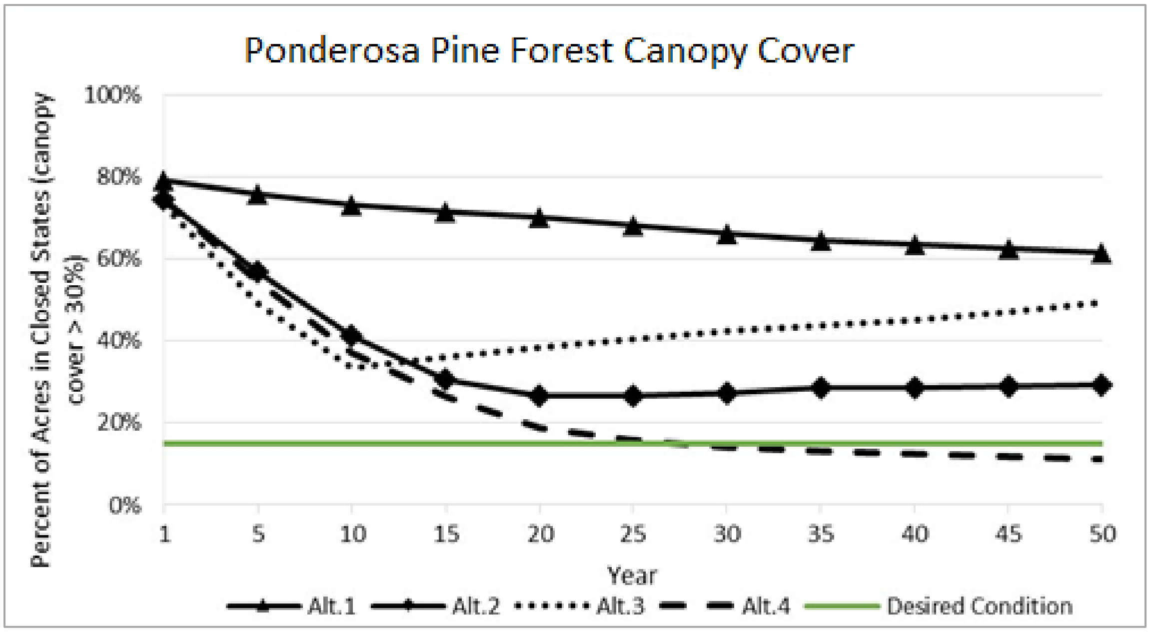

Figure 16. Ponderosa pine forest ERU canopy cover. Closed state conditions are when canopy cover exceeds 30 percent (ESSA 2006).

Indicator: Old Growth and Associated Components

The existing forest plan has standards and guidelines for retaining snags and coarse woody debris ***(V20, 23)***, and using harvesting practices that encourage old-growth development. The prolonged absence of fire in PPF is evident based on high snag densities and excessive fuel loading in current conditions (table 30). Coarse woody debris levels are at nearly 42 tons per acre, more than 5 times over the historic average (table 30) ***(V21-22, 40)***. Fuel loadings are expected to remain close to current conditions under this alternative ***(V40)***, improving on current conditions only slightly better than alternative 3.

Table 30. Old-growth forest components for desired conditions, current conditions, and for all alternatives (at year 50) for the ponderosa pine forest ERU

Ecosystem Characteristic	Desired Conditions	Current Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Number of snags greater than 8 inches dbh per acre	2 to 8	7.9	5.8	5.5	6.6	4.6
Number of snags greater than 18 inches dbh per acre	1 to 2	0.8	1.3	1.6	1.5	1.6
Tons of coarse woody debris per acre	3 to 10	42.3	41.6	24.0	17.9	29.8
Acres contributing to large trees and old-growth forest components	189,840	12,602	130,626	133,615	76,744	189,396

Data from VDDT model output

Indicator: Patch Size

Alternative 1 would reduce patch sizes (moving toward desired conditions) the least of any alternative on a landscape scale due to the low acreages of vegetation treatments expected to be implemented under this alternative, resulting in the fewest positive ***(V25-28)*** and fewest negative effects ***(V24)*** of patch size reduction.

Indicator: Fire

The 1987 Forest Plan did not include specific objectives for the use of natural and prescribed fire, though standards and guidelines state that prescribed fire can be used for site preparation, fuels reduction, and enhancement of wildlife habitat ***(V17-18, 29, 32-33, 61)***. Under the 1987 Forest Plan, standards and guidelines state that wildfires are permitted to burn for resource benefit, given certain suppression parameters. These parameters state that wildfires with high intensity are suppressed at 75 acres, while low-intensity fires are suppressed when threatening young tree plantations, or at the discretion of a wildlife biologist. Without more intensive treatments and a greater number of acres treated with fire, a high proportion of the late-successional stages currently present within PPF would remain in a closed-canopy structure with high tree densities and stressed conditions ***(V64)***. These treatments are also not likely sufficient to treat enough acres of departed PPF to reduce the risk of catastrophic events, such as uncharacteristically large patches of high-severity fire ***(V12, 38-39, 58-60)***, which would retain the highest likelihood of occurrence under this alternative.

Alternative 2 – Forest Plan

Research has found that within southwestern frequent-fire ecosystems, a timber management regime of uneven-aged thinning followed with frequent, low-severity understory burning has the potential to restore many ecosystem characteristics and processes to more closely mirror historical conditions (Moore et al. 1999). Within PPF, forest plan objectives for alternative 2 propose to treat an average of 5,750 acres using mechanical methods and an average of 20,000 acres using fire each year. These objectives more than double the acres treated mechanically and incorporate nearly 5 times the amount of fire (annually) that the forest uses (on average) in alternative 1.

Indicator: Seral State

Alternative 2 promotes the second greatest movement toward desired conditions for PPF as outlined in the forest plan. Alternative 2 would shift seral state departure from high (97 percent) to moderate (59 percent) after 50 years (figure 15) ***(V3)***.

Indicator: Canopy Cover and Ground Cover

Alternative 2 would show the second greatest movement toward desired open canopy conditions, with a 41 percent reduction in closed states after 50 years (29 percent closed states, figure 16) due to plan objectives for thinning and fire treatments. This alternative is expected to produce the greatest improvements of all alternatives in ground cover due to the combination of treatments, where a reduction in closed states would result in improved understory conditions and create grass-forb-shrub interspaces ***(V5-6)***.

Indicator: Old Growth and Associated Components

Alternative 2 would result in the second highest number of acres that contribute to large trees and old-growth forest components. Through using the combination of vegetation treatments described in forest plan objectives, alternative 2 would promote the development of late-successional stages ***(V32-33)***. Coarse woody debris levels would trend toward desired conditions after 50 years (table 30) ***(V20)***. Snag density would also decrease from current conditions toward a more natural density over time.

Indicator: Patch Size

Alternative 2 would reduce patch sizes (moving toward desired conditions) the most of any alternative due to the relatively high acreages in objectives for vegetation treatments (fire and cutting) to be implemented under this alternative, resulting in the highest positive ***(V25-28)*** but fewer negative effects ***(V24)*** of patch size reduction than either alternative 3 or 4. Overall, the combination of fire and high variability thinning treatments would create changes to existing PPF patch sizes on the landscape in a more efficient and direct manner than using either treatment alone. In PPF areas that are the most highly departed, cutting treatments could directly create desired patch sizes that fire could then maintain over time.

Indicator: Fire

The combination of mechanical treatments and fire would reduce fuel loadings ***(V40)*** and reduce the risk of uncharacteristic fire within treated areas and in areas near treated areas ***(V12, 34-36, 38-39, 54-56, 58-60).*** Alternative 2 would be the most effective at reducing the risk of uncharacteristic fire due to the combination of treatments. Ultimately, alternative 2 has a much greater potential than alternative 1 to restore conditions at a pace necessary to buffer stressors and restore ecosystem function through the return of a more natural fire regime ***(V30-33)***.

The combination of treatments given in forest plan objectives for alternative 2 would allow more flexibility to prescribe a range of treatments within areas where using only mechanical methods or fire would not be enough to move conditions toward desired conditions ***(V44)***. At the frequency and intensity of treatments proposed under alternative 2, the negative consequences of mechanical methods ***(V48-51, 84)*** could be expected at a lesser degree than in alternative 4, while the negative consequences of fire ***(V34-36)***, at least for planned ignitions, would be expected to be less than in alternative 3, which implements many more acres of fire treatments.

Alternative 3– Natural Forces Emphasis

Forest plan objectives for alternative 3 propose treating an average of 57,500 acres annually using prescribed fire and natural fire ignitions. This alternative also includes 2,220 acres of mechanical treatments, which would primarily focus on resource protection (water) and safety (treatments in the wildland-urban interface).

Indicator: Seral State

By predominantly incorporating fire to elicit desired changes on the landscape, this alternative shows the least improvement in seral state departure compared to other alternatives ***(V1)***. While seral state departure would show the greatest initial movement toward desired conditions, especially within the first 10 years, it would return to a highly departed (82 percent) after 50 years (figure 15) ***(V3).***

Indicator: Canopy Cover and Ground Cover

The fire treatments of alternative 3 would promote the greatest initial improvement in canopy openness, but would result in the second least improvement in closed canopy states (at 49 percent) by year 50 overall (figure 16). Similar to alternative 1, the understory conditions (species composition, and community structure) would likely remain highly impaired ***(V5, 7-8, 14-16)***, because the desired condition for percent of acres in closed canopy states (less than 15 percent) would not be attained and fire could have detrimental effects on ground cover ***(V9, 12, 29)***.

Indicator: Old Growth and Associated Components

This alternative would likely lead to the least improvement in old growth and associated components of all alternatives. Coarse woody debris would be the lowest of any alternative, but would remain well over the amount desired from reference conditions (table 30), which would have positive ***(V20)*** or negative ***(V21-22)*** impacts given the amount of fire proposed under this alternative. Snag density would remain higher than reference conditions in alternative 3, due to the increased presence and frequency of fire.

The reliance on fire to move departed systems toward desired conditions could have mixed effects on old-growth development over time. On one hand, the predominance of fire in alternative 3 could result in reduced development of late-successional stages, as a result of more acres burning into early successional stages or uncharacteristic shrub/grass/seedling sapling states (see table 14), which would increase future fire severity and damage the residual older trees ***(V69)***. Under this scenario, old-growth development would be expected to be less than in other alternatives. Moreover, by damaging large, older trees, this alternative could provide less old-growth habitat for species that depend on these areas. Conversely, frequent, low-severity fire can benefit old-growth development ***(V18, 32-33)***. Thus, the effects of fire in this alternative on old-growth development would largely depend on the frequency and severity of fire where it occurs.

Indicator: Patch Size

Due to the prevalence of fire, which has been largely absent from many fire-adapted ecosystems for several decades, alternative 3 would increase landscape heterogeneity and reduce patch sizes in PPF over the lifespan of the forest plan. Though this alternative would have effects similar to the other alternatives ***(V24-26, 28)***, the wide-ranging introduction of fire into areas that have not seen fire in decades without mechanically pre-treating areas with heavy fuel loads increases the potential for additional negative effects ***(V68).***

Indicator: Fire

Without some mechanical treatments (e.g., initial entry) in these degraded areas, the effectiveness of solely using prescribed burning or naturally-ignited fire to improve conditions would be limited ***(V29, 34-36, 59, 69)***. The understory conditions (species composition and community structure) would likely remain impaired ***(V5, 8-14)***, as large amounts of fire would increase proportions of bare ground, at least initially and may promote the regeneration of woody species instead of the desired grasses and forbs ***(V8-9, 14-16)***. The lack of mechanical treatments would also increase the risk of uncharacteristic fire ***(V12, 38-39, 58-60)*** under this alternative, particularly in areas impacted by prolonged drought, which would remain lower than risk in alternative 1. Thus, this alternative would be less effective than alternative 2 in moving PPF toward desired conditions. Conversely, the increased use of fire would promote a return to historic fire regimes more effectively and more quickly than other alternatives, provided that the fire could be managed to burn with lower severity ***(V18, 30-31, 33),*** minimizing negative impacts to air, soil, water, and vegetation ***(V34-36, 54-55, 59-60)***.

Alternative 4 – Human Uses Emphasis

Forest plan objectives for the treatment of PPF under alternative 4 include an average of 15,500 acres treated annually using mechanical methods, and for 2,500 acres to be treated with fire. The acres treated annually with fire would predominantly be from natural ignitions, as the use of prescribed fire is minimized in this alternative.

Indicator: Seral State

This combination of treatments would result in the most improvement in seral state departure, with departure decreasing to 41 percent (moderate) after 50 years (figure 15) with the extensive use of mechanical treatments that enable targeted stem removal ***(V3)***.

Indicator: Canopy Cover and Ground Cover

The intensity of mechanical treatments would also result in the most open canopy conditions of all alternatives, effectively reaching the target of less than 15 percent of acres in closed states by year 50 (figure 16). The reduction in closed-canopy states and the resulting increase in canopy openness could greatly benefit ground cover abundance and diversity ***(V5-6)***, though not to as high of a degree as alternative 2, which combines mechanical treatments with fire.

While this alternative would most effectively create the desired stand structure and canopy openness through mechanical treatment practices, the consequences of intensive mechanical treatments would be greater under this alternative than any other ***(V8-9, 48-50, 84)***.

Indicator: Old Growth and Associated Components

Alternative 4 would not readily promote the development of late-successional stages, because fire is an important process in maintaining the interspaces and understory diversity that characterizes old-growth forest (***V5, 17, 31-32)***. Fire also helps to create snags and balances levels of coarse woody debris ***(V20)***. Therefore, the lack of fire used in this alternative would do little to promote the development of many old-growth forest components; however, any existing old growth would be better protected from naturally occurring fire under this alternative (***V19***). Also, mechanical treatments around larger, older trees, could increase available resources and decrease stressors to the older tree ***(V17)***.

Models predict coarse woody debris would remain higher under this alternative after 50 years than in any other treatment except alternative 1 ***(V21-22)***, but snag density would conversely be the lowest of any alternative (table 27), presumably due to indirect effects of mechanical treatment (e.g., machinery inadvertently knocking them over) ***(V23)***.

Indicator: Patch Size

Alternative 4 would reduce patch sizes in PPF toward desired conditions and increase stand heterogeneity on a landscape scale due to the high acreages of mechanical vegetation treatments. However, with the minimal incorporation of fire under this alternative, repetitive thinning treatments would be needed over time to maintain desired patch sizes, as regeneration would quickly infill the understories on many treated sites. This factor causes this alternative result in the fewer positive ***(V25-27)*** and higher negative effects ***(V24)*** of patch size reduction than alternative 2, as the area of land is more highly fragmented, but natural fire regimes are not restored. On smaller, more localized scales, this alternative would initially reduce patch sizes the closest to desired conditions most readily of any alternative due to the high objective acres for cutting treatments.

Indicator: Fire

Fire is minimally incorporated into the forest plan objectives for this alternative. Therefore, the effects of fire would be limited to wildland-urban interface areas, and to areas in which unplanned ignitions (wildfire) occur. This alternative would largely reduce the benefits (***V18, 30-33***) and the negative consequences of fire (***V38-39, 54-56, 58-61***) by using mechanical treatments to alter stand structure and treat fuels in ways that lessen the risk of uncharacteristic fire. The risk of uncharacteristic fire is expected to be second lowest of all alternatives, being only higher than alternative 2. However, the lack of fire would also necessitate additional treatments to remove fuels created through the thinning process ***(V40)*** and challenge the regeneration of the desired grass-forb component in the newly opened understory ***(V31)*** more than other alternatives.

Spruce-Fir Forest (SFF) and Mixed Conifer with Aspen (MCW)

The SFF and MCW ERUs have no specific forest plan objectives for treatment in the existing forest plan or for any of the plan alternatives. Because of this, we expect minimal effects on these ERUs. Due to similarities between MCW and SFF, the effects that are possible from natural processes or due to the direct treatment of surrounding ERUs with plan components (MCD and PPF) are briefly described below.

Effects common to all alternatives

Modeling predicts that SFF and MCW forests would likely maintain current levels of departure or show slight improvements over time. It is predicted that more acres would shift into the aspen and deciduous tree state over the next 50 years in SFF, while over-represented medium-sized trees would shift into the missing large tree, closed-canopy state that was historically a dominant state of MCW. It is also likely that medium-sized trees would shift to open stands of large trees in SFF. This would support the formation of old-growth characteristics within some areas over time. These seral state shifts would occur predominantly because of natural processes such as drought, wildfire, insects or disease, and wind ***(V3, 5, 30-33, 55)***. Both ERUs are at risk of high-severity fire if drought stress continues ***(V36, 54-58)***. While patch sizes are within the historic range of variability for SFF and would likely remain there, patch sizes in MCW would likely remain uncharacteristically low, potentially causing problems with landscape connectivity for certain wildlife species ***(V33)***.

Alternative 1 – 1987 Forest Plan

In the 1987 Forest Plan, the Santa Fe NF was divided into separate management areas. Though there were no specific objectives for treating SFF or MCW in the existing forest plan, each of these management areas has a management emphasis (table 27) and standards and guidelines to follow. (A detailed description of each management area can be found in the 1987 Forest Plan.) The SFF and MCW ERUs were predominantly incorporated into the management areas C, F, and N, with the largest proportion in area N (threatened and endangered species). Management area N emphasizes protecting and enhancing wildlife habitat for sensitive species. The area contains 0 acres suitable for timber production, eliminating the associated negative effects ***(V48-50),*** but forest plan standards and guidelines allowed cutting for habitat improvements ***(V3, 45, 47)***. Under the standards and guidelines, there are strict parameters for fire suppression, controlling all fires at 10 acres or less, due to the propensity for these ERUs to burn with stand-replacing severity during times of extended drought ***(V31, 33, 36, 54-61)***.

In the absence of specific treatment guidelines under the current forest plan, some vegetation treatments occurred over the past decade within SFF, though none were documented specifically in MCW. Continuing under the guidance of this plan would maintain the current departure from desired conditions for both ERUs at a moderate level. There are no anticipated effects except for those occurring as a result of wildfire ***(V29-31, 34-36, 54-57, 61)*** or uncharacteristic fire ***(V38-39),*** which would remain under relatively high risk if the right conditions are present.

Alternative 2 – Forest Plan

Alternative 2 would have the second highest impact of all alternatives on SFF and MCW. Managed natural fires originating in PPF or MCD (as supported by forest plan objectives), may spread into the SFF or MCW, which could help maintain fire regimes within the naturally occurring range and decrease stand density of the existing forest ***(V3, 30),*** and would reduce the overload of coarse woody debris, which is highly departed from reference conditions ***(V21-22, 29)***. While mechanical treatments in adjacent MCD and PPF stands should not directly impact SFF and MCW, these treatments would reduce the risk of uncharacteristic fire ***(V38-39)*** occurring in these stands or moderate fire behavior by reducing fuels in the surrounding areas, especially since SFF and MCW are infrequent fire systems that typically burn with moderate to high severity when fire occurs ***(V31, 33, 36, 54-61)***.

Alternative 3 – Natural Forces Emphasis

The risk of these areas experiencing high-severity fire would be the highest under this alternative. Because this alternative uses a much greater occurrence of fire within MCD and PPF areas, the likelihood of fire spreading into the adjacent SFF and MCW ERUs under certain conditions, such as drought, would be increased. Conversely, if fire behavior is low-moderate in burns that are conducted or naturally occur in surrounding areas, the potential for fire to spread into these untreated areas would be reduced ***(V56)***. Without the use of mechanical treatments to reduce fuel loadings in the adjacent ERUs under this alternative, greater fire severities would be probable with unplanned ignitions ***(V40)*** particularly in areas also impacted by prolonged drought. The impacts of high-severity fire within these ERUs would be detrimental to vegetation, soil, at-risk species, and watersheds, and may increase the risk of beetle infestations ***(V36, 38-39, 54-58).***

Alternative 4 – Human Uses Emphasis

Alternative 4 would be the least likely of all alternatives to influence SFF or MCW, as there would be the lowest chance of a spillover effect from treating nearby ERUs using predominantly mechanical methods. As fire use would be minimized under this alternative in forest plan objectives, and adjacent ERUs having forest plan treatment objectives would be mechanically thinned, the risk of uncharacteristic fire should be lessened for these ERUs unless extreme drought conditions are prevalent ***(V38-39, 54-58)***.

3.2.5.3 Non-forest ERUs

Juniper Grassland (JUG) and Piñon-Juniper Grassland (PJG)

Effects common to all alternatives

Vegetation treatments conducted in grassland ERUs would reduce tree encroachment, returning the proper structure to grasslands and promoting the growth of grasses important for meadow restoration and grazing[V70]. Drought probability and severity are likely to increase in the future (Ford et al. 2012)***, leading to reduced grassland productivity, lower overall groundcover, shifts in species composition, and soil instability[V71]. Stressed grasslands will be more susceptible to invasive species invasion, altering site productivity, forage availability and quality, and displacing native species[V72].***

Alternative 1 – 1987 Forest Plan

While there are no specific forest plan objectives for vegetation treatments in the current (1987) forest plan, treatments averaged 14 acres (JUG) and 42 acres (PJG) using mechanical methods and 352 acres (JUG) and 47 acres (PJG) using fire on an annual basis over the past decade. The existing forest plan did contain standards and guidelines for management areas (table 27), some of which contained over 20 percent of JUG or PJG acres (table 31).

Table 31. Percentage of JUG and PJG in management areas from the 1987 Forest Plan

Management Area	A	B	C	D	E	F	G	H	HF	HO	I*
JUG (%)	1	4	13	14	2	5	13	17	6	0	
PJG (%)	0	0	2	2	0	2	14	4	1	0	
Management Area	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**X**
JUG (%)	0	48	2	21	13	0	4	8	3	24	19
PJG (%)	0	29	0	23	0	0	1	11	0	20	1

*I is included in other areas (P, Q, R, S)

Indicator: Seral State

According to modeling results, seral state departure would remain at the moderate level (39 percent) after 50 years (figure 17) ***(V1-2)***. The combination and scale of treatments used in the past decade, if continued, are expected to reduce departure in the first 15 years of the Plan, before departure begins to steadily increase up to year 50. Alternative 1 maintains the highest seral state departure level of all alternatives, making it the least effective to promote the benefits of seral state reduction ***(V3)***.

Standards and guidelines for management areas in the existing forest plan call for retaining three mast-producing mature piñon trees per acre in areas that are used for firewood harvesting. ***Retaining mature mast-producing piñon trees ensures that there is a seed source for future piñon regeneration, for wildlife use, for the collection of nuts for human consumption, and to sustain other traditional uses, meeting the varied needs of wildlife and people into the future[V73].*** The standards and guidelines also state that piñon and juniper firewood regeneration harvesting will be done in 1- to 20-acre stands on a 300-year rotation. At this level of treatment, there would be a sustainable supply of piñon and juniper firewood to meet the demands of forest users in years to come and variable ages of trees spanning a range of seral states.

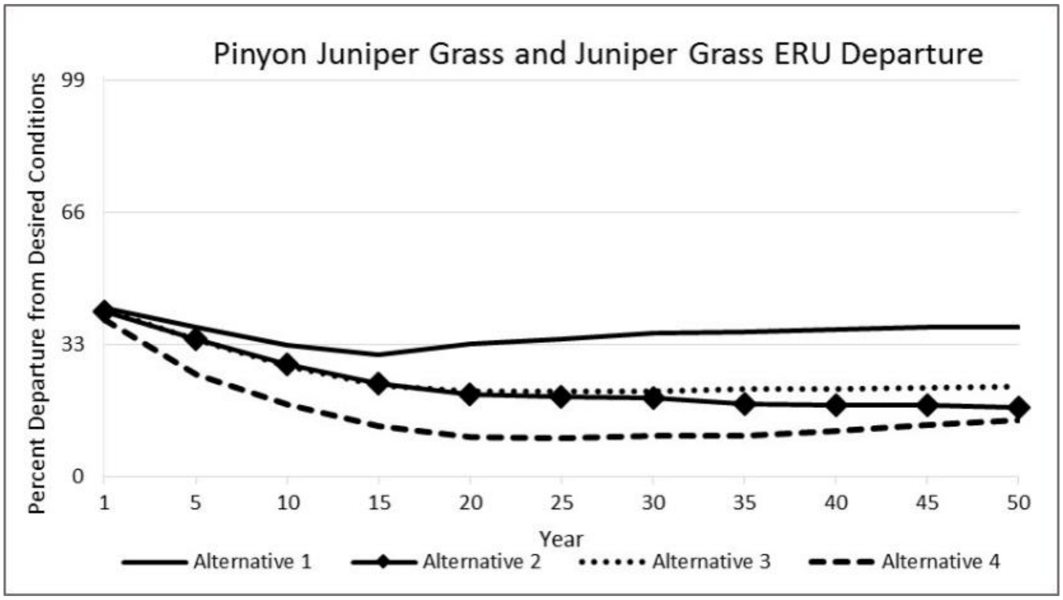

Figure 17. Juniper grassland and piñon-juniper grassland ERU departure. Departure is based off a nominal classification of low (0-33%), moderate (34-66%), and high (67-100%).

Indicator: Canopy Cover and Ground Cover

Modeling of treatment averages for alternative 1 predicts an increase in closed-canopy states due to early seral states growing into closed conditions ***(V1-2),*** showing the least improvement of all alternatives. At the same time, the percentage of closed-canopy states remains fairly consistent over a 50-year timespan, hovering around 60 percent (figure 18), which is the highest of all alternatives and remains the furthest from reference conditions. This would result in negative impacts to understory ground cover and plant diversity ***(V7-10, 14-16)***. These effects would be amplified in areas of fragile soils, such as management area K in the existing forest plan (48 percent JUG; 29 percent PJG).

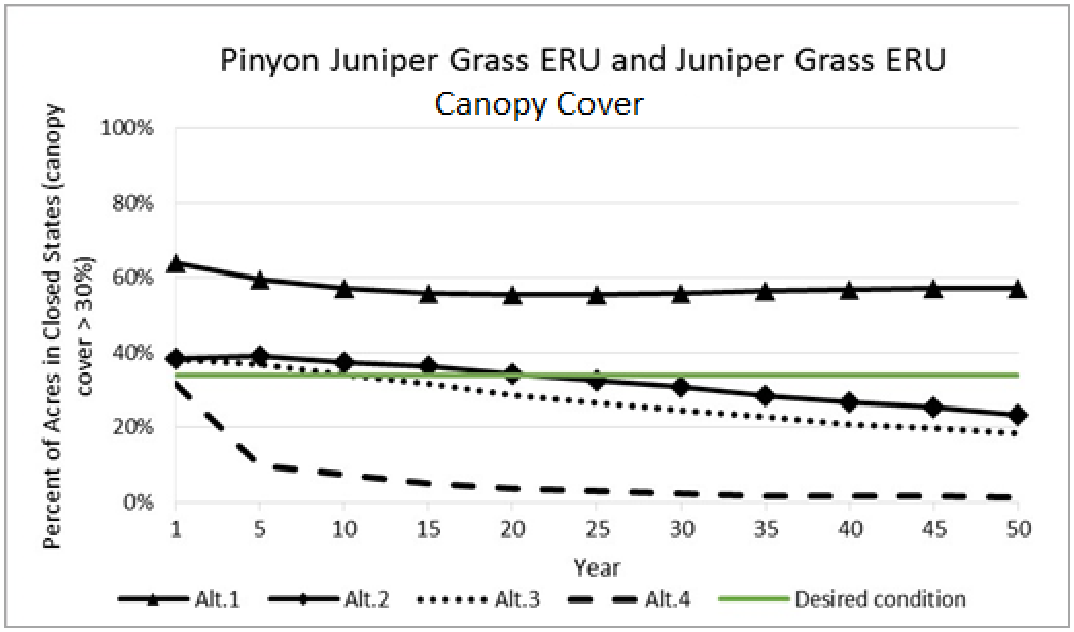

Figure 18. Piñon-juniper grassland and juniper grassland ERU canopy cover. Closed state conditions are when woody canopy cover exceeds 30 percent (ESSA 2006).

Indicator: Old Growth and Associated Components

The combination of treatments used in the existing forest plan are effective at increasing the acres that contribute to large trees and old-growth forest components, building greater structural diversity into the landscape. However, alternative 1 shows small-diameter snags (greater than 8 inches dbh) and coarse woody debris levels that are the most departed from reference conditions compared to all other alternatives (table 32) ***(V20, 23)***.

Table 32. Other stand components for desired conditions, current conditions, and for all alternatives (at year 50) for the piñon-juniper grassland and juniper grassland ERUs

Ecosystem Characteristic	Desired Conditions	Current Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Number of snags greater than 8 inches dbh per acre	2 to 8	4.0	6.8	5.1	4.0	5.4
Number of snags greater than 18 inches dbh per acre	0 to 2	0.7	1.0	1.1	1.0	1.1
Tons of coarse woody debris per acre	1 to 3	3.5	5.6	4.8	3.4	5.3
Acres contributing to large trees and old-growth forest components	42,248	19,823	52,734	47,536	37,339	52,058

Data from VDDT model output

Indicator: Patch Size

Alternative 1 would reduce patch sizes (moving toward desired conditions) in PJG and JUG the least of any alternative on a landscape scale due to the low acreages of vegetation treatments anticipated to occur under this alternative based on past averages, resulting in the fewest positive ***(V27-28)*** and fewest negative effects ***(V24)*** of patch size reduction.

Indicator: Fire

This alternative incorporates the second least amount of fire, depending on the frequency and size of natural ignitions, doing little to encourage the benefits of fire ***(V5, 30-33)***. Under existing forest plan standards and guidelines, wildfire suppression efforts will aim to control high-intensity fires at less than 100 acres, while allowing for the use of prescribed fire to maintain treated grasslands, enhance firewood production, or promote wildlife habitat ***(V6, 31, 33, 44)***. Without introducing fire over a wider range of acres or changing the degree of canopy openness, we can expect little to no increase in understory grass and forb growth. ***Reduced herbaceous growth and cover negatively impacts wildlife that forage and nest in open grassy areas due to a lack of availability across the local landscape and increased competition and resource pressure in nearby areas where adequate forage and cover is present***[V74], and limits site productivity to support livestock grazing ***(V8),*** affecting local ranchers and hunters by not providing the right habitat conditions for their respective species of concern. Furthermore, the risk of high-severity fire remains highest (or second highest depending on frequency and severity of fires in alternative 3) of all alternatives under these conditions ***(V12, 38-39)***.

Ultimately, the current treatment averages in alternative 1 would be the least effective at restoring the desired structure, composition, and function to these ERUs.

Alternative 2 – Forest Plan

Forest plan objectives for vegetation in alternative 2 propose treating 637 acres (JUG) and 275 acres (PJG) annually using mechanical methods and an average of 1,788 acres (JUG) and 625 acres (PJG) annually using fire.

Indicator: Seral State

As a result of these treatments, alternative 2 would reach lower seral state departure after 50 years (figure 17) than alternatives 1 and 3 ***(V3)***, but remain slightly higher than alternative 4 ***(V1-2)***. The mechanical treatments that would be incorporated in alternative 2 are able to directly shape stand structure to meet the desired conditions described in the forest plan. (Fire also shapes stands, but with less precision.) Because the acres treated using mechanical methods would be fewer than alternative 4, we should expect to experience fewer of the negative consequences, where they would be limited to more localized areas with this treatment ***(V48-50)***. The reduction in seral state departure would reduce some over-represented seedlings and saplings and provide for increased proportions of larger stems with interspaces ***(V3, 17-19, 31-32)***.

Indicator: Canopy Cover and Ground Cover

The reduction in small, dense stems would achieve desired canopy openness, reaching 23 percent of the landscape in closed-canopy states at year 50 (figure 18), increasing the potential for ground cover diversity in enlarged interspaces **(V5-6, 30-31, 44, 66-67, 70)** more than in any other alternative. Though the target openness would be met in this alternative, both alternatives 3 and 4 would reach the targeted canopy openness at a faster rate.

Indicator: Old Growth and Associated Components

By incorporating both fire and mechanical treatments according to forest plan objectives, alternative 2 would best support the development of old-growth characteristics, through the development of late-successional stages over time ***(V17-19, 31-32)***. This alternative would result in the acres contributing to large trees and old-growth components being the closest to desired conditions of all alternatives (table 32), though they are third highest. Snag density and coarse woody debris loadings are predicted to increase from current levels, providing habitat for certain insects and animal species, and depositing organic material to the soil through decomposition ***(V20)***.

Indicator: Patch Size

Alternative 2 would reduce patch sizes in PJG and JUG of all alternatives, leading to the greatest magnitude of positive effects ***(V27-28)*** and no anticipated negative effects. Patch sizes in these ERUs are not drastically out of desired ranges at 15 or 16 trees per acre (desired: approximately 1), so treatment at the acreages proposed in forest plan objectives could feasibly result in improvement in these ERUs, which collectively cover less than 9 percent of the Santa Fe NF land base. The use of fire in this alternative would support patch size alterations created through mechanical treatments.

Indicator: Fire

Forest plan objectives for vegetation treatments that incorporate fire under this alternative would encourage a return to a more natural fire regime ***(V29-33)***, and would reduce severe fire ***(V12, 38-39, 54, 56, 74)*** potential more than any other alternatives through multiple treatments. The application of fire would also support and sustain the changes made to stand structure (using fire and mechanical methods) over time ***(V3, 30, 32, 45, 47)***. Since the acreage treated with fire is less than alternative 3, this alternative should produce less detrimental effects and impacts of fire, depending on location and severity of the burns ***(V12, 34-36, 38).***

Alternative 3– Natural Forces Emphasis

Forest plan objectives for vegetation in alternative 3 propose the treatment of 3 acres (JUG) and 12 acres (PJG) annually using mechanical methods and an average of 8,500 acres (JUG) and 3,750 acres (PJG) annually using fire.

Indicator: Seral State

As a result of the forest plan objectives for vegetation treatments, alternative 3 would reduce seral state departure after 50 years (figure 17) more than alternative 1, but less than alternatives 2 and 4**.** For the first 20 years, the reduction in seral state departure between alternatives 3 and 2 would be nearly identical, dropping from 41 percent to roughly 21 percent, mitigating some of the negative effects of seral state departure within the lifespan of the Forest Plan ***(V1-2).***

Indicator: Canopy Cover and Ground Cover

At year 50, alternative 3 would yield greater canopy openness than alternatives 1 and 2, but less open conditions than alternative 4 (figure 18) ***(V4-5)***. By predominantly using fire as a vegetation treatment, alternative 3 would do the most to restore natural fire regimes in these departed ERUs. The increase in fire frequency would create larger openings, improve ecosystem resiliency, and improve the diversity of understory vegetation ***(V5-6, 30-31, 66-67)***, unless the fires burn with high severity, leading to detrimental effects ***(V12, 15, 29, 38-39, 54, 56, 74)***.

Indicator: Old Growth and Associated Components

The predominant use of fire in this alternative would help to incorporate more old-growth characteristics ***(V23, 38)*** than are present on the landscape currently, but would result in the lowest number of acres contributing to large trees and old-growth components out of all alternatives ***(V56, 69)***. Alternative 3 would keep coarse woody debris loading and snag density at desired reference levels (table 32) ***(V20)***.

Indicator: Patch Size

As the removal of excess woody vegetation is key to restoring the desired patch sizes of JUG and PJG, the minimal use of mechanical methods would reduce the effectiveness of this alternative to reach the desired condition of an average of 1 tree per acre. Additionally, the use of fire would have a positive effect ***(V28)*** and should not produce negative consequences ***(V24)***.

Indicator: Fire

The predominance of fire on the landscape would negatively impact nearby communities ***(V34-35)*** for a very brief time (e.g., unlikely more than a few days), but would encourage a return to a more natural fire regime at a faster rate than any other alternative ***(V29-33, 67)***. Also, since this alternative uses limited mechanical treatments that could reduce fuel availability, the risk for uncharacteristic fire behavior would likely be second highest (or highest, depending on unplanned fire frequency and severity) under this alternative ***(V12, 38-39)***. There would also be ***socio-economic consequences of a widespread or severe fire, such as reducing the availability of forest products (e.g., firewood, piñon nuts, etc.) for human use[V75].***

Alternative 4 – Human Uses Emphasis

Forest plan objectives for vegetation in alternative 4 propose treating 7,500 acres (JUG) and 1,500 acres (PJG) annually using mechanical methods and an average of 550 acres (JUG) and 250 acres (PJG) annually using fire.

Indicator: Seral State

Under the management objectives of alternative 4 that incorporate mostly mechanical methods, seral state departure would be reduced faster and to a greater degree than in any other alternative (figure 17). As a result, stand density would be quickly reduced, increasing canopy openness and creating larger interspaces between tree groups ***(V5-6, 66)***.

Indicator: Canopy Cover and Ground Cover

This alternative has the highest effectiveness to achieve targeted stand structure. Desired proportions of open canopy states (less than 35 percent closed) could be achieved almost immediately through this alternative, due to a starting point just above this threshold and the ability of mechanical treatments to target specific stems for removal. To open the canopy too much in PJG or JUG would be undesirable, as it ***disrupts the water cycle by reducing transpiration and intercept rates, allows for extreme soil heating, and removes valuable habitat for certain species[V76]***. To avoid these negative effects, forest plan desired conditions guide thinning treatment outcomes. Mechanical treatments within these ERUs could have other negative effects due to the large number of acres treated, especially if the treatments use mechanized equipment ***(V7-9, 48--50, 74)***.

Indicator: Old Growth and Associated Components

Alternative 4 is predicted to have the second highest number of acres contributing to large tree or old-growth conditions, due to the selective nature of mechanical treatments ***(V17, 19)***. Plan desired conditions guide thinning treatments to retain at least 20 percent of acres in mid and late-development closed states in order to retain areas capable of producing old growth-characteristics and providing suitable habitat and cover for birds and wildlife.

Indicator: Patch Size

Alternative 4 would reduce patch sizes in PJG and JUG the most of all alternatives due to the higher objective acres for mechanical treatments (***V27)*** and negligible negative effects. Patch sizes in these ERUs are not drastically out of desired ranges at 15 or 16 trees per acre (desired: approximately 1), so treatment at the acreages proposed in plan objectives could easily result in improvement in these ERUs, which collectively cover less than 9 percent of the Santa Fe NF land base. However, the absence of fire in this alternative would not support patch size alterations created through mechanical treatments, so treatments would need to be implemented in the future as trees encroach into the interspaces created by the initial treatments.

Indicator: Fire

Forest plan objectives for treatment include some acres of PJG and JUG treated with fire, though total acreage would be lower than for all other alternatives except alternative 1. If fire is not implemented following mechanical treatments, woody species and shrubs would gradually fill in the gaps and interspaces created by thinning, rendering the treatment ineffective at moving seral state proportions toward desired conditions in the long term ***(V1-2)*** and have negative impacts on ground cover in the short term ***(V15-16, 31)***. This alternative would also be largely ineffective at restoring natural fire regimes within these ERUs, which are currently departed ***(V30, 66)***. The lack of fire would be detrimental to the development of old-growth forest components for the future (even though late-stage seral states are present due to selective thinning ***(V32)***. The relative lack of fire would also keep snag density and coarse woody debris loadings at higher levels than desired conditions target (table 32), potentially increasing the risk of severe wildfire in these areas in instances of extreme drought ***(V12, 21-22, 29, 38-39)***; however, it is expected that the risk of uncharacteristic fire would be second lowest under this alternative ***(V12, 38-39)***.

Sagebrush Shrubland (SAGE)

Effects common to all alternatives

Under all alternatives, the SAGE ERU is ***likely to experience continued encroachment by woody species (e.g., juniper), leading to higher seral state departure and lower ecological integrity***[V77]. ***These woody encroaching species decrease water, nutrient, and light availability to understory plant species, reducing their abundance and diversity***[V78]. Likely this encroachment would be partially mitigated by impacts such as drought and insect-induced mortality on marginal tree and shrub sites, by tree removal for fuelwood, and by periodic fires (natural and planned ignitions).

Alternative 1 – 1987 Forest Plan

The existing forest plan incorporates SAGE acres predominantly into the F—Wild and Scenic Rivers (WSR) (23 percent) and S—Cultural-Wildlife-Range-Firewood (19 percent) management areas. Under forest plan standards and guidelines for area S, management practices should create structural diversity to support wildlife needs, including the use of fire for resource benefit ***(V30-31)*** (for WSR, see Effects Common to Vegetation). Alternative 1 would likely retain current SAGE treatment averages of 140 acres annually using combined treatments (mechanical and fire). Currently, 12,800 acres (37 percent) of SAGE are in exotic grass or shrub and tree invaded states. At the current rate of treatment, it would take 91 years to treat all of these highly departed areas ***(V77-78)***. Retaining the treatment levels of alternative 1 is unlikely to produce improvements to the current condition of this ERU outside of localized areas and retain the second highest levels of departure. This would have negative implications for maintaining canopy openness, ground cover, and restoring fire regimes ***(V7-11, 13-16, 29)***.

Alternative 2 – Forest Plan

Alternative 2 would treat an average of 300 acres annually using a variety of treatments and is expected to result in the lowest departure from desired conditions. Using either mechanical or fire treatments alone would not be appropriate or sufficient at restoring desired conditions in SAGE, especially in areas with high densities of species that could increase fire frequency and severity (e.g., annual brome grasses or forbs capable of producing continuous fine fuels). Thus, alternative 2 would allow for the flexibility to also incorporate invasive species removal or the reseeding of native plants ***(V44)***. These alternative treatments would allow for the restoration of highly degraded areas, where mechanical or fire treatments would not be appropriate ***(V11, 49)***, such as areas invaded by cheatgrass. Under forest plan objectives and guidelines, these areas could be targeted for invasive species removal before implementing prescribed fire or planting native species to favor species that would naturally occur in these systems. ***Restoring native species is a primary component in increasing the function of sagebrush shrublands, for resource benefits such as improved forage for grazing animals and a return to natural fire regimes*[V79]**. This sequence of restoration treatments in highly degraded areas would help boost resiliency to future disturbances or invasive species introductions by restoring native ground cover and structural conditions while also providing benefit to avian and terrestrial animals that depend on these systems for survival. However, mechanical treatments, especially involving mechanized equipment, would need to use caution to not negatively impact the areas being treated ***(V48-50)***.

Alternative 3 – Natural Forces Emphasis

Forest plan objectives for alternative 3 have the highest allotment for SAGE acres treated annually (2,000 acres). As this treatment would predominantly use fire as its management tool, the effectiveness of alternative 3 to solicit movement toward desired conditions in the forest plan is largely unknown. While this is a historically fire-adapted ecosystem, the effectiveness of the reintroduction of fire into the SAGE ERU is limited by having sufficient ground-level fuels, such as bunchgrasses, to carry the fire. In these highly departed SAGE systems, ground cover has been altered over time ***(V7-11, 13-16, 29)***. As Baker (2006) noted, it would be more beneficial to withhold fire until characteristic (native plant) understory conditions have been restored. This restoration would likely be accomplished in highly degraded areas by removing encroaching trees to thin and open the canopy, removing invasive species, and directly seed native plants. Though alternative 3 would accommodate restoration treatments like alternative 2, the magnitude of change would be less effective with the minimal use of mechanical treatments in this alternative ***(V16, 44-47, 65)***. The lack of mechanical treatments would pose difficulties in altering seral state departure ***(V3)*** in areas where fire should be avoided, such as where invasive species are present (***V72***). This alternative would result in the second greatest improvement in departure from desired conditions.

Alternative 4 – Human Uses Emphasis

There are no forest plan objectives for the SAGE ERU in alternative 4, thus, it is expected that this alternative would retain the highest level of departure over time. There is the potential that conditions in some areas would improve as SAGE areas merge with other ERUs with objectives (JUG, PJG) that would receive treatment (e.g., thinning and prescribed burning at edges where trees are invading sagebrush). But, in general, more emphasis would be placed on mechanical treatments within woodland and frequent-fire forest ERUs in alternative 4. Therefore, alternative 4 would result in little improvement in the conditions of SAGE, and effects ***(V2-3, 5-6, 16, 77-79)*** to the ERU are not expected.

Colorado Plateau/Great Basin grassland (CPGB)

Effects common to all alternatives

As described in SAGE, under all alternatives, there is predicted to be continued encroachment by woody species ***(V77-78)***. Likely this encroachment would be partially mitigated by impacts such as drought and insect-induced mortality on marginal tree and shrub sites and tree removal for fuelwood. Treatments conducted in grassland ERUs needed to restore grassland structure ***(V70)*** and increase resiliency to future disturbance ***(V71-72)***. On these sites, ***cheatgrass (a nonnative, invasive species) would continue to establish dominance by outcompeting and displacing native bunchgrasses, especially on sites where native vegetation has been reduced or removed by prior disturbances, such as fire, creating a positive feedback loop for the invasive species to proliferate and degrade sagebrush communities*[V80]**.

Alternative 1 – 1987 Forest Plan

In the existing forest plan, CPGB acres predominantly occur in management areas G—Wildlife-Range-Firewood (27 percent) and K—sensitive soils (10 percent). Under forest plan standards and guidelines, encroaching juniper would be cut, and fire would be used to maintain or improve grasslands ***(V30-31)***. Alternative 1 would likely retain current CPGB treatment averages of 147 acres annually through combined treatments (currently mechanical and fire). With 15,400 acres (37 percent) in shrub and tree-invaded states, at the current rate of treatment it would take 105 years to treat these highly departed areas, making this alternative second least effective at reducing departure from desired conditions. Without more intensive treatments and a higher number of acres treated, conditions would remain highly departed with low site productivity, increasing woody encroachment, and departed fire regimes ***(V7-11, 13-16, 29)***.

Alternative 2 – Forest Plan

Alternative 2 proposes the treatment of roughly 550 acres per year using a variety of treatment methods. At this rate of treatment, it would take 31 years to treat all highly departed CPGB areas, making it the second-best treatment plan timewise. The flexibility afforded by this alternative to choose specific management treatments that are best able to promote desired changes on the landscape, would be beneficial for grassland restoration ***(V44)***. Within this acreage allotment, highly degraded areas could be targeted for exotic species removal or the mechanical removal of encroaching trees, leading to more open canopy and native species growth ***(V5-6).*** However, staff using mechanical treatments, especially involving mechanized equipment, would need to use caution to not negatively impact the areas being treated ***(V48-50)***.

The application of prescribed fire would be the most effective way to restore this grassland ERU to a highly functioning state, and to a more natural fire regime ***(V30-31, 33)***, though large patches of bare ground would make the application of fire difficult ***(V7)***. Overall, this alternative would afford the greatest ability to return CPGB to the desired conditions outlined in the forest plan, where ***diverse and abundant ground cover species support soil stabilization and high water quality, while also providing high-quality, sustainable forage for grazing animals[V81]***.

Alternative 3– Natural Forces Emphasis

Forest plan objectives for alternative 3 propose treating 3,000 acres on average, predominantly using fire. This rate of treatment would be the most effective at treating highly departed areas within the lifespan of the forest plan. However as mentioned above, the large areas of bare ground would make carrying fire difficult ***(V7),*** reducing the effectiveness of this alternative. Since the fire regime in CPGB is highly departed, the reintroduction of fire (if possible) into this ERU would be highly beneficial to move the fire return interval closer to its natural range ***(V30-31, 33)***. If fire is implemented successfully, this alternative would improve site productivity, reduce tree encroachment, and move conditions toward the desired conditions outlined in the forest plan. These positive effects ***(V18, 30-31, 37, 44, 66, 70)*** and outcomes would be boosted if additional treatments consistent with objectives, guidelines, and the best available science (e.g., the removal of exotic species or planting of native grasses) were implemented prior to burning.

Alternative 4 – Human Uses Emphasis

There are no forest plan objectives for the Colorado Plateau Great Basin grassland ERU in alternative 4, thus, this alternative would retain the highest levels of departure from desired conditions. There is the potential that conditions in some areas would improve as some acres intergrade with PJG acres receiving treatment (e.g., thinning and prescribed burning at edges where juniper is invading grasslands). But, in general, more emphasis would be placed on mechanical treatments and boosting the availability of forest products in woodland and frequent-fire forest ERUs under alternative 4 ***(V75)***. Therefore, any indirect positive effects ***(V45-47, 70)*** or negative effects ***(V2, 48-50, 77-78)*** would be minimal.

Montane Subalpine Grassland (MSG)

Effects common to all alternatives

Like described in SAGE and CPGB, under all alternatives, there is predicted to be continued encroachment by woody species ***(V77-78)***. Likely this encroachment would be partially mitigated by impacts such as drought and insect-induced mortality on marginal tree and shrub sites, fires (planned and natural ignitions), and tree removal for fuelwood. Drought probability and severity are likely to increase in the future (Ford et al. 2012), stressing these grasslands and increasing their susceptibility to invasive species invasions ***(V71-72)***. Ruderal species such as Kentucky bluegrass would continue to establish dominance by outcompeting and displacing native bunchgrasses, especially on sites where native vegetation has been reduced or removed ***(V16)***.

Alternative 1 – 1987 Forest Plan

Under the existing forest plan, most MSG acres fall into management areas HF—Wilderness and Wild and Scenic Rivers (WSR), and M—Research Natural Areas (RNAs). Under forest plan standards and guidelines, RNAs limit or ban mechanized harvest and forest product collection, while naturally ignited fire is monitored for resource benefit ***(V51, 53).*** Over the last decade, MSG treatment averaged 124 acres annually. With 10,600 acres (60 percent) in shrub and tree invaded states, the current rate of treatment would take 85 years to treat highly departed areas, making this alternative the second least effective to reduce departure. Without more intensive treatments and a greater number of acres treated, conditions would remain highly departed. This alternative would promote little improvement in site productivity or reductions in tree encroachment over the life of the forest plan. Also, this alternative is unlikely to support grassland development and restoration needed to support grazing wildlife within MSG areas, or produce ground cover compositions needed to protect water quality, promote natural fire regimes, and stimulate proper nutrient cycling ***(V4-6, 7-10, 14-16, 29)***.

Alternative 2 – Forest Plan

Forest plan objectives for alternative 2 propose treating an average of 450 acres annually using a combination of treatments. At this rate of treatment, highly departed areas could be treated in 24 years, the second-fastest of all alternatives. As seral state departure, ground cover, and fire regimes are all departed from desired conditions, the flexibility to use the best treatment to promote grassland restoration is critical for improvement ***(V44)***. The use of fire or mechanical methods can be effective at reducing the seral state departure caused by tree encroachment, restoring stand structure to a more natural open condition ***(V5-6).*** However, mechanical treatments, especially involving mechanized equipment (outside of wilderness areas), would need to use caution to not negatively impact the areas being treated ***(V48-50)***.

A combination of treatments could restore natural ground cover diversity and compositions to support proper groundwater infiltration, stabilize soils, and provide resources for species that inhabit these areas. The application of prescribed fire would be the most effective way to restore this grassland ERU to a highly functioning state, and to a more natural fire regime ***(V30-31, 33)***, albeit at a much slower pace than in alternative 3. Ultimately, this alternative would have the highest ability to improve plant diversity and ecosystem function and resiliency within MSG due to the wide range of treatment options.

Alternative 3– Natural Forces Emphasis

Forest plan objectives for alternative 3 propose treating an average of 5,000 acres annually (on average) predominantly using managed fire. At this rate of treatment, it would be easy to treat all highly departed MSG acres within the lifetime of the forest plan, and perhaps allow time for follow-up treatments. This rate of treatment makes alternative 3 the most time effective choice for reducing departure in MSG. Since the fire regime in MSG is departed from reference conditions, the reintroduction of fire into this ERU would be highly beneficial to move the fire return interval closer to its natural range ***(V30-31, 33)***. Like alternative 2, alternative 3 would also allow the flexibility to choose other treatment methods when necessary or beneficial as determined by the best available science. Overall, this alternative would be equal to or just behind the ability of alternative 2 to restore ecosystem resiliency and plant diversity to the MSG ERU, and make great strides at returning the fire regime to a natural condition through restoring native plant compositions and converting stand structure to a more open state ***(V3, 5-6, 31)***.

Alternative 4 – Human Uses Emphasis

There are no forest plan objectives for the treating MSG in alternative 4, making this the least effective alternative for reducing departure. There is potential that conditions in some areas would improve, as montane grasslands are located within upper elevation forested areas (e.g., SFF and MCW) that would be influenced by natural processes such as fire ***(V30-31).*** Since vegetation treatments within SFF or MCW are also omitted from forest plan objectives within all alternatives, the likelihood of any effects is negligible. Therefore, alternative 4 would neither improve nor negatively impact ***(V48-50)*** montane subalpine grasslands under the lifetime of the revised plan.

Persistent Piñon-Juniper Woodland (PJO) and Piñon-Juniper Shrubland (PJS)

Effects common to all alternatives

Neither the existing forest plan nor alternatives include objectives for treating persistent PJO or PJS, thus direct effects from the vegetation treatment of other ERUs with forest plan objectives would be minimal. The use of managed fire in nearby ERUs or occurrence of wildfire under all alternatives would have indirect or direct benefits to PJO and PJS ***(V5-6, 30-33)***. Any fire that spreads into these PJ types would increase fire frequency and move the fire return interval closer to natural cycles for these systems. Additionally, fire that begins naturally or that is permitted to burn in these places would thin some of the seedling/saplings or small trees that are currently over-represented and create larger openings ***(V5-6)***. However, since fire has been absent within these ecosystems, there are increased fuel loads, which could promote high-severity fires ***(V38-39)***. Though persistent PJO historically supported high fire severity in the majority of acres burned under the normal fire regime, PJS historically burned with more moderate severity. Thus, high-severity fire could damage the soil, increase runoff, impact understory regeneration, or increase erosion, especially in PJS.

Alpine and Tundra (ALP)

There are no forest plan objectives for vegetation treatments in the ALP ERU. Though alpine and tundra are currently at low departure from reference conditions, it is expected that tree encroachment would continue to increase over time, especially with anticipated increases in temperature and decreases in precipitation (Allen et al. 2005). As these are high-elevation systems predominantly bordered by SFF and MCW, which also do not have plan objectives, the effects from vegetation treatments should be null. ALP systems are not fire-adapted, thus fire here is unlikely and should have minimal effects. Recreation and grazing would have the greatest negative effects on the vegetation within the ALP ERU ***(V8, 14-16)***. ***The soils and plant life at these high elevations are very fragile and are easily damaged by trampling,***

which can denude the thin organic layers at the soil surface, cause compaction on a microsite basis, and kill the existing vegetation that may have a difficult time re-establishing in the harsh environment[V82]; however, winter snowfall would provide some measure of protection against soil damage.

3.2.5.4 Management Areas and Research Natural Areas

Effects common to all alternatives

The Cañada Bonito Research Natural Area is proposed for designation as an RNA that will retain separate forest plan standards and guidelines from surrounding areas under all alternatives. The Cañada Bonito RNA is predominantly in MSG (49 percent), but also encompasses some acreage within MCD (22 percent) and SFF (18 percent) ERUs. The Cañada Bonito RNA has been proposed for designation as an RNA because of its area of high-quality Thurber fescue grassland that has been excluded from grazing. This area would serve as a prime study area for research devoted to assessing changes in Thurber grasslands under a shifting climate and other disturbance regimes. According to forest plan desired conditions for RNAs, ecological processes function with limited human interference. Because this area has been largely devoid of human impact, it creates a valid baseline from which to base scientific conclusions. Guidelines for management bar the creation of new roads or trails, motorized recreation, campfires, resource extraction, and vegetation removal to preserve the integrity of this area. Due to these guidelines, vegetation treatments occurring within certain ERUs elsewhere in the forest will not be applicable here. Thus, impacts to this RNA due to vegetation treatments in surrounding areas should be negligible. Natural processes will continue to shape the area. As such, fire is accepted within the RNA as a natural process according to the desired conditions. Under all alternatives, naturally ignited fire will be permitted to perform its ecological function within this RNA ***(V30-33)***.

Jemez National Recreation Area covers 57,650 acres in the Santa Fe NF (37 percent in MCD, 29 percent in PPF, and 19 percent in JUG). The area is important for recreation, cultural values, wildlife habitat, and ecological values. Under all alternatives, forest plan standards and guidelines for this management area aim to maintain or improve all values important to the area. Forest plan objectives for vegetation management using fire and mechanical treatments in MCD, PPF, and JUG would follow the directives in the forestwide section of the forest plan, except when management would be in conflict with maintaining recreational, ecological, cultural, or wildlife resource values. Mechanical treatments and planned fires would be implemented to protect cultural and recreation values, provide a greater diversity of wildlife habitat, and increase ecological resiliency in the area ***(V30, 33)***. These treatments would also protect this valuable area from uncharacteristic fire ***(V12, 38-39).*** However, it is unlikely that unplanned ignitions would be allowed to burn for resource benefit as they would in other areas of the forest. Instead, there would be a greater likelihood of deploying suppression tactics to ensure that all valuable uses and resources (e.g., cultural sites) of this recreation area are protected.

The *Mesita de los Ladrones Research Natural Area*, (51 percent in PJG, 48 percent in JUG, and less than 1 percent in CPGB) is a proposed RNA under all alternatives to conserve and study an over 500-acre juniper savanna. According to forest plan desired conditions, ecological processes function with limited human interference. Fire is accepted within the RNA as a natural process according to the forest plan's desired conditions and allows some prescribed fire for ecosystem benefit. The RNA's forest plan objectives support the return of natural fire regimes of PJG and JUG areas, resulting in the normal mixed effects of wildfire ***(V6, 29-33, 34-36)***. Plan standards dictate that vegetation should not be manipulated or removed for commercial or personal use. Thus, designating this area as an RNA would restrict the cutting of fuelwood in the area, but should have minimal impacts on the availability of these products on a larger scale.

The *Monument Canyon Research Natural Area* (52 percent in MCD and 48 percent in PPF) remains a designated RNA under all alternatives. According to forest plan desired conditions for RNAs, ecological processes function with limited human interference. Guidelines for RNAs bar the creation of new roads or trails, motorized recreation, campfires, resource extraction, and vegetation removal to preserve the integrity of this area. Due to these guidelines, the forest plan objectives slated for directly treating MCD and PPF would not apply here. Furthermore, impacts to this RNA due to vegetation treatments in surrounding areas would be negligible. In lieu of focused treatments, natural processes would continue to shape the area. As such, fire is accepted within the RNA as a natural process according to the desired conditions. Under all alternatives, naturally ignited fire would be permitted to perform its ecological function within this RNA ***(V30-33)***.

Effects common to alternatives 2, 3, and 4

Oil and Gas Leasing Areas (47 percent of acres in PPF and 24 percent of their acres in MCD). The oil and gas leasing areas occur within the Canadas-Nacimiento and north Jemez Mountains Geographic Areas. The management of MCD according to forest plan objectives would have impacts on this area, and in turn, mineral and resource extractions here would have impacts on the natural areas that surround it. The oil and gas industry are prohibited from drilling or construction activities during critical breeding and nesting seasons for multiple wildlife species, but there are no specific guidelines or standards for vegetation. Mechanical treatments within MCD would be beneficial to remove the timber resource in advance of mineral or gas development. Conversely, ***thinning treatments could cause a decreased aesthetic quality, reducing forest user satisfaction through the appearance of human-caused landscape manipulation*** [V83] by allowing a greater visibility of these mineral and gas extraction operations. Additional disturbance to areas already fragmented by industrial use could have negative consequences for vegetative communities ***(V7, 14, 50),*** and reduce ecosystem integrity. Fire treatments would need special consideration in areas surrounding oil and gas infrastructure, as oil and gas are combustible and may encourage extreme fire behavior during unplanned ignitions ***(V38-39)*** provided there are residual vegetative fuels near these areas**.**

Effects common to alternatives 2 and 3

Caja Del Rio Wildlife and Cultural Interpretive Management Area lies in the West Sangres and Caja Geographic Area and contains an abundance of cultural and biological resources. The West Sangres and Caja Geographic Area has desired conditions for low- to moderate-intensity fire, characteristic of natural regimes, especially in the wildland-urban interface areas near Santa Fe, and for sustaining multiple-use recreational opportunities. These desired conditions coincide with desired conditions for vegetation and recreation in the forest plan.

The area encompasses PJO (38 percent), PJS (44 percent), JUG and PJG (both less than 20 percent), but has been heavily impacted in the past by unauthorized motorized recreation use. Alternatives 2 and 3 propose creating a management area here to protect important habitats for many species of plants and animals, especially birds (see Wildlife and Connectivity). There are no forest plan objectives, guidelines, or desired conditions that directly delineate vegetation management within the Caja Del Rio, thus vegetation treatments would follow the forestwide objectives. Since the majority of acres of this management area occur in ERUs without objectives, direct effects would likely be minimal.

Forest plan objectives for vegetation treatments implemented in the surrounding PJG or JUG areas, would have indirect impacts to the area—especially prescribed fire treatments (e.g., smoke, visibility). Fire and mechanical treatments implemented in surrounding PJG and JUG sites should restore function to degraded habitats, increase connectivity across the landscape ***(V5, 30, 33),*** and reduce departed conditions in rangelands and grasslands ***(V6, 31)*** surrounding the Caja Del Rio. Forest staff implementing vegetation treatments using planned fire or mechanical methods must remain mindful of the impacts to the cultural resources in the area ***(V34-35, 84)***, and provide for their protection.

Alternative 3 – Natural Forces Emphasis

The Calaveras Management Area contains predominantly MCD (75 percent) and MCW (15 percent) ERUs, and is critical habitat for the Mexican spotted owl, Jemez Mountain salamander, and New Mexico meadow jumping mouse. Special management objectives for the Calaveras Management Area, located in the Jemez Mesas and Canyons Geographic Area, are incorporated into alternative 3, to provide additional resources in this area to support the conservation, growth, and development of old-growth forests, while also conserving high-quality habitat for endangered and threatened species ***(V20, 23)***. Fire would be the primary management tool used to gradually develop old-growth forest characteristics over time. Mechanical treatments included in the forest plan objectives could be implemented in areas of extreme density or to reduce the likelihood of increased fire severity that would damage or kill larger trees ***(V19)***. Repeated applications of prescribed fire, burning with low severity, would thin small-diameter stems, reduce fuel loadings, increase light to the forest floor, and increase grass and forb cover in the understory ***(V5, 18, 31)***. By returning to a more natural fire regime, the multi-aged, open stand structure with large, old dominant trees can be reached, mirroring historic conditions ***(V3, 30, 67)***. Landscape and habitat connectivity would be maintained to support wildlife needs. The combined effects of these management practices within this area would result in increased ecological integrity and resiliency.

The Holy Ghost Ipomopsis Botanical Area located in the Pecos River Canyon Geographic Area is recommended for inclusion under alternative 3. The area is characterized by MCD (81 percent) and PPF (19 percent) vegetation types. Designation of this area as a botanical area could help to further protect this endemic, federally-listed endangered species, and would help raise public awareness of this unique species. Having a designated botanical area could buffer this sensitive plant species from impacts of recreation or from vegetation treatments implemented in nearby areas. However, the designation of a Holy Ghost Ipomopsis Botanical Area could also promote increased visitation to this sensitive and vulnerable plant population and increase the risks of human-caused threats such as trampling or plant collection, or increase the risk of crushing plants via increased vehicle traffic on the narrow, dead-end canyon road.

Since this area is predominantly surrounded by ponderosa pine and dry mixed conifer forests, vegetation treatments may be implemented in the surrounding areas to alter forest structure to support greater ecosystem health and function ***(V3, 5, 18-19, 30)***. Restoring natural processes in these areas should benefit the population of Holy Ghost ipomopsis, as it evolved with natural processes like fire. Furthermore, there is potential for these natural processes to support population expansion of this endangered plant species over time into areas in which it once flourished ***(V33)***.

The *Wetland Jewels* are an assemblage of numerous wetland or riparian areas selected for special management under alternative 3. The Wetland Jewels Management Areas are found predominantly in the SFF (72 percent) ERU and within ALP, MCD, MSG, PPF, and PJO in much smaller percentages. Since there are no vegetation treatments slated for SFF in the forest plan objectives, impacts would be minimal. Wildfire that spreads into the SFF ERU (or other associated ERUs) could have detrimental impacts on these wetlands if severity is high ***(V38-39, 54-58).*** Plan objectives would direct treatments to maximize water quality and wildlife habitat, and for carbon sequestration by implementing restoration practices on

100 acres of impaired wetlands every 5 years. These practices would include invasive species removal, bank stabilization, stream channel restoration, seeding or planting native species in denuded areas, or by minimizing recreation impacts ***(V44)***. These treatments would increase resiliency in these areas and provide them with the ability to adapt to a changing climate or other stressors.

Effects common to Alternatives 2 and 4

The *Nogales Cliffhouse* and *Rattlesnake Ridge Cultural Interpretive Areas* are located in the Canadas and Nacimiento Geographic Area. Nogales encompasses the MCD (25 percent), PPF (58 percent), and PJO and SAGE (both less than 20 percent) ERUs, while Rattlesnake Ridge contains PPF (39 percent), PJO (37 percent), and SAGE (23 percent). The guidelines directing management of this cultural area do not include specific vegetation directives. However, mechanical or fire vegetation treatments that occur in areas surrounding these cultural landmarks must consider the impacts of those treatments on these unique areas ***(V8, 34, 48-50),*** and use caution so the area is not negatively impacted by adverse indirect effects of treatments such as ***noise pollution, poor air quality, or reduced scenic quality***[V84].

Alternatives 2 and 4 propose the inclusion of the *Poshuouinge Cultural Interpretive Area* and *Tsipinuouinge Cultural Management Area,* which are primarily characterized by the JUG ERU at 50 percent and 75 percent, respectively. Both cultural areas are located within the North Jemez Mountains Geographic Area. Standards and guidelines directing management of cultural areas do not include vegetation directives, nor do they prohibit treatments from occurring. Forest staff implementing vegetation treatments (fire and mechanical) in areas with forest plan objectives surrounding these cultural landmarks must consider the indirect impacts of the treatments on these unique areas and use caution so they are not negatively impacted ***(V48-50, 84).***

Alternative 4 – Human Uses Emphasis

Greater Santa Fe Recreation Area: The Greater Santa Fe Recreation Area is divided into two sections within the West Sangres and Caja Geographic Area: one lies near Santa Fe, and the other is near Los Alamos; both are popular areas for many forms of recreation. The area covers many ERUs, including MCD (44 percent), PPF (29 percent), and SFF, PJO, and JUG (all less than 20 percent). The area near Santa Fe also encompasses much of the Santa Fe fireshed, where many fuels reduction treatments are proposed, through the combined efforts of the Forest Service, tribes, and local community organizations. Forest plan objectives for vegetation treatments would reduce the risk of uncharacteristic fire in the recreation area ***(V12, 38-39)*** by treating 100 to 1,000 acres within high-risk MCD and PPF areas annually. This intensity of treatment would make great strides in protecting valuable resources and infrastructure of the city and people of Santa Fe and surrounding communities from the negative effects of fire ***(V34-36)***. The restoration treatments available to repair degraded recreation areas would help reduce negative impacts to the surrounding environment ***(V44)***.

Motorized Recreation Area. A motorized recreation area exists within the Jemez Mesas and Canyons Geographic Area, and is proposed under alternative 4 in recreation plan components for special management. PPF makes up 71 percent of this recreation area, while MCD, MCW, PJG, JUG, and PJO collectively make up the other 29 percent. While there are minimal direct effects to vegetation in this area that already has an existing road network, any newly created roads would displace trees and disturb vegetative ground cover ***(V8-9, 11, 14, 16, 50)***. Increasing motorized access within this area could also increase the risk of wildfire during drought conditions as motor vehicles pass through (or park on) flammable vegetation ***(V12, 54-55, 58)***. Furthermore, desired conditions for the Jemez Mesas and Canyons Geographic Area include healthy and productive ecosystems and high water quality and availability. If motorized recreation stays within the designated boundary of the recreation area, there should be minimal impacts to overall ecosystem health and water quality. But ***if motorized recreation expands into unauthorized areas, habitat degradation, fragmentation, and decreased water quality would result***[V85].

3.2.5.5 Geographic Areas

The Santa Fe NF has been divided into seven geographic areas (GA) to encompass large-scale differences and similarities in culture and resources across the landscape (see Geographic Areas in the Plan) in the three action alternatives proposed during forest plan revision. Each geographic area has a unique set of desired conditions. Generally, these desired conditions do not differ significantly from those within individual resource areas, such as vegetation. There are no perceived direct effects of delineating geographic areas during forest plan revision on vegetation. Vegetation treatment effects to geographic areas, as a whole, are also expected to be minimal, but on localized scales within geographic areas, there would be effects, which are described by geographic area and alternative below.

Geographic Areas dominated by Dry Mixed Conifer (MCD) and Ponderosa Pine (PPF)

Background

Canadas and Nacimiento Geographic Area

The Canadas and Nacimiento Geographic Area includes acres primarily represented by PPF (36 percent), MCD (32 percent), SAGE (10 percent), and SFF (10 percent). This area encompasses the designated areas: San Pedro Parks Wilderness and the Continental Divide National Scenic Trail, and the management areas: Nogales Cliff House Cultural Interpretive Area and Rattlesnake Ridge Cultural Interpretive Area. Part of this area is also used for commercial oil and gas development, enriching the economy of the surrounding areas. The Canadas-Nacimiento Geographic Area has desired conditions for high-quality headwater streams.

Jemez Mesas and Canyons Geographic Area

The Jemez Mesas and Canyons Geographic Area predominantly contains MCD (38 percent), and PPF (35 percent) ecosystems. The designated areas: Monument Canyon Research Natural Area and the Dome Wilderness lie within the area’s boundary, while Bandelier National Monument and the Valles Caldera National Preserve are located nearby. The Jemez River, a tributary of the Rio Grande, also flows through this area. The forests here are home to threatened and endangered species including the New Mexico jumping mouse, Jemez Mountain salamander, and the Mexican spotted owl. This geographic area has desired conditions for healthy and productive ecosystems, and for protecting water quality and availability.

North Jemez Mountains Geographic Area

The North Jemez Mountains Geographic Area is composed of mesas, meadows, and mountains in a rugged landscape that predominantly includes MCD (22 percent), PPF (25 percent), JUG (11 percent), and PJO (15 percent) ERUs. The Chama River Canyon Wilderness; Borrego Mesa; Tea Kettle Rock; and Cerro Pedernal, a sacred site of the Tewa people, are located within this area. There is a large expanse of roadless land within the wilderness area, which provides superb wildlife habitat and ecosystem connectivity. There are also mineral resources that support the oil and gas industry and contribute to the local economy. Furthermore, this area serves as the largest grazing region in the forest, so the quality of grasslands and ability of the land to support livestock is critical to the livelihood of many families. The North Jemez Mountains Geographic Area has desired conditions for natural and planned fires to enhance resources and move vegetation toward desired conditions outlined in the forest plan.

Effects common to all alternatives

All action alternatives have forest plan objectives for treating MCD and PPF using a mix of mechanical treatments and fire (planned and natural ignitions) with associated positive ***(V18-19, 30-31, 34-35, 37, 44-47)*** and negative ***(V34-36, 48-50)*** effects. These treatments are designed to reduce departure from desired conditions and help restore function and resiliency to ecosystems within the forest ***(V1, 3, 41-46)***. Treatments in all alternatives would reduce the risk of uncharacteristic fire ***(V12, 36, 38-39, 54-60)*** by reducing the density of stands and by decreasing fuel loadings ***(V40-44, 65)***. Desired conditions in all alternatives would also protect existing old growth or aim to promote the development of old-growth characteristics over time to increase habitat diversity and provide necessary habitat components for wildlife ***(V17-19, 32)***. Under all alternatives, designated areas (e.g., wilderness, research natural areas, wild and scenic rivers) would be managed under the more restrictive guidance outlined in objectives and guidelines within the forest plan, and would not be impacted directly by mechanical treatments occurring in nearby areas, but could experience indirect impacts ***(V63, 83-84)***. While all the aforementioned effects are common across alternatives, the magnitudes of these effects may differ by alternative and are discussed below.

Alternative 2 – Forest Plan

Plan objectives for vegetation treatments in MCD and PPF in alternative 2 would incorporate both mechanical treatments and fire to move toward desired conditions ***(V18-19, 30-31, 34-35, 37, 44-47)***. By using both methods, this alternative would reduce the risk of uncharacteristic fire ***(V12, 38-39, 54-57)*** and protect important resources within this area ***(V49-51)***, more than other alternatives. The combination of treatments also best promotes increased ground cover, resulting in the greatest gains in grass growth and understory productivity ***(V4, 5, 81),*** and also encourages the return of natural processes (e.g., fire return intervals) to the land ***(V5, 30-31, 61, 66-67)***. This alternative would result in the least detrimental impacts ***(V34-36, 48-50)*** to ecosystems and best help to move the forest toward desired conditions within these geographic areas.

Alternative 3– Natural Forces Emphasis

Forest plan objectives for vegetation treatments in alternative 3 emphasize letting natural processes prevail. The predominant use of fire to treat MCD and PPF acres could have mixed effects to the geographic areas and their ecosystems. This alternative would also allow for the return of more natural fire regimes on many acres of departed land, supporting natural plant structures, compositions, and processes ***(V5, 30-31, 61, 66-67)***. However, with increased applications of fire comes greater health impacts to surrounding communities ***(V34-36, 69),*** and the possibility of increasing the risk of a fire that burns with abnormally high severity under the right conditions ***(V38-39, 54-60)***. Ultimately, this alternative could cause the greatest detrimental impact to ecosystems, challenging the ability of the forest to move toward desired conditions in these geographic areas if fires become large and burn with high-severity. However, if fires burn with low- to moderate-severity, this alternative would potentially have less negative ecosystem impacts overall within these geographic areas than alternative 4 ***(V48-50)***, as these types of fires help build resiliency against uncharacteristic fire over larger areas than is practical using mechanical treatments alone ***(V37, 41)***.

Alternative 4 – Human Uses Emphasis

Forest plan objectives for MCD and PPF treatments in alternative 4 use mechanical treatments to restore desired stand structures to overly dense areas, and thus, reduce the risk of uncharacteristic fire by removing ladder fuels ***(V12, 38-39, 54)***. However, to fully reduce fire risk, the additional fuels created through mechanical treatments would need to be removed through methods other than burning ***(V21-22,***

40). Returning proper structure to forests benefits the health and function of forests and grasslands ***(V1, 3, 41-43, 45-47, 65),*** but the response of the understory is not as great as it is in alternative 2, which also includes fire. Mechanical treatments often pose detrimental ecological effects ***(V48-50)***. Because of the large number of acres treated using mechanical methods, this alternative may have the second greatest or greatest negative impact on ecosystems (depending on the frequency and severity of fire in alternative 3), moving away from the desired condition stated for these geographic areas.

Geographic Areas dominated by Dry Mixed Conifer (MCD) and Spruce Fir (SFF)

Background

East Sangres Geographic Area

The East Sangres Geographic Area traverses varied topography and includes 41 percent of acres in MCD and 26 percent of acres in SFF. The town of Las Vegas lies outside of the forest boundary to the east, while several smaller communities are dispersed in all directions. Gallinas Creek provides the drinking water for the city of Las Vegas and is an important target for restoration efforts. Desired conditions for this geographic area include safeguarding that the Gallinas Watershed supports acequias and provides a sustainable drinking water source for the city of Las Vegas and surrounding communities. Vegetation within this watershed has very low risk of uncharacteristic wildfire.

Pecos River Canyon Geographic Area

The Pecos River Canyon Geographic Area lies in the heart of the Sangre de Cristo Mountains. This geographic area includes acres represented by all of the terrestrial ERUs found in the forest except for the sagebrush (SAGE, PJS) types, but is dominated by MCD (31 percent), SFF (39 percent), and PPF (11 percent). The Pecos Wilderness, which is the second largest wilderness area in New Mexico, makes up the bulk of this area. The vast expanse of roadless area within the Pecos Wilderness provides prime habitat for many animal and plant species and protects high-quality water resources flowing into the Pecos River. The Pecos River Canyon is also home to an endemic plant species, the Holy Ghost ipomopsis. Though the plant's population is stable, protecting the habitat and the viability of the population of this federally listed endangered species is an important concern. Desired conditions for this geographic area include sustaining multiple uses in the Pecos River watershed, including quality habitat for the Rio Grande cutthroat trout, maintained wilderness characteristics in the Pecos Wilderness, and thriving populations of the Holy Ghost ipomopsis.

West Sangres and Caja Geographic Area

The West Sangres and Caja Geographic Area begins below Borrego Mesa, covering over 200,000 acres on the western slopes of the Sangre de Christo Mountains. This diversely vegetated area includes all terrestrial ERUs except SAGE, but is primarily composed of MCD (19 percent), SFF (24 percent), PPF (14 percent), and PJO (23 percent). The eastern portion of the geographic area houses the municipal watershed for the city of Santa Fe, as well as a ski area that attracts thousands of visitors each year. Many multiple-use trails throughout the area support recreation opportunities and the tourism industry. The separate western section is located on the Caja del Rio Plateau, north of the Cochiti Pueblo, and is dominated by PJO. The Caja area lacks the predominance of recreational use that characterizes the West Sangres, and instead predominantly supports traditional uses and cultural practices. The desired conditions for this geographic area state that most fire burns with low and moderate intensity, and there is a very low risk of uncharacteristic wildfire in the wildland-urban interface of Santa Fe and the city of Santa Fe's water sources (e.g., Santa Fe Watershed and Buckman Diversion).

Effects common to all alternatives

Desired conditions for all three geographic areas focus on maintaining water resources and protecting watersheds and communities from uncharacteristic fire. All action alternatives have forest plan objectives for treating MCD (and PPF) using a mix of mechanical treatments and fire (planned and natural ignitions) with associated positive ***(V18-19, 30-31, 34-35, 37, 44-47)*** and negative ***(V34-36, 48-50)*** effects. These treatments are designed to reduce departure from desired conditions and help to restore function and resiliency to ecosystems within the forest ***(V1, 3, 41-47)***. Treatments implemented in all alternatives would reduce the risk of uncharacteristic fire ***(V12, 36, 38-39, 54-60)*** by reducing the density of stands and by decreasing fuel loadings ***(V40-44, 65)***. By reducing the risk of uncharacteristic fire, potential detrimental impacts to watersheds are also reduced ***(V38-39, 54)***. There are no forest plan objectives for treating SFF or PJO in any alternative, making the impacts from vegetation treatments lower in these geographic areas than in the geographic areas with high proportions of both MCD and PPF (Canadas and Nacimiento, Jemez Mesas and Canyons, and North Jemez Mountains). Any effects of vegetation treatments within surrounding ERUs on SFF or PJO areas, would be limited to spill-over effects, such as fire that spreads into these areas. Also under all alternatives, designated areas (e.g., wilderness, research natural areas, wild and scenic rivers) would be managed under the more restrictive guidance outlined in objectives and guidelines in the forest plan, and would not be impacted directly by mechanical treatments occurring in nearby areas, but could experience indirect impacts ***(V63, 83-84)***. While all the aforementioned effects are common across alternatives, the magnitudes of these effects may differ by alternative and are discussed below.

Alternative 2 – Forest plan

The effects of vegetation treatments within MCD in these geographic areas would be the same as those given above under the MCD and PPF dominated geographic areas. However, due to a larger portion of acres within these geographic areas in the SFF ERU, the effects would be lower in magnitude within these geographic areas than in the ones dominated by MCD and PPF. Overall, this alternative would have the highest ability to move toward desired conditions in these geographic areas and maintain or improve the health of watersheds with associated effects ***(V43-44)***.

Alternative 3 – Natural Forces Emphasis

Vegetation treatments within MCD in alternative 3 have the highest likelihood of having spill-over effects into the untreated SFF areas due to the prevalence of fire treatments and may raise the risk for uncharacteristic fire ***(V12, 36, 38-39, 54-60)***. Furthermore, fires that naturally occur under the right conditions within SFF are often stand-replacing (***V56-57***). These fires would also present health impacts in surrounding communities ***(V34-35).*** Ultimately, this alternative would likely cause the greatest detrimental impacts to ecosystems and watersheds ***(V8-10, 14, 16, 29, 38-39, 54-55, 69)***, challenging the ability of the forest to move toward desired conditions in these geographic areas, especially if high-severity fires are experienced. However, if fires burn with low- to moderate-severity, this alternative would create less negative ecosystem impacts, as these types of fires help build resiliency against future uncharacteristic fires and help restore natural regimes and processes ***(V41-43, 67)***, moving toward desired conditions, but at a slower pace than alternative 2.

Alternative 4 – Human Uses Emphasis

The effects of vegetation treatments within MCD in these geographic areas would be the same as those given above under the MCD and PPF dominated geographic areas. However, due to a larger portion of acres within these geographic areas in the SFF ERU, the effects would be lower in magnitude within these geographic areas than in the ones dominated by MCD and PPF. Additionally, since this alternative focuses on mechanical treatments, which are localized in nature, there is little chance of a spill-over effect from treated areas to non-treated areas as there is with the use of fire. Because MCD acres average 30 percent across the three geographic areas, the mechanical treatments used in this alternative would be expected to result in the second least impacts to watersheds in the area ***(V48)***, and lessen the risk of uncharacteristic fire ***(V12, 36, 38-39)***, but have the lowest ability to restore natural fire regimes ***(V43, 67)***.

Woodland and Grassland Dominated Geographic Areas

Background

Rowe Mesa and Anton Chico Geographic Area

The Rowe Mesa and Anton Chico Geographic Area includes a wide range of ERUs but is dominated by piñon-juniper woodlands (42 percent) and grasslands (10 percent), and CPGB (25 percent). The land is often used for hunting, grazing, and for gathering forest products like fuelwood, latillas, and piñon nuts. This area is also widely used for motorized recreation and is home to the Mesita de los Ladrones Research Natural Area. This geographic area has desired conditions for restored productivity and reintroduced fire within grasslands; piñon pine and juniper woodlands are free from meadow encroachment.

Alternative 2 – Forest Plan

Alternative 2 has forest plan objectives for treating both CPGB and PJG ERUs, using mechanical methods and fire. Due to the combination of treatments, alternative 2 would have the highest potential to restore grassland productivity ***(V5, 44),*** as both treatments together have been found to be more effective than either one alone (Covington et al. 1997). Alternative 2 would also be the most effective at removing encroaching trees in grasslands, creating larger interspaces ***(V2, 4-5, 70)***. Alternative 2 would be the second most effective at restoring natural fire regimes within these systems ***(V5, 30-31, 43, 67)***. Ultimately, this alternative has the greatest potential to drive ERUs within this geographic area toward desired conditions.

Alternative 3 – Natural Forces Emphasis

Alternative 3 has plan objectives to treat both PJG and CPGB using fire treatments. The use of fire across both of these areas would make this the strongest alternative for returning natural fire regimes ***(V43, 67)***. As PJG and CPGB ERUs have natural fire regimes of low to moderate severity, there should be minimal negative effects ***(V31-34, 40-41, 43)*** and many benefits to the ecosystem ***(V18, 30-32, 41-43)***. However, this alternative has less ability to increase grass productivity than alternative 2, which uses a combination of treatment methods ***(V5, 44, 70)***.

Alternative 4 – Human Uses Emphasis

The mechanical treatments slated for PJG areas would do little to improve conditions within this geographic area. Furthermore, there are no objectives for treatments in CPGB under this alternative. Due to this low level and type of treatment, alternative 4 has the lowest ability to restore grassland productivity or restore natural fire regimes ***(V7, 71-72, 74)***. However, this alternative would provide the second greatest ability to directly target specific stems for removal to address tree encroachment issues in grasslands ***(V70, 77-78)***.

3.2.5.6 Cumulative Effects for all Alternatives on the Context Scale

Maintaining connections to lands that lie outside of the defined boundaries of the Santa Fe NF, is integral for an all-lands approach to land management into the future and to generate changes that benefit ecosystems and people over greater areas. Numerous Federal, State, tribal, county, and privately owned lands surround the Santa Fe NF. Two nearby national forests: Carson and Cibola, are developing land management plans with plan components similar to the Santa Fe. All three forests have objectives to increase fire acres for resource benefit, prioritize treatments in highly departed ERUs, and have identical desired conditions for vegetative ecosystems. Having similar forest plan direction can make a large positive impact on the condition of treated ERUs within central-northern New Mexico, increasing resiliency to disturbances, reducing uncharacteristic fire risk, and potentially supporting an increase in timber and forest product industry on a larger scale than any one forest could alone. These efforts, combined with similar efforts on tribal, State, and other Federal lands (e.g., National Park Service, Bureau of Land Management) will further benefit central-northern New Mexico.

The cumulative effects that past activities have had on vegetation and fuels were discussed in detail as part of the affected environment section for vegetation and fuels. Throughout the broader landscape, past management practices have resulted in forest conditions that are departed, creating a risk of not achieving desired conditions in the future. Trees are smaller and younger, overall, than they would have been historically, and fuels are built up and more continuous. Grasslands are encroached on by woody species and current herbaceous understory cover is lower than the potential.

Broad regional stressors that may intensify in the future include rising population levels and participation in outdoor recreation, both locally and nationally, with resulting increased demand for and pressures on public lands. Higher temperatures and more frequent drought will likely lead to increased fire frequency and severity, and increased demand for high-elevation recreation opportunities to escape the heat of lower elevations. Related to vegetation conditions, these changes may lead to increased demand for commercial and noncommercial forest products, elevated importance of public lands in providing for the habitat needs of displaced wildlife species, and changing societal desires related to the mix of uses that public lands should provide. Growing recreation use over the planning period due to increasing population levels and demand in the surrounding area could affect ecosystem integrity by creating larger impacts (e.g., denuding areas of vegetation, vandalism to plants and other natural forest resources, soil compaction, disturbance of wildlife patterns) in high use areas. However, the sustainable recreation plan direction included in all action alternatives provides measures to mitigate such impacts from recreation activities.

The cumulative environmental consequences of proposed management efforts in the context of the larger ecoregion would contribute to the movement of vegetation toward desired conditions. These efforts would contribute to landscape restoration on a large scale, with a focus on reestablishing the composition, structure, patterns, and processes necessary to facilitate healthy, resilient, sustainable ecosystems. These management efforts would also lessen the impact of invasive species, improve wildlife habitat, and reduce the risk of uncharacteristic wildfire. Increasing health and ecosystem function through management would also increase the ability of ecosystems within the context area to adapt to climate change. Ultimately, ecosystems exhibiting desired conditions better provide for multiple uses, and better contribute to sustainable social and economic systems.

3.3 Riparian and Wetland Ecosystems

Riparian ecosystems encompass any surface water and its associated aquatic habitat, connected shallow groundwater, aquatic and riparian vegetation, associated soils (i.e., hydric and alluvial), and contributing fluvial landforms. Riparian areas represent transitional areas at the interface between the terrestrial and aquatic ecosystems. As ecotones, riparian areas encompass sharp gradients of environmental factors, ecological processes, and plant communities (Gregory et al. 1991). Riparian areas have distinct combinations of flora, fauna, and soil characteristics compared to nearby deserts, grasslands, or forests; their distinct habitats make riparian areas hotspots of biological diversity vital to connecting upland habitat with aquatic habitat. Although riparian areas occupy less than 3 percent of the context landscape in the Santa Fe NF, they support about 80 percent of the forest's plant and animal diversity.

Wetland ecosystems include open water wetlands, slope wetlands, marshes, wet meadows, cienegas, bogs, and fens. Wetland ecosystems occur at nearly all elevations in the Santa Fe NF, where they support a wide diversity of riparian and wetland herbaceous species that can vary widely with elevation and water availability, as well as biophysical characteristics (i.e., gradient, salinity). Wetlands are most common in wide, low-gradient meadows, where the water table is seasonally high, soils are saturated, and trees or shrubs are mostly absent. The prevalent vegetation and aquatic life require saturated or seasonally saturated soil conditions (hydric soil) for growth and reproduction. Many areas classified as wetland ecosystems based on soils, vegetation, and hydrologic regime could be also be considered riparian areas as described above, but there are extensive wetland ecosystems not associated with surface water streams present in the national forest.

Riparian and wetland ecosystems provide similar roles for the healthy ecological function of landscapes, providing ecosystem services critical to the provisioning of clean water, regulating hydrologic regimes, and providing habitat for numerous aquatic, terrestrial, and avian species. Given their similar functional role, for the purposes of assessing effects of potential forest plan alternatives, we group wetland and riparian ecosystems into riparian management zones (RMZ). RMZs constitute a management designation with the intent to create forest plan objectives and standards for managing these important areas, encompassing both riparian areas and wetland ecosystems.

3.3.1 Affected Environment

Both historical and ongoing land uses impact riparian areas in the Santa Fe NF. The wide variety of impacts mirror those elsewhere in the region, including hydrologic alterations associated with dams and water diversions (Graf 1993, Nilsson and Berggren 2000), agricultural drainage (Dahl 1990), grazing (Fleischner 1994, Patten 1998, Belsky and Blumenthal 1999), and the widespread introduction of nonnative species (Stein and Flack 1997, Mack et al. 2000). Demand for water, fertile land, and forage for livestock in the arid and semi-arid West affected many aquatic, riparian, and wetland areas, and these pressures will likely increase as population grows and drought cycles intensify with a changing climate (Baron et al. 2002). The vital importance of riparian and wetland ecosystems to the health of watersheds and the sustainable future of the human and natural systems that rely on the waters of the Santa Fe NF, make protecting and restoring riparian areas a priority in the forest plan's desired conditions, objectives, and future management direction.

The national forests of the Southwestern Region classify riparian areas, as with other parts of the landscape, into categories defined by vegetative communities called ecological response units (ERUs) (Wahlberg et al. 2014). ERUs are grouped by dominant vegetation species; however, these terrestrial ecological groupings share multiple ecosystem components. Specific grouped ecosystem components are site potential or climate; soil, geomorphology, and geology; plant associations or native species; structure and associated successional stages; and ecological processes or disturbance regimes (Wahlberg et al. 2014). In the context of land management planning, the historical range of variability specific to each ERU can provide a baseline for managers to identify desired future conditions and the management actions needed to move current conditions within the reference range of natural conditions. The Santa Fe NF classifies the condition of ecological systems by their departure from reference conditions.

There are six main riparian ERUs in the Santa Fe NF: herbaceous, narrowleaf cottonwood/shrub, Rio Grande cottonwood/shrub, willow/thinleaf alder, ponderosa pine/willow, and upper montane conifer/willow. Inclusive within these ERUs, or as isolated features on the landscape outside of the ERUs, occur discrete bodies of water such as wetlands, seeps, springs, ponds, lakes and reservoirs, and their associated vegetation composition and structure. Riparian ERUs collectively occupy about 3 percent of the Santa Fe NF landscape (table 33).

Table 33. Riparian ecological response units of the Santa Fe NF

Symbol	ERU	Acres	Percentage
HERB	Herbaceous	**15,373**	0.91%
CWG (cottonwood group)	Narrowleaf cottonwood/shrub	**15,010**	0.89%
	Rio Grande cottonwood/shrub	**7,493**	0.45%
MCWG (mixed conifer/willow group)	Willow/thinleaf alder	**6,957**	0.41%
	Ponderosa pine/willow	**665**	0.04%
	Upper montane conifer/willow	**495**	0.03%
	Totals	**45,993**	**2.74%**

The key ecosystem characteristics for riparian ERUs used to assess current condition include similarity to site potential; vegetative ground cover, coarse woody debris, and fire frequency; and riparian proper functioning condition (PFC). For a full description of individual riparian ERUs see Triepke et al. (2014) and the Forest Plan Assessment. Below, we briefly describe each ERU and its current condition (table 33). There are PFC surveys for only about 19 percent of Santa Fe NF's riparian areas, and no PFC assessments for spring or wetland ERUs. Consequently, PFC comparisons to reference conditions are not reported in table 34.

The herbaceous (HERB) riparian ERU is the most extensive riparian ERU, occurring at nearly all elevations (5,500 to 12,000 feet) in the Santa Fe NF. Riparian and wetland herbaceous species vary greatly with elevation and climate, but sedges and rushes are particularly important to system function (Neary and Medina 1996). HERB ERUs are common in wide, low-gradient meadows, where the water table is seasonally high with saturated soils, and trees or shrubs are mostly absent (Lemly and Culver 2013). Decreased flooding, channelization, downcutting, and lowered water tables contribute to a reduction in available soil moisture and an increase in upland species. On NFS lands, instream flows are reduced and their timing is altered by human water uses (Floyd et al. 2009). Road density and other human-caused impacts such as grazing and recreating are likely deteriorating understory composition and condition as site potential and proportion of bare soil are significantly departed at 73 and 60 percent, respectively. These alterations to the landscape have an impact on wildlife as there is a reduction in breeding and forage cover. Reduced cover and dominance by sod forming grasses negatively affects stream temperature, bank stability, and sedimentation. Because of the more open habitat, HERB may be the riparian ERU most impacted by invasive species. Invasives have been identified in all of the local zones. They were originally spread mainly along roadways, but are becoming increasingly established in riparian areas, distributed by stream flows (USDA Forest Service 2013a). Uncharacteristic wildfire, including fire suppression activities (e.g., containment lines), are also current threats to this ecosystem as increased fire severity occurrence relative to reference is occurring in this ERU.

The regional riparian mapping project (RMAP) cottonwood group (CWG) includes eight RMAP types, but only two are found in the Santa Fe NF including 15,010 acres (0.89 percent of plan area) of narrowleaf cottonwood-shrub and 7,493 acres (0.45 percent of plan area) of Rio Grande cottonwood-shrub (RCSH). Narrowleaf cottonwood/shrub is generally found at lower elevations and lacks the spruce-dominated overstory. Rio Grande cottonwood/shrub occurs along low-gradient streams with wider floodplains that provide flood terraces with infrequent flood regimes (Durkin et al. 1995). CWG is found across most of the forest, occurring in all but the central part, with the majority of the acreage found in the northeastern and northwestern areas. Most streams in which CWG occurs have been affected by historical overgrazing and altered stream nutrient, sediment load, and flow regimes. Flow alterations lead to a shift in species composition, with a significant reduction in cottonwood cover. As a result of human activity, exotic shrubby species such as Russian olive and saltcedar encroach on CWG riparian areas, leading to a 56 percent departure from site potential.

The mixed conifer/willow group (MCWG) is composed of thinleaf alder plant associations, ponderosa pine/willow and upper montane conifer/willow ERU types. This riparian group stretches along various elevational gradients from lower elevations (3,500 feet) in mountain canyons and valleys to higher mountainous elevations (10,000 feet). At lower elevations, this ERU group can be found along perennial and seasonally intermittent streams. The MCWG riparian ERU frequently occurs in wet drainages associated with thinleaf alder, willow, cottonwood, ponderosa pine and mixed conifer forests. At higher elevations, this ERU is found along streambanks, seeps, fens, and isolated springs and is shrub- and herb-dominated. MCWG is the least represented riparian ERU group found in the forest. A total of 8,117 acres (0.44 percent) occur in the Santa Fe NF, with the majority being thinleaf alder.

Table 34. ERU structure, composition, disturbance regime compared to reference conditions

ERU	Characteristic	Similarity to Site Potential (%)	Ground Cover Bare Soil (%)	Ground Cover Veg BA (%)	Coarse Woody Debris (pieces/mile)	Fire Return Interval (years)
HERB	Reference condition	100%	3%	51%	>30	Infrequent
	Current condition (% departure from reference)	73%	60%	29%	41%	0%
CWG	Reference condition	100%	12%	37%	>30	Infrequent
	Current condition (% departure from reference)	56%	39%	48%	58%	0%
MCWG	Reference condition	100%	8%	25%	>30	Infrequent
	Current condition (% departure from reference)	54%	39%	22%	38%	34%

3.3.2 Issues (Need for Change statements)

Protection and need for restoration of riparian areas emerged as a key issue for the revision of the forest plan. Riparian systems have been degraded and are at risk across the forest.

Key riparian issues identified to address in forest plan revision are as follows:

1. The forest needs to establish desired conditions that will restore or maintain characteristic composition and cover of riparian vegetation.
2. The forest needs to establish standards and guidelines that minimize the ecological impacts of multiple uses in the riparian area.

3. Forest plan objectives and standards should recognize that riparian systems are linked to upland terrestrial systems and that the upland ecological condition will, in part, determine riparian ecological health.

Other key issues identified for the forest plan that were not explicitly labeled as riparian issues, but are intertwined with riparian ecological function include:

1. Restoration of ecosystem resiliency. The key components related to riparian systems are summarized below.
   a. Promoting ecological connectivity across landscapes and jurisdictional boundaries;
   b. Reducing spread and establishment of nonnative species;
   c. Incorporate adaptive management strategies for uncertain future environmental conditions and stressors, such as insect-, disease-, and climate change-induced effects (e.g., increases in fires, severe drought, flooding), making resources more adaptable to changing conditions; and
   d. Restoring vegetation structure, function, spatial patterns, and species composition at multiple spatial scales (e.g., landscape, patch or stand, and within patch) that supports resilient ecosystems.
2. Water and the key components related to riparian systems are summarized below.
   a. The forest should develop standards and guidelines that improve hydrological function and condition of water-dependent systems by maintaining and restoring upland and riparian vegetative cover, and reducing erosion and sedimentation from disturbed sites (e.g., reclaiming roads) where feasible.

3.3.3 Methodology and Analysis

3.3.3.1 Resource-Specific Assumptions

Analysis related to riparian management zones is inclusive of the effects to riparian areas and wetland ecosystems.

- The Forest Plan does not establish separate objectives and guidelines in the proposed alternatives for the 6 riparian ERUs, but rather emphasizes riparian restoration across all alternatives. Consequently, the assumption is that the potential effects from implementing the forest plan's alternatives would be similar across all the riparian and wetland ERUs.
- Grazing impacts will continue to be ongoing for all alternatives. The proposed differences in acres of grazing will not be at a magnitude to significantly impact riparian and wetland ecosystems, but may have some differences in the terrestrial uplands. The primary impact for grazing that may directly affect riparian areas will be the number of grazing infrastructure improvements proposed with each alternative. Greater emphasis on improving range infrastructure will be the most important activity to directly reduce cattle impacts on riparian areas. The level of range infrastructure improvements is the same across all alternatives.
- Regardless of the alternative, environmental consequences within the foreseeable future to riparian areas and wetland ecosystems from management activities (timber harvesting or forest restoration) are expected to be minor. This is because project designs incorporating best management practices, aquatic management zone design features, and wildlife habitat mitigation would be implemented; riparian areas and wetland ecosystems would be avoided. New road construction in riparian areas related to timber harvesting is not expected to occur. Livestock grazing would continue into the

foreseeable future throughout the planning area; continued impacts to riparian areas and wetland ecosystems may occur. Continued monitoring and adaptive management applied to livestock grazing would aid in minimizing impacts to riparian areas and wetlands.

- The forest plan defines riparian restoration objectives by stream miles and the proposed alternatives differentiate riparian restoration objectives by the number of stream miles proposed for treatment. Restoration focused on riparian habitat such as revegetation, invasive plant treatment, off-site watering, etc., are implicitly included in the stream mile objectives.

3.3.3.2 Indicators and Evaluation Criteria

Effects indicators are measures of an action's impact on the environment (beneficial and adverse; direct, indirect and cumulative). Appropriate effects indicators are the indicators that will best reflect how the plan-guided management actions will likely affect riparian areas and wetland ecosystem function, and those that will also translate into measurable indicators that may be incorporated into specific projects proposed in the future to accomplish the forest plan's guidance and objectives.

- Vegetation Structure and Composition - We assess the desired condition of riparian areas by evaluating whether the vegetation species composition and the structure of vegetation is within the range of variability of the reference condition established for the particular ERU. Assessing how forest plan alternatives would impact vegetation and structure helps determine if the alternative will move riparian and wetland ecosystems toward or away from desired conditions.
- Proper Functioning Condition (PFC) is the only key ecosystem characteristic unique to riparian areas and not referenced in the upland vegetation ERU section of the forest plan. PFC provides a methodology for assessing the physical functioning of riparian-wetland areas (USDI 1997 and 1998) and provides a consistent approach for assessing the physical functioning of riparian-wetland areas through consideration of hydrology, vegetation, and soil or landform attributes. The on-the-ground condition termed PFC refers to how well the physical processes are functioning. PFC can be interpreted as a state of resiliency indicating that riparian-wetland areas will retain core ecosystem functions during a high-flow event or other disturbance, ultimately sustaining the riparian system's ability to maintain values related to both physical and biological attributes. Specific attributes collected to evaluate PFC include hydrogeomorphic features of the stream and floodplain, vegetation, features, related erosion and deposition, soil type, and water quality.

3.3.4 Drivers and Stressors

A stressor is an environmental condition, external stimulus, or event (apart from a direct management action) that strains the ability of watershed processes to function within their historic range of variability. Riparian and wetland ecosystems respond to the drivers of watershed processes that include hydrologic and ecological processes. Hydrologic processes include the connection of water above- and belowground as it is routed to riparian management zones (RMZs) and ultimately to channel networks (e.g., a precipitation event followed by infiltration and runoff). This contributes to watershed ecological processes, such as sediment and nutrient transport from hillslopes routed through a channels and subsurface flow (Naiman 1992). These processes are heavily influenced by the condition and type of vegetation, ground cover, soil, and riparian vegetation within the watershed. Stressors can act directly on hydrologic processes (e.g., drought), or indirectly on watershed, and specifically riparian, conditions (e.g., ground cover) to affect watershed function. Major stressors to RMZs are the same as those more generally described for water resources including drought and high-severity wildfire. Climate change drives the effects of these stressors to a different order of magnitude.

One characteristic of climate change in northern New Mexico is more frequent drought than historical averages. Streamflow data are available for some gauging stations in or near the forest with periods of record dating back as far as 1914. While human activity undoubtedly influenced streamflow before then, the 100-year record provides a good baseline for comparison to current conditions. The most conspicuous recent indicator of drought in northern New Mexico began in the spring of 1996 (SCCSC 2013), following several years of above-average temperatures and was exacerbated by subsequent below-average precipitation. Stream gauge data from across the northern mountains of New Mexico reflect this same drop in available water. An analysis of streamflow data from several USGS gauge stations in the southern Sangre de Cristo Mountains showed an average flow reduction of 20 percent from 1996 (drought initiation) through 2013. Furthermore, the average snowmelt runoff duration was reduced by 12 days. Overall, there has been less water available in recent years, both in terms of the annual total and the springtime snowmelt pulse.

In the broader Four Corners region, records show snowpack has been declining since the 1950s (EPA 2016). Diminished snowpack in this area has serious implications for the water supply to communities around the Santa Fe NF, which largely rely on water from the headwaters of the Rio Grande in Colorado, as well as the headwaters of the San Juan River (via an inter-basin transfer to the Chama River). Losing a portion of these major water sources would make communities more reliant on the dwindling supply from local headwater streams and groundwater recharge originating in the Santa Fe NF. Increasing drought will continue to be a primary stressor impacting RMZs' function.

The increasing drought cycles and reduced water yield from the Santa Fe NF leave RMZs more vulnerable to vegetation damage from insects and disease, increased fire risk (on average, more than 2 percent of the land in New Mexico has burned per decade since 1984), desiccated soils, reduced ground cover, and reduced riparian overall function. In general, these effects reduce the holding capacity of watersheds, causing them to release water faster (Moody and Martin 2001), in turn reducing the perennial supply of water in rivers downstream. Regionally, most of the major river systems in the southwestern United States are expected to experience reductions in streamflow and other limitations to water availability (Garfin et al. 2013).

In the Santa Fe NF, between 2010 and 2014, several large wildfires burned more than 71,000 acres with moderate to high soil burn severity. Summer monsoon rains subsequently resulted in extensive upland erosion and gullying within Cochiti Canyon (and elsewhere), as well as flooding in downstream rivers several orders of magnitude larger than "normal" monsoon peaks. These effects occurred because insufficient upland groundcover combined with hydrophobic and highly erosive soils, allowed for easy detachment and transport of soil to stream channels. This overabundance of sediment will likely remain in stream channels, impacting water quality and aquatic habitat for decades. Research shows severe flooding and erosion may ensue even after only moderate rain events (DeBano et al. 1998; Neary et al. 2005). Low and moderate severity burns typically have much smaller effects on runoff and erosion.

The climatic drivers impacting RMZ function and vegetation would be similar across proposed alternatives. Outside of these large-scale external drivers and stressors influencing the function and condition of RMZs, the primary stressor will be the types and intensity of management activities proposed that would directly and indirectly impact RMZs. The effects of management that may occur under the Forest Plan are analyzed in the sections that follow.

3.3.5 Environmental Consequences

3.3.5.1 Common Effects to Riparian Management Zones

Mechanical harvest and thinning vegetation treatments use heavy equipment such as forwarders, skid-steers, and feller-bunchers. Potential effects, both positive and negative, from mechanical harvest and thinning are listed below.

- ***Removing and thinning woody species encroachment will help restore desired vegetation species composition and structure in Riparian Management Zones, returning riparian areas toward desired conditions and contributing to more natural hydrologic cycles and functions.*** [RMZ1]
- ***Heavy equipment use in sensitive riparian areas can compact and rut the soil. Rutted soil is likely to channelize water, making it more susceptible to erosion and entrainment*** (Elliot et al. 2010)***; compacted soils have reduced infiltration, resist revegetation, and have increased erosion. The increase in erosion from channelized runoff and compacted surfaces will lead to degraded riparian hydrologic function and increase sedimentation into streams.***[RMZ2]
- ***Removing and thinning encroaching woody species from Riparian Management Zones, particularly from HERB and CWG ERUs may increase hydrologic connectivity between riparian areas and streams by increasing shallow subsurface flow available to replenish streams*** (Huxman et al 2005, Scott et al 2006)***.*** [RMZ3]

Stream channel and riparian restoration actions include a suite of possible activities that all should have the beneficial effect of ***rehabilitated geomorphic and biological processes, which would help to restore stream and riparian ecosystem services. Restoration actions will ensure that streams and riparian areas are properly functioning, which provide clean water, regulated water temperature, water storage, sediment storage, nutrient cycling and good habitat*** (Gregory et al. 1991). [RMZ4]

- Heavy equipment use for any restoration action including road decommissioning will increase ground disturbance and may increase erosion causing sedimentation through the riparian area into the adjacent waterway. ***Sediment and turbidity adversely affect water quality, aquatic habitat, and flood capacity by making water more difficult to clean, decreasing the oxygen supply to fish and amphibians, decreasing habitat diversity and availability, as well as decreasing channel volume*** (Henley et al. 2000; Postel and Thompson 2005).[RMZ5]

Road decommissioning is a common restoration practice that involves using heavy equipment to treat the road prism to reduce erosion and hydrologic impact. Levels of treatment range widely, but generally requires decompacting the road and may involve removing the road prism and reshaping the area to match natural hillslope contours.

- ***Road decommissioning should benefit surface water resources and Riparian Management Zones through restored hillslope drainage patterns, increased infiltration, increasing water storage and retention, restored hydrographs, decreased channel aggradation, and improved water quality.*** [Wa4 and RMZ6]
- ***Reducing road system mileages may limit motorized use impacts in RMZ including the spread of invasive plants and increases in erosion. Ultimately, these should result in a water supply that is less expensive to clean to standard, increased baseflows during the dry periods of the year, and improved fisheries***.[Wa4 and RMZ7].

- Heavy equipment is often used to accomplish restoration, thereby disturbing the ground within or adjacent to flowing water. Ground disturbance dislodges soil, making it easier to erode and entrain, thereby, introducing sediment and turbidity to the waterbody ***(RMZ5). Further, restoration activities may temporarily alter stream shade by removing vegetation during work.*** [Wa5, RMZ8]

Invasive species (noxious weed) removal and treatment includes both hand (pulling weeds) and chemical treatment (applying herbicides).

- As one of the major limiting factors in properly functioning condition (PFC) of Riparian Management Zones, ***removal of invasive species should help promote recovery of vegetation species and composition and PFC of Riparian Management Zones.*** [RMZ9]

- ***Use of chemical application can adversely affect water quality when sediment or chemicals are delivered to a water body through the riparian area*** [RMZ10]. ***Longer than predicted residence times of herbicide in soils are not uncommon, and as the herbicide remains in the soil it can inhibit the recovery of native vegetation.*** [RMZ11]

Restoration by wildfire and prescribed fire.

- ***Fire may reduce encroachment of woody species where the densities of woody species is outside the range of natural variability for riparian ERUs in the Santa Fe NF, encouraging the return of natural fire regimes and restoring native ground cover.*** [RMZ12]

- ***Fire may cause adverse effects to Riparian Management Zones if fire severities cause super-heating of the soil. High heat not only removes groundcover, but can cause soil hydrophobicity by which water is repelled from soil pores*** (DeBano et al. 1976) [RMZ13]***. In large areas of hydrophobicity, excessive runoff is generated because infiltration is significantly reduced*** (DeBano 1971)***. Excessive runoff can result in flashier hydrographs*** (Moody and Martin 2001) ***as well as erosion and sedimentation*** (Certini 2005)***, both of which adversely affect water quality and aquatic habitat.*** [Wa8, RMZ14] ***In some cases, high-severity fire in riparian areas could cause heating of the soil to temperatures high enough to kill both existing vegetation and the native seeds and volatize available nutrients in the soil, in these cases natural recovery potential could be retarded and the riparian areas left more vulnerable to invasion by nonnative species, which thrive after disturbances and are well adapted to nutrient poor soils*** [RMZ15]**.**

Dispersed recreation areas can be detrimental to riparian areas where human use concentrates in riparian areas adjacent to streams and wetland features. Detrimental effects intensify if sites are accessed by motorized vehicle.

- ***Concentrated human use can destabilize soils by foot and vehicle traffic damaging aquatic habitat and water quality through loss of vegetation and increased sedimentation*** [RMZ16]***. Water quality can be further degraded by human waste, fuel (for stoves, ATVs, etc.), and other contaminants that are introduced to waterbodies*** [Wa18, RMZ17]**.** Restoring dispersed sites can have the long term positive impacts on vegetation and water quality (***RMZ 1, 4, and 6***) and have short-term negative impacts (***RMZ 2, 5, and 8***).

Dispersed sites that are merely closed and not actively rehabilitated will not experience the short-term impacts from heavy equipment use in riparian areas (***RMZ 2 and 5***), but also will not likely improve or recover completely on their own. ***Sites will remain compacted from years of vehicle traffic; the***

compaction will inhibit revegetation leaving exposed soils and vulnerabilities to invasive plant encroachment. The compacted bare ground will prevent infiltration of precipitation, which will cause continued runoff and erosion degrading water quality. [RMZ18]

3.3.5.2 Indicator: Vegetation Species Composition and Structure

Alternative 1-1987 Forest Plan

Alternative 1 includes a suite of criteria related to ensuring that proposed management does not degrade riparian function. Existing forest plan standards for riparian management zones include:

- Ground cover – Provide average ground cover of plants and litter at 80 percent of natural levels.
- Shade – Provide shading over perennial and intermittent water surfaces that is 80 percent of natural levels considering unit reaches of about two miles in length.
- Bank cover – Provide shrub and tree cover along bank lengths that is 80 percent of natural levels. Give emphasis to the protection of streambank stability provided by woody plant roots, particularly on outside bends of stream channel meanders.
- Streambed Sedimentation – Composition of sand, silt, and clays within streambeds should not exceed 20 percent of natural levels.
- Plant Composition – Provide at least 60 percent of the woody plant composition in three or more riparian species.
- Plant Structure – Provide at least three age classes of riparian trees and shrubs, with at least 10 percent of the cover in the seedling sapling stages and 10 percent in the mature and over-mature.
- Crown Cover – Provide crown cover of both trees and shrubs that is 80 percent of natural levels considering unit reaches of about 2 miles in length.

However, the existing forest plan does not include any objectives for forest vegetation restoration; instead mechanical timber harvest ***(RMZ 1-3)*** and wildfire suppression are emphasized. While at the forest plan scale riparian areas are not highly departed from reference, vegetation composition and structure as a result of prolonged wildfire suppression at the local-scale are more highly departed**.** Some departed sites have dense assemblages of woody species as a result of the absence of fire, which could contribute to altered hydrology (***RMZ 12-14***). ***Altered hydrology results from the change in water balance caused by a shift from herbaceous vegetation to shrubs and conifers, which have more extensive canopies and are more deeply rooted. The deeper roots allow increased uptake of subsurface water, increased rates of rainfall interception, and have higher rates of evaporation and transpiration—these properties combine to result in reduced water yield to riparian areas and streams when compared with riparian areas dominated by herbaceous species*** [RMZ19]***.***

Alternative 1 also includes management objectives for rangeland, stream channel, aquatic habitat, and riparian area conditions, but does not contain specific components which direct restoration of these areas. Therefore, both adverse (***RMZ 2, 5, 10-11, and 13***) and beneficial effects ***(RMZ 1, 3-4, 6-9, and 12)*** of the various restoration activities are least likely to occur by this alternative when compared with all other alternatives.

Alternative 2 - Forest Plan

In alternative 2, the addition of new Plan objectives that emphasize vegetation treatments through mechanical treatments and fire would help to actively achieve desired ecological conditions in all treated ERUs. The stated goals for restoring vegetation composition and structure in ERUs would direct future forest work, though the highest priority ERUs for treatment are not the six riparian or wetland ERUs. By increasing the occurrence of vegetative treatments, the adverse effects of mechanical treatments ***(RMZ 2)*** and fire ***(RMZ 13)*** would be greater for this alternative when compared to alternative 1. By the same logic, where vegetative treatments may be applied to RMZs with over-dense woody vegetation, the beneficial effects of mechanical treatments and fire ***(RMZ 1, 3, 12)*** would be greater under alternative 2 compared to alternative 1. Because the proposed acres for vegetation treatments would be fewer in alternative 2, the potential adverse effects from mechanical treatments ***(RMZ 2)*** and increased fire ***(RMZ 13)*** use would be lower in alternative 2 than either alternative 3 or 4.

Alternative 2 also has a Plan objective for invasive species removal of 600 acres over 10 years, which would be higher than objective acres for alternative 3 at 300 acres, but lower than alternative 4 at 1,500 acres, leading to higher potential impacts from invasive species removal ***(RMZ 10-11)*** and higher benefits ***(RMZ 9)*** under alternative 2 compared to either alternative 1 or 3, but lower impacts than alternative 4**.**

Alternative 3 - Natural Processes Emphasis

Though desired conditions for vegetation in all ERUs match those of alternative 2, alternative 3 would primarily use fire or practices that mimic natural processes to conduct restoration and vegetation treatments ***(RMZ 12, 15)***. Alternative 3 would include the highest acreage for vegetation objectives of all alternatives, with the potential to treat the most acres of mixed dry conifer (up to 820,000 acres) and ponderosa pine (922,000 acres), as well as non-forested vegetation (165,000 acres), moving these areas toward desired conditions. However, with the reliance on fire to restore departed ERUs toward desired conditions, the likelihood of experiencing a fire of uncharacteristic severity is increased (***RMZ 13-15***; see also: Vegetation and Fire) more than for all other alternatives. Alternative 3 would have the lowest target for treating invasive species compared to the other action alternatives; consequently, the impacts (***RMZ 10-11***) and benefits (***RMZ 9***) related to invasive plant removal would be the lowest in alternative 3, compared to the other action alternatives.

Alternative 4 - Human Uses Emphasis

Plan objectives for alternative 4 propose to treat the fewest overall acres of mixed dry conifer (up to 325,000 acres), ponderosa pine (up to 253,000 acres), and non-forested vegetation (up to 120,000 acres), but emphasizes mechanical treatments and minimizes use of fire compared with the other alternatives. Relying on mechanical treatments as the principal vegetation management tool would effectively limit the treatable area because of logistical access (i.e., logging equipment cannot access steep slopes) ***(RMZ 5)***. Some minimal allowance of wildfire to achieve these objectives would be accepted; all other fires would be suppressed to protect merchantable resources and where natural fire occurs it will help maintain riparian vegetation structure and composition (***RMZ 12)***. As a result, the greatest possibility of adverse effects associated with mechanical treatments would occur under alternative 4 ***(RMZ 2)***. Unlike alternatives 2 and 3, this alternative contains a guideline that does not allow using prescribed fire to handle the byproducts of mechanical treatments, and instead, requires that other methods such as chip and grind or lop and scatter be used. These additionally created woody fuels, if not treated, may mean naturally ignited wildfires occurring within these areas would be more likely to result in high soil burn severity, causing the most adverse impacts to riparian areas when compared with other alternatives ***(RMZ 13-15)***.

The six riparian ERUs are not highly departed from reference condition for fire return interval and, consequently, are not identified as priority ERUs that would drive the forest's future larger scale vegetation treatments, though there would be smaller-scale treatments to restore vegetation in RMZs. The larger-scale vegetation treatments would focus on returning upland areas toward desired conditions. Thus, the potential for direct adverse or beneficial impacts to riparian management zones would be less than it may be for other alternatives. It remains unknown how the cumulative impacts might accrue to impact riparian function indirectly through changes in upland erosion and stream channel function as a result of the mechanical vegetation treatments proposed in this alternative.

3.3.5.3 Indicator: Proper Functioning Condition

Alternative 1 – 1987 Forest Plan

Alternative 1 includes a suite of criteria related to ensuring that proposed management does not degrade riparian function. Existing forest plan standards for Riparian Management Zones are described in the section above for the Vegetation Structure and Composition Indicator. The existing forest plan describes desired conditions as achieving satisfactory riparian conditions, where satisfactory conditions are defined as, "*the area in question meets 75% of the standards*." These standards may be inadequate to support designated uses or conditions specified by the state's designated water quality standards and water quality improvement plans for streams where existing water quality is degraded. Further, alternative 1 has limited plan components for designating the extent of riparian management zones and only describes the need for stream management zones for timber sales and provides vague direction for designating RMZs for other activities. Riparian areas comprise management zones (FSH 2509.23), which combine the ecologic concerns of riparian ecosystems with the hydrologic concerns of floodplains and streamside slopes. Riparian areas include all riparian ecosystems, all 100-year recurrence interval floodplains and all other lands within at least 100 horizontal feet of the annual high-water edge of perennial or interrupted water bodies (FSM 2526).

While the existing plan does include standards to protect riparian areas, there is no forestwide direction to implement restoration. Given that with the existing forest plan riparian conditions are moving away from desired conditions, the current standards without clear direction for restoration is proving to be inadequate to protect and restore riparian areas. However, alternative 1 does have has several plan components that would improve riparian conditions for about 730 acres in the Jemez River, Rio Guadalupe, and Rio Gallina drainage basins. Additional riparian components are included in several Plan Amendments for Mexican spotted owl habitat, Rio Chama, Jemez River and Pecos River Wild and Scenic areas, and the Jemez National Recreation Area. These plan components would help to increase the health, function, and condition of some riparian areas in the forest, but would ultimately provide fewer benefits than other alternatives. The short term and long term effects, both beneficial and adverse, would be as stated above for restoration actions of restoring vegetation composition (***RMZ 1-3)***, riparian restoration actions (***RMZ 4-5)***, road decommissioning ***(RMZ 6-8),*** and restoring dispersed recreation sites (***RMZ 16-17***).

Alternative 2 – Forest Plan

In alternative 2, there are Plan objectives that focus on restoring ecological conditions in riparian areas. The proposed objectives that will be most important for improving PFC trends toward reference desired conditions are the objectives for miles (15 miles over 10 years) of stream restoration, riparian and aquatic habitat improvements, and projects designed to treat riparian invasive species. Projects designed to achieve these objectives will directly improve attributes of PFC including geomorphology and riparian vegetation. Geomorphology improvements will include reduced stream channel entrenchment, bank erosion, and an increase in connectivity between stream channel and adjacent riparian areas (***RMZ 4, 6, 7).***

Vegetation improvements will increase ground cover, stream shading, and restore riparian ERUs toward the composition and structure of reference conditions (***RMZ 1, 9***). In addition, decommissioning roads increase ground cover, decrease erosion, improve water quality, and improve soil and hydrologic function ***(RMZ 6-7)***. Under alternative 2, both the adverse ***(RMZ 2, 8-9, 11)*** and beneficial effects ***(RMZ 4, 6-7, 10, 13, 16-17)*** of restoration activities would be higher than alternative 1. The adverse impacts would generally arise as short-term effects from heavy equipment use, causing increased erosion potential following some projects ***(RMZ 2, 5)***.

Additional improvements to riparian condition may result from the objectives for rehabilitating two dispersed recreation sites every three years. Alternative 2 guidelines emphasize rehabilitating sites and closing them where impacts cannot be mitigated. Closure, mitigation and rehabilitation actions (i.e., grading, planting, seeding) would be expected to have beneficial effects such as the long-term recovery of vegetation through a reduction in motorized use and improved water quality (***RMZ 1, 4, 6, 16, 17)***, as well as the adverse effects resulting from short-term impacts from heavy equipment used to rehabilitate the site (***RMZ 2, 5, 8***), or longer term if the site can only be closed but not mitigated with revegetation to control ongoing erosion (***RMZ 18***). The increased erosion will result from the persistent exposed soil because years of vehicle traffic leave the areas too compacted to revegetate with native species, which are adapted to higher nutrient and wetter soils. By contrast, most nonnative invasive species will easily invade and begin to dominate these highly disturbed areas creating a persistent issue of vegetation composition highly altered from reference ERUs. The number of sites treated and the de-emphasis on closing sites makes these activities only moderately likely to have a beneficial impact on riparian areas when compared with alternative 3, but are more likely to benefit the surrounding area than under alternative 4.

Alternative 2 would strike a balance between setting achievable riparian restoration goals, which would help RMZs begin to trend toward 'properly functioning condition (PFC)' ***(RMZ 4)***, while limiting the potential adverse impacts from implementing the proposed restoration treatments ***(RMZ 2, 8-9, 11, 19)***.

Alternative 3 – Natural Processes Emphasis

Alternative 3 has similar restoration plan objectives as alternative 2, but the magnitude of the objectives, and resulting adverse and beneficial effects, are increased in scale. These objectives include the following actions and related beneficial and adverse effects toward improving PFC: improve five watersheds, 30 miles of riparian and stream channel restoration, and 60 miles of aquatic habitat restoration over 10 years ***(RMZ 4, 6-7)***. ***Road decommissioning objectives would result in a smaller road system that would reduce access and spread of invasive species, as well as improve hydrologic function and connectivity of riparian and upland ecosystems*** [RMZ20] and would have mixed associated effects ***(RMZ 5-9)***. Resulting adverse effects would be the second lowest of all alternatives. Long-term beneficial effects ***(RMZ 4)*** from these activities would outweigh the adverse impacts ***(RMZ 8-9)***.

Alternative 3 also contains forest plan objectives for rehabilitating two dispersed recreation sites every three years. Alternative 3 guidelines, however, emphasize rehabilitating and closing the sites, rather than simply mitigating impacts. Closure, mitigation, and rehabilitation actions (i.e., grading, planting, seeding) would be expected to have both beneficial and adverse effects on riparian areas through decreased motorized use and a corresponding decrease in erosion from compacted and bare soils (***RMZ 16-18***). The number of sites treated and the emphasis on rehabilitating and closing the sites makes these activities likely to have the largest benefit to PFC when compared with other alternatives.

Alternative 4 - Human Use Emphasis

Alternative 4 lacks most of the restoration plan objectives contained within alternatives 2 and 3, and primarily relies on changes to vegetation structure and function to lead to improving riparian PFCs.

Alternative 4 contains Plan objectives for rehabilitating four dispersed recreation sites every three years. Alternative 4's specific guidelines, however, emphasize rehabilitating the sites while maintaining them as open for use. Rehabilitation actions themselves (i.e., grading, planting, seeding) would be expected to have both beneficial effects from vegetative recovery and adverse effects resulting from heavy equipment use similar to ***RMZ 2***. The emphasis on keeping the sites open for use, however, makes it likely rehabilitation activities would not be effective as vegetation is not likely to reestablish when continuously disturbed. These plan components are, therefore, likely to have the largest adverse effect on surface water resources when compared with other alternatives ***(RMZ 2, 5, 8-9, 16-18)***.

Alternative 4 includes no restoration objectives or components for road decommissioning, thus would not elicit the associated benefits of this action (***RMZ 6-7, 20***). Adverse effects associated with roads would be expected given two Plan guidelines in the roads section (i.e., temporary and closed roads could be added to the system and the motorized trail network would be expanded through the designation of a motorized recreation area), which would expand the forest road system rather than decommissioning unnecessary roads. Expanding the forest road system would increase forest access, but would also have other associated effects damaging riparian condition ***(RMZ 2)***. The motorized recreation area, however, would also limit new road construction and decommission roads unnecessary to recreation.

Alternative 4 would result in the most harm to RMZs when compared with other alternatives. ***Watersheds and RMZs would be expected to move away from properly functioning condition as a result of increased sedimentation from logging and an expanded motorized road system, leading to the long term degradation of sensitive riparian areas.*** [*RMZ*21]

3.3.5.4 Cumulative Effects

The spatial and temporal distribution of riparian ecosystems across the landscape is dependent on climate, geology and hydrology, collectively.

The timeframe for assessing cumulative effects on RMZs is 15 years. Cumulatively, the RMZs account for just 3 percent of the forest land base. However, the position of RMZs on the landscape as transitional zones between the upland terrestrial ecosystems and the stream ecosystems mean that all activities in a watershed that impact water quality, water yield, and vegetation structure and composition will also cumulatively affect the RMZ. The spatial boundaries of the analysis are the 142 sub-watersheds that overlap the administrative Santa Fe NF, but also extend beyond the forest.

Past, present and future activities within the administrative boundary of the Santa Fe NF include livestock grazing, prescribed and natural fires, wildfire suppression, recreation, mining, vegetation management, noxious weed treatments, road construction and maintenance, road decommissioning, wildlife habitat restoration and management, watershed restoration and management, and oil and gas extraction, among others. Beyond the forest boundary, past, present, and future actions by other entities that add to cumulative effects include the activities described above, as well as activities associated with rural residential communities. Within any watershed, regardless of land ownership, these activities cumulatively affect (both beneficially and adversely) water quality, water quantity, and watershed condition (see the Water Resources Section: ***Wa1 – Wa37***). RMZs will be cumulatively impacted by the same management uses that will impact water quality, water quantity, and watershed condition (***RMZ 1-18***).

The cumulative effects of historic and ongoing livestock grazing described in the Water Resources section are inclusive of impacts to riparian management zones for the past, present, and future for both Indicators-Vegetation Composition and Structure and PFC (***Wa 24-34***). The future impacts of grazing are not predicted to be significantly different than the present condition for riparian management zones, though cumulatively, the more intensive and extensive grazing allowed on adjacent land ownerships without the permitting standards of the Forest Service could cause both the vegetation structure and composition and the PFC of the forest's RMZs to move farther away from desired conditions. ***Intense or extensive grazing causes the removal of ground cover, increases erosion, increases sedimentation, degrades water quality, and can facilitate invasive species spread, all of which are particularly detrimental to riparian condition.***[RMZ22]

Compared to other ERUs, the past history of wildfire suppression has had less direct impact on the change in vegetation structure and composition within RMZs because fires are considered naturally infrequent in these areas. However, cumulatively, the history of suppressing natural wildfire combined with historic over-grazing have resulted in overly dense forests that carry crown fire and severely burn soils (Covington and Moore 1994a; Dunmire 2013) ***(RMZ 12)***. ***The absence of wildfire in the ecological regime of Forest watersheds has had a negative effect on Riparian PFC through the adverse alteration of hydrologic processes, such as water absorption, retention, and release*** (Keane et al. 2002). To some degree, ***the absence of wildfire affects Riparian Management Zones PFC in identical ways to overall watershed function by impacting water quality, stream channel morphology and equilibrium by increasing sediment deposition beyond the channels capacity to transport sediment downstream, and the accumulated sediment and altered channels decrease available aquatic habitat*** [RMZ23]**.** The Santa Fe NF works with adjacent land managers to unify an approach to fire management and will find ways to manage fire that include fire use in watersheds, regardless of ownership. Cumulatively, reintroducing fire to the landscape should have beneficial effects on riparian management zones by improving water quality and watershed condition and have other associated effects ***(RMZ 9- 13).***

Forest thinning within and around the Santa Fe NF includes both hand thinning and mechanical treatments. Riparian ERUs are not identified as priority treatment areas for mechanical treatments, but may be a focus of smaller targeted treatments to change vegetation structure and composition within riparian areas. Still, cumulative adverse effects from larger-scale mechanical treatments and harvest would likely occur to surface water resources and watershed condition in treated areas, which may negatively impact nearby RMZs' PFCs ***(RMZ 2, 5)***. These cumulative impacts would also include fugitive dust emissions, increased soil compaction from heavy equipment, resulting in reduced infiltration and increased erosion and sedimentation (Elliot et al. 2010). However, forest management would incorporate best management practices to mitigate these impacts. Over time, forest thinning activities should result in forests more resilient to disturbance by wildfire, which should cumulatively benefit RMZs by improving water quality and watershed conditions.

Mining and energy production has occurred within and around the forest for many years. Oil and natural gas have been extracted from the Santa Fe NF since the 1940s; at present there are 209 oil and gas leases covering approximately 89,000 acres in the Santa Fe NF, while few projects are located within RMZs, their potential to cumulatively degrade water quality could adversely impact RMZ PFC. ***Mining activities are ground-disturbing with potential adverse impacts to surface water resources and watersheds, and therefore cumulative impacts to RMZs such as water extraction, increased erosion and sedimentation,***

as well as the creation of acid mine drainage, and other water pollutants(Gleick 1994; Dudka and Adriano 1997). ***Leasable energy production operations can also contaminate water quality through the introduction of pollutants to groundwater and surface water*** [RMZ24]**.** The Watersheds and Water Resources section describes potential impacts to RMZs' PFCs by degradation of water quality and water quantity from cumulative mining and energy production activities.

Across the Santa Fe NF, there are over 6,583 miles of system and non-system roads; beyond the forest border are many more miles. While the forest has decommissioned some roads during the past 15 years, within most non-wilderness sub-watersheds, road densities remain above levels that can disrupt watershed functions (Al-Chokhachy et al. 2016). Roads adversely affect hydrologic processes in several ways (see also: Water Resources Section, ***Wa10 - Wa14***). Current and future plans in the forest propose shrinking the forest's road system through road decommissioning. Some road decommissioning will occur off-forest; however, new roads may be built as they serve adjacent land manager needs. Cumulatively, adverse impacts to RMZ PFC through degradation of water quality and connectivity of riparian areas are expected through the use of the remaining roads and any construction of new roads (see: "Roads and Facilities" for many specific effects of roads) (***RMZ 5-8***). Therefore, in combination with off-forest roads, the NFS motorized transportation system can be expected to have cumulative adverse impacts to water resources and watersheds, and therefore, cumulative adverse impacts to RMZs ***(RMZ 2, 5-8)***.

Rural development around the Santa Fe NF in conjunction with Forest developments (e.g., campgrounds, ranger stations, day-use sites) can adversely affect water resources through ground disturbance and water quality contamination (see also: WRS, ***Wa17 – Wa19***).[RMZ25] In the forest, best management practices are used to mitigate these impacts, thereby minimizing cumulative impacts on RMZs by present or future Santa Fe NF activities.

3.4 Watersheds and Water Resources

3.4.1 Affected Environment

3.4.1.1 Watersheds

A watershed (drainage basin) is a region or land area drained by a single stream, river, or drainage network (36 CFR 291.19). These drainage areas are defined by the highest elevations surrounding a selected location on a stream so that a drop of water falling inside the boundary will drain to the stream, while a drop of water falling outside the boundary will drain to a stream in the adjacent watershed.

Watersheds span the landscape at many different scales which are nested within one another. The largest unit of scale is called a "region" (level 1 hydrologic unit; Seaber et al. 1987), which encompasses about 177,560 square miles. The Santa Fe NF is located within three hydrologic regions:

- Colorado River (flows west to Utah and Arizona)
- Rio Grande (flows south through New Mexico to Mexico)
- Arkansas River (flows east to the Great Plains)

Sub-regions (level 2 hydrologic unit), basins (level 3 hydrologic unit), sub-basins (level 4 hydrologic unit), watersheds (level 5 hydrologic unit), and sub-watersheds (level 6 hydrologic unit) are nested within each other, and within regions. Watersheds each encompass about 250,000 acres; sub-watersheds each encompass approximately 40,000 acres. For this analysis, the scale of "sub-watersheds" is used. There are 142 sub-watersheds in the Santa Fe NF (figure 19).

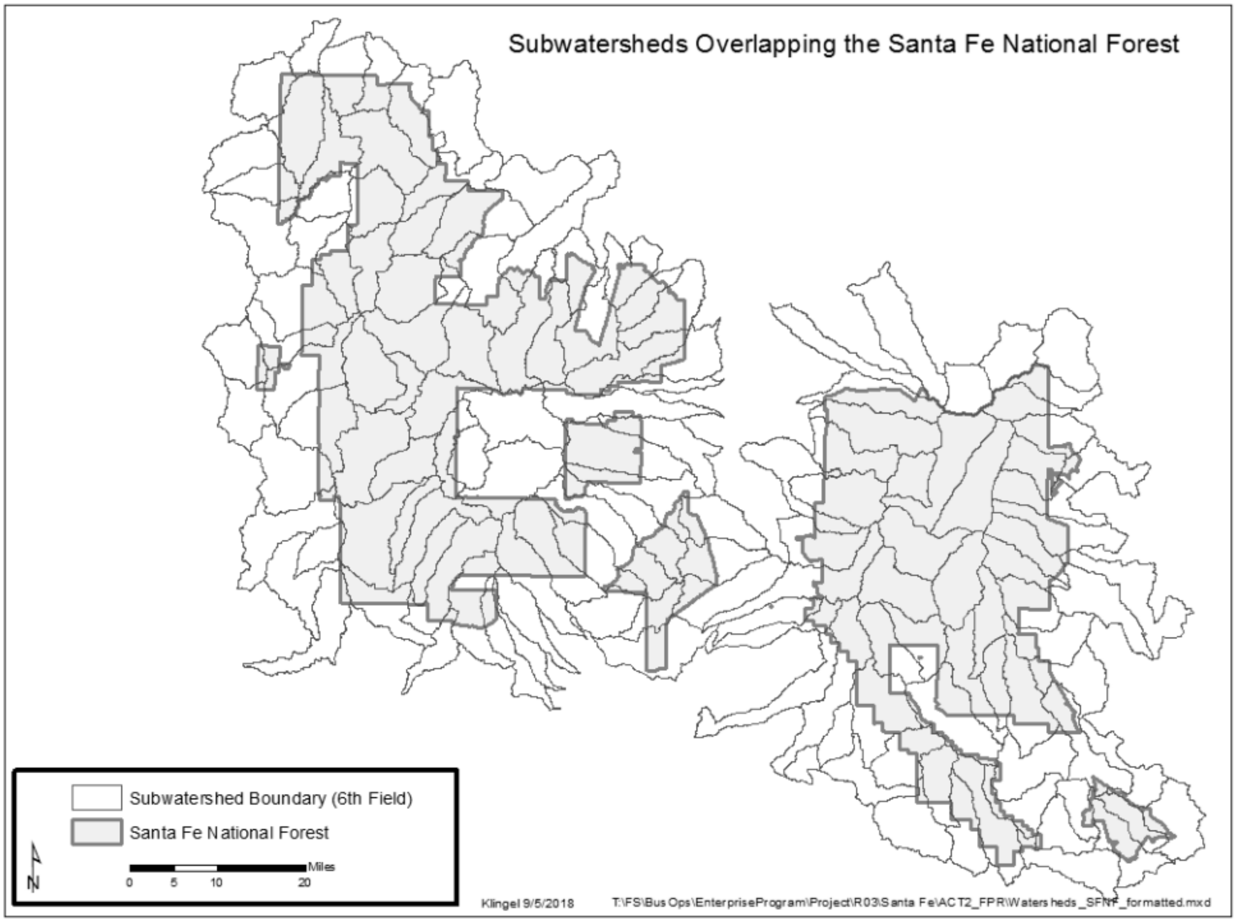

Figure 19. Sub-watersheds of the Santa Fe NF

Watershed Condition

Watershed condition is the state of the physical and biological processes within a watershed; these processes affect soil condition and hydrologic function, which in turn support ecosystems. Watershed condition can be represented by a continuum from naturally pristine to degraded. Naturally pristine indicates the watershed characteristics (e.g., soil condition, ground cover, etc.) that capture, store, and release water, sediment, wood, and nutrients function to ensure these processes occur at rates similar to those in undisturbed, natural systems. Where they do, watersheds create and sustain functional terrestrial, riparian, aquatic, and wetland habitats capable of supporting diverse populations of native species.

The watershed condition framework (WCF), an analysis methodology developed by the Forest Service, classifies the state of all NFS watersheds and provides guidance to help the national forest evaluate, prioritize, and measure the progress of restoration within watersheds (USDA Forest Service 2011a and 2011b; Potyondy and Geier 2011). One hundred sixteen sub-watersheds in the Santa Fe NF were classified[9] by the WCF in 2015; the other 26 sub-watersheds contain relatively small portions of the forest and were therefore not classified. Sub-watersheds are classified as one of three condition categories:

- **Class 1 (properly functioning)** – Watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition, and they are functioning properly.

[9] The Santa Fe NF no longer manages the Valles Caldera National Preserve. Therefore, the Headwaters San Antonio Creek sub-watershed will not be evaluated in future WCF assessments.

- **Class 2 (functioning at risk)** – Watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition, and they are functioning, but at risk.
- **Class 3 (impaired function)** – Watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition, and their function is impaired.

Watersheds with characteristics (and hydrologic processes) closer to the naturally pristine state are likely to be "properly functioning," whereas those that have been severely altered are more likely to be degraded (resulting in impaired function). The desired condition for watersheds in the Santa Fe NF is properly functioning.

The results of the 2015 watershed condition assessment show 6 percent of the forest's sub-watersheds are considered to be functioning properly, 88 percent are functioning at risk, and 6 percent are considered impaired. Overall, 94 percent of the Santa Fe NF sub-watersheds are not properly functioning (figure 20).

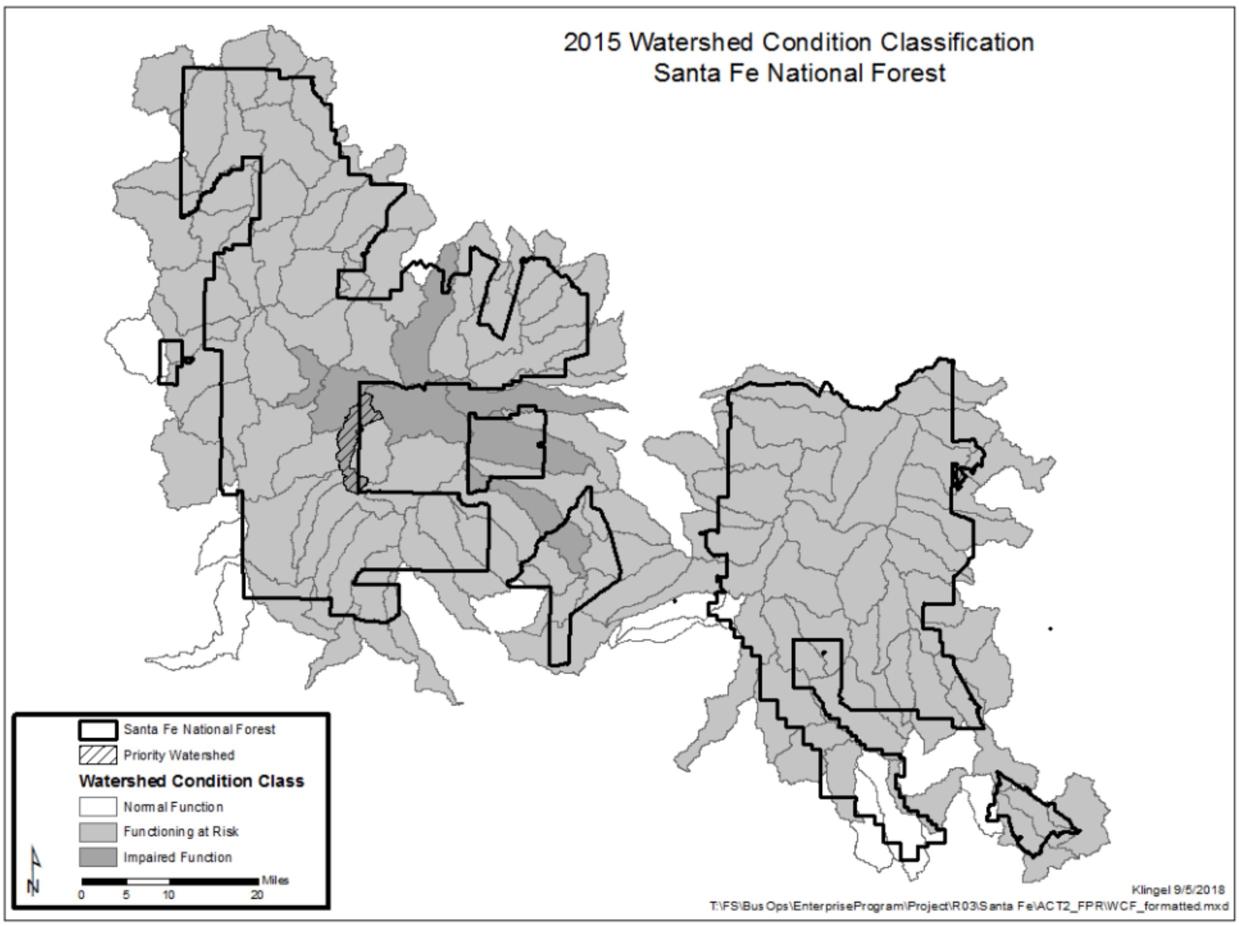

Figure 20. Watershed condition for each sub-watershed (6th level) HUC (from the 2015 WCF Assessment)

Sub-watersheds are placed into these condition classes through the use of analysis metrics within the following indicator groups: aquatic physical, aquatic biological, terrestrial physical, and terrestrial biological. In the Santa Fe NF, the following analysis indicators exhibit the greatest departure from reference (natural) conditions: water quantity, riparian and wetland vegetation, roads and trail influences, soils, and fire regime (table 35). The number of watersheds with indicators functioning at risk or with impaired function indicates there is a widespread need to restore ecosystem resiliency across the landscape. A full listing of the sub-watersheds and their condition indicator ratings appears in the project record.

Table 35. Watershed condition framework ratings for 116 sub-watersheds in the Santa Fe NF, number of watersheds listed by indicator and analysis metric

Indicator Groups	Aquatic Physical			Aquatic Biological		Terrestrial Physical		Terrestrial Biological				
Indicators	**1. Water Quality**	**2. Water Quantity**	**3. Aquatic Habitat**	**4. Aquatic Biota**	**5. Riparian/ Wetland Veg.**	**6. Road and Trail**	**7. Soils**	**8. Fire Regime**	**9. Forest Cover**	**10. Rangeland Vegetation**	**11. Terres-trial Invasive Species**	**12. Forest Health**
Functioning Properly	54	23	82	43	1	0	0	9	96	75	100	116
Functioning at Risk	35	90	30	61	108	41	33	55	11	40	14	0
Impaired Function	27	3	4	12	7	75	83	52	7	1	2	0

Beyond simply assessing watershed condition, the WCF is used to identify priority watersheds, areas where land management decisions should emphasize maintaining or improving watershed condition. Where restoration is needed, a wide range of treatments should be sequenced based on a long-term work plan (a Watershed Restoration Action Plan; WRAP).

A watershed restoration action plan was developed (USDA Forest Service 2011a) for the Outlet San Antonio Creek sub-watershed; the watershed was subsequently identified as a priority watershed during the 2015 WCF. In 2018, it remains the only priority watershed in the Santa Fe NF.

The Outlet San Antonio Creek sub-watershed (14,800 total acres) is largely managed by the Santa Fe NF (91 percent). There are over 39 miles of streams and over 1,400 acres of riparian vegetation within the sub-watershed. It is potential habitat for the Rio Grande cutthroat trout and is critical habitat to the Mexican spotted owl, the northern goshawk, the Jemez Mountain salamander, and the New Mexico meadow jumping mouse. Impaired WCF metrics for this watershed are aquatic biota, riparian vegetation, water quality, roads and trails (both density and maintenance), soil condition, and fire condition.

3.4.1.2 Water Resources

Surface Water

Surface water in the Santa Fe NF includes streams, reservoirs, lakes, wetlands, stock ponds, seeps and springs (figure 21). These features provide habitat for diverse communities of vegetation, wildlife, and fish, as well as water for downstream uses including crop irrigation, domestic livestock, municipal and domestic water supplies, commercial, industrial, and other uses.

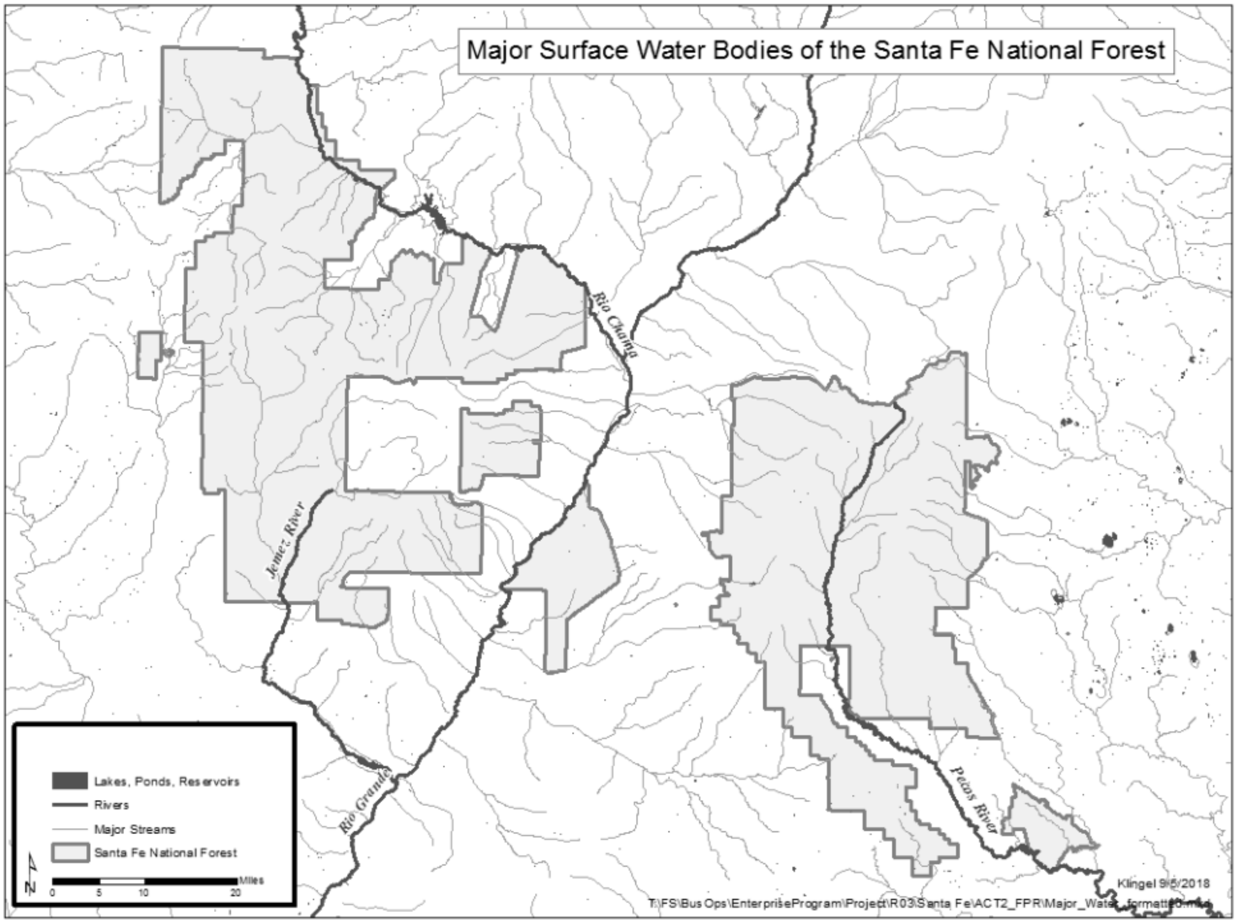

Figure 21. Major surface water bodies of the Santa Fe NF

Of more than 5,700 miles of rivers and streams in the Santa Fe NF, about 985 miles (17 percent) are perennial. There are also 4,807 intermittent and ephemeral stream miles on Forest lands; additional stream miles pass through non-forest in-holdings that are surrounded by the administrative forest boundary (table 36).

Table 36. Stream miles in the Santa Fe NF plan area

Ownership	Perennial	Intermittent	Ephemeral	Total
Santa Fe NF	985	643	4,164	5,792
Admin Boundary[10]	1,188	794	4,557	6,539

Across the Santa Fe NF, the existing condition of stream channels differs widely, ranging from little to highly disturbed, with varying degrees of impaired function. As assessed by the Santa Fe NF WCF process, the two main components of stream function—channel shape and riparian vegetation—rated nearly 90 percent impaired. At a finer scale, Santa Fe NF channel conditions vary along stream reaches, as a result of both human-caused and natural disturbances.

[10] Non-forest administered lands within the forest boundary

Stream channel condition at the reach scale is assessed using the proper functioning condition (PFC) method (Prichard 2003). This method qualitatively evaluates hydrologic (stream channel and floodplain) function, vegetation, and erosion/depositional processes to determine the stream's resiliency to disturbance and rates each reach as properly functioning, functioning at risk, or non-functional. Properly functioning condition means that a stream can withstand high flows without excessive erosion. Functional-at-risk means that a stream can withstand large events, but has an existing soil, water or vegetation attribute that makes it susceptible to degradation. Nonfunctional means that stream characteristics are not able to dissipate stream energy and are not stable during high flows.

To date, the Santa Fe NF has assessed 189 miles of its 985 perennial stream miles (19 percent) using the PFC method (table 37). Approximately 41 percent of all perennial streams outside of designated Wilderness areas have been assessed by the PFC method; there are 325 perennial stream miles in designated Wilderness areas that have not been assessed for PFC. Most Wilderness miles are assumed to be properly functioning; however, several evaluated streams in the San Pedro Parks Wilderness were recently evaluated as functioning-at-risk, likely related to current and historic livestock management.

The results of the field surveys show that for all analyzed streams, most were in proper functioning condition, less than 30 percent were functional-at-risk, and very few were found to be non-functional.

Table 37. Stream channel condition ratings

Stream Condition	Stream Miles Assessed	Percentage of Assessed Stream Miles
Proper Functioning	134	71%
Functional at-Risk	52	28%
Non-functional	3	2%

The Santa Fe NF contains approximately 580 springs and seeps[11] and 7,000 acres of wetlands.[12] Springs and seeps occur where groundwater emerges on sloping terrain, toe-slope breaks, and geologic formation transition zones. Many springs in the forest flow almost constantly throughout the year, though flows can vary from year-to-year. The Forest has developed approximately 315 springs for livestock use (61 percent).

There are 782 natural and human-made waterbodies (for human, livestock, and wildlife consumption), totaling 953 acres, within the Santa Fe NF administrative boundary. Reservoir storage of water (for human use) is minimal, with the four largest reservoirs holding about 4,465 acre-feet: McClure (3,255 acre-feet), Nichols (685 acre-feet), San Gregorio (255 acre-feet) and Fenton Lake (270 acre-feet). For comparison, Cochiti Dam holds about 500,000 acre-feet.

Hydrology and Yield

Across the Santa Fe NF, average annual precipitation ranges from about 11 inches at the lower elevations to over 40 inches at the high peaks. The hydrology (e.g., average annual streamflow, baseflow, and groundwater recharge) are dominated by snowmelt runoff, though the influence of snow decreases southward and at lower elevations. Surface water in the forest is fed primarily by snowmelt (snowmelt runoff in the spring and early summer, then by groundwater inputs due to recharge from melting snow). On average, surface runoff peaks in May-June during maximum snowmelt, and decreases through the summer. Some stream channels, however, such as those in the Jemez Mountains, are known to be fed by

[11] National Hydrologic Dataset, USGS (NHD) and Spring Stewardship Institute, Museum of Northern Arizona (SSI) databases
[12] National Wetlands Inventory database

the local aquifer and do not have as much hydrograph variation when compared with snowmelt-fed channels.

Although most annual peak flows occur during May or June, the largest floods on record often occur during summer monsoonal rains, when rainfall intensity exceeds the rate at which soils absorb moisture (especially following high-severity wildfires). Within drier portions of the forest, many smaller tributary channels have their largest floods during intense summer thunderstorms. These thunderstorm-induced floods tend to affect specific water features, due to intense local rainfall under a thunderstorm cell. Some ephemeral streams, in the more arid portions of the forest, may only flow once every few years during intense thunderstorm precipitation. Precipitation from summer thunderstorms also helps to maintain base stream flows.

Forestwide, a detailed analysis of present-day water yield has not been conducted. Reference levels of water yield are also unknown; however, research suggests that water yield in pre-settlement, open-canopied ponderosa pine forests was higher than in the closed-canopy forests (with larger evapotranspiration rates) prevalent today (Covington and Moore 1994b). In addition to changes in forest condition, recent climatic drought conditions and the resultant decline in winter and summer precipitation have contributed to decreased water storage, runoff, and yield. Since 1996, annual water yield from the Santa Fe municipal watershed (in the Santa Fe NF) is less than 80 percent of the long-term (98-year) average.

Surface Water Quality

The quality of water within the Santa Fe NF is generally high and is used both in and outside of the forest for many purposes. The pollutants described below are regulated through water quality standards determined by the State of New Mexico Environment Department (NMED 2017). These standards are set at levels necessary to protect the designated use(s) of a waterbody. Designated uses include (but are not limited to) domestic water supply, municipal water supply, primary contact (e.g., swimming, water skiing), secondary contact (e.g., fishing, boating), wildlife habitat, livestock watering, cold water habitat, and irrigation.

NMED classifies surface water bodies into one of five water quality categories. Until sampling indicates otherwise, waters not listed for water quality impairments (categories[13] 1 to 3) are providing their designated uses; categories 4 and 5 are considered polluted and are not providing their designated uses (see figure 22). Pollutants in category 4 waters, however, are considered managed by total maximum daily load (TMDL) regulation or other measures, while category 5 waters are not. Both category 4 and 5 waters require special site-specific measures to ensure projects are not contributing to water quality degradation.

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[13] NMED classifies surface water bodies into one of five water quality categories:

- Category 1: Attaining all designated uses
- Category 2: Attaining some designated uses, and no use is threated or impaired
- Category 3: Insufficient data to determine if designated uses are attained
- Category 4: Impaired or threatened for one or more designated use; a total maximum daily load (TMDL) is not necessary because
    - 4a – A TMDL assessment has already been completed
    - 4b – Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard
    - 4c – The impairment is not caused by a pollutant.
- Category 5: Impaired or threatened for one or more designated uses by a pollutant; a TMDL needs to be developed or revised. These are the waters which constitute the CWA Section §303(d) List of Impaired Waters

To date, about 16 percent of all stream miles in the Santa Fe NF have been assessed by the NMED, which analyzes surface water quality every two years. During the most recent analysis (NMED 2016), approximately 25 percent of all surveyed perennial streams and two reservoir lakes were classified as impaired (categories 4 and 5), and are not attaining their designated uses. Improving the water quality in the Santa Fe NF is becoming increasingly important as the demand for clean water resources increases for human use, and the timing and volume of surface runoff responds to climate change. Table 38 displays miles of Santa Fe NF stream by water quality category.

Table 38. Santa Fe NF (SFNF) 2016 water quality categories of monitored streams, by sub-basin

	Category 1 to 3		Category 4		Category 5	
Sub-basin Watersheds	**Watershed Miles**	**SFNF Miles**	**Watershed Miles**	**SFNF Miles**	**Watershed Miles**	**SFNF Miles**
Jemez	24	18	14	14	190	135
Mora	91	31	88	7	0	0
Pecos Headwaters	236	154	99	58	64	7
Rio Chama	186	95	15	15	220	65
Rio Grande-Santa Fe	112	31	0	0	199	51
Rio Puerco	97	22	8	0	31	18
Upper Rio Grande	190	68	12	5	117	25

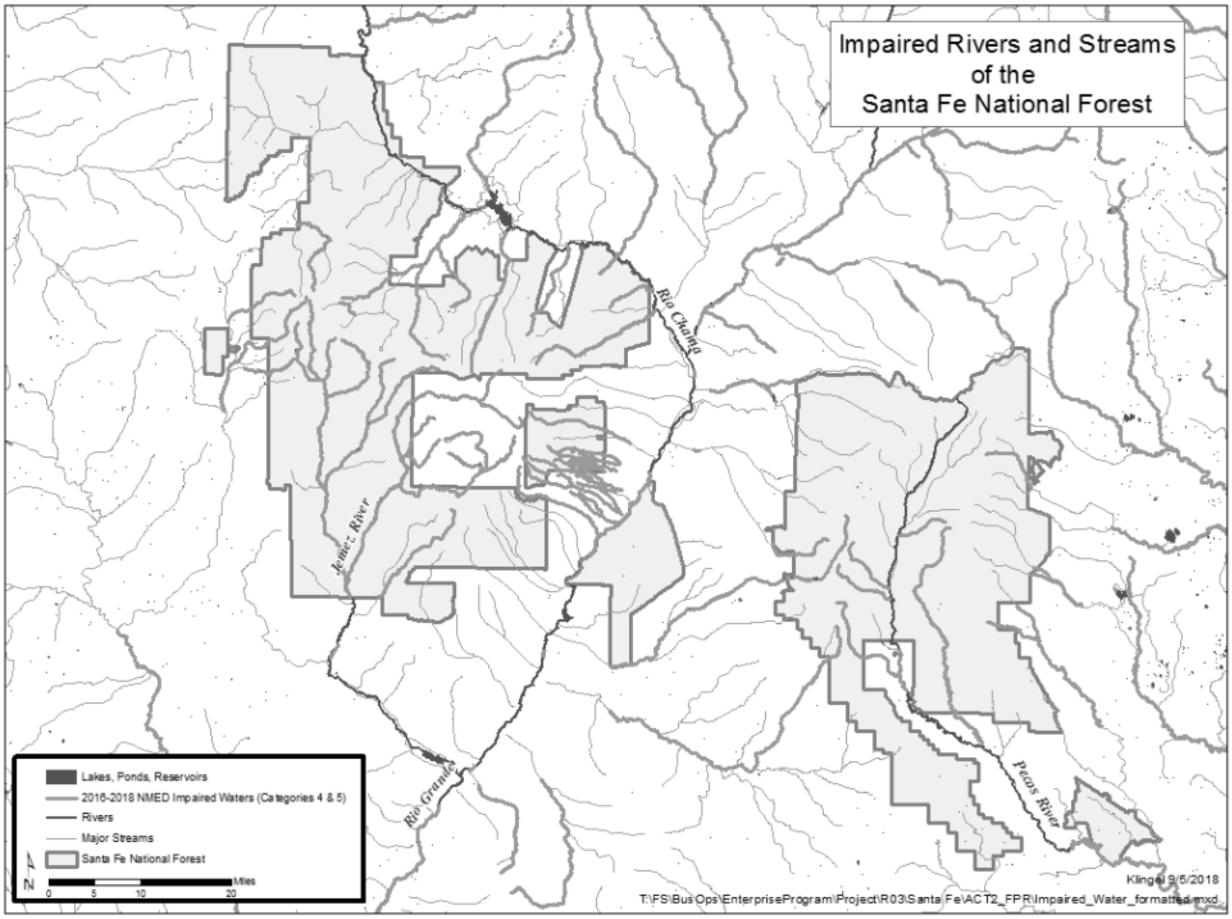

Figure 22. Impaired rivers and streams of the Santa Fe NF

Turbidity, sedimentation, and specific conductance account for the largest cause of water quality impairments, affecting 171 miles (3 percent) of Santa Fe NF streams. Sediment levels in streams vary significantly with stream flows, with the highest levels during spring runoff and additional spikes during monsoon runoff. Some stream reaches show evidence of sediment accumulation from varying sources, such as local stream bank erosion or contributing watershed conditions (e.g., high sediment-producing geology and roads close to streams). Streams that drain from the Jemez Mountains generally have higher turbidities than streams draining from the Sangre de Cristo Mountains, due to differences in geology (finer-grained sedimentary rock versus coarser-grained granitics).

Sediment accumulation is a natural function in lower gradient streams, but some areas show evidence of sediment accumulation outside the range of natural variability. Management-related turbidity and sedimentation can result from poorly located roads and trails, transportation routes in bad condition, degraded streambanks, and degraded upland vegetative conditions (e.g., recent wildfire burns). Roads and trails that do not drain effectively or are in close proximity to streams will transport detached soil to stream channels, contributing non-point source sediment and turbidity pollution to the water body. In New Mexico, the Water Quality Control Commission has designated the Forest Service as the authority for implementing the New Mexico Nonpoint Source Management Program on National Forest System lands. Responsibilities include the control, abatement, and prevention of non-point source pollution resulting from all Forest activities (USDA Forest Service 2017). The Forest complies with this duty through appropriate project design, best management practices (USDA Forest Service 2012a), and other mitigation measures.

Nutrients and eutrophication[14] account for the second largest cause of water quality impairments, affecting more than 151 miles (3 percent) of streams in the Santa Fe NF. The primary sources of nutrient loading from within the Santa Fe NF administration boundary are natural runoff from forest and grasslands, rangeland grazing, recreation sites, septic systems, and loss of riparian habitat along streams. In addition, there is one point source discharge in the Santa Fe NF: the Buckman Diversion Water Treatment Plant is permitted by the Environmental Protection Agency (EPA) under the National Pollution Discharge Elimination System and authorized under a Forest Service special use permit.

Aluminum accounts for the third largest cause of water quality impairment at the plan scale, affecting 120 miles (2 percent) of Santa Fe NF streams. Natural conditions contribute to high aluminum concentrations throughout the Jemez Mountains and impacts to aquatic life are unclear (NMED 2016). Geothermal springs originating from the Valles Caldera have naturally high levels of heavy metals and other pollutants, in addition to thermal effects (Trainer, et al., 2000). Los Alamos National Laboratory is a known source of other contaminants, such as gross alpha particles and PCBs.

Water temperature is the fourth most common source of water quality impairment at the plan scale, affecting 83 miles (2 percent) of all streams in the Santa Fe NF. The daily fluctuation of stream temperatures is moderated mainly by primary and secondary shade structure (vegetation) and stream bedload, since direct sunlight (solar input) has the greatest influence on daily stream temperature (much more than air temperature). Changes in stream surface shading caused by Forest Service management activities (e.g., roads, livestock grazing), high summer air temperatures, and low flows are important factors contributing to warmer water. In addition, reduced stream flow from drought or water diversion also contributes to warmer water temperatures in some streams. The majority of streams that exceed State temperature standards occur in the Jemez Mountain area; where in a few instances, geothermal activity may also influence surface stream temperatures.

Water Uses

The majority of watersheds in the Santa Fe NF provide water for human use downstream. Consumptive water uses are those which temporarily remove and store water apart from the natural hydrologic system (e.g., municipal water supplies, irrigation, campground supplies, firefighting). Drinking water is a significant consumptive use of forest water; 11 community water systems serving about 98,000 people are fed by surface water streams that originate in the Santa Fe NF.

Two municipal supply watersheds (defined in the Safe Drinking Water Act, P.L. 93-523) occur in the forest: the Santa Fe River Municipal Watershed (city of Santa Fe) and the Gallinas Creek Municipal Watershed (city of Las Vegas). The Santa Fe River Municipal Watershed is within the headwaters Santa Fe River sub-watershed, and contains 16,819 acres, with 15,000 acres in the Santa Fe NF and 6,720 acres in the Pecos Wilderness area. The Santa Fe River Watershed has been closed to all uses since 1932 to protect the watershed from fire and pollution (USDA 1932a; Secretary of Agriculture letter). To minimize the risk of large-scale, high-severity fire, fuels reduction projects (thinning and prescribed burning) have been implemented in the non-wilderness portion of the Santa Fe Watershed over the past 20 years and are ongoing today.

[14] The process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

The City of Las Vegas water supply is obtained primarily from Porvenir Creek and Gallinas Creek-Porvenir Creek sub-watersheds. The sub-watersheds include 48,968 acres of NFS and non-NFS lands. The portions of these sub-watersheds located outside the Pecos Wilderness (16,605 acres) are managed for municipal supply as well as other uses. Approximately 14,000 acres of Porvenir Creek occurs in the wilderness and is not included as part of the municipal supply watershed. To protect the City's water supply from large-scale high-severity fires, 8,170 acres of fuels reduction is occurring in the Gallinas Creek Watershed.

Irrigation accounts for the largest consumptive use in the Santa Fe NF. Diversions and irrigation ditches (about 30 miles of acequia in the forest) have been operational for many years, resulting in significant flow alteration within some surface waterbodies. The Rio Chama is augmented with water from three headwater streams in Colorado (the San Juan Chama Project) and has several dams for water storage. Streamflow is diverted from Rio de las Vacas and Clear Creek into Naciemento Creek; Pacheco Canyon receives water diverted from the Rio en Medio.

The Santa Fe NF administration also uses water for facilities (e.g., campgrounds, offices) and land management activities (e.g., firefighting, road maintenance, and livestock watering). Current administrative water use in the forest is estimated to be slightly higher than in the past (1987) because new wells have been drilled at campgrounds (Jemez Falls and Vista Linda), in response to increased user demand. Implementation of upland water infrastructure for livestock has also increased in the last 15 years.

Non-consumptive uses are those in which the water remains in the hydrologic system (e.g., ecological flows for aquatic ecosystems, rafting, and swimming). By volume, the largest water uses are for ecological flows,[15] which maintain freshwater habitats and water quality, as well as providing recreation.

Of approximately 3,850 water rights within the NF administrative boundary, 40 percent provide water for domestic use only, 24 percent for irrigation, 9 percent for domestic and livestock use, 4 percent for livestock use only, and the rest are for other use classes. In terms of water quantity, more than 50 percent of the amount diverted is for irrigation, while 25 percent is for municipal use and 15 percent is used for domestic purposes (NM Office of the State Engineer database; NMOSE).

Groundwater

The Santa Fe NF is an important source of groundwater recharge. All groundwater in northern New Mexico originates as infiltrating precipitation. Surface water from each basin supplies both shallow and deep geologic aquifers. Two deep aquifer systems are connected with the Santa Fe NF, the Rio Grande aquifer, and the Colorado Plateau aquifer (figure 23).

The importance of water contributed by the Santa Fe NF is illustrated by Anderholm (1994) who describes the process of mountain front aquifer recharge for the Santa Fe River. Mountain front recharge includes infiltration through upland soils and infiltration through stream channels. Average annual surface water yield from the Santa Fe municipal watershed is 5,700 acre-feet per year and from Tesuque Creek is 2,000 acre-feet. Estimates of natural mountain-front recharge are about 2,320 acre-feet per year in the Santa Fe River drainage and 690 acre-feet in the Rio Tesuque drainage (Anderholm 1994). Aquifers of the Mora and San Miguel County region's aquifers are generally recharged through direct rainfall and mountain front recharge and localized recharge also occurs along portions of the Pecos, Gallinas, and Canadian rivers, which recharge the underlying alluvial aquifers (NMOSE 2005). Other areas, such as the

[15] On the Santa Fe NF, these flows have not been quantified, and the State of New Mexico does not recognize instream flow as a beneficial use. Water, however, can be dedicated to instream flow for the purposes of recreation, fish, and wildlife habitat.

Rio Chama watershed are too complex geologically for any one type of recharge mechanism to obviously predominate (NMOSE 2006).

Groundwater and surface water are interdependent in almost all ecosystems. Groundwater plays significant roles in sustaining the flow, chemistry and temperature of streams, lakes, springs, seeps, and wetlands. Many communities around the Santa Fe NF are heavily reliant on it, as are groundwater-dependent ecosystems.

Water Uses

For the purposes of jurisdiction over the appropriation and use of groundwater, the NMOSE has established underground water basins within the State (NMOSE 1995). Three declared groundwater basins—the Canadian, Rio Grande, and San Juan—underlie the Santa Fe NF.

The NMOSE water rights database identifies 2,551 wells within the administrative Santa Fe NF boundary with 516 (20 percent) occurring on NFS lands. The NMOSE database identifies 30 municipal drinking water associations or municipal water supplies within or near the forest boundary that use groundwater to supply about 32,000 people and 56 other drinking water sources (springs and wells) within and near the forest boundary that supply about 15,000 people. Most groundwater withdrawals occur from the shallow alluvial aquifer; the majority of uses are for domestic purposes and irrigation. In some areas, mainly at lower elevations, these withdrawals can significantly reduce instream flows.

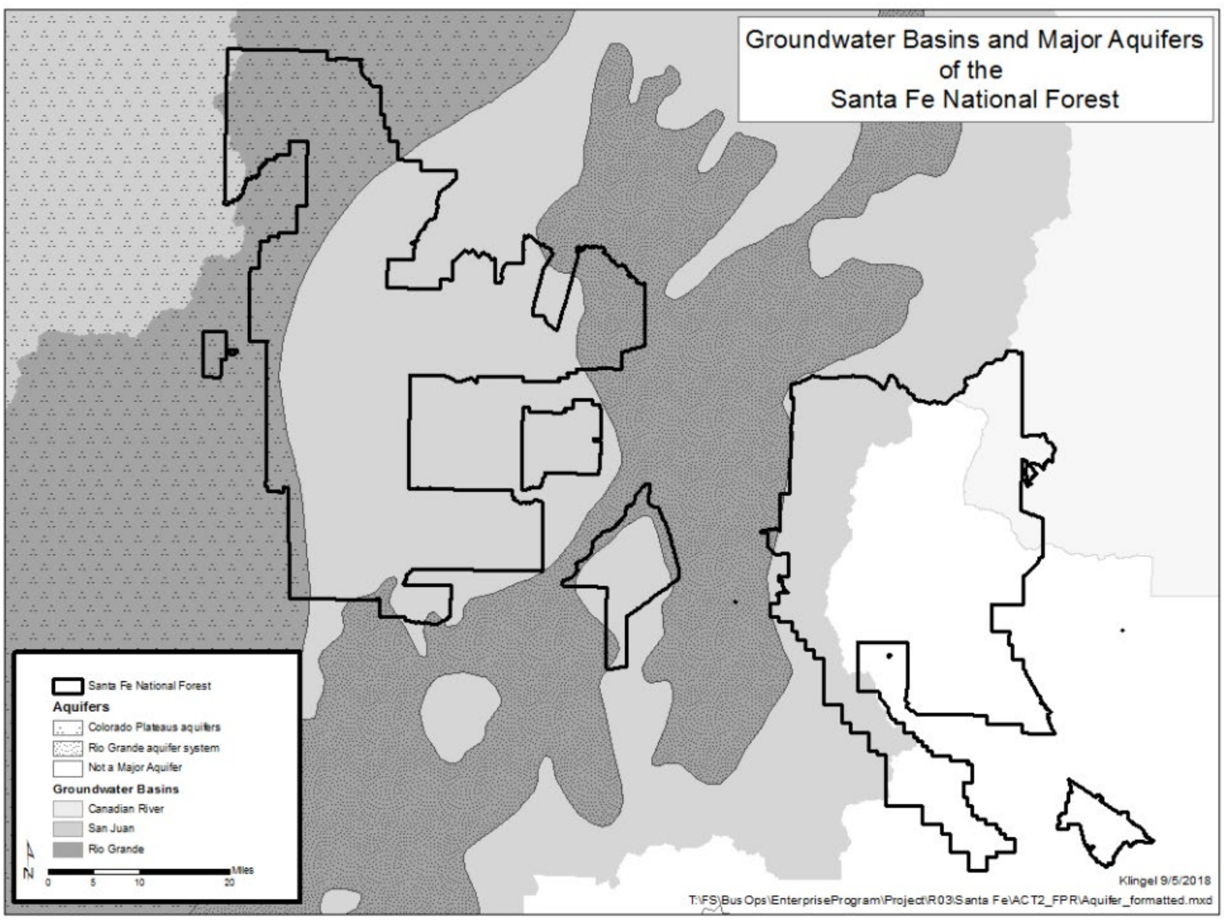

Figure 23. Major groundwater basins and aquifers of the Santa Fe NF

3.4.2 Methodology and Analysis Process

This section describes the methodology and analysis processes used to determine the environmental consequences by each alternative on watershed and water resources. Environmental consequences are not site-specific at this planning level and will be described with qualitative descriptions supported by past studies and observations.

3.4.2.1 Assumptions

Assumptions Unique to Watersheds and Water Resources

- The various watershed restoration activities described in the plan will occur at the extent necessary to achieve the objectives described by each alternative. The specific locations and designs of these activities are not known at this time. Therefore, this analysis refers to the potential of the effect to occur, realizing that in many cases, these are only estimates.
- The actual improvement rates of watershed condition are dependent on funding and support by Forest Service leadership and collaborators.

Water Resources

- Some resources (e.g., groundwater) are not within the agency's authority to control; these will be noted.
- Conditions described in this analysis are generalized Forest-wide and may not represent water quality or flow conditions at any specific location.

3.4.2.2 Chronological and Spatial Bounds of Analysis

The environmental consequences to both watersheds and water resources (surface and groundwater) will be analyzed within a 15-year timeframe (same as the planning period). The spatial bounds of these analyses are the 142 (12-digit hydrologic unit code) "sub-watershed" boundaries that overlap the Santa Fe NF administrative boundary.

3.4.2.3 Effects Indicators

Four indicators were used to examine the effects on surface water:

- Restoration Activities
- Motorized Route Density
- Recreation Activities
- Livestock Grazing Activities

Only the restoration activities indicator was used to examine effects on watershed.

Restoration is a good measure of impacts to watershed function because it can have long-term benefits as well as short-term adverse effect (e.g., soil compaction, erosion, sedimentation) (Elliot et al. 2010). Restoration activities include thinning, prescribed burning, stream channel restoration, riparian restoration, and road decommissioning. On the Santa Fe NF, these landscape scale activities are currently ongoing (e.g., the Jemez Mountains Landscape Restoration Project and the Gallinas Municipal Watershed Wildland Urban Interface Project).

Road density is a good measure of impacts to watershed function because roads disrupt hydrologic processes like infiltration as well as cause erosion and sedimentation (Gucinski et al. 2001). The Santa Fe

NF has over 6,583 miles of road within the administrative boundary. While the forest has decommissioned some roads over the past 30 years, most sub-watersheds contain road densities above levels that can disrupt watershed functions (Al-Chokhachy et al. 2016). In general, watersheds with more than 1 mile of road per square mile are considered to have moderate to high road density (Potyondy and Geier 2011). Table 39 shows road density in the Santa Fe NF, by sub-watershed count.

Table 39. Road* density of Santa Fe NF sub-watersheds

Road Density (mi/mi^2)	Number of Sub-watersheds
< 1	18
1 – 2.4	39
2.4 – 3	16
3 – 4	23
4 – 5	14
> 5	6

*ML2-ML5 roads

Recreation is a good measure of impacts to watershed function because it can have adverse effects on hydrologic processes and water quality through soil compaction and water pollution (Leung and Marion 2000), especially where activities are concentrated near water bodies. Existing developed recreation facilities in the forest include 30 campgrounds, 12 picnic areas, 11 fishing access sites, 3 boat launches, several scenic overlooks and interpretive sites, 1,090 miles of trail, and innumerous dispersed campsites.

Livestock grazing is a good measure for watershed function because it can adversely affect hydrologic processes and water quality (e.g., compaction, erosion, sedimentation, stream shade, nutrient enrichment, and waterborne pathogens), especially where animals are concentrated within riparian areas (Armour et al. 1991). Livestock grazing is currently authorized within 134 sub-watersheds (97 percent) of the Santa Fe NF; cows and bulls are the only permitted livestock.

3.4.3 Drivers and Stressors

A stressor is an environmental condition, external stimulus or event (apart from a direct management action) that strains the ability of watershed processes to function within their historic range of variability. Watershed processes include the physical actions between a precipitation event and the residence of that water within a basin (e.g., an ocean). For example, infiltration and runoff, sediment transport, wood entrainment and nutrient routing from hillslopes through a channel network are all important watershed processes (Naiman 1992). These processes are heavily influenced by the condition and type of vegetation, ground cover, soil, and riparian vegetation within the watershed. Stressors can act directly on hydrologic processes (e.g., drought), or indirectly on watershed conditions (e.g., ground cover) to affect watershed function. Major stressors to water resources include drought and high-severity wildfire. Climate change drives the effects of these stressors to a different order of magnitude.

One characteristic of climate change in northern New Mexico is drought. Streamflow data are available for some gauging stations on or near the forest with periods of record dating back as far as 1914. While human activity undoubtedly influenced streamflow prior to that time, the 100-year record provides a good baseline for comparison to current conditions. The most conspicuous recent indicator of drought in northern New Mexico began in the spring of 1996 (SCCSC 2013), following several years of above-average temperatures and was exacerbated by subsequent below-average precipitation. Stream gauge data from across the northern mountains of New Mexico reflect this same drop in available water.

An analysis of streamflow data from several U.S. Geological Survey gauge stations in the southern Sangre de Cristo Mountains showed an average flow reduction of 20 percent from 1996 (drought initiation) through 2013, and the average snowmelt runoff duration was reduced by 12 days. Overall, less water has been available in recent years, both in terms of the annual total and the springtime snowmelt pulse.

In the broader Four Corners region, records show snowpack has been declining since the 1950s (EPA 2016). Diminished snowpack in this area has serious implications for the water supply to communities around the Santa Fe NF that largely rely on water from the headwaters of the Rio Grande in Colorado, as well as the headwaters of the San Juan River (via an inter-basin transfer to the Chama River). Losing a portion of these major water sources will make communities more reliant on the dwindling supply from local headwater streams and groundwater recharge originating in the Santa Fe NF.

Water yield from the Santa Fe NF is a function of both climate (precipitation) and watershed condition. Watershed condition is affected by drought through increased vulnerability of forests to insects and disease, increased fire risk (on average, more than 2 percent of the land in New Mexico has burned per decade since 1984), desiccated soils, reduced ground cover, and reduced riparian function. In general, these effects reduce the holding capacity of watersheds causing them to release water faster (Moody and Martin 2001), in turn reducing the perennial supply of water in rivers downstream. Regionally, most of the major river systems in the southwestern United States are expected to experience reductions in streamflow and other limitations to water availability (Garfin et al. 2013).

While the supply of water in and around the Santa Fe NF is likely to diminish, the demand is likely to increase. As climate change continues to bring warmer temperatures, water loss to the atmosphere (through evapotranspiration and soil desiccation) will rise. Forests and farmlands will thus need more water to survive.

Exacerbating this problem, less precipitation is falling as snow, diminishing the mountain snowpack. In northern New Mexico, the snowpack is a very important natural reservoir that historically released its water during late spring and early summer. Today, spring melting is occurring earlier in the year; the Colorado River, Rio Grande, and several other southwestern rivers have hydrographs that peak earlier, suggesting that the spring temperatures in these regions are warmer than in the past (EPA 2016). Several researchers have specifically studied Santa Fe NF watersheds. Fritze et al. (2011) showed that snowmelt is occurring 5 to 20 days earlier in the southern Sangre de Cristo Mountains with higher streamflow in March and April, but less from May-June (based on 60 years data from 1948-2008); the Santa Fe and Gallinas municipal watersheds are dependent on these upland snow sources. Salgado and Gutzler (2013) evaluated climate change impacts in the upper Pecos River Basin and concluded that the timing of snowmelt exhibits a trend of earlier runoff which coincides with warmer temperatures in the spring and early summer (March through June). They also found that within the most recent 30-year period, these temperature changes account for a larger percentage of the variability in streamflow than precipitation (drought) alone.

While dams and reservoirs can help to maintain later peak flows in downstream rivers, there are many water users dependent on unregulated systems upstream. For these users, climate change means less water will be available when it is most needed for domestic use, irrigation, recreation, etc. Climate change also means less water is available to terrestrial and aquatic ecosystems, implying, among other things, increased (both in size and intensity) wildfire activity.

In the Santa Fe NF, between 2010 and 2014, several large wildfires burned more than 71,000 acres with moderate to high soil burn severity. Summer monsoon rains subsequently resulted in extensive upland erosion and gullying within Cochiti Canyon (and elsewhere), as well as flooding in downstream rivers several orders of magnitude larger than "normal" monsoon peaks. These effects occurred because insufficient upland groundcover, hydrophobic and highly erosive soils allowed for easy detachment and transport of soil to stream channels. This overabundance of sediment will likely remain in stream channels, impacting water quality and aquatic habitat for decades. Research shows severe flooding and erosion may ensue even after only moderate rain events (DeBano et al. 1998; Neary et al. 2005). Low and moderate severity burns typically have much smaller effects on runoff and erosion.

3.4.4 Environmental Consequences

3.4.4.1 Water Resources

Groundwater

The majority of groundwater withdrawals in southeastern northern New Mexico occur on lands outside the Santa Fe NF, and therefore, the Forest Service has no influence on their control. Forest Service groundwater policy (Forest Service Manuals 2560, 2880) as well as agency technical guides, provide direction for well drilling and pumping in the Santa Fe NF, specifying that these activities must not adversely affect connected riparian habitat and water quantity and quality. Because direction in the Forest Service manual is considered adequate and groundwater withdrawal is governed by State regulations, additional management direction was not specified by any of the action alternatives and they are not analyzed in this environmental impact statement

Surface Water

This analysis provides a qualitative assessment, by indicator, of forecasted trends in surface water quality, water quantity, and the hydrograph. Alternatives are compared based on their potential to impact surface water resources.

Indicator: Restoration Activities

Restoration activities within this indicator include stream channel and riparian restoration, invasive species removal, prescribed burning and wildfire, mechanical treatments, seeding, planting, and road decommissioning, all of which are intended to have beneficial effects to Forest resources.

Effects Common to all Alternatives

Stream channel and riparian restoration should have the long-term beneficial effects of rehabilitated geomorphic and biological processes, which would help to restore stream and riparian ecosystem services. Properly functioning streams and riparian areas provide clean water, regulated water temperature, water storage, sediment storage, nutrient cycling and good habitat (Gregory et al. 1991) ***Wa1*****.**

Mechanical forest thinning and prescribed burning should reduce the likelihood uncharacteristic wildfire will occur (Agee and Skinner 2005), benefitting surface water resources through maintaining ground cover. ***Adequate groundcover reduces erosion potential by slowing the flow of water over the landscape and adding root strength to the soil. Indirectly these activities maintain water storage capacity while also reducing erosion and sedimentation*** (Johansen et al. 2001) **Wa3.**[16]

Planting, seeding and grading are rehabilitation activities commonly associated with larger restoration projects. For example, these strategies may be used to repair and prevent resource damage at dispersed

[16] Wa2 was deleted and remaining effects retained their original numbering.

campsites or after wildfire, providing the long-term beneficial effects (see ***Wa3***) associated with increasing groundcover.

Road decommissioning is a common restoration practice which involves reshaping roads to minimize impacts to stream channels (e.g., stream diversion and augmentation) while also reducing sediment delivery to the hydrologic network. Road decommissioning should provide long-term ***benefit to surface water resources through restored hillslope drainage patterns, increased infiltration, water storage and retention, restored hydrographs, decreased channel aggradation, and improved water quality. Ultimately, these should result in an urban water supply that is less expensive to clean to standard, increased baseflows during the dry periods of the year, and improved fisheries*** [Wa4]**.**

Cumulatively, these restoration activities have the potential to increase watershed resiliency to climate change, which in the southwest, is predicted to result in a hotter and drier environment, with more variability in year-to-year precipitation and earlier snow-melt (Allen et al., 2005; Cayan et al., 2013); summer monsoonal precipitation is projected to decline, although model results are varying (Pascale et al., 2017). ***By increasing riparian and wetland vegetation (Wa1), increasing groundcover (Wa3), and decreasing disturbance to natural drainage patterns (Wa4), restoration enables watersheds to slow the flow and infiltrate runoff into the soil, improving water storage (e.g., within wetlands) during wetter periods. Restored stream channels, resistant to erosion by healthy riparian vegetation, are then better able to deliver a sustained supply of clean water to downstream users during drought periods*** [Wa4.5]**.**

While restoration activities are intended to, and are typically successful at improving long-term resource conditions, they usually pose some risk of causing unintended, short-term adverse impacts to stream channels and water quality. With the implementation of effective mitigation measures, the long-term benefits to water resources usually out-weigh the short-term risks. The following paragraphs discuss the potential short-term, adverse impacts of restoration activities.

Heavy equipment is often used to accomplish restoration, thereby disturbing the ground within or adjacent to flowing water. ***Ground disturbance dislodges soil making it easier to erode and entrain thereby introducing sediment and turbidity to the waterbody. Sediment and turbidity adversely affect water quality, aquatic habitat, and flood capacity by making water more difficult to clean, decreasing the oxygen supply to fish and amphibians, decreasing habitat diversity and availability, as well as decreasing channel volume*** (Henley et al. 2000; Postel and Thompson 2005)[Wa5]. Restoration activities may temporarily alter stream channel geometry and stream shade. ***Changes in channel geometry and shade can degrade habitat quality by making a channel shallower or deeper, warmer or cooler, and slower or faster) than biota prefer*** [Wa6]**.**

Invasive species (noxious weed) removal and treatment includes pulling weeds and applying pesticides, both of which can have short-term, adverse effects to water quality when sediment (see ***Wa5***) or chemicals are delivered to a water body. Good water quality is important for meeting all the designated uses of water including drinking water and aquatic habitat. A variety of pesticides are used to treat noxious weeds; ***the specific effects of these chemicals to aquatic and human life are therefore varied, but can be summarily described as harmful to life (e.g., poison, cause mutations, etc.)*** [Wa7]**.**

Restoration by wildfire and prescribed fire can cause short-term, adverse effects to surface water resources when soil is super-heated. High heat not only removes groundcover, but can cause soil hydrophobicity by which water is repelled from soil pores (DeBano et al. 1976). In large areas of hydrophobicity, excessive runoff is generated because infiltration is significantly reduced (DeBano

1971). Excessive runoff can result in flashier hydrographs (Moody and Martin 2001) as well as erosion and sedimentation (Certini, 2005), both of which adversely affect water quality and aquatic habitat[Wa8]. The use of fire for restoration mitigates these impacts by carefully monitoring fuel and climate conditions in order to avoid high-severity fire. Prescribed fire and managed wildfire can have long-term beneficial effects on water resources because they prevent fuel accumulation, thereby minimizing the extent of high-severity burn and associated adverse impacts on water resources[Wa8.25].

Mechanical treatments (a vegetation restoration practice) utilizes heavy equipment such as forwarders, skid-steers, and feller-bunchers. ***The machinery requires fuel and hydraulic fluid which when spilled can pollute water, adversely affecting biotic communities[Wa8.5]. The equipment can also disturb and rut the soil as they move across the project area, especially where they change direction. Rutted soil is likely to channelize water, making it more susceptible to erosion and entrainment*** (Elliot et al. 2010)[Wa9]**.** Where soil is delivered to a stream channel, it contributes to turbidity and sedimentation, ultimately affecting water quality, aquatic habitat, and flood capacity (see ***Wa5***).

The use of heavy equipment can also compact the soil (Han et al. 2006; Greacen and Sands 1980, Elliot et al. 2010). ***Compacted dirt results in decreased infiltration and increased overland flow. Ultimately, this may result in flashier hydrographs within stream channels. Where soils are severely compacted, root growth may be hindered, preventing ground cover from reestablishing; this can lead to prolonged erosion [Wa10].***

Soil compaction from mechanical treatments results in reduced infiltration and excessive runoff (Greacen and Sands, 1980). ***Road drainage features (e.g., ditches and cross drains) constructed to gather the resulting runoff typically route the flow along the contour to the nearest stream channel. This can affect a stream's hydrograph by de-watering the soil and channels downslope from a road, while augmenting flow in the discharge channel*** (Gucinski et al. 2001)***. Effects to de-watered channels may include aggradation, desiccated riparian vegetation, and depleted aquatic habitat, among others. Effects to augmented channels can include incision, channel widening, turbidity, depleted aquatic habitat, and elevated stream temperatures, among others [Wa11].***

As part of mechanical treatment operations, the construction of temporary roads is often required in order to mobilize the equipment to the project area and haul materials away. Temporary roads are similar to permanent roads in that they require soil disturbance, compaction and drainage manipulation. Roads can be significant sediment sources to water bodies (Gucinski et al. 2001) because soil disturbed during construction (e.g., cut and fill) and use is more susceptible to being entrained by water flowing across the ground surface. Where surface water enters a stream channel (e.g., at a cross-drain), the eroded soil is introduced to the hydrologic network. Sediment contributions from roads can be extreme where culverts are plugged and stream flow is either diverted down the road, or the road fill at the stream crossing is eroded and delivered to the channel below. Excessive sediment adversely affects aquatic habitat and causes channel aggradation, which ultimately decreases flood capacity[Wa12].

Where roads cross stream channels they can interrupt geomorphic (and biologic) connectivity (Gucinski et al. 2001). ***Where culverts are under-sized, they can physically and hydraulically prevent the passage of sediment and wood downstream. Ultimately, a stream channel starved of sediment and wood may incise or widen, which can adversely affect water quality (e.g., turbidity, temperature) and aquatic habitat[Wa13].***

Where roads parallel stream channels or frequently cross them, the reduction in tree canopy over the stream channel can affect stream shade (Gucinski et al. 2001), leading to increased stream temperature. ***Elevated water temperature adversely affects cold water aquatic habitat and other aspects of water quality (e.g., dissolved oxygen, algal growth).***[Wa14]

Planting, seeding and grading are rehabilitation activities commonly associated with restoration. These strategies may be used to repair and prevent resource damage at dispersed campsites, or after wildfire. These activities can require ground disturbance, which may cause adverse impacts to water quality, aquatic habitat, and flood capacity (see ***Wa5***).

Without effective mitigations, the adverse effects described above (***Wa1*** through ***Wa14***) are likely, even though these restoration activities are intended to improve resource conditions. A standard (in alternative 1) and guideline (within alternatives 2, 3, and 4) requires effectively applying best management practices to help ensure impacts (***Wa1*** through ***Wa14***) are avoided.

Effects Common to Alternatives 1, 2, and 3

Alternatives 1, 2, and 3 all have objectives for road decommissioning. Road decommissioning is a common restoration practice meant to eliminate the long-term adverse effects of roads described above (see ***Wa4***), but which can have its own unintended, short-term, adverse effects on water quality and aquatic habitat (see ***Wa5, Wa6, Wa8.25, Wa8.5***).

Alternative 1 – 1987 Forest Plan

Alternative 1 includes no objectives for forest vegetation restoration; instead mechanical timber harvest and wildfire suppression are emphasized. Alternative 1 includes management objectives for rangeland, stream channel, aquatic habitat, and riparian area conditions, but does not contain components which direct restoration of these areas. Therefore, both short-term adverse (***Wa5*** through ***W14***) and long-term beneficial effects (see ***Wa1*** through ***Wa4***) of the various restoration activities are least likely by this alternative when compared with other alternatives; this alternative is not likely to result in watersheds resilient to climate change and drought (***Wa4.5***); similar to alternative 4.

Plan objectives for restoration activities in alternative 1 are focused on road decommissioning. The 1987 Plan specifies 660 miles of road should be decommissioned within 10 years (meanwhile, during the same timeframe, 95 miles of road should be constructed, for a net decrease of 565 miles). Components also direct the rehabilitation of temporary roads. This is the most road decommissioning (and road construction) of any alternative, and would therefore, also have the most potential for short-term adverse impacts to surface water resources (through ground disturbance, erosion, and sedimentation; see ***Wa5, Wa6, Wa8.5***). The most beneficial long-term impacts of road decommissioning (see ***Wa4***) might be expected if road decommissioning at the scale specified was actually implemented. However, the objectives for road decommissioning in alternative 1 have proven themselves infeasible to date, and the long-term beneficial effects have been minimal, if any.

Alternative 2 – Forest Plan

In alternative 2, the addition of new plan objectives would restore ecological conditions and increase (over alternative 1) both short-term adverse and long-term beneficial effects to water resources. These objectives include the following actions and related effects; improving two watersheds, 15 miles of riparian and stream channel restoration, 30 miles of aquatic habitat restoration (see ***Wa1, Wa8.5, Wa5, Wa6, Wa10, Wa12***), and 6,000 acres of invasive species removal (see ***Wa5, Wa7***). Similarly, vegetation objectives in alternative 2 specify directly treating, over a 10-year period, up to 280,000 acres of mixed dry conifer and 350,000 acres of ponderosa pine, as well as 115,000 acres of non-forested vegetation using mechanical treatments and fire (prescribed and natural lighting ignitions), which would result in more short-term adverse (see ***Wa5, Wa6, Wa8, Wa8.5,*** and ***Wa9*** through ***Wa14***) as well as long-term beneficial effects (see ***Wa1*** through ***Wa4, Wa8.25***) associated with these activities, when compared with alternative 1. Alternative 2 also adds a guideline that ensures burn pile fuel sizes are appropriately mixed (i.e., not all pieces are large-diameter fuels), reducing the likelihood that hydrophobic conditions and associated adverse effects (see ***Wa8***) would occur (more than by alternative 1). Given differences in acres treated, compared with alternative 3, alternative 2 represents fewer long-term beneficial and short-term adverse effects (referenced above); and when compared with alternative 4, alternative 2 represents more of the long-term beneficial effects and fewer short-term adverse effects.

Alternative 2 contains objectives for rehabilitating two dispersed recreation sites every three years. Alternative 2 guidelines emphasize rehabilitating sites and closing them where impacts cannot be mitigated. Closure, mitigation, and rehabilitation actions (i.e., grading, planting, and seeding) would be expected to have both long-term beneficial (***Wa3***) and short-term adverse effects (***Wa5***) on water resources. The number of sites treated and the de-emphasis on closing sites makes these activities only moderately likely to have a long-term beneficial impact on surface water resources when compared with alternative 3, but more likely than alternative 4.

Plan objectives for restoration activities by alternative 2 include 100 miles of road decommissioning (or mitigation) within 10 years. This is the second lowest amount of road decommissioning possible among the alternatives, and would therefore, have moderate short-term adverse impacts to surface water resources (through ground disturbance, erosion, and sedimentation (see ***Wa5, Wa8.5***); as well as moderate long-term beneficial impacts (see ***Wa4***). Alternative 2 contains a guideline that requires temporary roads to be closed, decommissioned, or obliterated upon project completion to protect surface water resources. The addition of these actions would further disturb the soil, making it more susceptible in the short-term to erosion, entrainment, and delivery to a water body (see ***Wa5***).

Restoration using these objectives would ensure that over the long-term, hydrologic processes exhibit improved function and are better protected from disturbance by uncharacteristic wildfire. Properly functioning watersheds would ultimately provide a cleaner, more sustainable water supply (i.e., watershed resiliency to climate change; ***Wa4.5***).

Alternative 3 – Natural Processes Emphasis

Alternative 3 is similar in restoration plan objectives to alternative 2, but the magnitude of the objectives, and resulting short-term adverse and long-term beneficial effects, are increased in scale. These objectives include the following actions and associated effects: improve five watersheds, 30 miles of riparian and stream channel restoration, and 60 miles of aquatic habitat restoration (see ***Wa1***). The objective for invasive species removal, 3,000 acres over 10 years, is decreased in comparison to alternative 2, because road decommissioning objectives would result in a smaller road system that would reduce access and spread of invasive species. Resulting short-term adverse effects (see ***Wa5, Wa7***) would be the second lowest of all alternatives; long-term beneficial effects from these activities would outweigh the adverse impacts.

Alternative 3 contains objectives for rehabilitating two dispersed recreation sites every three years. Alternative 3 guidelines however emphasize rehabilitating and closing the sites, rather than simply mitigating impacts. Closure, mitigation and rehabilitation actions (i.e., grading, planting, seeding) would be expected to have both long-term beneficial (***Wa3***) and short-term adverse effects (***Wa5***) on water resources. The number of sites treated and the emphasis on rehabilitating and closing the sites, however, makes these activities likely to have the largest long-term beneficial effect on surface water resources when compared with other alternatives.

Alternative 3 includes vegetation objectives that would treat the most acres of mixed dry conifer (up to 820,000 acres) and ponderosa pine (922,000 acres), as well as non-forested vegetation (165,000 acres), but emphasizes the use of fire rather than mechanical treatment as compared with the other alternatives. Realizing the long-term beneficial effects (see ***Wa1*** and ***Wa3***) to surface water resources at this scale, without the use of pre-fire mechanical treatment, would be challenging and uncertain. Improved watershed conditions would depend on the ability of fire managers to achieve low severity burns, which depend on climate (see the Drivers and Stressors section for more information), low fuel loads, and other factors. As a result, the greatest potential for short-term adverse effects by high-severity fire (e.g., hydrophobicity, erosion, sedimentation; see ***Wa8***) would occur in this alternative. Like alternative 2, a guideline ensures fuel size within prescribed burn piles are appropriately mixed to reduce the likelihood of hydrophobic conditions on soil and its effects (***Wa8***). However, because of the reduced road access, most areas of the forest would not be thinned and pile burned (reducing the likelihood of high-severity fire), meaning this guideline would not be enough to realize the long-term benefits to surface water resources (see ***Wa3***).

Plan objectives for restoration activities include 250 miles of road decommissioning within 10 years. This is the second highest amount of road decommissioning among the alternatives, and would therefore, have the most potential for short-term adverse impacts to surface water resources (through ground disturbance, erosion, and sedimentation; see ***Wa5***) as well as long-term beneficial impacts (see ***Wa4***). Like alternative 2, alternative 3 also contains a guideline that would require temporary roads to be closed, decommissioned, or obliterated upon project completion to protect surface water resources. An additional guideline directs that construction of permanent or temporary roads should be avoided unless needed for a permitted activity or to meet desired conditions. This alternative limits temporary roads the most and would result in the least disturbance to the soil and least potential for delivery to a water body (see ***Wa12, Wa13, Wa14***).

Watersheds would move away from properly functioning condition largely as a result of increased sedimentation from wide-spread, high-intensity wildfire. Restoration by these objectives would do more harm than good to hydrologic processes and therefore also adversely affect watershed resiliency to climate change (see ***Wa4.5***).

Alternative 4 – Human Uses Emphasis

Alternative 4 lacks most of the restoration objectives contained within alternatives 2 and 3. While some ground disturbance and associated short-term impacts would be avoided (see ***Wa5***), ultimately this lack of treatment has negative implications for surface water resources because the long-term beneficial effects (see ***Wa1*** through ***Wa4***) would not be achieved. Further, without directly treating stream and riparian areas, the ecosystem services (see ***Wa1***) provided by these resources would not be realized.

Alternative 4 contains objectives for rehabilitating four dispersed recreation sites every three years. Alternative 4's specific guidelines, however, emphasize rehabilitating the sites while maintaining them as open for use. Rehabilitation actions themselves (i.e., grading, planting, seeding) would be expected to have both long-term beneficial (***Wa3***) and short-term adverse effects (***Wa5***) on water resources. The emphasis on keeping the sites open for use, however, makes it likely rehabilitation activities would not be effective (vegetation is not likely to reestablish when continuously disturbed). These plan components are, therefore, likely to have the largest long-term adverse effect on surface water resources when compared with other alternatives.

Alternative 4 includes vegetation objectives to treat the fewest acres of mixed dry conifer (up to 325,000 acres), ponderosa pine (up to 253,000 acres), and non-forested vegetation (up to 120,000 acres), but emphasizes the use of mechanical treatments over fire as compared with the other alternatives. Using mechanical treatments as the only tool would effectively limit the treatable area because of logistical access (i.e., logging equipment cannot access steep slopes). Some minimal use of wildfire to achieve these objectives would be allowed; all other fires would be suppressed to protect merchantable resources. As a result, the greatest possibility of long and short-term adverse effects associated with mechanical treatments (see ***Wa5, Wa6, Wa9*** through ***Wa13***) would occur by this alternative. Unlike alternatives 2 and 3, this alternative contains a guideline that does not allow the use of using prescribed fire to handle the byproducts of mechanical treatments, and instead, requires that other methods such as chip and grind or lop and scatter be used. This would mean naturally ignited wildfires would be likely to result in high soil burn severity, causing the most long-term and wide-spread adverse impacts to surface water resources (see ***Wa8***) when compared with other alternatives.

Alternative 4 includes no restoration objectives or components for road decommissioning. Long-term adverse effects associated with roads (see ***Wa12, Wa13, Wa14***) would be expected given two guidelines in the roads section (i.e., temporary and closed roads could be *added* to the system and the motorized trail network would be expanded through the designation of a motorized recreation area), which would expand the forest road system rather than decommissioning unnecessary roads. The motorized recreation area, however, would also limit new road construction and decommission roads unnecessary to recreation.

Restoration by these objectives would do the most harm to surface water resources when compared with other alternatives. Watersheds would be expected to move away from properly functioning condition as a result of increased sedimentation from logging, high-intensity wildfires, and an expanded motorized road system. Watershed resiliency to climate change would decline, jeopardizing a sustainable supply of clean water during drought periods (see ***Wa4.5***).

Indicator: Motorized Route Density

Motorized route density within a watershed is a good proxy measure of risk to surface water resources because the adverse effects by roads (described under the restoration indicator section) are amplified as density increases. Activities within this indicator include motorized route construction, including temporary roads, (increases route density) and decommissioning (reduces route density).

Effects Common to Every Alternative

The presence of motorized routes within watersheds can have many long-term adverse impacts to hydrologic processes (Gucinski et al. 2001) including altering hydrographs, causing channels to widen, incise, and aggrade, degrading water quality through sedimentation and turbidity, disrupting geomorphic and biologic connectivity, and increasing stream temperatures; see ***Wa11, Wa12, Wa13, Wa14***. While various plan components (in transportation, riparian and other sections) seek to diminish the adverse effects by roads, as motorized route density increases within a watershed, water resources are more likely to be adversely impacted. In general, watersheds with more than 1 mile of road per square mile can be considered to have moderate to high road density (Potyondy and Geier 2011)***. High road density in the headwaters can alter the timing and magnitude of peak flows at lower elevations, meaning more water reaches downstream channels faster. In this way, road density can have significant consequences to agriculture and urban development through flooding*** [Wa15]***.***

The 1987 Forest plan (alternative 1) was amended in 2008 and 2012 to incorporate oil and gas specific leasing stipulations. Alternatives 2, 3, and 4 apply these same stipulations to an Oil and Gas Leasing Management Area. While oil and gas leasing generally proliferates road construction, increasing motorized route density, some of the guidelines would ensure new roads are not constructed broadly throughout the area: new roads will not be constructed within inventoried roadless areas, steep and erosive slopes will not be leased (i.e., no road construction to these areas), nor will areas be leased within a 1-mile radius of a drinking water source (i.e., no road construction to these areas). In general, however, the land use associated with oil and gas leasing is likely to increase road density and the potential for adverse impacts (see ***Wa11, Wa12, Wa13, Wa14***) to surface water resources.

Every alternative contains 314,172 acres of designated Wilderness. Within designated Wilderness, motorized and mechanized (e.g., bicycle) travel are prohibited, and motorized and mechanized roads and trails are not present; only walking trails are permitted. Therefore, these designated management areas have only positive effects on surface water resources in that they lack the adverse effects caused by roads (***Wa11, Wa12, Wa13, Wa14***) and road density (***Wa15***)

Every alternative contains 56.1 miles of designated Wild and Scenic Rivers (WSRs). Within designated WSRs, new road construction and motorized trail construction is restricted by stipulations that require the protection of the water quality and free-flowing condition at the time of designation. Since ***roads are likely to adversely affect both hydraulics (e.g., bridges, culverts and rip-rap can impinge upon free flowing condition of streams),*** [Wa16] and water quality (see ***Wa11, Wa12, Wa13, Wa14***), the likelihood for adverse effects to aquatic habitat in the future, by new roads, is minimized by the WSR designations.

Alternative 1 – 1987 Forest Plan

A 1987 Forest Plan guideline emphasizes the reconstruction and rehabilitation of existing roads over building new roads, as well as closing or obliterating unnecessary roads. However, an objective proposes to construct 95 miles of road and reconstruct (for drainage improvement) 715 miles of road, every 10 years. Public access was diminished by the 2005 Travel Management decision, by which motorized travel was limited to routes on the motorized vehicle use map. Plan objectives also specify decommissioning 660 miles of road within 10 years for the first two decades, prioritizing roads causing damage to riparian areas, sensitive soils, other resources, or within management areas emphasizing low road densities. However, to date, decommissioning has only been minimally implemented across the forest, and nowhere near the objective scale, demonstrating that it is infeasible to accomplish with current levels of funding and staffing. The beneficial effects (see ***Wa4***) to surface water resources by road decommissioning, therefore, are not attributable to alternative 1.

The 1987 Plan also recommended 1,853 acres of wilderness. These areas are all within existing inventoried roadless areas, and therefore, have similar management to designated wilderness in that new road construction and motorized as well as mechanized use is prohibited. The plan also proposed the Cañada Bonita Research Natural Area (323 acres), which similarly has restricted road construction. Overall, these recommendations have had a positive effect on surface water resources, because they have eliminated the potential in these areas for the adverse impacts by roads (see ***Wa11, Wa12, Wa13, Wa14***) and road densities (see ***Wa15***) to occur, although the acres affected are minimal.

Overall, actually implementing these alternative 1 objectives would reduce road density within watersheds the most of any alternative, while improving road drainage. This would benefit watersheds by reducing adverse impacts (see ***Wa11, Wa12, Wa13, Wa14***) the most of all alternatives. Alternative 1 objectives, however, have proven themselves unattainable, and are therefore, found to be ineffective at protecting and improving surface water resources.

Alternative 2 – Forest Plan

Although road decommissioning objectives in alternative 1 proved unfeasible, alternative 2 objectives for reduced road density are based on recent road decommissioning accomplishments and are a fraction of what was specified by alternative 1. Therefore, it is likely that implementing alternative 2 objectives (100 miles decommissioned, or mitigated, in 10 years) could be implemented and would result in decreased road density. Alternative 2 also includes the Caja del Rio Management Area, which further limits road density through a guideline that restricts the construction of most permanent or temporary roads. Together, these plan components would result in protected and improved surface water resources because they would help to restore hydrologic processes, decreasing the adverse impacts of road density (see ***Wa15***). Alternative 2 represents the second greatest capacity for limiting and reducing road density when compared with other alternatives.

Effects by Alternative 3

Across the forest, objectives in alternative 3 would decrease road density by 250 miles in 10 years. Although alternative 1 objectives direct decommissioning more miles, that objective has proven unachievable. Therefore, this alternative, when compared with others, represents the largest mileage of realistic road decommissioning to result in the smallest road density, decreasing the adverse effects of roads (see ***Wa11, Wa12, Wa13, Wa14***), and providing the most beneficial effects (***Wa4***) to surface water resources.

Road density would be further limited by this alternative through an additional guideline (within the transportation section) limiting the construction of permanent or temporary roads to those required for a permitted activity or to help meet desired ecological conditions. Guidelines also specify that roads would be constructed and maintained at the lowest maintenance level required for their intended purpose. In addition, alternative 3 includes the Caja del Rio, Wetland Jewels, and Calaveras Management Areas, which have a standard or guideline that disallows new road construction within their boundaries. The Wetland Jewels Management Area has an additional objective for restoration, requiring road decommissioning, among other projects. The combination of these plan components would minimize the adverse effects of roads (see ***Wa11, Wa12, Wa13, Wa14***) and road density (***Wa15***), while maximizing the beneficial effects (see ***Wa4***) of restoring hydrologic processes, the most compared with other alternatives.

Alternative 4 – Human Uses Emphasis

Objectives in alternative 4 direct forest managers to maintain 100 miles of road within 10 years; they do not, however, specify any road decommissioning. In fact, the road system may be expanded by alternative 4 through two guidelines, which allow for adding routes to the motor vehicle use map (MVUM) and converting temporary roads to permanent roads. This alternative also includes the addition of two motorized recreation management areas on the Española and Jemez Ranger Districts. A guideline for this area promotes the conversion of unmaintained roads in poor condition to motorized trails and only decommissioning unmaintained roads that are causing resource damage. Therefore, the road and trail density has only a small likelihood of being further reduced within these management areas. Rather, because of the management area emphasis on keeping and maintaining motorized routes, it is likely motorized route density would increase in these areas. Therefore, this alternative represents the largest road network and road density that when compared with other alternatives would result in the greatest adverse effects (see ***Wa11, Wa12, Wa13, Wa14***) to hydrologic processes and surface water resources.

Indicator: Recreation Activities

Activities within this indicator include motorized and non-motorized trail construction and maintenance, developed recreation site construction and maintenance, as well as dispersed camp site management and use.

Effects Common to All Alternatives

Recreation is especially harmful where there is repetitive, heavy use, and within close proximity to a water body. The construction of campgrounds, picnic areas, and trails disturbs the soil, making it more likely to erode and become deposited within a waterbody (see ***Wa5, Wa20, Wa21***). Sediment and turbidity adversely affect aquatic habitat and can cause geomorphic processes to become imbalanced. Construction also typically involves using heavy machinery which can adversely affect water quality (see ***Wa8.5***).

Dispersed recreation areas are detrimental to surface water (when compared with developed sites) because they are often situated too close to streams and lakes. By their nature, they offer no services (e.g., toilets, fencing) to help and guide people toward best management practices. Dispersed sites are typically difficult to manage because they can be numerous and in remote locations. Especially where accessible by vehicle, but also possible at wilderness sites, soil compaction and bare soil from over-use can result in erosion and sedimentation (Leung and Marion 2000; ***Wa10***). ***Streambanks are often destabilized through foot-shear and trailing, adversely affecting aquatic and riparian habitat where banks become less resilient to flood flows, eliminating under-cuts and adding sediment to streams*** **[Wa17]**. [17] ***Water quality is adversely affected when human waste, fuel (for stoves, ATVs, etc.), and other contaminants are introduced to waterbodies*** **[Wa18]**.

While developed sites permanently alter the environment, they are generally designed with best management practices in mind, meaning properly sited developed recreation should impact surface water resources less than dispersed sites because they concentrate and manage the use. Developed recreation sites guide people to have a contained minimal impact on the local environment, and are monitored for condition and use. That being said, ***impermeable surfaces, faulty sanitation services, and water supply diversions can be detrimental to water quality and quantity if not well sited and managed because they can contribute pollutants as well as alter flow volumes*** **[Wa19]**.

Trails can adversely impact surface water resources where ***they concentrate water over long distances giving it erosive power. The effect is amplified on motorized trails because they are typically wider, more compacted, more disturbed, and often rutted, which further concentrates water. If the eroded soil is delivered to a stream channel, sedimentation can adversely affect water quality and aquatic habitat (***see **Wa5*;*** Olive and Marion 2009***)*** **[Wa20]**. ***Where trails intercept overland flow, they can dewater soil and stream channels downslope while augmenting flow to other hillslopes and streams. Adding water to drier areas can result in erosion, channel incision, and channel widening, which have implications*** **(**see ***Wa5*** and ***Wa6*****)** ***for water quality and geomorphic processes*** **[Wa21]**.

Designated wilderness is common to every alternative (314,172 acres). Management of wilderness prohibits motorized and mechanized ground disturbance as well as establishes wilderness guidance for recreation activities (e.g., camping a minimum distance from surface water). Wilderness management protects water resources through minimizing ground disturbance and associated effects to water resources (see ***Wa5***).

Similarly, common to every alternative, 15,040 acres of Wild and Scenic River (WSR) corridor (8 segments) are designated and 12 additional segments are officially "eligible." Standards for both of these areas direct managers to protect and enhance the river values for which they were designated, as well as their water quality and free-flowing nature. Standards also limit facility, road, and trail construction, especially in "wild" segments. Ultimately, WSR management should benefit surface water

[17] Wa16 intentionally left blank.

resources because ground disturbance and recreation activities are scrutinized, minimizing the potential for adverse effects (see ***Wa5, Wa10, Wa17, Wa18, Wa19, Wa20, Wa21***).

Alternative 1 – 1987 Forest Plan

The maintenance of specific developed recreation sites is listed as a plan objective in alternative 1, but it does not provide direction regarding mitigating resource damage at these sites. Nor does it provide direction regarding dispersed recreation, such as whether to close, rehabilitate or mitigate dispersed sites causing resource damage. Many of the most popular dispersed sites are located along MVUM designated routes that parallel major rivers and streams. Without plan guidance to specifically focus on these problems, surface waters continue to be adversely affected (see ***Wa5, Wa10, Wa17, Wa18***). Theoretically, road decommissioning objectives by alternative 1 would discourage the use of remote dispersed sites (roads not on the MVUM are closed to public motor vehicles, and are largely inaccessible to dispersed recreation), but to date, these objectives have not been implemented and have had no effect on dispersed use. Therefore, because alternative 1 lacks direction regarding treating dispersed recreation sites and effectively proliferates more dispersed sites, it would cause the most adverse impacts to surface water resources, when compared with other alternatives.

Alternative 1 does not provide guidance on trail (motorized and non-motorized) construction or use, except that overland travel was eliminated by the 2005 Travel Management Rule. Nor does alternative 1 limit over-snow travel. Alternative 1 does establish an objective for 160 miles of trail maintenance within 10 years; an infeasible task given most of the trail maintenance by current staffing and budgets is accomplished by volunteers. Impacts to water resources (see ***Wa19, Wa20, Wa21***) have occurred, because of minimal trail maintenance. Therefore, because alternative 1 completely lacks guidance on trail construction or use and effectually fails to achieve its trail maintenance objectives, it would cause the most adverse impacts to surface water resources when compared with other alternatives.

Alternative 1 also recommends 1,853 acres of wilderness. Since recommendation, these areas have been managed for wilderness character (i.e., no roads, no mechanized tools). Within these areas, human-made impacts are minimized and adverse effects to water resources by ground disturbance (***Wa5***) and heavy dispersed use (***Wa10, Wa17, Wa18***) are minimal. Alternative 1 nearly (second only to alternative 4) recommends the least acres of recommended wilderness; it therefore is less likely than alternatives 2 and 3 to offer the beneficial effects of designated wilderness to surface water resources.

Effects by Alternatives 2 and 3

Because both alternatives 2 and 3 include objectives for road decommissioning routes not on the MVUM, the use and proliferation of remote dispersed recreation sites would be discouraged. Decommissioning roads which provide motorized access to remote areas of the forest would prevent many users from reaching these dispersed sites. Dispersed site use would instead become more concentrated along major National Forest System roads (forest roads), making it more observable and manageable. Together with plan guidelines to close or rehabilitate dispersed sites causing resource damage, this would have beneficial effects on surface water bodies and resources by minimizing the adverse impacts associated with dispersed sites (***Wa5***). These benefits would be realized most by alternative 3, but both alternatives 2 and 3 would benefit surface water resources more than alternatives 1 and 4.

Alternative 2 – Forest Plan

Alternative 2 does not specifically emphasize mitigating resource damage at developed recreation sites, but instead includes a guideline that prescribes deferred maintenance at 6 sites within 10 years. Presumably, some of this maintenance would have beneficial effects on surface water resources (***Wa3***), but resource damage would not be prioritized over other needs. Plan guidance does, however, encourage treating dispersed sites causing resource damage (guideline). These areas may be kept open and mitigated (or closed, or rehabilitated) where they are causing resource impacts. In comparison to alternatives 1 and 4, alternative 2 would benefit surface water resources more. Because dispersed sites under this alternative may continue to be used (rather than closed and rehabilitated), it could be less beneficial to surface water resources than alternative 3.

Under alternative 2, the trails system could be expanded by constructing 3 miles of trail within 10 years (objective). Trail construction has the potential to adversely affect surface water resources (***Wa5, Wa20, Wa21***), but adverse effects by alternative 2 would be expected to be more minimal in comparison with alternatives 1 and 4, which have objectives for more miles of trail construction, but greater than alternative 3, which proposes no new miles of trail.

Alternative 2 seeks to maintain 75 percent of system trails within a 10-year period (objective). These actions would help to decrease the adverse impacts to surface water resources associated with trails (***Wa20, Wa21***), ground disturbance (***Wa5***), and compaction (***Wa10***). The benefits of trail maintenance under alternative 2 would be more than those by alternative 3 (which lacks objectives for trails maintenance), but are expected to be significantly less than those by alternative 4 (which seeks to maintain 120 percent of the trail system in 10 years).

Alternative 2 also includes 25,868 acres of recommended wilderness, which would limit ground disturbance caused by recreation within these areas to non-motorized, non-mechanized impacts. Recreation within wilderness is generally spread throughout a large area with limited visitation (when compared with areas open to motorized travel), minimizing the adverse impacts to surface water resources associated with heavily used dispersed campsites (***Wa5, Wa10***) and developed sites (***Wa19***). Benefits to surface water resources by alternative 2 are second only to alternative 3, which recommends significantly more acres of wilderness (270,130 acres).

Effects by Alternative 3

Alternative 3 specifically addresses developed recreation sites causing resource damage through an objective to treat (close or rehabilitate) 6 sites within a 10-year period. This alternative also provides guidance to close or rehabilitate (rather than mitigate) dispersed recreation sites causing resource damage (guideline). Treating and closing these recreation sites would have beneficial impacts on surface water bodies and resources, because many of the adverse effects (see ***Wa5, Wa10, Wa19***) associated with developed and dispersed recreation would be addressed. Alternative 3 would offer the most benefits to surface water resources when compared with other alternatives, because it is the only alternative that specifies treating developed recreation sites causing resource damage and closing dispersed sites.

Alternative 3 prioritizes mitigating the impacts of trails (e.g., decommissioning trails) rather than maintaining trails to a standard for continuous use. The alternative also prohibits the construction of new trails, and no motorized over-snow travel would be permitted. Effects to surface water resources by alternative 3 are expected to be beneficial, given that the size of the trail system would be frozen at current levels or decreased, and over-snow travel would be eliminated; the adverse impacts associated with new trails, trail construction, and soil compaction would be avoided (see ***Wa5, Wa20, Wa21***). When compared with the other alternatives, alternative 3 offers the most benefits to surface water resources because it would result in the smallest trails network, and therefore, least adverse impacts.

Alternative 3 recommends 270,130 acres of wilderness, which would limit ground disturbance by recreation within these areas to non-motorized, non-mechanized impacts. Recreation within wilderness is generally spread throughout a large area with limited visitation (when compared with areas open to motorized travel), minimizing ground disturbance and adverse impacts to water resources associated with heavily used dispersed campsites (***Wa5, Wa10***) and developed sites (***Wa19***). Because when compared with other alternatives, alternative 3 recommends the most acres of wilderness, it would offer the most benefit to surface water resources by limiting motorized access and associated adverse impacts.

Alternative 4 – Human Uses Emphasis

Under alternative 4, recreation opportunity and infrastructure would be expected to expand beyond current levels. New developed recreation sites would be constructed, and 12 developed sites would receive deferred maintenance within a 10-year period (objective). Maintenance, however, would not be prioritized by those causing resource damage, but instead, by other metrics. Adverse effects to water resources (***Wa19***) would be expected from increased development and use, especially if maintenance is not specifically aimed at addressing resource impacts. When compared with other alternatives, alternative 4 would be expected to have the most adverse effects on surface water resources, because it would result in the greatest expansion of recreation opportunity and access, increasing the potential for human-caused erosion and water contamination.

Alternative 4 does not include objectives for road decommissioning, but instead increases objectives for road and trail maintenance. The alternative also designates a motorized recreation management area in which 10 miles of motorized trail would be maintained every year, with the objective of maintaining 25 percent of the trail system every 3 years. This increased access (through maintenance) would likely encourage the proliferation and use of more dispersed recreation sites in remote areas of the forest. Where dispersed sites cause resource damage, they would be rehabilitated or otherwise mitigated, but preferentially kept open. Increased development and use, even with some rehabilitation and mitigation actions, would increase the likelihood surface water resources would be adversely affected (see ***Wa5, Wa10***); more than any other alternative.

Indicator: Livestock Grazing Activities

This indicator assesses how plan components may affect surface water resources through changes in available forage or forage condition, permitted area, permitted numbers, and range infrastructure.

Effects Common to Every Alternative

Where numerous cattle are drinking from surface water sources (within the riparian or out of a trough in the uplands), ***their consumption represents a significant decrease in available water to stream channels, riparian vegetation, wildlife, and humans*** [Wa22]***.*** Given that daily water intake for a beef cow may vary from 3 to 30 gallons per day depending on age, body size, stage of production, and the environment (Rasby and Walz 2011), roughly 9,000 gallons of water are consumed by cattle from springs and stream channels on a single Santa Fe NF allotment every day livestock are present.

Livestock grazing can also adversely and directly affect water quality (Armour et al. 1991). Where animals concentrate at stream channels and springs, they are most likely to contaminate surface waters. The majority of livestock generated pollution is related to soil disturbance and erosion. ***Soil becomes compacted in areas where livestock habitually congregate. Compacted soil is less hospitable to plant roots than un-compacted soil. Where plant roots are unable to penetrate the soil they are less able to take in nutrients and water, making plants more vulnerable to toppling, disease, and drought, as well as decreasing bank strengt***h (Abernethy and Rutherfurd 2001)***, causing streams to become more susceptible to erosion.*** [Wa24]

Their hooves and body weight alone easily collapse and otherwise erode stream banks as they trail along, cross, and drink from streams. Soil can be dislodged by hoof action where the ground is moist and sloped (Warren et al. 1986). The loosened soil becomes entrained during precipitation and high flows, contributing to turbidity (fine grained suspended sediment) and sedimentation (considered pollutants).

Significant contributions of sediment to a channel can disrupt the delicate balance between incision and aggradation, adversely affecting aquatic and riparian habitats. In addition, sediment laden water quality has adverse effects to the human environment; it decreases the flood capacity of stream channels and it is more expensive to clean in municipal water facilities (**see Wa5 and Wa6**).

Through their feces and urine, livestock contribute nutrients and organic matter (Sheffield et al. 1997), bacteria (e.g., *Escherichia coli*) (Davies-Colley et al. 2004), and protozoan pathogens (e.g., Giardia) (Nader et al. 1998) to stream channels. ***Nutrient addition to surface waters, particularly phosphorus and nitrogen, can increase algal growth, decrease water clarity, and increase ammonia concentrations which can be toxic to fish*** [Wa29]***. The increased organic matter also serves as a food source for bacteria and other microorganisms, resulting in lower oxygen levels in the water*** [Wa30]***.*** Bacteria and protozoan pathogens can be harmful to humans and wildlife.

Livestock adversely affect stream temperature (Beschta 1997)***. Where stream channels lack significant vegetative cover due to grazing, solar exposure may warm surface water, harming cold water dependent aquatic species.*** [Wa32]

Livestock adversely affect stream channel form, process, function and habitat where they have diminished or eliminated woody riparian species (e.g., grey alder*, Alnus incana;* narrowleaf willow*, Salix exigua;* shining willow*, Salix lucida;* yellow willow*, Salix lutea*) because ***as large wood (branches and trunks) accumulates within stream channels it can significantly affect hydraulics; directing flow, creating areas of scour, and areas of sedimentation*** (Tabacchi et al. 2000). ***This diversity is critical to aquatic habitat*** [Wa33]***.***

Livestock adversely affect baseflows by decreasing woody species in the riparian. ***During flood flows, flexible plants (e.g., willows) protect the stream banks by bending in the current, effectively covering the banks and slowing erosion. They trap sediment, rebuild and expand floodplains, raise the water table, and expand riparian communities. Larger and well vegetated floodplains retain water longer*** (Tabacchi et al. 2000)***, raising stream baseflow during the driest part of the year*** [Wa34]***.***

Effects by Alternatives 1, 2, and 3

Alternatives 1, 2, and 3 contain areas of additional recommended wilderness. By law, livestock grazing, where established at the time a specific wilderness area is designated, shall be permitted to continue after designation. Alternative 1 recommends 1,853 acres of wilderness (100 percent of which would continue to be grazed), alternative 2 recommends 25,868 acres (100 percent of which would continue to be grazed) and alternative 3 recommends 270,130 acres (87 percent of which is within active range allotments and may continue to be grazed).

Because wilderness makes range management more difficult due to minimal motorized access (FSM 2323.22 specifies limited and occasional motorized travel in wilderness for allotment management), adverse impacts to surface water resources (see ***Wa24*** through ***Wa34***) would be more likely by alternatives with large number of acres of grazed wilderness; alternative 2 being the most likely to cause adverse impacts (alternative 3 recommends more acres of wilderness than any other alternative but also has a guideline to close grazing permits, where possible). The use of motorized and mechanized equipment itself however can adversely affect surface water resources (see ***Wa5, Wa9, Wa10***). Headwater streams, which typically occur in designated wilderness, are most likely to be adversely impacted; impacts to the headwaters (especially water quality) can affect miles of stream, well beyond a wilderness boundary.

Effects by Alternatives 1, 2, and 4

There are 314,172 acres of designated wilderness in the Santa Fe NF. Currently, 257,337 of these acres (82 percent) are open to grazing. They would remain designated wilderness and open to grazing under alternatives 1, 2 and 4. Managing livestock grazing in designated wilderness is made much more difficult by the lack of motorized access, making the potential for adverse impacts to surface water resources (see ***Wa24*** through ***Wa34***) more likely by alternatives 1, 2 and 4 than by alternative 3 (which could close existing wilderness grazing allotments). However, as supported by the Wilderness Act and Forest Service policy (FSM 2323.22), permittees may be authorized limited (and occasional) motorized travel in wilderness for allotment management. The potential use of motorized and mechanized equipment to maintain range allotments could itself, adversely affect surface water resources (see ***Wa5, Wa9, Wa10***). Headwater streams, which typically occur in designated wilderness, are most likely to be adversely impacted; impacts to the headwaters (especially water quality) can affect miles of stream, well beyond a wilderness boundary.

Effects by Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 contain objectives and plan components for vegetation restoration. While they vary in method (mechanical, wildfire, prescribed fire) they aim to treat areas of overly dense forest with the primary purpose of reducing the risk of uncharacteristic wildfire: alternative 2 proposes to treat up to 280,000 acres of mixed dry conifer forest, 350,000 acres of ponderosa pine forest, and 115,000 acres of non-forested vegetation; alternative 3 proposes to treat up to 820,000 acres of mixed dry conifer forest, 992,000 acres of ponderosa pine forest, and 165,000 acres of non-forested vegetation; and alternative 4 proposes to treat up to 325,000 acres of mixed dry conifer forest, 253,000 acres of ponderosa pine forest, and 120,000 acres of non-forested vegetation. Where the canopy is opened up, grasses and forbs should flourish, increasing livestock forage in upland areas. Ultimately, this should reduce adverse impacts to surface water resources (see ***Wa24*** through ***Wa34***) by limiting concentrated use near surface water bodies and the riparian habitat. Because alternative 3 proposes to treat the most acres, it is more likely than any other alternative to increase forage in the uplands, thereby reducing adverse impacts.

Alternatives 2, 3, and 4 contain objectives for improving range infrastructure. Range infrastructure (e.g., fencing, water tanks, etc.) helps managers achieve an appropriate distribution of livestock as well as rest or close rangelands. This infrastructure can wear out and break, causing livestock to concentrate in undesirable areas, especially near water. Concentrating livestock in riparian areas typically breaks down stream banks, widens stream channels, decreases the population and vigor of key riparian species (e.g., sedges and willows), and degrades water quality by contributing sediment and fecal coliform bacteria to the stream. Regular improvement of range infrastructure would result in better livestock management, prevent concentrated livestock use around water, and avoid the long-term adverse impacts to water resources (see ***Wa24*** through ***Wa34***) associated with uncontrolled livestock distribution and intensive grazing. Alternatives 2 and 4 would improve 50 percent of all range infrastructure within a 10-year period; alternative 3 objectives would remove 50 percent of all unnecessary range infrastructure within a 10-year period. This would be especially important if livestock numbers and allotment acres increase (even temporarily) under alternative 4. Alternative 3 would have a neutral effect on surface water resources if the infrastructure removed was truly unnecessary. If livestock numbers were to decrease by alternative 3, it would be fitting that fewer range infrastructure improvements would be required.

Alternatives 2, 3, and 4 contain objectives related to riparian restoration activities; alternative 2 specifies 15 miles of riparian habitat should be restored within a 10-year period, while alternative 3 specifies 30 riparian miles in the same time period. Alternative 4 objectives specify only invasive species treatments within the riparian habitat (rather than activities included by alternatives 2 and 3: such as stream channel stabilization, planting native species, promoting natural revegetation of bare ground, and redirecting other uses). Actions aimed directly at restoring riparian vegetation should increase available forage, resulting in decreased grazing pressure, and therefore, fewer adverse impacts to surface water resources (see ***Wa24*** through ***Wa34***). Because alternative 4 does not include a full range of restoration tools, benefits to surface water resources would be reduced when compared with those by alternative 2 (moderate benefit) and alternative 3 (the most benefit).

Land management activities other than grazing (e.g., restoration, recreation, and timber extraction) are expected to indirectly affect range forage production and condition. Where forage is increased (as expected by alternative 2) stocking rates would likely be increased, and similarly, where forage is decreased (over the long term; as expected by alternatives 3 and 4), stocking rates should decrease. As long as stocking is in pace with forage availability, and riparian areas are adequately protected, adverse impacts to surface water resources (see ***Wa24*** through ***Wa34***) are expected to be neutral when compared with the current condition (alternative 1).

Alternative 1 – 1987 Forest Plan

Alternative 1 contains no specific objectives or plan components for vegetation restoration. It focuses on maintaining healthy rangelands and forage, but provides no specific guidance on how to do this. Further, in this alternative, the use of wildfire has largely been curbed to meet standards and guidelines that limit fire severity to impractically low levels, resulting in dense forest vegetation. Without actively restoring upland areas by thinning or burning overly dense forests, acres of available livestock forage (grasses and forbs) are limited to open areas, typically valley bottoms and riparian areas. Livestock, therefore, congregate in these sensitive environments where food and water are abundant, resulting in adverse impacts to surface water resources (see ***Wa24*** through ***Wa34***).

Alternative 1 contains objectives and plan components for riparian condition, but provides no management direction on riparian restoration. Without specifically managing for riparian improvement, continuous livestock grazing in riparian pastures has resulted in adverse impacts to surface water resources (see ***Wa24*** through ***Wa34***).

Alternative 1 provides no objectives for treating invasive (plant) species, which are typically not nutritious forage for livestock (with the exception of some nonnative grasses, purposefully introduced by ranchers before the inception of the Santa Fe NF). Many noxious plants in the forest are found within riparian habitats. By not treating them, they further stress surface water resources by concentrating grazing on the remaining forage in these areas. Intensive use on sensitive terrain (e.g., riparian) has significant potential to cause adverse impacts (see ***Wa24*** through ***Wa34***) to surface water resources.

Alternative 1 provides no direction on improving range infrastructure (only an objective to remove fences and loose wire as they are abandoned). Infrastructure (e.g., fencing, water tanks, etc.) helps managers achieve an appropriate distribution of livestock, as well as close areas to grazing. Periodically, this infrastructure breaks, allowing livestock to concentrate in undesirable areas (e.g., riparian habitat). Without specific plan direction to improve range infrastructure, much of it remains non-functional, and livestock management is made much more difficult. As described above, concentrated livestock use has significant potential to cause adverse impacts to water resources (see ***Wa24*** through ***Wa34***).

Watershed Condition

Indicator: Restoration Activities

Hydrologic processes within their natural range of variability characterize properly functioning watersheds (Petersen 1999). This indicator provides a qualitative assessment of how well restoration plan components and activities will protect and restore the hydrologic processes of infiltration, subsurface flow, overland flow, resistance to flow, discharge, and sediment transport. Therefore, this indicator should forecast how effective each alternative will be at moving watersheds toward "properly functioning" condition (see the Watershed Condition Framework discussion above within the Affected Environment section and Potyondy and Geier 2011). Restoration activities considered by this indicator include mechanical treatments, prescribed burning, seeding, planting, invasive species (plant) eradication, road decommissioning, as well as stream channel and riparian restoration.

Effects Common to Every Alternative

Hydrologic processes can be adversely affected by management activities such as fire suppression, prescribed fire, timber extraction, fuels reduction, noxious weed treatments, road construction, recreation, and livestock grazing (see ***Wa5*** through ***Wa34***). Watershed condition becomes adversely affected where the majority of watershed acres have compromised hydrologic function. ***Properly functioning watersheds serve people and ecosystems by capturing precipitation, storing it for release during drier periods*** [Wa35]***. They also clean water by filtering it through soil and vegetation*** [Wa36]***. Impaired and functioning at risk watersheds are less able, or incapable, of providing these ecosystem services*** [Wa37]***.***

Where degraded, the beneficial effects of properly functioning watersheds (***Wa35, Wa36***) are most likely realized if restoration activities are coordinated in time and space. While every alternative contains plan components that encourage and guide restoration activities, the scale and degree of coordination differs, and in turn, their likely effectiveness.

Alternative 1 – 1987 Forest Plan

While restoration activities are encouraged under the 1987 Plan, guidance for a landscape-scale restoration strategy was not included. This has resulted in restoration treatments which are not spatially focused (ideally by watershed) or chronologically coordinated with one another. As part of the 2015 Watershed Condition Assessment (USDA Forest Service 2011a and 2011b; Potyondy and Geier 2011), watershed components such as aquatic biota, aquatic habitat, water quality, water quantity, road density, road related sediment, soil condition, wildfire resilience, forest health, and terrestrial habitat were evaluated across the forest. The Assessment found only 6 percent of the forest's watersheds to be in "properly functioning condition." Restoration efforts under the 1987 Forest Plan were likely not successful at moving watersheds toward desired (proper functioning) condition; the 1987 Forest Plan has adversely affected watersheds over the past 30 years, because it lacks guidance on focused, coordinated treatments at the landscape scale (see the following for specifics on how land management activities and restoration can affect watershed condition: ***Wa1, Wa3-Wa6, Wa8, Wa10-Wa12, Wa14-Wa15, Wa17-Wa21, Wa24, Wa29-Wa30, Wa32-Wa34***).

Effects by Alternatives 2 and 3

The effectiveness of restoration activities (moving watersheds toward properly functioning condition) by alternatives 2 and 3 would be similar in that they both contain landscape-scale restoration objectives (across many program areas) that focus (spatially and temporally) on improving WCF "impaired" and "functioning at risk" watersheds. These coordinated restoration efforts would be more effective than alternatives 1 and 4, because the beneficial effects of restoring impaired hydrologic processes (***Wa35 – Wa37***) would be cumulative and synergistic within the watersheds that most need treatment.

Additionally, alternatives 2 and 3 would be more effective than alternatives 1 and 4 at positively influencing watershed condition, because they include objectives and guidelines that use prescribed *and* managed wildfire. As a restoration tool, fire has the ability to improve watershed condition by reducing the potential for uncharacteristic wildfire and its associated effects to hydrologic processes (see ***Wa8***) over more acres, faster, than any other land management activity.

Alternatives 2 and 3 also include objectives (wildlife, fish and plants) for stream and aquatic habitat restoration, lacking in alternatives 1 and 4. By addressing stream channels and aquatic habitats directly, treatments could mitigate the damaging cumulative effects of land management activities (see ***Wa5*** through ***Wa34***) within the larger watershed (e.g., increasing stream channel resiliency by planting bank-stabilizing riparian species), thereby helping to prevent these ecosystems from further deterioration.

Overall, hydrologic processes (e.g., infiltration, subsurface flow, overland flow, resistance to flow, discharge, and sediment transport) could be expected to be better maintained or improved by alternatives 2 and 3 than by other alternatives, because they are focused within watersheds that need improvement, include using fire as a restoration tool, as well as directly address restoring streams and aquatic habitats.

Alternative 2 – Forest Plan

This alternative would increase the rate and scale of restoration above current levels (alternative 1). Alternative 2 objectives (across multiple program areas) focus on improving at least 2 WCF "impaired" or "functioning at-risk" watersheds, restoring 15 miles of stream channel and 30 miles of aquatic habitat, eradicating or suppressing invasive plant species on 6,000 acres, and decommissioning 100 miles of road within a 10-year period.

Unique to alternative 2, restoration objectives for vegetation management would be accomplished using both fire (wildfire as well as prescribed fire) and mechanical treatments. By first reducing fuel levels through mechanical means, the likelihood prescribed fire would result in high soil burn severity (and therefore adverse effects to hydrologic processes; see ***Wa8***) is minimized. Over a 10-year period, between 253,500 and 745,000 acres of ponderosa pine and dry mixed conifer (as well as some areas of non-forested vegetation) would be treated (up to 219,500 acres by mechanical and 526,000 acres by fire), restoring, between 7 and 21 percent of Forest watershed acres (the forest is contained within 142 6th field sub-watersheds, which total 3,532,997 acres in area). While less than 25 percent of the total watershed area across the forest would be treated, all treated acres are expected to benefit watershed condition, given that the risk of high soil burn severity would be decreased through prior fuels reduction by mechanical means.

While the scale of restoration is less than alternative 3, alternative 2 would diminish the risk of high-intensity wildfire in treated areas. Together with a suite of additional restoration objectives (riparian *and* upland) targeted within watersheds most in need of treatment, alternative 2 would be more likely than any other alternative, to effectively improve watershed conditions (and therefore ecosystem services; see ***Wa35 –Wa37***).

Effects by Alternative 3

This alternative would increase the rate and scale of restoration beyond every other alternative. The alternative 3 objectives (over multiple program areas) focus on improving at least 5 WCF "impaired" or "functioning at-risk" watersheds, restoring 30 miles of stream channel and 60 miles of aquatic habitat, eradicating or suppressing invasive plant species on 3,000 acres, as well as decommissioning 250 miles of roads within a 10-year period. Alternative 3 also includes two management areas (Wetland Jewels and Calaveras) that contain additional restoration objectives. Within 10 years, at least 5 restoration projects (including road decommissioning and riparian treatments) would be implemented at multiple Wetland Jewels, while 2 restoration projects (mechanical treatments and burning) would be implemented in the Calaveras area. These projects should result in improved hydrologic processes (e.g., infiltration and storage; ***Wa1 –Wa4***) within 13 sub-watersheds.

Unique to alternative 3, restoration objectives for vegetation largely rely on fire (wildfire as well as prescribed fire), using mechanical treatments only in a few select situations (e.g., fire containment line preparation and structure protection). Using prescribed fire without first pre-treating areas through mechanical fuel removal could, however, cause some areas to burn especially hot, resulting in adverse impacts (***Wa8***) to hydrologic processes and watershed condition. Avoiding these impacts would largely depend on the atmospheric and fuel moisture conditions (e.g., temperature, relative humidity, wind speed and direction, and fuel moistures) at the time of burning, as well as the proportion of watershed acres affected. It is reasonable to assume some watersheds would be adversely impacted by high soil burn severity, while conditions are improved in others.

Under this alternative, more acres would be treated than any other; a testament to the logistical feasibility of widespread treatment by fire when compared to mechanical methods. Over a 10-year period, between 470,650 and 1,907,000 acres would be implemented (42,150 acres by mechanical, and up to 1,865,000 acres by fire), which represents between 13 and 54 percent of Forest watershed acres. Although the majority of watershed acres across the forest would be treated, benefits to watershed condition (see ***Wa35*** through ***Wa37***) would be entirely reliant on soil burn severity; low severity would be more difficult to achieve in dense forest that is not mechanically thinned prior to burning. Therefore, when the risk of high soil burn severity is considered, alternative 3 may not offer widespread benefits to watershed condition. Under alternative 3, watershed condition would be most likely improved where treatments are implemented during low risk burn conditions, at the watershed scale, and where impaired or functioning at risk watersheds are targeted.

Alternative 4 – Human Uses Emphasis

Restoration objectives by this alternative are limited to vegetation management (mechanical treatments and invasive species treatments). Projects would eradicate or suppress invasive plant species on 15,000 acres and along 100 miles of stream channel every 10 years.

Alternative 4 objectives and guidelines (fire and fuels; vegetation) emphasize the utilization of forest products by limiting the use of fire (prescribed fire would not be allowed, but limited and controlled wildland fire could be). Logistically, preventing the use of prescribed fire would result in fewer acres treated because economics, slope, and sensitive landscape features prevent widespread timber harvest. Over a 10-year period, between 316,000 and 689,000 acres would be treated (up to 650,000 acres by mechanical and 56,000 acres by fire). Therefore, only between 8 and 20 percent of Forest watershed acres would be improved by this alternative.

Treating less than 25 percent of the forest's total watershed area may not result in significantly reducing adverse impacts to hydrologic process by watershed disturbance (see ***Wa5 –Wa34***), especially where these treatments are scattered across many watersheds. By focusing on merchantable forest products and invasive species rather than targeting the watersheds most in need of restoration (those not in properly functioning condition) with a suite of restoration methods, these efforts are unlikely to have beneficial effects on watershed condition (thereby decreasing the ecosystem services provided by healthy watersheds; see ***Wa35 –Wa37***).

Ultimately, in comparison with alternatives 2 and 3, alternative 4 would be the least likely to protect and restore watershed condition. Alternative 4 would be expected to have slight benefits to watershed condition over alternative 1, which does not have any landscape-scale restoration objectives. Alternative 4 would not likely improve watershed condition, because without the use of fire, treatments are logistically limited in scale and location, making it improbable the risk of uncharacteristic wildfire (for a significant number of watersheds) would be reduced. Nor does alternative 4 contain objectives for targeting the watersheds most in need of improvement; a full suite of restoration methods (e.g., treatments to stream channels, riparian, and aquatic habitat) are not objectives by this alternative, making it unlikely these environments would have the resiliency to recover from the detrimental impacts of uncharacteristic wildfire (***Wa8***) when it happens.

3.4.4.2 Cumulative Effects

Past, present, and future activities within the administrative boundary of the Santa Fe NF include livestock grazing, prescribed and natural fires, wildfire suppression, recreation, mining, vegetation management, noxious weed treatments, road construction and maintenance, road decommissioning, wildlife habitat restoration and management, watershed restoration and management, and oil and gas extraction, among others. Beyond the forest boundary, past, present, and future actions by other entities include those described above, as well as activities associated with rural residential communities. Within any watershed, regardless of land ownership, these activities cumulatively affect (both beneficially and adversely; see ***Wa1 –Wa37***) water quality, water quantity, and watershed condition.

The timeframe for assessing cumulative effects on watersheds and water resources is 15 years. The spatial boundaries of the analysis are the 142 sub-watersheds (level 6 hydrologic units) that overlap the administrative Santa Fe NF, but also extend beyond the forest. Watersheds managed predominantly by the Santa Fe NF[18] are less likely to incur adverse cumulative effects by management actions occurring on non-FS lands, while watersheds with little forest land,[19] and those under mixed management are most likely to have adverse cumulative effects to water resources. Table 40 describes the land ownership for the 142 watersheds that overlap the Santa Fe NF.

Within the 142 analysis sub-watersheds, multiple agencies (Federal and State), counties, municipalities, tribes, and other groups (e.g., soil and water conservation districts) manage the natural resources. Their published management plans largely complement the forest plan components pertaining to water resources and properly functioning watersheds. Most of the plans specifically refer to protecting water resources through land conservation measures such as hazardous fuels reduction, suggesting the planned present and future activities on managed adjacent lands may have beneficial cumulative effects on water

[18] These sub-watersheds are predominantly (>50% by area) managed by the Santa Fe NF: Abiquiu Creek, Apache Creek, Arroyo de Los Diegos, Arroyo del Cobre-Rio Chama, Arroyo del Yeso-Arroyo Seco, Arroyo Leguino, Barbero Canyon, Bull Creek, Cabo Lucero Creek-Tecolote Creek, Canada de Cochita, Canada de Tio Alfonso-Rio Chama, Canada del Oso Sarco-Embudo Creek, Canon de La Canada, Canones Creek, Capulin Canyon-Rio Grande, Church Canyon-Jemez River, Coyote Creek, Dry Gulch-Pecos River, El Rito, Glorieta Creek-Pecos River, Headwaters Borrego Canon, Headwaters Canoncito de las Lleguas, Headwaters Cow Creek, Headwaters Rio Cebolla, Headwaters Rio de Las Vacas, Headwaters Rio Puerco, Headwaters Rio Santa Barbara, Headwaters Rio Tesuque, Huckbay Canyon-Rio Chama, Indian Creek-Pecos River, La Junta Canyon-Rio Pueblo, Los Alamos Canyon, Lower Rio Gallina, Middle Rio Gallina, Ojito Canyon-Abiquiu Reservoir, Ojitos Canyon, Outlet Canoncito de las Lleguas, Outlet Cow Creek, Outlet Rio Cebolla, Outlet Rio de Las Vacas, Outlet San Antonio Creek, Panchuela Creek, Peralta Canyon, Poleo Creek, Polvadero Creek, Porvenir Canyon, Porvenir Canyon-Gallinas Creek, Rio Capulin, Rio Chiquito, Rio del Oso, Rio del Oso-Rio Chama, Rio Frijoles, Rio Guadalupe, Rio La Casa, Rio Medio, Rio Mora, Rio Mora-Pecos River, Rio Nambe, Rio Puerco-Abiquiu Reservoir, Rio Quemado, Rito Penas Negras, San Pablo Canyon, Upper Rio Gallina, Vallecita Creek,Virgin Canyon

[19] These sub-watersheds have less than 50 percent of their area managed by the Santa Fe NF: 130202010603, Alamo Canyon-Rio Grande, Arroyo Blanco, Arroyo Calabasas, Arroyo de la Plaza Larga, Arroyo de Los Chamisos, Arroyo de Los Pinos-Rio Puerco, Arroyo del Vegoso-Pecos River, Arroyo Hondo, Arroyo Lopez, Arroyo Pecos-Gallinas River, Arroyo San Jose-Rio Puerco, Bobcat Canyon, Canada Ancha-Rio Grande, Canada de Cochita-Rio Grande, Canada Jaquez-Canada Larga, Canon Mesteno-Tecolote Creek, Canon Santo Domingo, East Fork Jemez River, El Canon de Pena, El Rito-Rio Chama, Glorieta, Creek, Headwaters Arroyo San Jose, Headwaters Manuelitas Creek, Headwaters San Antonio Creek, Los Alamos Canyon-Rio Grande, Oso Canyon, Outlet Arroyo Chijuilla, Outlet Arroyo del Puerto Chiquito, Outlet Arroyo San Jose, Outlet Canada Ancha, Outlet Rio Puerco, Outlet Santa Fe River, Rio La Casa-Mora River, Rio Ojo Caliente-Rio Chama, Rio Tesuque-Pojoaque Creek, Rito Cebollla, San Cristobal Arroyo-Galisteo Creek, Tortolita Canyon-Pecos River, Tres Hermanos Creek, Vallecita Creek-Jemez River, Water Canyon-Rio Grande

resources and watersheds (e.g., reduced erosion and improved water retention). The following paragraphs highlight how specific activities in the Santa Fe NF, together with similar activities on other lands within the same watershed, might cumulatively affect water resources and watershed condition.

Table 40. Number of watersheds and corresponding percentage of all watersheds overlapping the Santa Fe NF boundary managed by various land managers

Land Managers	Number of Watersheds with > 80% of their area managed by this group	Number of Watersheds with 50%- 80% of their area managed by this group	Number of Watersheds under Mixed Management All managers have <50% of the watershed
Santa Fe NF	37	28	
Percentage of all watersheds (142) that overlap the forest boundary	*26%*	*19%*	
National Park Service	3	1	
Percentage of all watersheds (142) that overlap the forest boundary	2%	*1%*	
Bureau of Land Management	0	3	
Percentage of all watersheds (142) that overlap the forest boundary		*2%*	
Tribes	8	6	
Percentage of all watersheds (142) that overlap the forest boundary	*6%*	*4%*	
Private	14	24	
Percentage of all watersheds (142) that overlap the forest boundary	*10%*	*17%*	
Other			18
Percentage of all watersheds (142) that overlap the forest boundary			*13%*

Livestock (both sheep and cattle) grazing has occurred within and around the Santa Fe NF for the past 400 years. Prior to becoming the Santa Fe NF (in 1915), grazing was intensive (between 1870 and 1890 the number of livestock in New Mexico increased from 300,000 to 2,300,000 animals; Peterson, 1950 in Vogt 2018) and combined with a drying climate, resulted in a reduction in vegetative ground cover (especially native grasses) and riparian woody species (DeBuys 1985; Dunmire, 2013; Leopold, 1951). Subsequent soil loss, channel incision, and degraded watershed function are present not only in the forest, but also on surrounding lands (Dunmire 2013; DeBuys 1985; Leopold 1951). Best management practices to mitigate adverse impacts to water and watersheds (see ***Wa24 –Wa34***) have since been implemented in the Santa Fe NF; the forest intends to manage livestock grazing on National Forest System lands to improve surface water quality and watershed condition. Thus, while grazing by other non-Forest entities may adversely impact the watersheds, these effects would not be exacerbated by planned Forest Service actions.

The majority of the Santa Fe NF is composed of ERUs with very short fire return intervals (7 to 10 years). Wildfire suppression (Covington and Moore 1994) since the establishment of the Santa Fe NF and historic over-grazing (Dunmire 2013) have resulted in overly dense forests, which carry crown fire and severely burn soils. The absence of wildfire in the ecological regime of Forest watersheds has had a negative effect on watershed function through the adverse alteration of hydrologic processes, such as water absorption, retention, and release (Keane et al. 2002). The absence of wildfire has consequently also affected water quality, stream channel equilibrium, and aquatic habitat. Forest management across every alternative, to varying degrees, would allow for some use of wildland fire and prescribed fire. Cumulatively, re-introducing fire to the landscape should have beneficial effects (avoiding and minimizing adverse effects; see ***Wa8***) on water quality and watershed condition.

Forest thinning within and around the Santa Fe NF includes both hand thinning and mechanical treatments. Cumulative adverse effects to surface water resources and watershed condition include fugitive dust emissions, soil compaction, reduced infiltration, erosion and sedimentation (Elliot et al. 2010; see ***Wa5, Wa6, Wa8.5 –Wa14***). Forest management would use best management practices to mitigate these impacts. Over time, forest thinning activities should result in forests more resilient to disturbance by wildfire, which should cumulatively benefit water resources and watershed conditions.

Mining and energy production has occurred within and around the forest for many years. Oil and natural gas have been extracted from the Santa Fe NF since the 1940s; at present there are 209 oil and gas leases covering approximately 89,000 acres in the Santa Fe NF. There were 50 producing oil and natural gas wells leased and 54 unpatented mining claims (all small "recreational" operations) for locatable minerals (e.g., copper, gold, silver, uranium, and rare earth elements). No future locatable mineral exploration or development projects with significant surface resource impacts are projected. Saleable minerals (e.g., sand, gravel, cinders, pumice, and crushed rock) are sold by the Forest Service to interested parties; some operations are at a commercial scale. ***These mining activities are ground-disturbing with potential adverse impacts to surface water resources and watersheds such as water extraction, increased erosion and sedimentation, as well as the creation of acid mine drainage, and other water pollutants*** [Wa38] (Gleick, 1994; Dudka and Adriano, 1997)***. Leasable energy production operations can also contaminate water quality through the introduction of pollutants to groundwater and surface water*** [Wa39]***.*** Therefore, in combination with off-forest mining and leasing activities, adverse cumulative effects to water quality, water quantity, and watershed condition could occur**.**

Across the Santa Fe NF, there are over 6,583 miles of system and non-system roads; beyond the forest boundary are many more miles. While the forest has decommissioned some roads during the past 15 years, within most non-wilderness sub-watersheds, road densities remain above levels that can disrupt watershed functions (Al-Chokhachy et al. 2016). Roads adversely affect hydrologic processes in several ways (see ***Wa10 –Wa14***). While most alternatives propose shrinking the forest's road system, adverse impacts are expected through the use of the remaining roads. Therefore, in combination with off-forest roads, the NFS motorized transportation system can be expected to have adverse cumulative impacts to water resources and watersheds.

Rural development around the Santa Fe NF in conjunction with Forest developments (e.g., campgrounds, ranger stations, day-use sites) can adversely affect water resources through ground disturbance and water quality contamination (see ***Wa17 –Wa19***). In the forest, plan components and best management practices are used to mitigate these impacts, thereby, minimizing adverse cumulative impacts by present or future Forest activities.

3.5 Wildlife, Fish and Plants

3.5.1 Affected Environment

When people think of the outdoors, they often think of the wildlife, fish, and plants that are found across the varied landscapes. Over the last few centuries, though society has shifted to a more urban-centric environment, the need for wildlife-related recreation and enjoyment has remained high. In 2016, more than 103.7 million U.S. residents (16 years old and older) participated in some form of wildlife-related recreation, this constituted 41 percent of the population. Those same people spent $156.9 billion on their activities (USFWS 2016). Given the amount of time and money invested in wildlife-related recreation, it is without question society appreciates, wants, and requires robust populations of wildlife, fish, and plants as well as healthy habitats within the environment in which they are found.

The diversity and sheer number of wildlife, fish and plant species found in the forest makes individual species management problematic; therefore, these species have been classified into several categories which include: Aquatic, Terrestrial, At-Risk, and Invasive species. Aquatic plant and animal species include commonly-found species that spend all or the majority of their time in water and are usually represented by fish (e.g., trout, chubs, etc.), amphibians (e.g., frogs, salamanders, etc.), and water-dependent plants (e.g., cattails, pondweeds, etc.) and macro-invertebrates (e.g., aquatic insects, clams, etc.). Terrestrial plant and animal species include commonly found species that spend all or the majority of their time on dry land and are usually represented by mammals (e.g., deer, rabbits, etc.), birds (e.g., eagles, jays, etc.), reptiles (e.g., snakes, lizards, etc.), and land-based plants (e.g., trees, grasses, etc.) and macro-invertebrates (e.g., beetles, snails, etc.). At-risk species include both aquatic and terrestrial species that are known to be at-risk of persistence in the forest and include federally listed (threatened, endangered, candidate and proposed) species as well as forest-identified species of conservation concern. Invasive species are nonnative organisms whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health. Their impact to native species and ecosystems is discussed in this report as an issue affecting at-risk species. The first three groupings (Aquatic, Terrestrial, and At-Risk) are managed for their persistence in the forest while the last grouping (Invasive) is managed for their eradication or control since they are not native flora and fauna of the forest and are likely to cause economic or environmental harm or harm to human health.

The presence of wildlife on the landscape is frequently a function of the ecosystem. Specific ecological conditions created by local soil, air, water, aspect, elevation, precipitation, etc. create areas that are favorable or unfavorable for a particular species. The set of ecological conditions that support individual species is often referred to as the species' habitat. Given the range of variation in the Santa Fe NF, a multitude of habitats support a diversity of wildlife.

The Santa Fe NF has five ranger districts over two mountain ranges. They are home to over 1,300 animal, plant, and fungi species. The two mountain ranges are different in origin and composition. The Jemez Mountains are volcanic in origin with pumice and tuff parent materials for soil with sandy sedimentary lowlands while the Sangre de Cristo Mountains are uplift, a southern extension of the Rocky Mountains mostly granitic in origin. These differences are the basis for a few species found only in the Santa Fe NF or within only one of the forest's mountain ranges. For certain species, changing land use patterns outside of the forest have reduced potential habitat availability and increased their reliance on Santa Fe NF managed lands.

The diversity of species found in the Santa Fe NF also provides ecosystem services that in turn benefit society as a whole. This includes ecosystem supporting services such as nutrient cycling (by plants, animals, and invertebrates), soil formation and manipulation (e.g., burrowing insects and mammals), primary production (plants), and seed dispersal (e.g., animals). Regulating services including carbon sequestration (plants), pollination (both forest plants and adjacent croplands by vertebrates and invertebrates), and erosion control and water storage (plants) are additional key ecosystem services provided. Species also provide provisioning services such as food (e.g., forage, game, and wild foods), fiber, medicine, and forest products. Finally, some species provide cultural services including recreation (e.g., hunting, fishing and birdwatching), opportunities for scientific discovery and education, and cultural, intellectual, or spiritual inspiration.

A multitude of factors may negatively impact the forest's wildlife. The most important direct drivers of biodiversity loss and ecosystem service changes are habitat change (such as land use changes, disruption of natural processes, or physical modification of rivers or water withdrawal from rivers), climate change, invasive species, overexploitation, and pollution. Therefore, careful management of these threats to biodiversity is necessary for the continuous protection of our forest wildlife.

3.5.1.1 Terrestrial Species and Habitats

Numerous wildlife species are found in the forest, ranging from the smallest and often microscopic invertebrates to the 700+ pound bull elk. It is unknown exactly how many species reside in the Santa Fe NF, but these animals and their interactions with each other and their environment form the complex ecosystems we are responsible for managing.

Like humans, wildlife needs a place to live, therefore, healthy habitats are required to not only keep our ecosystems functioning properly, but to maintain viable populations of wildlife as well. These habitats are varied and provide the necessary food, water, shelter, and space for all the organisms that live within. Species composition is dependent on the vegetation type, referred to as an ERU throughout the Plan and FEIS, yet many species utilize multiple ERUs. Therefore, to maintain healthy wildlife populations, it is imperative that all ERUs are in or approaching reference conditions.

Fortunately, some of the ERUs in the Santa Fe NF are in, or near, reference condition providing high-quality habitat, meaning the range of ecological conditions required for species persistence are in functioning order. However, some ERUs, especially the frequent-fire systems (e.g., ponderosa pine, mixed conifer dry, and many grasslands) are in highly altered states due to a long history of fire suppression. This usually results in lesser quality habitat for the animals that historically used these areas. It is these areas that need most attention to maintain viable populations of wildlife that live there.

3.5.1.2 Aquatic Species and Habitats

Fish need healthy habitats that provide cold, clean water, food to eat, areas of cover to hide from predators, and clean substrates to lay their eggs. Important indicators of healthy habitats include water quality measures such as cool to cold water temperature; appropriate stream channel dimensions; lack of excess turbidity, sedimentation, and nutrients; and adequate stream flow. Other physical habitat components important to healthy habitats include relatively even proportions of pools and riffles, deep pools, stable streambanks, healthy riparian areas, and sufficient cover and channel complexity in the form of large woody debris.

Ecological conditions in aquatic ecosystems are currently highly departed from desired conditions. Of the 524 miles of perennial streams assessed for water quality impairments, 85 percent were found to have at least one impairment, with most having multiple impairments including high water temperature, turbidity, sedimentation, nutrients, and low flow alterations (NMED 2016). Physical habitat condition in streams is also impaired across the forest where healthy riparian vegetation is lacking leading to unstable streambanks, over-widened and shallow channels, a lack of deep pools, and insufficient large woody debris. It is within these areas that the greatest management needs exist.

3.5.1.3 At-Risk Species

Most of the species in the Santa Fe NF are assumed to have stable or increasing populations. Therefore, their persistence in the forest does not appear to be at-risk. These species are analyzed as part of the terrestrial species and habitats and aquatic species and habitats sections in this chapter. There are, however, several species that are considered to be at-risk in the forest. These "at-risk" plant and animal species were identified and evaluated within the Santa Fe NF Assessment (Santa Fe NF 2016) and include federally listed (threatened, endangered, candidate, and proposed) species as well as species of conservation concern (SCC). SCCs are identified by forest staff with assistance from their partners (government agencies, non-government organizations and publics) and approved by the regional forester. They are defined as native species found in the forest with a reasonable concern for their continued persistence based on the best available scientific information (BASI). There are also a number of rare and endemic species that do not appear to be declining in population; however, due to their naturally low population number or limited geographic distribution, additional strategies must be employed to prevent negative impacts; therefore, they are often managed similarly to at-risk species.

The Santa Fe NF has identified 36 at-risk species within its boundaries (table 41). Four federally recognized species (three endangered and one threatened) are commonly found in the Santa Fe NF and rely in the forest for most or all of their natural life-cycle requirements. These include the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), Mexican spotted owl (*Strix occidentalis lucida*), Jemez Mountain salamander (*Plethodon neomexicanus*) and the Holy Ghost ipomopsis (*Ipomopsis sancti-spiritu*). These species are managed according to recovery plans developed by the U.S. Fish and Wildlife Service (USFWS) that outline critical habitat (CH) and ecological conditions necessary to facilitate their protection and recovery. There are four other federally listed species found in northern New Mexico (USFWS, IPaC System) including southwestern willow flycatcher (*Empidonax traillii extimus*), western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), Canada lynx (*Lynx Canadensis*), and Rio Grande silvery minnow (*Hybognathus amarus*), however, these species are not routinely observed in the Santa Fe NF and no resident populations are known to exist in the forest. The Forest Service is required by law to follow the recovery plans for these species and to consult with the USFWS should any action be taken that may impact individuals of these species or their critical habitats, of which no critical habitat has been designated in the Santa Fe NF.

A total of 32 SCCs were identified during the assessment process. These SCCs were determined to be at risk due to small or endemic populations, limited habitat, current degraded habitat or specific ecological conditions, or current Forest Service management activities or other threats which may result in negative impacts to the species. They include: 1 amphibian; 8 birds; 3 fish; 3 invertebrates; 6 mammals; and 11 plants (table 41).

3.5.2 Methodology

3.5.2.1 A Habitat Approach for Managing At-Risk Species

Identification of at-risk species allow forest managers to focus management efforts in areas that will provide the greatest benefit to those at-risk species but also ensure management actions do not cause further population decline. If management activities focus on ecosystem integrity and maintaining resilient (disturbance-absorbing) and connected habitats, then ecological conditions for forest species would be effectively restored and maintained. Improved ecological conditions would increase the diversity of plant and animal communities, protect important abiotic (geologic) features, and support the abundance, distribution, and long-term persistence of at-risk species, as well as those species considered common and secure.

Species often utilize multiple ERUs throughout their life cycle and associations between at-risk species and ERUs important to them were identified in the Assessment (Santa Fe NF 2016) (table 42). These associations allow forest managers to manage species through the coarse-filter approach by managing

ERUs that compose their habitat. Management actions to restore or maintain appropriate ecological conditions for each ERU will ultimately improve habitat conditions for at-risk species using those ERUs.

Table 41. At-risk species for the Santa Fe NF*
Federally listed species are denoted with an * and all others are species of conservation concern (SCC).

Scientific Name	Common Name
Mammals	
*Zapus hudsonius luteus**	New Mexico meadow jumping mouse
Cynomys gunnisoni	Gunnison's prairie dog
Euderma maculatum	Spotted bat
Lepus americanus	Snowshoe hare
Martes caurina	Pacific (American) marten
Sorex cinereus	Masked shrew
Sorex palustris	Water shrew
Birds	
*Strix occidentalis lucida**	Mexican spotted owl
Accipiter gentilis	Northern goshawk
Aegolius funereus	Boreal owl
Athene cunicularia hypugaea	Western burrowing owl
Cypseloides niger	Black swift
Falco peregrinus anatum	American peregrine falcon
Gymnorhinus cyanocephalus	Pinyon jay
Lagopus leucurus	White-tailed ptarmigan
Melanerpes lewis	Lewis's woodpecker
Amphibian	
*Plethodon neomexicanus**	Jemez Mountains salamander
Lithobates pipiens	Northern leopard frog
Fish	
Oncorhynchus clarkii virginalis	Rio Grande cutthroat trout
Catostomus plebeius	Rio Grande sucker
Gila pandora	Rio Grande chub
Invertebrate	
Ashmunella ashmuni	Jemez woodlandsnail
Gastrocopta ruidosensis	Ruidoso snaggletooth
Pisidium lilljeborgi	Lilljeborg's peaclam
Plant	
*Ipomopsis sancti-spiritu**	Holy Ghost ipomopsis
Abronia bigelovii	Tufted sand verbena
Asclepias uncialis var. *uncialis*	Greene's milkweed
Astragalus micromerius	Chaco milkvetch
Calochortus gunnisonii var. *perpulcher*	Gunnison's mariposa lily
Cypripedium parviflorum var. *pubescens*	Large yellow lady's-slipper
Erigeron subglaber	Pecos fleabane
Lilium philadelpihcum	Wood lily
Mentzelia conspicua	Chama blazing star
Mentzelia springeri	Springer's blazing star
Draba heilii	Heil's alpine whitlow grass
Salix arizonica	Arizona willow

Table 42. At-risk species (federally listed and SCCs) and their associated ecological response units (ERU)
Note that species are typically associated with more than one ERU.

ERU	Mammals	Birds	Amphibians	Fish	Invertebrate	Plants	Total
Alpine and Tundra	1	1	0	0	0	1	3
Colorado Plateau / Great Basin Grassland	2	1	0	0	0	2	5
Juniper Grass	2	2	0	0	2	1	7
Mixed Conifer-Frequent Fire	1	2	1	0	1	3	8
Mixed Conifer with Aspen	1	2	1	0	1	4	9
Montane / Subalpine Grassland	3	1	0	0	0	1	5
PJ Woodland	1	3	0	0	0	2	6
Ponderosa Pine	2	4	0	0	1	2	9
PJ Sagebrush, PJ Grassland	1	2	0	0	0	2	5
Spruce-Fir	2	4	1	0	0	3	10
Riparian	4	2	1	3	1	2	13

By its nature, this coarse-filter approach does not encompass all risk factors for at-risk species. Fine-filter (specific) management actions may be necessary to address key ecosystem characteristics that are not addressed through general ecological health of ERUs or where non-ecological (human-caused) forces are impacting species viability. For example, it may be necessary to protect waterfalls critical for the breeding and nesting success of an at-risk species or to address recreational disturbance which may negatively impact the viability of at-risk species.

Since species-based management is often not administratively practical, habitat-based management activities should remain the primary tool to address multiple objectives beneficial for at-risk species conservation. For example, 13 at-risk species in the forest reside in or depend on riparian ecosystems. Therefore, enhancement of ecological conditions within riparian systems will benefit 13 at-risk species (36 percent) found in the forest. Singles species management actions, or fine-filter approach, would only be used when coarse-filter actions are insufficient to address the ecological needs of the species in question.

3.5.2.2 Assumptions

- Species that are not classified as at-risk species (threatened and endangered species and species of conservation concern) in the Santa Fe NF are assumed to have stable or increasing populations.
- ERUs approaching desired conditions will provide optimal habitat, meaning it should contain all the necessary ecological conditions for forest wildlife. Most desired vegetative conditions are based on reference conditions.
- Habitat availability, meaning the extent and distribution of ERUs will not change significantly throughout the life of the plan.
- Degraded ecological conditions have contributed to the decline of some species, therefore, ecological conditions at or near reference condition should benefit those species and help maintain their persistence in the forest.
- Vegetation that closely mirrors appropriate distributions of natural vegetative transitional states, or seral states, makes better wildlife habitat than vegetation that is departed from the appropriate seral state distributions (as defined by desired conditions).

- As long as small or endemic populations are not destroyed and can tolerate interim condition, short-lived ground disturbance activities such as thinning projects or prescribed fire do not negatively impact species when the end result is improved ecological conditions.

3.5.2.3 Indicators and Evaluation Criteria

Restoring and maintaining ecological conditions that support all species of plants and animals is the cornerstone for conserving wildlife resources in the forest. Upon completion of the Assessment, it was determined that plan components need to address all wildlife, at-risk species, and wildlife connectivity. Measuring the positive and negative impacts of management actions to those ecological conditions that support wildlife will determine environmental consequences. Three indicators: (1) Habitat Quality Ratings, (2) At-Risk Wildlife Issues and Threats, and (3) Wildlife Habitat Connectivity were chosen to evaluate the environmental consequences of each alternative on wildlife.

Indicator 1: Habitat Quality Ratings

ERU-specific vegetative conditions compose wildlife habitat and are used to determine the impact of each alternative on all wildlife. These ERU vegetative conditions include seral state proportion, snag density, patch size, site potential, ground cover, coarse woody debris, and fire regime and characteristics. Although the Assessment evaluated individual population measures during the SCC evaluation process, these measures are not considered since they are species-based and cannot be used to analyze all wildlife species.

The Santa Fe NF consists of 12 primary ecological response units (ERUs), which are the foundational habitat for all forest wildlife. They are Alpine and Tundra (ALP), Colorado Plateau/Great Basin Grassland (CPGB), Juniper Grassland (JUG), Mixed Conifer with Frequent Fire (MCD), Mixed Conifer with Aspen (MCW), Montane/Subalpine Grassland (MSG), Ponderosa Pine (PPF), Piñon-Juniper Woodland (PJO), Piñon-Juniper Sagebrush (PJS), Piñon-Juniper Grassland (PJG), Spruce-Fir (SFF), and Riparian (RIP). Riparian habitats are sometimes further divided into more distinct herbaceous components (i.e., Herbaceous, Cottonwood, and Willow). However, because riparian habitats only comprise 2.74 percent of the forest, they are considered as one ERU for this analysis, as further subdivision would create miniscule acreages, which are more appropriately analyzed at the project level.

Across these ERUs, wildlife habitat is composed of four habitat elements.

1. **Extent -** the amount of habitat available (Santa Fe NF Assessment, table 18),
2. **Distribution -** the representativeness and redundancy of habitat across the forest (fragmentation determined visually from ERU maps),
3. **Quality -** the percent of current vegetative seral state departure from desired conditions (Santa Fe NF Assessment, table 3),
4. **Processes –** including disturbances such as impacts from fire and flooding (Santa Fe NF Assessment, table 13).

Elements 1 and 2 (extent and distribution of habitat), describe habitat availability. It should be noted that that some individual species require habitat elements or conditions that are naturally rare. This analysis does not evaluate habitat at that fine of scale. It only provides generalizations for broad scale ERUs. For example, alpine-tundra habitats can be found through mountain ranges throughout the western United States, but in the Santa Fe NF, their extent is limited. Though alpine-tundra habitat is limited in extent, it does not affect the quality of the habitat that may be found there. It does provide inference that large populations of alpine-tundra dependent species may not be found in the Santa Fe NF.

Elements 3 and 4 (quality of habitat and processes affecting habitat) describe habitat quality. Each habitat element was given a Habitat Rating to represent its status in the forest (table 43).

Table 43. Quality rating determination for each habitat element

Habitat Rating*	Element 1: Extent of Habitat	Element 2: Distribution of Habitat*	Element 3: Quality of Habitat	Element 4: Processes Affecting Habitat
1 (lowest/poorest)	<5% of the forest	highly fragmented or isolated	67-100% departure	High impact (high fire regime departure)
2 (moderate/medium)	6-20% of the forest	restricted to certain areas	34-66% departure	Moderate impact (moderate fire regime departure)
3 (highest/best)	21-100% of the forest	broadly dispersed	0-33% departure	Low impact (low fire regime departure)

* Forested and grassland ecosystems often occur in large swaths often dictated by elevation. Other environmental factors such as climate, slope, and aspect may dictate fragmentation. Some ERUs such as MSG are naturally fragmented, and their Distribution score is adjusted accordingly.

Habitat ratings are generalizations on how well the habitat provides the ecological conditions necessary to maintain both adequate numbers of native species as well as species diversity. Keep in mind, they are broad generalizations and cannot be used as a basis for predicting necessary ecological conditions for any specific species. Habitat ratings are given a score between 1 and 3, with 3 being the highest rating possible. Therefore, a rating of 3 should equate to the highest quality habitat that would accommodate and benefit the greatest number of species. The four habitat elements considered in the habitat rating are (1) Extent of habitat available, (2) Distribution of habitat in plan area, (3) Quality of habitat, and (4) Processes affecting habitat. These elements are combined into two primary categories, Habitat Availability (elements 1 and 2) and Habitat Quality (elements 3 and 4) and further described below.

Habitat availability could be used as a general indicator of what type of animals are most likely to be encountered in the forest. Since frequent-fire forests (MCD and PPF) comprise over 50 percent of the Santa Fe NF, one should reasonably expect to see wildlife species dependent upon these habitats on a large portion of the forest. Habitat availability could also be an indicator for how well species can adapt and respond to changes in the forest. ***Abundance and redundancy of habitat allows for populations to be more resilient to disturbances meaning they can avoid areas that are disturbed and find alternate suitable habitat. Species are also less susceptible to long-term fluctuations in populations since finding suitable mates for reproduction would be easier since similar habitats and populations would be nearby. Therefore, species within habitats that are abundant and well-distributed would not be limited by issues pertaining to movements and genetic flow***[WL1]***. Conversely, species with limited amounts and distribution of habitat throughout the forest would be impacted by decreased movement and genetic flow between populations***[WL2]. The Habitat Availability Score is noted in table 44.

Table 44. Habitat availability elements for each ecological response unit (ERU)
Quality Rating: 3 = highest/best, 2 = moderate/medium, 1 = lowest/poor

Habitat Elements	ALP	CPGB	JUG	MCD	MCW	MSG	PJO	PPF	PJS	PJG	SAGE	SFF	RIP
Habitat Availability:													
Extent of habitat available	1	1	2	3	1	1	2	3	1	1	1	2	1
Distribution of habitat in plan area	1	1	2	3	2	2	3	3	1	2	2	2	2
Average Habitat Availability*	**1**	**1**	**2**	**3**	**1.5**	**1.5**	**2.5**	**3**	**1**	**1.5**	**1.5**	**2**	**1.5**

Habitat quality should be a general indicator of how well the habitat provides the ecological conditions necessary for an animal to exist within that habitat. Habitat quality may or may not change considerably depending upon the amount of restoration work conducted in each ERU. ***Species within habitats that are of the highest quality (3) would meet their basic life-cycle needs and be provided ample food resources and have few issues finding breeding or brood rearing habitat conditions. Therefore, their populations should not decline and continue to thrive*** [WL3]***. Species within habitats rated as moderate quality (2-2.5) should find most of the ecological conditions they require but not all. Their populations should be sustained but may not be at the optimum capacityWL4. Species within habitats of the lowest quality rating (1-1.5) would be the most severely impacted by deteriorated ecological conditions and food availability may be low and breeding or brood rearing habitat may be absent. Therefore, their populations would struggle and may experience decline***[WL5]***.***

Although quality habitat is the main driver for maintaining viable and healthy populations of wildlife, it is not the only consideration when managing for wildlife. Proper arrangement and distribution of habitats throughout the forest is critical. Desired conditions in both Terrestrial and Aquatic Species and Habitats require this arrangement. For example, desired conditions specify that aquatic and terrestrial habitats are distributed across the forest in a way to help self-sustain wildlife populations (***WL1***). Human-caused impacts are also taken into consideration and attempts are made to minimize negative impacts to wildlife. For example, desired conditions seek to keep wildlife populations free from harassment and human disturbance so as not to disrupt vital functions (e.g., breeding, feeding, and rearing young). ***Wildlife populations may experience population declines if impacts to their behavior reduce their ability to feed or reproduce***[WL6].

Indicator 2: At-Risk Wildlife Issues and Threats

In addition to the habitat conditions for Indicator 1, species specific ecological conditions are analyzed for at-risk species. Issues (coarse-filter, habitat quality) and threats (fine-filter, species specific) for each at-risk species are identified. Since issues and threats usually impact multiple at-risk species they are evaluated for the suite of at-risk species as opposed to for individual species. Individual species evaluations are only conducted when that species requires specific management actions. Thus, ecological conditions and human-caused influences (issues and threats) that impact at-risk species will be evaluated individually.

Indicator 3: Wildlife Habitat Connectivity

Wildlife habitat connectivity is a growing concern, this includes not only habitat connectedness within the forest but beyond its borders as well. All species, especially those that occupy and utilizes multiple ERUs, require the ability to move freely. Although many people equate connectivity to specific areas or corridors, it is far more complex than that. It involves the identification of potential barriers such as easily recognized physical barriers (e.g., major highways or urban centers), as well as the not-easily seen barriers such as out-of-reference ecological conditions. The latter being equally, if not more, important to connectivity.

Another confounding aspect of wildlife connectivity is not only that plants and animals “move around” in the forest, but their patterns are always subject to change, sometimes in drastic fashion. This is why identification of specific corridors may prove problematic. Decisions, therefore, must be made when conditions dictate a need for change in management. Oftentimes, changes in on-the-ground conditions are unexpected and prodigious resulting in significant impact to affected species. For example, uncharacteristic fire has the potential to severely alter movements of species between adjacent or nearby environments, thus, disrupting connectivity of the landscape. For these reasons the management of wildlife resources must incorporate an extremely flexible adaptive management program.

In order to measure the effectiveness of plan components on wildlife connectivity two specific conditions will be evaluated, physical obstructions and ecological function. Physical obstructions are barriers that impede or hinder wildlife movements such as urban centers, roadways, and fences. Obstructions will be located, and alternatives will be evaluated for their mitigation or restriction on creating new obstructions. This will allow the forest to identify areas where egress and ingress (wildlife movements into and out of an area) are most likely to occur (or not occur). Secondarily, the forest will evaluate the ecological function (condition of the habitat) within those areas where movements are seemingly unimpeded. Wildlife connectivity is increased when ecological function is restored. This dynamic approach to improving habitat connectivity will foster increased wildlife movements by restoring habitat "in the right places" without binding management to specific geographic areas (corridors).

3.5.3 Stressors and Drivers

A multitude of influences have major impacts on wildlife, fish, and plant species within the forest. When the habitat changes so do the wildlife that use it. Often stressors beyond our control influence habitat change. Over the long term, as climates change, altered temperature and moisture regimes create conditions that result in vegetation change. Before that occurs, there may be more immediate effects where populations become stressed and their viability is reduced. In other words, they are not adapted to the altered conditions and their populations may see decline. The plants and animals that move in to take advantage of the new conditions are often vastly different than their predecessors.

A consequence of seral state departure and a significant driver of wildlife populations is uncharacteristic high-severity fire. Though it may loosely correlate with climate change, its primary cause is unnaturally high fuel loads in frequent-fire systems. This is the result of long-term fire suppression and past land use practices. These unnatural conditions often result in large-scale, stand-replacing fire in areas that are adapted to frequent, patchy, low-intensity burns. When a large-scale, high-intensity fire occurs, small isolated populations within those stands may be completely lost while more robust populations simply shift their range in the drastically altered landscape. It may take years or decades before populations return to those areas while some may never return. The same effect may occur when disease and insect infestation alter the landscape. Although rarity of habitat does not necessarily reflect an issue, naturally occurring habitat that is limited in its extent in the forest could be drastically impacted by large-scale disturbance events. This could have serious impacts on species dependent upon those limited habitats.

Lastly, human activities both on and off the forest have tremendous influence on wildlife populations. Many animals alter their behavior or may move from an area when human presence is above their threshold of tolerance. This is not to say that we are not to be a part of the system, rather, we must recognize our influence on wildlife populations and strive to strike a balance, so we do not become a reason for decline.

3.5.4 Environmental Consequences

3.5.4.1 Indicator: Habitat Quality Ratings

Effects Common to All Alternatives

Habitat availability will not change within each alternative since management actions would not have an effect on the extent and distribution of the habitats (ERUs) across the forest. For example, the amount of ponderosa pine forest (PPF) ERU throughout the forest is unlikely to change significantly although the condition of PPF may change substantially.

Habitat quality may or may not change considerably depending upon the amount of restoration work conducted in each ERU. Since no restoration objectives are proposed in ALP, MCW, PJO, PJS, and SFF habitat quality within these ERUs will not change between alternatives (table 45). Habitats within these ERUs are rated as moderate to high and should provide the ecological conditions for wildlife (WL3 and WL4).

Table 45. ALL WILDLIFE: Quality of habitat rating in ERUs with no restoration objectives (habitat elements 3 and 4)

(Quality Rating: 3 = high/best, 2 = medium/moderate, 1 = low/worst)

ERU	All Alternatives
Alpine and Tundra	3
Mixed Conifer w/Aspen	2
Piñon-Juniper Woodland	2.5
Piñon-Juniper Sagebrush	2
Spruce Fir Forest	2

Effects Common to Alternatives 2, 3, and 4

Exclusive of habitat improvements (vegetative treatments) there are many forestwide standards and guidelines that are common to alternatives 2, 3, and 4 that benefit wildlife in general. For example, standards and guidelines seek to reduce activities that negatively impact wildlife. Maintaining the integrity of reproductive processes required by wildlife helps maintain populations in general. These oftentimes are in the form or reducing anthropomorphic activities that hinder reproduction (for example, reducing activities in elk calving areas or during migratory bird nesting seasons). New forestwide standards and guidelines also seek to protect geologic and physical features (e.g., talus slopes, cliffs, canyon slopes, caves) that are important to wildlife. ***Preservation of ecological features can provide necessary areas for species to perform basic life-cycle needs such as hibernation, feeding, courtship display, nesting, or brood rearing. Without these protections, wildlife populations may exhibit population decline** [WL6]**.***

Alternative 1 – 1987 Forest Plan: Summary

Table 46. Quality of habitat rating within ERUs that could benefit from restoration - no action

(Quality Rating: 3 = highest/best, 2 = moderate/medium, 1 = lowest/poor)

Habitat Elements	CPGB	JUG	MCD	MSG	PPF	PJG	SAGE	RIP
Habitat Quality:								
Quality of Habitat	1	2	1	2	1	2	2	1
Processes Affecting Habitat	1	2	1	1	1	2	1	1
Average Habitat Quality	**1**	**2**	**1**	**1.5**	**1**	**2**	**1.5**	**1**

Terrestrial Habitat

Wildlife habitat is closely associated with vegetative conditions, especially seral state condition and fire regime class (disturbance factors). There are a number of ERUs where restoration may improve wildlife habitat (ecological conditions) since the quality is considered low to moderate (table 46). Currently, CPGB, MCD, and PPF are among the most highly departed vegetative systems in the forest and received a habitat quality rating of 1. Wildlife within these areas would struggle to meet their most basic life-cycle needs (***WL5***). MSG and SAGE receive a habitat quality rating of 1.5 and although the habitat is slightly better than the previous ERUs, there is still a strong likelihood that wildlife populations would continue to struggle to meet their basic life-cycle needs (***WL5***). JUG and PJG have a habitat quality rating of 2 have habitat that would be considered moderate in quality. Some wildlife populations may thrive, but other wildlife populations would continue to struggle to meet their basic life-cycle needs (***WL4***).

Under the no-action alternative there is some direction for improving habitat for wildlife, however, the direction is often management area-specific and does not apply forestwide or throughout entire ERUs. Desired conditions for vegetation within ERUs would provide for appropriate seral state conditions and fire regime, however, forestwide objectives, standards, and guidelines to move toward those desired vegetative conditions are lacking in some management areas. These two vegetative conditions (seral state and fire regime) are considered the most influential characteristics in determining quality habitat; therefore, this alternative provides only minimal guidance for maintaining and improving habitat for all wildlife since direction is only given in certain management areas. For example, an objective in the no action alternative seeks to improve 1,200 acres of big game winter habitat in the San Miguel and Banco Largo areas. Another plan component in Management Area B provides direction to manage oak communities for early seral stages and late seral stages. This direction is limited in scope as far as geographic areas are concerned and wildlife throughout the forest outside of these areas may suffer (***WL4 and WL5***). Another compounding aspect of this alternative is that direction is often provided as species specific guidance. For example, a Peregrine falcon specific standard advises that stands within 200 feet of canyon rims in falcon feeding zones will receive uneven age, deferral, or other silvicultural treatment to enhance these habitat features. Though helpful for this particular species, the needs for the vast majority of species found in the forest are not addressed and may experience declines due to deteriorated habitat. Due to this lack of forestwide direction, it is likely some areas within the forest could see significant deterioration of habitat quality especially if the area lies within a Management Area that does not emphasize wildlife or if a species in question is not specifically addressed by this alternative (***WL4 and WL5***). Given the constrained focus of management to specific areas or species, this alternative provides the least effect on overall terrestrial habitat and would result in the greatest number of species being impacted by out-of-reference ecological conditions.

Aquatic Habitat

The no-action alternative does not provide a focused approach to aquatic ecosystem restoration and management. While guidelines are included that provide management direction for riparian areas and streambed sedimentation, specific objectives for riparian, aquatic, and native fish restoration are lacking. For example, a plan component directs that the composition of sand, silt, and clays within streambeds should not exceed 20 percent of natural levels. Though useful guidance, the lack of objectives results in a rate of improvement within impaired aquatic systems that may be extremely slow and may not be directed to the areas of greatest need. The lack of specificity in standards and guidelines in various riparian systems (i.e., Herbaceous, Cottonwood, and Willow) provides little direction for forest managers needing to focus their management efforts to provide the greatest amount of benefit for each system. The vegetation within each riparian system has a tremendous influence on water quality and their subsequent aquatic systems. Forestwide aquatic systems will only move toward desired conditions provided the improvement use the correct guidance and unimpaired systems do not degrade further from their current conditions. Also, outside of Management Area H, there is minimal direction to increase the distribution of native wildlife. Current trends suggest the demand for water, fertile land, and forage for livestock in the arid and semi-arid West has already affected many aquatic, riparian, and wetland areas and pressures will likely increase with time, threatening the integrity and long-term viability of these vital ecosystems and the biota they support (Baron et al. 2002). This demonstrates the ineffectiveness of current plan guidance.

Water quality impairments are likely to continue and riparian and aquatic habitat conditions are likely to remain degraded. The distribution of aquatic species is likely to decline over time due to small population sizes and catastrophic events such as uncharacteristic wildfire and drought (***WL1***).

Riparian (RIP)

Availability and quality of riparian habitat is often complex. Although riparian habitats make up only small portion of the forest they are well distributed throughout the forest and found in multiple watersheds; therefore, they receive a moderate distribution rating. Aquatic species within these areas should be protected against extirpation since species would be found in multiple locations throughout the forest (***WL1***). However, since riparian habitat often consists of long linear threads (vegetation along streams and rivers) it is not very abundant habitat which may be detrimental to wildlife (***WL2***).

The average habitat quality is moderate (61 percent average seral state departure) with herbaceous habitats being the most highly departed (73 percent seral state departure) and cottonwood and willow moderately departed (56 and 54 percent, respectively). However, water conditions in riparian areas play a major role in providing appropriate ecological conditions for aquatic species and in many areas water conditions are severely departed (Santa Fe NF 2016). Riparian habitats are also prone to major disturbances so their processes rating (element 4) is also low. Disturbance factors such as fire in upland areas can seriously impact riparian areas through erosion and subsequent siltation of waterways. Siltation of streams decreases oxygen levels and may cause mortality in many aquatic species. Therefore, Quality of Habitat is given a low rating (1). Aquatic species within these areas would struggle to meet their most basic life-cycle needs (***WL5***). This alternative provides the least effect to aquatic habitat and would result in the greatest number of species experiencing population decline.

Summary of the No-Action Alternative

Under the no-action alternative, seven ERUs (ALP, JUG, MCW, PJO, PJS, PJG, and SFF) received a habitat quality score of moderate to high (2+). These ERUs should provide excellent habitat for all the wildlife in the forest and their populations should continue to thrive. Two ERUs (MSG and SAGE) received a habitat quality score of low to moderate (1.5), therefore, some wildlife species may be affected by poor or deteriorating habitat conditions. This would include some species struggling to meet all of their basic life-cycle needs and subsequently may experience population decline. Four ERUs (CPGB, MCD, PPF, and RIP) received the lowest habitat quality rating (1). Wildlife within these ERUs are most likely to struggle to meet their basic life-cycle needs and may experience population declines.

Alternative 2 – Forest Plan

Table 47. Quality of habitat rating within ERUs that benefit from restoration - proposed action
(Quality Rating: 3 = highest/best, 2 = moderate/medium, 1 = lowest/poor)

Habitat Elements	CPGB	JUG	MCD	MSG	PPF	PJG	SAGE	RIP
Habitat Quality:								
Quality of Habitat	2	3	2	3	2	3	3	2
Processes Affecting Habitat	2	3	2	2	2	3	2	2
Average Habitat Quality	**2**	**3**	**2**	**2.5**	**2**	**3**	**2.5**	**2**

In all ERUs the quality of habitat is improved over the no-action alternative.

Terrestrial Habitats:

Under the proposed action (alternative 2), desired conditions for each ERU provide specific guidance for appropriate seral state distributions as well as many other habitat features. However, as opposed to the no action alternative, the proposed action sets objectives, standards, and guidelines to move toward those desired conditions. The proposed action sets a maximum objective of 630,000 acres of restoration work to be completed in PPF and MCD over a 10-year period and an additional 87,000 acres of restoration work in highly departed non-forested ERUs. There is also an objective to restore or enhance at least 50,000 acres of terrestrial wildlife habitat during each 10-year period of the life of the plan. This totals 767,000 acres that could be improved for wildlife habitat. These objectives would help increase the rate in which desired conditions are achieved and would ultimately improve wildlife habitat. Restoration activities within these ERUs are primarily accomplished with mechanical treatments and prescribed fire; however, more adaptive management strategies may be required to achieve objectives (e.g., reseeding following shrub encroachment in grasslands, restoring fire in invasive species invaded grasslands, considering efficacy of fire in SAGE restoration). Moving toward desired conditions would decrease seral state departure and positively affect habitat for all wildlife species (***WL3***).

Habitat improvements through restoration objectives results in ERUs increasing their habitat rating by a factor of 1 (table 47). Although the greatest amount of restoration work is directed in MCD and PPF, these two ERUs make up the greatest amount of the forest so proportionally, restoration work within each ERU should improve habitat similarly. In CPGB, MCD, and PPF the habitat quality rating increases from 1 to 2, in MSG and SAGE the rating increases from 1.5 to 2.5, and in JUG and PJG the rating increases from 2 to 3. Therefore, wildlife populations within these seven ERUs should be maintained or increased due to improved habitat conditions (***WL4 and WL3***). This alternative provides the greatest effect to terrestrial habitat and would benefit the greatest number of species.

Aquatic Habitats:

Alternative 2 provides a comprehensive and focused approach to aquatic ecosystem protection and restoration. Specific objectives for riparian and aquatic restoration and watershed restoration are included that would provide moderate improvements toward maintaining or improving habitat for aquatic and riparian species. For example, there is an objective that strives to complete aquatic restoration projects on 30 miles of aquatic habitat (e.g., increase pool quantity, provide stream cover, remove or install of fish barriers, restore beaver populations, treating invasive aquatic species, etc.) every 10 years. Standards and guidelines for the protection of water and habitat quality should lead to improvements in water quality and when combined with vegetative restoration objectives should lead toward improved aquatic habitat conditions. There is direction to manage coldwater streams to move toward State of New Mexico standards for stream water temperatures for High Quality Coldwater systems. This should improve the quality of habitat within stretches where management occurs. Riparian and aquatic habitat conditions are likely to make improvements toward desired conditions and should maintain or increase aquatic species populations (***WL3***).

Riparian (RIP)

With the proposed action, plan components would direct management activities to improve the aquatic habitat within the Riparian ERU. The habitat quality rating increases from 1 to 2. Therefore, aquatic species populations within this ERU should be maintained or increased due to improved habitat conditions (***WL4***). This alternative provides the second greatest effect to aquatic habitat and would result in a high number of species maintaining or increasing their population.

Summary of Alternative 2 – Forest Plan:

Under the proposed action, eight ERUs (CPGB, JUG, MCD, MSG, PPF, PJG, SAGE and RIP) are likely to improve the quality of habitat for all wildlife. This is achieved through objectives, standards, and guidelines that combine the use of prescribed fire and mechanical treatments. Under the proposed action, all ERUs would achieve a habitat quality rating of 2 or higher, therefore, this alternative allows for the greatest number of species to meet their basic life-cycle needs (***WL3 and WL4***).

See appendix E for plan components addressing habitat quality.

Alternative 3 - Natural Processes Emphasis

Table 48. Quality of habitat rating within ERUs that benefit from restoration* - natural processes emphasis
(Quality Rating: 3 = highest/best, 2 = moderate/medium, 1 = lowest/poor)

Habitat Elements	CPGB	JUG	MCD	MSG	PPF	PJG	SAGE	RIP
Habitat Quality:								
Quality of Habitat	2	3	1	3	1	3	3	2
Processes Affecting Habitat	2	3	1	2	1	3	2	2
Average Habitat Quality	**2**	**3**	**1**	**2.5**	**1**	**3**	**2.5**	**2**

* Gray fill denotes the ERU where quality of habitat is improved over the no-action alternative.

Terrestrial Habitats

Under the natural processes emphasis alternative (alternative 3) the same set of desired conditions as the proposed action are proposed. This alternative, however, places more emphasis on natural processes such as fire to achieve desired conditions, with less emphasis on mechanical treatments. For example, in ponderosa pine forests, objectives for prescribed fire treatments increase from a maximum acreage of 250,000 acres to 900,000 acres, while mechanical treatment acreage decreases from 100,000 to 22,000 acres. The manner in which treatments are applied affects the amount of restoration that can occur and impacts the total acreage of treatment since more acreage can be treated by prescribed fire as opposed to mechanical treatments. Under this alternative, objectives for treatments in certain ERUs increase substantially. In non-forested ERUs, treated acre objectives increase 379 percent (maximum acres: 87,000 to 330,150), while treated acreage objectives in forested ERUs (PPF and MCD) increase 277 percent (maximum acres: 630,000 to 1,742,000). The objective to restore or enhance terrestrial wildlife habitat during each 10-year period also increases from 50,000 to 100,000 acres under this alternative. This totals over 2 million acres that could be improved for wildlife habitat (some areas require treatment multiple times within the life of the plan).

The differences in treatment approach and acreages primarily affects the rate at which desired conditions are obtained but they also introduce an additional threat to habitat, namely the increased likelihood of uncharacteristic (large-scale, high-severity) fire. This risk is primarily associated with frequent-fire forested systems like PPF and MCD. Non-forested ERUs are not at as great of risk for uncharacteristic fire as frequent-fire forests, though they are still susceptible to the negative effects of such fires. The objectives in this alternative should increase the rate in which desired conditions are achieved which would ultimately improve wildlife habitat, however, ***the additional risk of uncharacteristic fire in frequent-fire forested systems (PPF and MCD) could potentially harm wildlife through direct mortality or complete destruction of the habitat and the ecological conditions within[WL7].***

The natural processes emphasis alternative would improve the habitat within five terrestrial ERUs. In CPGB, the habitat quality rating increases from 1 to 2; in MSG and SAGE the rating increases from 1.5 to 2.5; and in JUG and PJG the rating increases from 2 to 3 (table 48). Therefore, wildlife populations within these five ERUs should be maintained or increased due to improved habitat conditions (***WL3 and WL4***). This would result in the same effects as the proposed action.

There would be an increased potential for uncharacteristic fire in MCD and PPF. Therefore, the habitat quality rating does not improve and remains at a habitat quality rating of 1. Wildlife within these areas would struggle to meet their most basic life-cycle needs (***WL5***).

Aquatic Habitats:

Under the natural processes emphasis alternative (alternative 3) the same set of desired conditions as the proposed action are proposed. This alternative, however, places more emphasis on natural processes and increases the amount of restoration work. For example, the objective to complete aquatic restoration on priority projects and restore aquatic habitat increases from 30 miles to 60 miles. Standards and guidelines for the protection of water and habitat quality should lead to improvements in water quality and when combined with restoration objectives should lead to improved habitat conditions within riparian areas. Riparian and aquatic habitat conditions are likely to make improvements toward desired conditions. ***The distribution of native fish is likely to stabilize and increase highly over time due to active efforts to expand their populations***[WL8]***.***

Riparian (RIP)

With the proposed action, plan components would direct management activities to improve the aquatic habitat within the Riparian ERU. The habitat quality rating increases from 1 to 2. Therefore, aquatic species populations within this ERU should be maintained or increased due to improved habitat conditions (***WL4***). This alternative provides the greatest effect to aquatic habitat and would result in the highest number of species maintaining or increasing their population.

Summary of Natural Processes Emphasis – Alternative 3:

Under the natural processes emphasis alternative, six ERUs (CPGB, JUG, MSG, PJG, SAGE and RIP) would likely to improve the quality of habitat for all wildlife. This would be achieved through objectives, standards, and guidelines that emphasize the use of prescribed fire. Therefore, 11 ERUs would achieve a habitat quality rating of 2 or higher (***WL4***). Two of the ERUs (MCD and PPF), however, are exposed to additional risk from uncharacteristic fire, and subsequently, do no improve their habitat quality score, keeping them at a habitat quality rating or 1 (***WL5***). This alternative is the second-best option for improving habitat for all wildlife.

See appendix E for plan components addressing habitat quality.

Alternative 4 - Human Uses Emphasis

Table 49. Quality of habitat element within each ecological response unit (ERU) – human uses emphasis
(Quality Rating: 3 = highest/best, 2 = moderate/medium, 1 = lowest/poor)

Habitat Elements	CPGB	JUG	MCD	MSG	PPF	PJG	SAGE	RIP
Habitat Quality:								
Quality of Habitat	1	2	1	2	1	2	2	1
Processes Affecting Habitat	1	2	1	1	1	2	1	1
Average Habitat Quality	**1**	**2**	**1**	**1.5**	**1**	**2**	**1.5**	**1**

Terrestrial Habitats:

Under the human uses emphasis alternative (alternative 4) the same set of desired conditions as the proposed action are proposed. This alternative, however, places more emphasis on human uses such as mechanical treatments to achieve desired conditions, with less emphasis on prescribed fire. For example, in ponderosa pine forests, objectives for mechanical treatments increase from a maximum acreage of

100,000 acres to 230,000 acres, while prescribed fire treatment acreage decreases from 250,000 to 23,000 acres. The manner in which treatments are applied affects the amount of restoration that can occur and impacts the total acreage of treatment since less acreage can be treated by mechanical treatments as opposed to prescribed fire. Under this alternative, objectives for treatments in certain ERUs change substantially. In non-forested ERUs, treated acre objectives increase 47 percent (maximum acres: 87,000 to 128,000), while treated acreage objectives in forested ERUs (PPF and MCD) decrease 25 percent (maximum acres: 630,000 to 478,000). The objective to restore or enhance terrestrial wildlife habitat during each 10-year period is removed and goes from 50,000 to 0 acres under this alternative. This totals 606,000 acres that could be improved for wildlife habitat.

The differences in treatment approach and acreages primarily affects the rate at which desired conditions are obtained. Although the acreages for vegetative treatment in alternative 4 are similar to alternative 2 (606,000 acres compared to 767,000 acres) and could improve wildlife habitat (***WL2***), they also introduce multiple threats to wildlife because of the increased human uses. Additional threats such as ground and soil disturbance, intrusive human activity, and introduction of invasive species or disease are some of the additional threats that need to be considered under this alternative. ***Although habitat would improve, wildlife would be negatively impacted due to trampling or ground compaction, increased competition from invasive species, or changes in their behavior (human disturbance) that decreases their survival rate***[WL9]***.*** Because of these additional threats, the effects would be similar to the no-action alternative (table 49).

The human uses emphasis action would direct habitat improvement within seven terrestrial ERUs (CPGB, JUG, MCD, MSG, PPF, PJG, and SAGE); however, additional threats introduced through increased human uses (***WL9***) negates any gains made in habitat, and therefore, habitat quality ratings do not improve. The effects to wildlife and wildlife habitat within this alternative are similar to the no-action alternative. Wildlife populations would continue to struggle to meet their basic life-cycle needs (***WL5***).

Aquatic Habitats:

Under the human uses emphasis alternative (alternative 4), the same set of desired conditions as the proposed action are proposed. This alternative, however, places more emphasis on human uses and eliminates restoration work in riparian areas. For example, the objective to complete aquatic restoration on priority projects and restore aquatic habitat decreases from 30 miles to 0 miles. There are also additional guidelines that call for ***adding temporary or permanent roads to the system, which could result in degraded riparian habitat due to erosion and subsequent siltation***[WL10]. Water quality impairments are likely to continue and riparian and aquatic habitat conditions are likely to remain degraded. The lack of a focused restoration objectives does not move riparian and aquatic ecosystems toward maintaining or improving habitat for aquatic and riparian species and does not increase the distribution of native fish species. Therefore, ***the distribution of native fish is likely to decline over time due to small population sizes and catastrophic events such as uncharacteristic wildfire and drought, which increases erosion and causes excessive siltation leading to potential aquatic species die-offs***[WL11]***.***

Riparian (RIP)

The effects to aquatic species habitat in this alternative are similar to the no-action alternative. Wildlife populations would continue to struggle to meet their basic life-cycle needs (***WL5, WL10, and WL11***).

Summary Alternative 4 – Human Uses Emphasis

Under alternative 4, the same effects as the no-action alternative would occur and wildlife within the ERUs would continue to struggle to meet their basic life-cycle needs (***WL5***).

See appendix E for plan components addressing habitat quality.

All Wildlife Summary:

Alternative 1 lacks direction to improve habitat for all wildlife species. Although not all ERUs are in poor reference condition, improvements in departed ERUs are unlikely to occur. Alternative 2 not only maintains the habitats that are in reference, it is reasonably expected to improve habitat conditions for wildlife in eight ERUs that are highly departed. Alternative 3 also maintains habitat conditions in ERUs that are not highly departed and improves conditions in six of the highly departed ERUs; however, there is concern regarding the use of prescribed fire in highly departed frequent-fire forested systems (MCD and PPF). Alternative 4 is similar to alternative 1 in that habitat conditions within the ERUs should be maintained; however, the introduction of additional threats to wildlife with increased human uses negates any gains in improved habitat. Alternative 2 is the best option for maintaining and improving the habitat for all wildlife species. See table 50.

Table 50. ALTERNATIVE COMPARISON – ALL WILDLIFE: Quality of habitat elements within each ecological response unit (ERU)

Gray fill denotes the alternative with the greatest likelihood of providing quality habitat for all wildlife. (Quality Rating: 3 = high/best, 2 = medium/moderate, 1 = low/worst)

ERU	Habitat Availability	Habitat Quality			
	All Alternatives	Alternative 1 1987 Forest Plan	Alternative 2 Forest Plan	Alternative 3 Natural Processes	Alternative 4 Human Uses
Alpine and Tundra	1	3	3	3	3
Colorado Plateau/Great Basin	1	1	2	2	1
Juniper Grass	2	2	3	3	2
Mixed Conifer Frequent Fire	3	1	2	1	1
Mixed Conifer w/Aspen	1.5	2	2	2	2
Montane Subalpine Grass	1.5	1.5	2.5	2.5	1.5
Piñon-Juniper Woodland	2.5	2.5	2.5	2.5	2.5
Ponderosa Pine Forest	3	1	2	1	1
Piñon-Juniper Sagebrush	1	2	2	2	2
Piñon-Juniper Grass	1.5	2	3	3	2
Sagebrush Shrubland	1.5	1.5	2.5	2.5	1.5
Spruce Fir Forest	2	2	2	2	2
Riparian	1.5	1	2	2	1

3.5.4.2 Indicator: At-Risk Wildlife

At-Risk Species

There are 36 at-risk species identified in the Santa Fe NF (4 federally listed and 32 SCCs) all of which rely on quality habitat found in the forest. Quality habitat is defined by ecological conditions that are at or approaching reference condition as well as abiotic (non-living features like water or rock) and geological features (e.g., cliff and rock formations) that provide all the life-cycle requirements for a particular species. ERUs form the foundation for habitat types.

Wildlife habitat within ERUs provides shelter, food, cover, and other physical needs for the wildlife it supports and consists of many biotic and abiotic components. Biotic components include vegetative conditions such as seral state, snag density, coarse woody debris, and vegetative composition. Historically, natural disturbance processes at varying intervals reset these conditions on varying scales resulting in a myriad of vegetative conditions that maximized species diversity. Abiotic components that support wildlife, such as water and other geologic features, need to be found in sufficient quantity and quality so as to meet the needs of wildlife that depend on it. To compound matters, not all species rely on the same habitat components, therefore, habitat that has some degraded components may negatively impact some species but not others.

Methodology

Each at-risk species is associated with one or more habitat types (ERUs). These ERUs are where the species is known to spend all, or most of its life, or it can be an ERU that provides habitat for a critical life-cycle need. For example, certain bird species may spend most of their life off the forest but rely on a certain grassland-land type within the forest for breeding and nesting purposes. Identifying degraded ecological conditions within ERUs allows forest staff to best direct their management actions to maintain or improve conditions for at-risk species. Although wildlife habitat is critical for species needs, it is not the only consideration. There are human-related activities that occur in the forest that can also negatively impact at-risk species. These can be direct impact from humans (e.g., hiking) or from permitted activities (e.g., utilities).

Issues and threats that are known to negatively impact at-risk species were identified (table 51). *Issues are defined as ecological conditions that are currently degraded. This often results in lower quality habitat that may negatively impact at-risk species.* For example, inadequate snag densities within ponderosa pine forests may negatively impact snag-dependent at-risk bird species since they rely on these features for foraging and nesting. Eight habitat-related issues were identified. These are most often addressed through course filter plan components. *Threats are defined as forest activities (direct from humans) that may negatively impact at-risk species*. Threats may not be currently impacting species, but if allowed, could potentially threaten the persistence of at-risk species in the forest. For example, recreational disturbance from rock climbers may negatively impact cliff-dwelling at-risk species by interrupting critical life-cycle needs (e.g., breeding or nesting). Six activity-related threats were identified. These are most often addressed through fine filter plan components.

Table 51. Issues and threats associated with at-risk species (Santa Fe NF Plan Final Assessment Report, 2016, Volume I. Ecological Resources)

	Issues with Degraded Ecological Conditions - Habitat (*Mostly Coarse Filter*)								Threats from Human or Forest Activities (*Mostly Fine Filter*)					
At-Risk Species Common name and (*scientific name*)	A. Highly Departed Seral State	B. Highly Departed Coarse Woody Debris	C. Highly Departed Snag Density	D. Uncharacteristic Fire	E. Invasive Vegetation Encroachment	F. Disconnected Flood plains (wet soils)	G. Limited or Specific Soil Conditions	H. Specific Ecological Features or Conditions	I. Nonnative Predation (Aquatic)	J. Ground/Soil Disturbance (Livestock Grazing, Roads and Trails)	K. Intrusive Human Activity (Rec Disturbance)	L. Unnatural Disease (introduced or spread)	M. Man-made Features (Mortality/Alt. Behav.)	N. Chemical Applications (e.g., pesticides)
American marten (*Martes caurina*)		X		X	X									
American peregrine falcon (*Falco peregrinus anatum*)								X			X		X	X
Arizona willow (*Salix arizonica*)	X	X		X	X	X				X				
Black swift (*Cypseloides niger*)	X							X			X			
Boreal owl (*Aegolius funereus*)				X										
Chaco milkvetch (*Astragalus micromerius*)							X	X		X				
Chama blazing star (*Mentzelia conspicua*)		X			X		X	X		X				
Greene's milkweed (*Asclepias uncialis*)	X	X			X					X				
Gunnison's prairie dog (*Cynomys gunnisoni*)											X	X	X	
Gunnison's mariposa lily (*Calochortus gunnisonii*)	X			X				X						
Heil's alpine whitlowgrass (*Draba heilii Al-shebaz*)										X	X			
Holy Ghost ipomopsis (*Ipomopsis sanctispiritu*)				X						X	X			
Jemez Mountain salamander (*Plethodon neomexicanus*)				X								X		
Jemez woodland snail (*Ashmunella ashmuni*)	X			X			X	X						
Large yellow lady's-slipper (*Cypripedium parviflorum*)		X		X	X					X	X			
Lewis's woodpecker (*Melanerpes lewis*)	X		X	X										
Lilljeborg's peaclam (*Pisidium lilljeborgi*)				X										X
Masked shrew (*Sorex cinereus*)	X			X	X	X					X			
Mexican spotted owl (*Strix occidentalis lucida*)	X		X	X				X						
NM Meadow jumping mouse (*Zapus hudsonius luteus*)	X			X	X	X		X		X	X			
Northern goshawk (*Accipiter gentilis*)	X			X				X					X	
Northern leopard frog (*Lithobates pipiens*)	X			X		X		X	X	X	X	X	X	X
Pecos fleabane (*Erigeron subglaber*)	X	X		X	X					X	X			
Pinyon jay (*Gymnorhinus cyanocephalus*)													X	
Rio Grande chub (*Gila Pandora*)	X	X		X	X	X		X	X	X	X			X
Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*)	X	X		X	X	X		X	X	X	X	X		X

At-Risk Species Common name and (*scientific name*)	A. Highly Departed Seral State	B. Highly Departed Coarse Woody Debris	C. Highly Departed Snag Density	D. Uncharacteristic Fire	E. Invasive Vegetation Encroachment	F. Disconnected Flood plains (wet soils)	G. Limited or Specific Soil Conditions	H. Specific Ecological Features or Conditions	I. Nonnative Predation (Aquatic)	J. Ground/Soil Disturbance (Livestock Grazing, Roads and Trails)	K. Intrusive Human Activity (Rec Disturbance)	L. Unnatural Disease (introduced or spread)	M. Man-made Features (Mortality/Alt. Behav.)	N. Chemical Applications (e.g., pesticides)
Rio Grande sucker (*Catostomus plebeius*)	X	X		X	X	X		X	X	X	X			X
Ruidoso snaggletooth (*Gastrocopta ruidosensis*)							X	X		X				
Snowshoe hare (*Lepus Americana*)		X		X	X									
Spotted bat (*Euderma maculatum*)	X			X							X			
Springer's blazing star (*Mentzelia springeri*)	X	X			X		X	X		X				
Tufted sand verbena (*Abronia bigelovii*)	X			X			X	X						
Water shrew (*Sorex palustris*)	X			X	X	X		X			X			
Western burrowing owl (*Athene cunicularia hypugaea*)	X							X			X			
White-tailed ptarmigan (*Lagopus leucurus*)	X										X			
Wood lily (*Lilium philadelphicum*)	X			X										

Note: Columns displaying X's indicate presence of an issue or threat for a species.

Issues for At-Risk Species Related to Degraded Ecological Conditions (Habitat)

Issues A through H deal with wildlife habitat and focus specifically on degraded ecological conditions (table 51). These issues are typically addressed through coarse-filter plan components within the proposed action and alternatives.

Issue A. - Highly Departed Seral State

Over 60 percent of all at-risk species in the Santa Fe NF are impacted by highly departed seral state (table 48; Santa Fe NF Plan Final Assessment Report, 2016). Seral state is a complex issue that deals with the ecological succession of vegetation as it progresses toward a climax community. It looks at how vegetative systems age and develop over time and what the average range of age classes (with corresponding plant compositions) of vegetation exist within the system. For example, a healthy and productive (in-reference condition) forest will consist of a mix of young, middle-aged, and old trees as well as gaps in between. These gaps may consist of open ground or herbaceous vegetation. A complete description of ERUs and their seral state composition is found in the Assessment (Santa Fe NF 2016). The variability in vegetative structure also contributes to other ecological conditions necessary for some species such as snag density (amount of standing dead trees) or the amount of coarse woody debris (amount of dead tree material on the ground). These components may be critical for the persistence of some species and are indirectly tied to seral state condition since seral state impacts the recruitment, retention, and size classes of these features (Parsons and DeBenedetti 1979, Moore et al. 1999). Departure from reference conditions can negatively impact the habitat associated with these ecosystems. For example, a spruce-fir forest that consists of 80 percent early successional tress (young trees) may lack the structure and snags provided by old and dying trees. This can negatively impact the wildlife species dependent upon the seral states within healthy spruce-fir forests (Hemstrom 2001).

Another issue caused by out-of-reference seral state is the increased potential for large-scale, high-severity (e.g., uncharacteristic; stand-replacing) fire. In both forested and non-forested ecosystems, fuel loads can build to levels that increase the potential for severe and detrimental fire effects (i.e., catastrophic). Besides devastating the vegetative conditions within an ERU, these stand-replacing fires can also potentially wipe out at-risk species that reside in those systems, especially if they are rare or endemic.

The cause of seral state departure can usually be traced back to long-term human-made actions such as fire-suppression or inappropriate grazing. Vegetative conditions, including how they naturally transition over time and with disturbances, are the foundation of most wildlife habitat. Therefore, vegetation that closely mirrors appropriate distributions of these natural vegetative transitional states, or seral states, makes better wildlife habitat than vegetation that is departed from the appropriate seral state distributions (as defined by historic or reference conditions). Some at-risk species depend upon in-reference seral state condition in one, or multiple, ERUs for persistence in the forest (table 52).

The vegetation analysis in this EIS considers seral state departure for each ERU in the Santa Fe NF. Since at-risk species habitat can be linked with specific ERUs, information about each ERU's seral state departure can be used as an indicator for specific habitat conditions required by some at-risk species. This is a complex issue; however, since many habitat features can be linked to seral state. For example, vegetative structure (amount, size, and spacing of vegetation) may be a key component required for basic life-cycle needs (foraging, nesting, breeding territory) of some at-risk species and this can be directly associated with seral state. However, since seral state is related to the aging of vegetation over time, it can be indirectly associated with other habitat components such as snag development or the buildup of coarse woody debris. ERUs with moderately or highly departed seral states are likely to provide poorer habitat conditions for at-risk species while ERUs with low departure of seral states are likely to provide better habitat conditions for at-risk species. This assumption is supported by numerous species-specific studies (Werner and Glennemeier 1999).

Seral state departure impacts on at-risk species is analyzed separately for upland and riparian ERUs. Species that depend on upland ERUs for their habitat are addressed in the upland section and species that depend on the riparian ERUs (i.e., Herbaceous, Cottonwood, and Mixed-Conifer Willow) are addressed in the riparian section.

Seral State - Upland Analysis

Metric: Percent Seral State Departure

Thirteen at-risk species are impacted by highly departed seral state (table 52) and are found in upland ERUs: Greene's milkweed, mariposa lily, Jemez woodland snail, Lewis's woodpecker, Mexican spotted owl, northern goshawk, Pecos fleabane, spotted bat, Springer's blazing star, tufted sand verbena, western burrowing owl, white-tailed ptarmigan, and wood lily. These species utilize 11 of the 12 upland ERUs as habitat: ALP, CPGB, JUG, MCD, MCW, MSG, PJO, PPF, PJG, SAGE, and SFF (table 50).

Table 52. At-risk species impacted by departed seral state and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
Arizona willow													X
Black swift													X
Greene’s milkweed							X			X			
Gunnison’s mariposa lily						X							
Jemez woodland snail			X	X				X					
Lewis’s woodpecker								X					
Masked shrew													X
Mexican spotted owl				X				X					
NM Meadow jumping mouse													X
Northern goshawk				X	X			X					
Northern leopard frog													X
Pecos fleabane												X	
Rio Grande chub													X
Rio Grande cutthroat trout													X
Rio Grande sucker													X
Spotted bat					X							X	
Springer’s blazing star							X						
Tufted sand verbena			X								X		
Water shrew													X
Western burrowing owl		X											
White-tailed ptarmigan	X												
Wood lily								X					

Note: Columns displaying X’s indicate impact of the species in that ERU.

The remaining seven ERUs (CPGB, MSG, SAGE, JUG, PJG, MCD, and PPF) have seral state conditions that are highly departed or are moderately departed and trending away from reference condition (table 53), therefore, they may be impacting the viability of at-risk species in the Santa Fe NF. Seral state departure may impact at-risk species in different ways. For example, at-risk birds oftentimes require structural components for nesting. These in-reference conditions also provide the necessary foraging grounds for birds and mammals. Canopy closure from out-of-reference conditions within forested ERUs may impact at-risk plants while inappropriate ground cover could impact not just plants, but ground dwelling birds as well.

Effects Common to All Alternatives

One ERU, PJS does not contain any at-risk species impacted by this issue, therefore, will not be analyzed in the seral state indicator for at-risk species. Four ERUs (ALP, PJO, MCW, and SFF) are at moderate to low seral state departure and are not expected to trend away from desired condition between alternatives or within the life of the plan. Since vegetative conditions are in low departure, at-risk species that are not be affected by this issue include white-tailed ptarmigan, spotted bat, Pecos fleabane, and Springer's blazing star.

Table 53. Seral state departure within ERUs (Santa Fe NF Assessment 2016)

System	ERU Code	ERU Name	Departure	Departure Index
Grassland	CPGB	Colorado Plateau/Great Basin	High	93
Grassland	MSG	Montane/Subalpine Grassland	Moderate	60
Shrubland	ALP	Alpine and Tundra	Low	---
Shrubland	SAGE	Sagebrush Shrubland	Moderate	41
Woodland	JUG	Juniper Grass	Moderate	45
Woodland	PJG	Piñon Juniper Grass	Moderate	45
Woodland	PJS	Piñon Juniper Sagebrush	Moderate	46
Woodland	PJO	Piñon Juniper Woodland	Low	28
Forest	MCD	Mixed Conifer-Frequent Fire	High	74
Forest	MCW	Mixed Conifer with Aspen	Moderate	47
Forest	PPF	Ponderosa Pine Forest	High	97
Forest	SFF	Spruce-Fir Forest	Moderate	54

Alternative 1 – 1987 Forest Plan

Under the no-action alternative, seral state conditions are addressed primarily through active timber and fuels management. These vegetative prescriptions also vary widely by management areas. Areas with a heavy timber focus have very specific forest conditions they are trying to achieve while other areas have little to no vegetative direction at all. The current Forest Plan allows for timber management and prescribed burning and promotes management to reduce hazardous fuels. Prescribed fire, using planned and unplanned ignitions, would continue to be used to enhance and accomplish resource objectives, particularly in fire-dependent ecosystems. Forestry objectives under the current plan are more focused on timber production and reference practices that are less common today where focus has now shifted to forest restoration. Although treatments will continue in both non-forested and forested ERUs, the rate of treatment often results in improvements that take more than 50 years (see vegetation analysis). Since there is no foreseeable improvement in seral state conditions, multiple effects would continue to occur. ***At-risk bird and mammal species that depend on appropriate vegetative structure for nesting, denning, and foraging would continue to be impacted by out-of-reference seral state conditions and may experience population declines[WL12]. At-risk plant species dependent upon bare ground or open canopies for germination would struggle to maintain viable populations in areas in which they are found[WL13].*** The species currently identified as being at-risk and impacted by seral state departure in the upland ERUs either became at-risk or did not improve under the current direction, therefore, their viability is unlikely to increase under this alternative.

In summary, this alternative provides specific direction for seral state condition in only certain management areas and lacks overall forestwide direction. Although the 1987 Forest Plan does not prevent the work needed to improve seral state conditions, it does not provide specific direction and implementation under this plan has not always helped us achieve these vegetative desired conditions. Therefore, seral state conditions are less likely to be achieved, especially in areas without timber or fuel management. This will continue to negatively affect multiple ecological conditions directly linked to seral state and will continue to impact at-risk species that are dependent upon appropriate seral state conditions. This alternative has the least effect on seral state and may continue to impact at-risk species (***WL12 and WL13***).

Alternative 2 – Forest Plan

Vegetative desired conditions for appropriate seral state distributions for each ERU can be found in the Plan (proposed action). In addition to desired conditions, there are large-scale vegetation objectives as well as standards and guidelines in the Timber and Range sections that are designed to move toward those conditions. Although plan components addressing seral state are typically found in the Vegetation sections, they can also be found in Fire, Forestry, Range, Terrestrial Species, and At-Risk Species sections. If the proposed action moves forward, the following changes and subsequent effects are likely to occur.

Non-forested ERUs (CPGB, MSG, SAGE, JUG, and PJG)

Desired conditions within the proposed action explicitly defines the percentage of seral states in each non-forested ERU (early, mid-, late-, and encroached by woody species). They also provide guidance on openness as well as fire return interval, some even describe dominant vegetative species types. The proposed action then sets a maximum objective of 87,000 acres of restoration work to be completed over a 10-year period. There is also an objective to restore 50,000 acres of wildlife habitat in that same time period that can be applied in these areas. These objectives will help increase the rate in which desired conditions are achieved and ultimately improve conditions for the at-risk species reliant upon appropriate seral state conditions. Standards and guidelines within other sections of the plan dictate how the restoration work is to be carried out to not impact the habitats or other wildlife, fish, and plant species. For example, a guideline in the Invasive Species section requires the authorized activities eliminate or reduce the potential for introduction of or spread of invasive species. The complement of desired conditions, objectives, standards, and guidelines would increase the viability of species that are negatively impacted by out-of-reference seral state conditions in non-forested ERUs. The following discussion demonstrates how improved seral state conditions would increase the viability for at-risk species.

Colorado Plateau/Great Basin Grassland (CPGB)

The objectives, standards, and guidelines within this alternative (see above) to restore grassland conditions would benefit populations of prairie dogs that are reliant upon CPGB. The western burrowing owl, an at-risk species, uses this ERU for its primary habitat; however, it is dependent on the availability of prairie dog colonies for nest sites. ***The improved seral state condition will increase the likelihood of prairie dogs occupying the habitat and creating the necessary nesting sites for burrowing owls[WL14].***

Montane Subalpine Grassland (MSG)

Gunnison's mariposa lily prefers early seral state conditions and is usually found in grasslands and open forests where it can receive full sun (Lesica 2012). Currently, 1 percent of MSG is in early seral stage while 60 percent is invaded by woody encroachment. The objectives, standards, and guidelines in the proposed action would benefit the lily directly by restoring acres in MSG and moving toward desired conditions which call for the ERU to be 20 percent early seral stage and tree and shrub canopy covers less than 10 percent of the landscape. ***The improved seral state condition will increase the likelihood that at-risk plant species will find favorable growing conditions (ex. soil and sunlight) to maintain or increase its viability[WL15].***

Sagebrush Shrubland (SAGE)

Tufted sand verbena is endemic to outcroppings with strongly gypseous soils and favors more open landscapes. Currently, 40 percent of SAGE is in early to mid- seral stage while 41 percent is invaded by woody encroachment. Although this ERU is not a frequent-fire ecosystem, because of the verbenas endemic nature the additional fuel load from the woody encroachment, it leaves the plant susceptible to large-scale fire which can completely remove it from the isolated pockets in which it is found. The objectives, standards, and guidelines in the proposed action would benefit the tufted sand verbena directly by restoring acres in SAGE and moving toward desired conditions which call for the ERU to be 70 percent early- to mid-seral stage and groups of trees and single trees cover less than 10 percent of the landscape. ***The improved seral state condition would decrease the fuel load (woody encroachment) and greatly reduce the threat of fire which could eliminate at-risk plant and animal species from the landscape[WL16].***

Juniper Grassland (JUG)

Tufted sand verbena faces similar threats of out of reference seral states within JUG. The out of reference conditions create fuel loads that could potentially eliminate areas of tufted sand verbena. Currently, the ERU is overstocked with small seedlings and saplings (52 percent) when reference condition calls for 25 percent. The same disproportionate figure holds true for and medium to large trees (21 percent current, 10 percent reference. This creates conditions where fire becomes more intense and burns larger areas increasing the chances for extirpating the plant from its endemic range. The Jemez woodland snail is also found in JUG and is also highly susceptible to large-scale fire due to its narrow range within limestone outcroppings located in JUG. The excess fuel loads from out of reference seral states could result in fires damaging to snail populations. The objectives, standards, and guidelines in the proposed action would benefit both the tufted sand verbena and Jemez woodland snail by restoring acres in JUG and moving toward desired conditions which call for the ERU to be 50 percent more open canopy. This will reduce fuel loads and lessen the risk of that populations could be extirpated (***WL16***).

Piñon-Juniper Grass (PJG)

Greene's Milkweed is especially impacted by invasive encroachment. Invasive plants often compete for limited resources (for example, sunlight, water, nutrients) and due to their vigorous nature soon crowd out native plants. This encroachment often occurs when seral state is out of reference and disproportionate vegetative conditions allows invasive plants to gain a foothold. For example, an uncharacteristic fire can create bare ground conditions ripe for invasive encroachment. Currently, understory composition has been moderately impacted (36 percent departure) by invasive species such as bull thistle, Russian olive, salt cedar and Siberian elm. The objectives, standards, and guidelines in the proposed action would benefit Greene's milkweed by restoring acres in PJG and moving toward desired conditions. There is also an objective to eradicate or suppress 600 acres of invasive plant species annually, which would also help restore appropriate seral state conditions. ***The improved seral state condition would decrease the amount of invasive encroachment and greatly reduce the likelihood that invasive plant species would outcompete native plants for available resources*[WL17]*.***

Forested ERUs (PPF and MCD)

Desired conditions within the proposed action explicitly defines the percentage of seral states in each forested ERU (i.e., early, mid-, and late-). They also provide guidance on tree size class, vegetation structure, fire return interval, dominant understory vegetative species types, as well as specific ecological conditions indicative of a healthy ecosystem. The proposed action sets a maximum objective within MCD and PPF of 280,000 to 350,000 acres of restoration work to be completed respectively, over a 10-year period. This objective will help increase the rate in which desired conditions are achieved and ultimately improve conditions for the at-risk species reliant upon appropriate seral state conditions. Guidelines for All Vegetation Types provide direction to encourage naturally occurring species, avoid ecologically sensitive areas, and improve herbaceous vegetation growth and soil and water condition. The complement of desired conditions, objectives, standards, and guidelines would increase the viability of species that are negatively impacted by out-of-reference seral state conditions in forested ERUs. The following discussion demonstrates how improved seral state conditions would increase the viability for at-risk species.

Ponderosa Pine Forest (PPF)

There are five at-risk species dependent upon seral state conditions within PPF, three birds (Mexican spotted owl, northern goshawk, and Lewis's woodpecker), one invertebrate (Jemez woodland snail), and one plant (wood lily) most of which respond differently to ecological conditions created by seral state composition. The Jemez woodland snail and wood lily are both impacted by uncharacteristic fire. Currently, only 3 percent of PPF are in reference seral state condition with 60 percent of the forest in the medium to large tree category which creates closed canopy conditions making them extremely susceptible to uncharacteristic fires. The objectives, standards, and guidelines in the proposed action would reduce this risk of uncharacteristic fire by moving toward desired conditions which call for 86 percent of PPF to be open canopy. This would improve seral state and reduce the likelihood that uncharacteristic fire would negatively impact at-risk species (***WL16***). The Mexican spotted owl and the northern goshawk are extremely dependent upon the structural components provided by in-reference seral state condition. These structural components provide nesting, roosting, and foraging sites for these forest dwelling birds. With an overabundance of medium to large trees in PPF the structural requirements of the forest (primarily the size, shape, and amount of trees) is out of reference and therefore degrades the habitat for both the goshawk and the owl, the latter of which also depend on the recruitment of large snags. Besides the objectives there are guidelines that describe the exact structural conditions required by goshawks. ***The improved seral state condition would restore structural components as well as snags and provide the necessary nesting and foraging habitat required for at-risk birds*[WL18]*.*** Lastly, Lewis's woodpecker is extremely dependent upon appropriate abundance of large snags for use as nesting sites. Snag density will be discussed in further detail under Issue C; however, appropriate seral state condition contributes to the recruitment rate of snags in the proper size classes (i.e., large mature trees). The proposed action would improve conditions for snag recruitment for the Lewis's Woodpecker and thereby provide more nesting sites for this species within this ERU (***WL18***). The viability for all five species affected by seral state condition would increase under this action.

Mixed-Conifer with Frequent Fire (MCD)

There are three species dependent upon seral state conditions within MCD, they are Jemez woodland snail, Mexican spotted owl, and northern goshawk. All three are impacted by the same degraded ecological conditions as in PPF, which includes the increased risk of uncharacteristic fire and the lack of structural components for nesting and foraging habitat for at-risk birds. Within this ERU, 60 percent of the forest is currently in the large closed-canopy tree category which not only makes them extremely susceptible to uncharacteristic fires but also alters their structural components which negatively impacts the birds. The desired conditions in the proposed action calls for 72 percent of MCD to be open canopy. The objectives, standards, and guidelines in the proposed action improves seral state conditions and reduces the risk of uncharacteristic fire for the snail (***WL16***) as well as improves structural tree components for the birds (***WL18***). The viability for all three species affected by seral state condition would increase under this action.

In summary, objectives, standards, and guidelines within the proposed action will improve seral state condition in ERUs containing at-risk species. This will positively affect multiple ecological conditions directly linked to seral state and potentially benefit numerous at-risk species found within. Therefore, this alternative has the greatest effect on seral state and its impact to at-risk species (***WL14** through **WL18***).

Alternative 3 - Natural Processes Emphasis

The natural processes emphasis alternative places more emphasis on natural processes such as fire to achieve desired conditions, with less emphasis on mechanical treatments. The manner in which treatments are applied affects the amount of restoration that can occur and impacts the acreage of treated areas since more acreage can be treated by prescribed fire as opposed to mechanical treatments. Under this alternative, objectives for treatments in certain ERUs increase substantially. In non-forested ERUs, treated acre objectives increase 279 percent (maximum of 87,000 to 330,150 acres), while treated acreage objectives in MCD and PPF increase 193 percent (maximum of 280,000 to 820,000 acres) and 163 percent (maximum of 350,000 to 922,000 acres). The differences in acreages and treatment approach primarily affects the rate at which desired conditions are obtained. The speed at which ecological conditions are obtained has little impact on overall viability unless the means to which desired conditions are achieved introduces other risks that may negatively impact the species. Those situations are discussed below.

Non-forested ERUs (CPGB, MSG, SAGE, JUG, and PJG)

The natural processes emphasis alternative sets an objective of 115,150 to 330,150 acres of restoration work in non-forested ERUs to be completed over a 10-year period. This objective will help increase the rate in which desired conditions are achieved. Restoration activities within these ERUs would primarily be accomplished through prescribed fire. Ecological conditions linked to seral state would improve and individual species response would be the same as mentioned in the proposed action (***WL14–WL17***). Although there is added risk of larger patches of high-severity fire in the non-forested ERUs it is unlikely the fires would be catastrophic where long-lasting ecological impacts would occur due to intensity and duration; therefore, there is no known added risks associated with increasing the amount of restoration using fire. The viability for at-risk species within these ERUs should increase and the effects would be the same as the proposed action.

Forested ERUs (PPF and MCD)

The natural processes emphasis alternative increases the objective of treated acres for both MCD and PPF. Over a 10-year period, there would be an objective of 120,000 to 820,000 acres of restoration work in

MCD, while PPF would see an objective of 272,000 to 922,000 acres. Restoration activities within these ERUs would primarily be accomplished through prescribed fire, this would improve seral state conditions within the forest (***WL18***). However, due to the highly departed characteristics of these two forested ERUs, and their increased fuel loads, the risk of uncharacteristic fire (Issue D) may also increase, particularly when combined with other natural disturbances affecting the landscape (e.g., drought). See Issue D for effects.

In summary, objectives, standards, and guidelines within this alternative will improve seral state conditions in both non-forested and forested ERUs positively affecting multiple ecological conditions directly linked to seral state. The increased use of fire, however, increases the potential for large-scale, high-intensity fire in forested ERUs under certain conditions, which could negatively impact at-risk species (see Issue D). Therefore, this alternative has the second greatest effect on seral state and its impact to at-risk species (***WL7, WL11, WL14–WL18, and WL84***).

Alternative 4 - Human Uses Emphasis
The human uses emphasis alternative places more emphasis on human uses such as mechanical treatments to achieve desired conditions, with less emphasis on prescribed fire. The manner in which treatments are applied affects the amount of restoration that can occur and impacts the acreage of treated areas since restoration is primarily limited to mechanical treatments. Under this alternative, objectives for treatments varies by ERU. In non-forested ERUs, treated acre objectives increase 47 percent (maximum of 87,000 to 128,000 acres), while treated acreage objectives in MCD and PPF decrease 20 percent (maximum of 280,000 to 225,000 acres) and 28 percent (maximum of 350,000 to 253,000 acres), respectively. The differences in acreages and treatment approach primarily affects the rate at which desired conditions are obtained. The speed at which ecological conditions are obtained has little impact on overall viability unless the means to which desired conditions are achieved introduces other risks that may negatively impact the species. Those situations are discussed below.

Non-forested and Forested ERUs

The human uses emphasis alternative sets an objective of 68,000 to 128,000 acres of restoration work in non-forested ERUs to be completed over a 10-year period. In forested ERUs (MCD and PPF), there would be an objective of 75,000 to 225,000 acres of restoration work in MCD, while PPF would see an objective of 103,000 to 253,000 acres. Ecological conditions linked to seral state would improve and individual species response would be the same as the proposed action (***WL14–WL18***). However, the increased use of mechanical treatments may introduce additional threats to at-risk species. For example, there is a guideline to add existing routes from forestry uses to the MVUM. This would increase Ground and Soil Disturbance (Threat J) and Intrusive Human Activity (Threat K). See issues J and K for effects.

In summary, the objectives, standards, and guidelines within this alternative will improve seral state conditions in both non-forested and forested ERUs positively affecting multiple ecological conditions directly linked to seral state. The increased human activity associated with mechanical treatments, however, increases the potential for ground and soil disturbance and increased intrusive human activity in both non-forested and forested ERUs, which could negatively impact at-risk species (see threats J and K). Therefore, this alternative has the third greatest effect on seral state and its impact to at-risk species (***WL14–WL18***, ***WL47, WL48, and WL51–56***).

Seral State Upland Summary:
Alternative 1 lacks forestwide direction to improve seral state conditions and focuses active forest management in specific areas targeted for timber or fuels. Alternatives 2, 3, and 4 provide objectives and guidelines that result in positive trends toward desired seral state and improve ecological conditions

required by at-risk species within non-forested and forested ERUs. This would increase the viability for all species impacted by departed seral state. Alternatives 3 and 4, however, introduce additional issues and threats to at-risk species by means of obtaining those seral state conditions (fire and mechanical treatments). Alternative 3 increases the risk of uncharacteristic fire while alternative 4 increases ground and soil disturbance and likelihood of increased intrusive human activity. Both of these alternatives, therefore, may negatively impact at-risk species. Alternative 2 is the best option for increasing the viability of at-risk species impacted by seral state departure.

See appendix E for plan components addressing seral state departure.

Seral State - Riparian Analysis (To be conducted by similar approach as above.)

Metric: Composition and Structure within RMZ

Nine at-risk species are impacted by highly departed seral state in Riparian areas: Arizona willow, black swift, masked shrew, New Mexico meadow jumping mouse, northern leopard frog, Rio Grande chub, Rio Grande cutthroat trout, Rio Grande sucker, and water shrew. In-reference vegetative conditions, consisting of composition and structure, provide the ecological conditions for numerous bird and mammal species. That same vegetation provides key ecological functions to the RMZ such as providing shade to decrease water temperatures or to provide absorption and filtration during high rain events. It also serves to store water during periods of drought (see Water and RMZ sections).

There are six main riparian ERUs in the Santa Fe NF: Herbaceous, Narrowleaf Cottonwood/shrub, Rio Grande Cottonwood/shrub, Willow/Thinleaf Alder, Ponderosa Pine/Willow, and Upper Montane Conifer/Willow. Inclusive within these ERUs or as isolated features on the landscape outside of the ERUs, occur discrete bodies of water such as wetlands, seeps, springs, ponds, lakes and reservoirs and their associated vegetation composition and structure. Riparian ERUs collectively occupy about 3 percent of the Santa Fe NF landscape. Due to their importance to wildlife, management activities are directed in these areas; however, due to their small size, management activities are not parsed out by individual riparian ERUs. They are simply managed as a single ERU (Riparian).

Alternative 1 – 1987 Forest Plan

Under the no-action alternative there is forestwide guidance for appropriate composition and structure within RMZ. For example, a standard requires shrub and tree cover along bank lengths that is 80 percent of natural levels. While another standard requires at least three age classes of riparian trees and shrubs, with at least 10 percent of the cover in the seedling sapling stages and 10 percent in the mature and overmature stage. Although the plan provides guidance for desired conditions within RMZs and should move toward those conditions, the lack of objectives results in a rate of improvements that may not move toward desired conditions quickly or regularly. There is also minimal guidance on specific Riparian vegetation types (i.e., Herbaceous, Cottonwood, and Willow). Alternative 1 includes management objectives for rangeland, stream channel, aquatic habitat, and riparian area conditions, but does not contain components which direct restoration of these areas. ***In RMZs where vegetative composition and structure (seral state) is not in reference condition at-risk birds and mammals will not be able to forage, find protect cover, or move about their habitat as needed to secure basic life-cycle needs[WL77]. Out-of-reference seral state within RMZs will also negatively impact soil and water characteristics (ex. temperature, flow, nutrient load) and may cause declines in aquatic species reliant upon those characteristics[WL78].*** Due to its lack of restoration objectives, it is unlikely seral state conditions with RMZs will improve during the life of the plan. This will continue to negatively affect multiple ecological conditions within the RMZ and potentially impact at-risk species dependent upon those conditions. This alternative has the least effect on seral state and its impact to at-risk species (***WL77 and WL78***).

Alternative 2 – Forest Plan
Riparian areas are referred to as riparian management zones (RMZs) and are specifically addressed in the new forest plan (proposed action). In addition to RMZs having their own specific desired conditions, the Aquatic Species and Habitat section also describes in detail how these areas should look, function, and be restored. The entire suite of plan components addressing this issue can be found in appendix E. Although plan components specifically addressing vegetation within RMZs are typically found in the Riparian Management Zone and Aquatic Species and Habitat sections they can also be found in Vegetation, Forestry, Water, At-Risk Species, Range, and Roads sections as well.

Desired conditions within the proposed action explicitly defines the percentage of seral states in each riparian ERU (i.e. early, mid-, late-, and novel). They also provide guidance on structure, coarse woody debris, and soil conditions. The proposed action provides desired conditions that define specific conditions as they pertain to RMZs and sets an objective of restoring the composition and structure of 15 miles of stream every 10 years as well as 30 miles of aquatic habitat projects every 10 years. Standards and guidelines within the RMZ section also direct activities to restore composition and structure within riparian areas. For example, guidance is provided to protect understory species, maintain tree density, promote large woody material recruitment, and avoid channel downcutting during fuelwood cutting or wood removal. The complement of desired conditions, objectives, standards, and guidelines would increase the viability of species that are negatively impacted by out-of-reference seral state conditions within riparian areas. Restoring composition and structure within RMZs would increase viability of species that are dependent upon those ecological conditions. ***If seral state conditions are restored in RMZ at-risk bird and mammal species would be able to forage, find protective cover, or move about their habitat as needed to secure basic life-cycle needs[WL79]. The improved seral state conditions within RMZ would also improve soil and water characteristics and increase the viability of at-risk plants and aquatic species that are dependent upon those conditions[WL80].***

In summary, objectives, standards, and guidelines within the proposed action will improve seral state condition in riparian areas. This will positively affect multiple ecological conditions required by at-risk bird, mammal, and aquatic species. This alternative has the second greatest effect on seral state and its impact to at-risk species (***WL79 and WL80***).

Alternative 3 - Natural Processes Emphasis
Under the natural processes emphasis alternative, the objective for annual riparian area treatments increases from 15 miles of stream restoration (composition and structure) in the RMZ every 10 years to 30 miles. It also increases the objectives for aquatic habitat restoration projects from 30 miles every 10 years to 60 miles. The objectives of restoring seral state would improve the ecological conditions for at-risk mammal, plant, and fish species (***WL79 and WL80***). Since the amount of stream miles treated increases, this alternative has the greatest effect on seral state and its impact to at-risk species (***WL79 and WL80***).

Alternative 4 - Human Uses Emphasis
Under the human uses emphasis alternative, the objective for riparian treatments decreases from 15 stream miles of restoration every 10 years to 10 miles. Instead of restoring composition and structure of floodplains the focus of the restoration is on invasive plant control. It also completely removes all objectives for aquatic habitat restoration projects. Since the restoration objectives of composition and structure are removed, it is unlikely riparian areas will move toward desired conditions and at-risk species will continue to be negatively impacted. Since composition and structure restoration objectives are removed but invasive plant control objectives remain, this alternative has the third greatest effect on seral state and its impact to at-risk species (***WL77 and WL78***).

Seral State Riparian Summary:

Out-of-reference seral state within RMZs effects the vegetative communities and can seriously impact at-risk species by altering the composition of their native habitats for mammals, robbing the soil of critical nutrients and water for native plants, and altering the water characteristics required by certain aquatic species. Alternative 1 provides guidance on riparian conditions but lacks objectives and specificity within riparian vegetative systems (i.e., Herbaceous, Cottonwood, and Willow), therefore, the rate and focus of restoration work and progress toward desired conditions would be variable. Alternatives 2 and 3 provide desired conditions and objectives that restore seral state (composition and structure) within RMZs. Alternative 4 attempts to slow the degradation of riparian areas but does not address returning areas that are already impacted through restoration of stream composition and structure. Alternative 3 is the best option for increasing the viability of at-risk species impacted by out-of-reference seral state followed by alternative 2, then 4.

See appendix E for plan components addressing seral state composition.

Issue B. – Highly Departed Coarse Woody Debris (CWD)

When a large tree falls it becomes coarse woody debris (CWD) and provides habitat for small animals and insects. When these logs rot, they store water and provide nutrients for the continued growth of the forest. Dead wood rotting on the forest floor eventually gets incorporated into the soil. This deteriorating wood feeds many insects and bacteria which provide nitrogen to feed the trees and other plants in the forest. CWD is not only limited to upland habitats, it has significant impact on riparian areas as well and many aquatic species depend on downed woody material. CWD not only provides foraging and escape cover for fish but it contributes to the creation of optimum aquatic habitat by slowing down water and contributing to pool development. Out of reference conditions of CWD may result in significant negative impacts to at-risk species (Siitonen, 2001). If CWD is not in adequate supply or below desired conditions identified as tons per acre (CWD load), it may result in lack of prey items for carnivorous birds or mammals (MacNally et al. 2001). On the other hand, if CWD is in excess or above desired conditions it may create unfavorable soil conditions, especially for at-risk plant species by prohibiting growth or germination or resulting in more intense fires that negatively impact soil conditions. This is also a key factor in proper functioning aquatic habitats. Thus, CWD loads in reference condition should provide optimum habitat for terrestrial and aquatic animal species as well as soil conditions for plant species (Sturtevant et al. 1997). Currently, 11 at-risk species (31 percent) may be impacted by improper CWD loads in the forest, these occur in three terrestrial forested ERUs (PJO, MCW, and SFF) and one non-forested ERU (PJG) (table 51). Five species also utilize riparian (RIP) areas where coarse woody debris is a key component not only for creating habitat but for maintaining stream function as well by trapping sediment and influencing channel formation.

The cause of departed CWD loads can usually be traced back to long-term human-made actions such as fire suppression resulting in excess CWD in many of the forested ERUs. Riparian areas, on the other hand, tend to lack enough CWD. The popularity of riparian areas for people, cattle, and wildlife often results in the suppression of woody recruitment because of increased trampling or grazing. In reference CWD loads in both upland and riparian areas would provide the ecological conditions required for some at-risk species (table 54).

CWD departure is analyzed separately for upland and riparian ERUs. Species that depend on upland ERUs for their habitat are addressed in the upland section and species that depend on the riparian ERUs (i.e., Herbaceous, Cottonwood, and Mixed-Conifer Willow) are addressed in the riparian section.

Table 54. At-risk species impacted by departed coarse woody debris and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
American marten												X	X
Arizona willow												X	X
Chama blazing star							X						
Greene's milkweed							X			X			
Large yellow lady's-slipper												X	
Pecos fleabane												X	
Rio Grande chub													X
Rio Grande cutthroat trout													X
Rio Grande sucker													X
Snowshoe hare												X	
Springer's blazing star							X						

Note: Columns displaying X's indicate impact of the species in that ERU.

Coarse Woody Debris – Upland Analysis

Metric: Tons of CWD per acre

Nine upland ERUs do not contain any at-risk species impacted by departed CWD loads and will not be analyzed as part of the at-risk species analysis. Many of these ERUs are grassland or shrubland systems (ALP, CPGB, JUG, MSG and SAGE) and do not typically support substantial CWD loads due to the openness of the systems. For example, reference conditions in grasslands often call for tree and shrub cover of less than 10 percent. Historically, animals dependent upon CWD did not evolve in those systems. Some forested ERUs have departed CWD loads but do not contain at-risk species that are impacted by departed CWD (MCD, MCW, PPF, and PJS). Departed CWD conditions are still a concern within these ERUs and are subsequently analyzed in the Vegetation section.

Eight at-risk species impacted by highly departed coarse woody debris are found in upland ERUs: American marten, Arizona willow, Chama blazing star, Greene's milkweed, large yellow lady's-slipper, Pecos fleabane, snowshoe hare, and Springer's blazing star. These species utilize three upland ERUs as habitat: PJO, PJG, and SFF (table 54).

Two ERUs (PJO, and PJG) have departed CWD loads that may be impacting the viability of at-risk species in the Santa Fe NF. The effects of this departure and the alternatives to address this issue are analyzed below.

Effects Common to All Alternatives

One ERU, SFF, is at low CWD departure and is not expected to trend away from desired condition between alternatives or within the life of the plan; therefore, ***CWD loads that are at or near reference condition provide all the ecological conditions necessary for at-risk species. This includes foraging and nesting habitat for birds and mammals[WL19].*** In SFF, American marten, Arizona willow, large yellow lady's-slipper, Pecos fleabane, and snowshoe hare are not negatively affected by CWD loads.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative CWD loads are mostly managed as dead and down timber for firewood collection. BMP's for timber provide guidance for leaving downed timber in stream channels. There is some direction to retain large diameter CWD when managing for Mexican Spotted Owl and Jemez Mountain Salamander. The current Forest Plan allows for timber management and prescribed burning and promotes management to reduce hazardous fuels. Prescribed fire, using planned and unplanned ignitions, would continue to be used to enhance and accomplish resource objectives, particularly in fire-dependent ecosystems. Forestry objectives under the current plan are more focused on timber production and reference practices that are less common today where focus is now on forest restoration. Although treatments within these ERUs will continue under the no-action alternative, the rate of treatment often results in improvements that take more than 50 years (see vegetation analysis). ***If CWD is not in adequate supply or below desired conditions identified as tons per acre (CWD load), it may result in lack of prey items or foraging areas for carnivorous birds or mammals[WL20]. On the other hand, if CWD is in excess or above desired conditions it may create unfavorable soil conditions, especially for at-risk plant species by prohibiting growth or germination or resulting in more intense fires that negatively impact soil conditions[WL21].***

In summary, this alternative provides specific direction for CWD in only certain management areas and lacks overall forestwide direction. It is unlikely CWD conditions will improve significantly during the life of the plan, especially in areas outside of timber and fuelwood treatment areas. This will continue to negatively affect multiple ecological conditions directly linked to CWD. This alternative has the least effect on CWD and its impact to at-risk species (***WL20 and WL21***).

Alternative 2 – Forest Plan

Vegetative desired conditions for appropriate CWD loads for each ERU can be found in the plan (proposed action). Although plan components specifically addressing CWD loads are typically found in the Vegetation sections they can also be found in Fire, Forestry, Terrestrial Species, and At-Risk Species sections as well. If the proposed action moves forward, the following changes and subsequent effects are likely to occur.

The proposed action provides desired conditions that define specific CWD conditions within each forested ERU. This includes specific measures of tons per acre. The proposed action sets a maximum objective of 87,000 acres for restoration work to be completed over a 10-year period within the non-forested ERUs. There are also timber objectives that promote the collection of fuelwood. Both of these objectives would decrease CWD departure and positively affect ecological conditions required by some at-risk species. The following discussion demonstrates how improved CWD conditions would increase the viability for at-risk species.

Piñon-Juniper Woodland (PJO)

There are three at-risk plants dependent upon CWD within PJO, they are: Greene's milkweed, Chama blazing star, and Springer's blazing star. All three of these at-risk plant species depend upon in-reference CWD loads within PJO. Reference conditions within PJO call for 4.1 tons of CWD per acre, however, there is currently 17.4 tons per acre. The desired conditions in the proposed action calls for "2 to 5 tons per acre" within PJO. Although there are no restoration objectives for PJO, this ERU contributes a great deal of fuelwood for local communities. A Timber objective of 72,539 cords of fuelwood would reduce the CWD load in areas of PJO. This would move CWD loads in these areas toward reference conditions. ***With restored CWD loads, at-risk plant species would benefit from the increased amount of bare soil allowing for increased propagation and spread as well as reduced concern from uncharacteristic fire*[WL22]*.*** The viability for all three species would increase under this action.

Piñon-Juniper Grasslands (PJG)

Greene's milkweed is dependent upon in-reference CWD loads within PJG. Besides contributing to the development of proper soil conditions for the plant germinate and spread, if CWD loads are too high, the excess buildup of CWD reduces the amount of vegetative cover and increases the proportion of bare soil. Reference conditions within PJG call for 3.5 tons of CWD per acre, however, there is currently 12.3 tons per acre. The desired conditions in the proposed action calls for "1 to 3 tons per acre" within PJG. The objective to restore 87,000 acres of non-forested ERUs would restore the optimum CWD loads for Greene's Milkweed (***WL22***). The viability for the milkweed would increase under this action.

In summary, restoration and timber objectives within the proposed action will improve CWD loads in ERUs containing at-risk species. This will positively affect ecological conditions directly linked to CWD and potentially benefit numerous at-risk plant species found within; therefore, given the amount of acreage affected, this alternative has the second greatest effect on CWD and its impact to at-risk species (***WL22***).

Alternative 3 - Natural Processes Emphasis

Under the natural processes emphasis alternative, the objectives for treatments in certain ERUs increase substantially. For example, in non-forested ERUs, treated acre objectives increase 279 percent (maximum acres: 87,000 to 330,150). The differences in acreage and treatment approach primarily affects the rate at which desired conditions are obtained. This objective would only help increase the rate in which desired conditions are achieved within PJG.

The same two ERUs (PJO and PJG) mentioned in the Upland Analysis discussion as having departed CWD conditions are similarly addressed in this alternative as in the proposed action (alternative 2). Since at-risk species analysis focuses on viability, the speed at which ecological conditions are obtained has little impact on overall viability unless the means to which desired conditions are achieved introduces other risks that may negatively impact the species. There may be a risk of uncharacteristic fire (Issue D) under this alternative.

Piñon-Juniper Woodland (PJO)

Since fuelwood objectives will not change from the proposed action, at-risk species found within PJO would respond similarly to the proposed action. Their viability would increase as CWD moves toward desired conditions (***WL22***).

Piñon-Juniper Grasslands (PJG)

The amount of PJG acreage restored under this alternative increases substantially (up to 279 percent). At-risk species found within this ERU would respond similarly to the proposed action and their viability would increase as CWD moves toward desired conditions (***WL22***). Although there is a slight added risk of large-scale fire in PJG due to increased use of fire it is unlikely the fires would be uncharacteristic where long-lasting ecological impacts would occur due to intensity and duration; therefore, there is no known added risk associated with increasing the amount of restoration using fire. Due to the increased acreage, this alternative provides the greatest benefit to at-risk species.

In summary, restoration and timber objectives within this alternative will improve CWD loads in PJO and PJG. This will positively affect ecological conditions directly linked to CWD and potentially benefit numerous at-risk plant species found within. Given the increased amount of acreage affected, this alternative has the greatest effect on CWD and its impact to at-risk species (***WL22***).

Alternative 4 - Human Uses Emphasis
Under the human uses emphasis alternative, the objectives for treatments in certain ERUs vary only slightly from the proposed action. In non-forested ERUs, treated acre objectives increase 47 percent (maximum of 87,000 to 128,000 acres). This objective would only slightly increase the rate in which desired conditions are achieved within PJG.

The same two ERUs (PJO, and PJG) mentioned in the Upland Analysis discussion as having departed CWD conditions are similarly addressed in this alternative as in the proposed action (alternative 2). Since at-risk species analysis focuses on viability, the speed at which ecological conditions are obtained has little impact on overall viability unless the means to which desired conditions are achieved introduces other risks that may negatively impact the species. There is the risk of increased Ground/Soil Disturbance (Issue J) and Increased Human Activity (Issue K) under this alternative.

Piñon-Juniper Woodland (PJO)

At-risk species found within PJO would respond similarly to the proposed action and their viability would increase as CWD moves toward desired conditions (***WL22***). There are no known added risks associated with increased human uses since mechanical treatments as a restoration practice would be minimal. Fuelwood collection would likely not increase the threat of ground disturbance or human disturbance since that activity is already occurring and does not require the construction of new roads.

Piñon-Juniper Grasslands (PJG)

With only a slight increase in restoration objectives (47 percent), at-risk species found within this ERUs would respond similarly to the proposed action and their viability would increase as CWD moves toward desired conditions (***WL22***). There is, however, added risk of Ground/Soil Disturbance (Threat J) and Increased Intrusive Human Activity (Threat K) since mechanical objectives in non-forested ERUs would increase. The increased human activity associated with mechanical treatments, could negatively impact at-risk species (see Threats J and K).

In summary, the objectives within this alternative will improve CWD loads conditions in both PJO and PJG positively affecting ecological conditions directly linked to CWD. The increased human activity associated with mechanical treatments, however, increases the potential for ground and soil disturbance and increased intrusive human activity in PJG, which could negatively impact at-risk species (see Threats J and K). Therefore, this alternative has the third greatest effect on CWD and its impact to at-risk species (***WL22, WL47, WL48, and WL51–56***).

Coarse Woody Debris Upland Summary:
Alternative 1 lacks forestwide direction to improve CWD, guidance for CWD loads is usually provided in management areas targeted for timber or fuels. At-risk species that are impacted by this issue (Issue B) may continue to be affected especially if they are outside the management areas that have CWD direction. Alternatives 2, 3, and 4 provide objectives, standards, and guidelines that result in positive trends toward

CWD conditions. This would increase the viability for all species impacted by departed CWD. Alternative 3 provides the greatest amount of improvement followed by alternative 2. Alternative 4 introduces additional threats to at-risk species by increased means (mechanical treatments) of obtaining those desired conditions (see Threats J and K). Alternative 3 is the best option for increasing the viability of at-risk species impacted by CWD.

Coarse Woody Debris – Riparian Analysis

Metric: Pieces per mile (12 inches or larger in diameter at a length of 35 feet from the large end)
Five at-risk species are impacted by highly departed coarse woody debris in Riparian areas: American marten, Arizona willow, Rio Grande chub, Rio Grande cutthroat trout, and Rio Grande sucker (table 51). In-reference CWD loads within riparian areas provide the ecological conditions for numerous plants and aquatic species. The excess downed woody material slows water flow and provides key ecological features to stream channels such as providing cover or foraging areas for aquatic species. It can also increase nutrient load and create more favorable soil and water characteristics for some species (see Water and RMZ sections). ***CWD loads in Riparian areas that are in-reference condition provide the cover and foraging areas for aquatic species as well as provide the soil and water characteristics for at-risk plant and fish species[WL81].***

Alternatives 1, 2, 3, and 4

Coarse woody debris is considered a vital component in the composition and structure of vegetation within Riparian areas. This is captured by the same objectives and guidelines that manage for seral state within Riparian areas. The effects of management by alternatives within these areas is identical to the Seral State analysis.

Coarse Woody Debris Riparian Summary:

Out-of-reference CWD within Riparian effects the vegetative communities and can seriously impact at-risk species by altering the composition of their native habitats at-risk species and altering the soil and water characteristics required by certain aquatic species. Direction for CWD is provided for individual species, but outside of single species management and management areas, direction is minimal. Alternative 1 also does not have any objectives to restore areas that have already been altered and CWD loads are managed primarily through timber and fuel programs. Alternatives 2 and 3 provide desired conditions and objectives that restore CWD loads within Riparian areas. Alternative 4 attempts to slow the degradation of riparian areas but does not address returning areas that are already impacted through restoration of stream composition and structure, including CWD. Alternative 3 is the best option for increasing the viability of at-risk species impacted by out-of-reference CWD loads followed by alternative 2.

See appendix E for plan components addressing coarse woody debris.

Issue C. – Highly Departed Snag Density

When a tree dies but remains standing, it becomes a snag and provides habitat for and array of animals, especially birds. Ecologically, a dead tree is as important to the forest ecosystem as a live one (Franklin et al. 1987) and, according to Marcot (2002), provides several key ecological functions that influence the ecosystem. Snags provide homes for birds and foraging opportunities for insectivorous animals. If snags are not in adequate supply or below desired conditions identified as snags per acre, it may result in lack of nesting locations or foraging areas insectivorous birds or mammals (Ganey 1998). Conversely, large-scale fire often results in too many snags per acre and not enough live trees (Holden et al. 2006). Snag densities in reference condition should provide optimum habitat for at-risk species, therefore, departed snag densities may result in significant negative impacts to at-risk species. Currently, two at-risk species are impacted by departed snag densities in the forest, these occur in three terrestrial forested ERUs (MCW, MCD, and PPF) (table 55).

Table 55. At-risk species impacted by departed snag densities and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
Lewis's woodpecker								X					
Mexican spotted owl				X	X			X					X

Note: Columns displaying X's indicate impact of the species in that ERU.

The vegetation analysis in this EIS considers snag densities for each ERU in the Santa Fe NF. Since at-risk species habitat can be linked with specific ERUs, information about each ERU's snag density departure can be used as an indicator for specific habitat conditions required by some at-risk species. ERUs with an adequate supply of large snags provide the ecological conditions required by at-risk bird species for nesting and foraging (Scott 1979). Since the at-risk bird species in this analysis prefer larger trees for nesting and foraging, only snags larger than 18 inches dbh are considered.

Snag Density Analysis

Metric: Snags per acre
Two at-risk species may be impacted by departed snag densities—Lewis's woodpecker and Mexican spotted owl. These two species use three of the 12 upland ERUs as habitat: MCW, MCD, and PPF (table 51).

Nine upland ERUs do not contain any at-risk species impacted by departed snag densities and will not be analyzed as part of the at-risk species analysis. Many of these ERUs are grassland or shrubland systems (ALP, CPGB, MSG, and SAGE) and do not typically support substantial numbers of snags due to the openness of the systems and general lack of large trees. For example, reference conditions in grasslands often call for tree and shrub cover of less than 10 percent. Historically, animals dependent upon snags did not evolve in those systems. Some forested and woodland ERUs have desired snag densities but do not contain at-risk species that are impacted by departed snag densities (JUG, PPJ, PJS, PJO, and SFF). Appropriate snag densities are still a concern within these ERUs and are subsequently analyzed in the Vegetation section. Lastly, Mexican spotted owls are known to nest in terrestrial ERUs, primarily PPF and MCD, therefore snag densities in riparian areas will not be considered in this analysis.

Three ERUs (MCW, MCD, and PPF) are used by two at-risk bird species. The Mexican spotted owl uses all three ERUs for foraging and nesting while the Lewis's woodpecker predominantly uses PPF for those same life-cycle needs. Currently MCW, MCD, and PPF have snag densities (18 inches and greater) that are in or near reference condition (table 56) (Santa Fe NF Assessment). The effects of the alternatives to address snag densities are analyzed below.

Table 56. Snags greater than 18 inches dbh per acre in MCW, MCD, and PPF

	Reference	Current
Mixed-Conifer with Aspen (MCW)	4.0	5.2
Mixed-Conifer Frequent Fire (MCD)	3.0	3.5
Ponderosa Pine Forest (PPF)	0.8	0.8

Alternative 1 – 1987 Forest Plan

Under the no-action alternative there is forestwide direction for appropriate snag densities. Silvicultural treatments are to leave sound snags (10 inches and larger dbh) and manage for 220 natural snags per 100 acres on a minimum of 40 percent of the ecosystem area with emphasis on peripheral edges of openings. This guidance is focused in areas slated for timber harvest. Since the majority of timber harvest occurs in MCD and PPF management, the no-action alternative will result in snag densities that remain at or near reference condition. ***With the appropriate number of snags offered in these forested systems, at-risk bird species should find snags readily available for nesting and foraging***[WL23]***.*** There should be no negative impacts to at-risk species dependent upon this ecological condition. Therefore, snag densities in the forest should not be impacted by this alternative (***WL23***).

Alternatives 2, 3, and 4:

Vegetative desired conditions for appropriate snag densities for each ERU can be found in the proposed action. Although plan components specifically addressing snag densities are typically found in the Vegetation sections they can also be found in Fire, Forestry, Terrestrial Species, and At-Risk Species sections as well.

The proposed actions (2, 3, and 4) provides desired conditions that define specific snag densities within each forested ERU. This includes specific measures of snags per acre. The proposed action also sets varying objectives for restoration work to be completed over a 10-year period within the MCD and PPF. Since snag densities are currently at or near desired conditions, this objective would serve to maintain current conditions. Therefore, the viability of the Mexican spotted owl and the Lewis's woodpecker would not be impacted by this issue. These alternatives have the greatest effect on maintaining snag densities and their impact to at-risk species (***WL23***).

Snag Density Summary:

Although snag densities have remained at or near reference conditions within MCW, MCD, and PPF, alternative 1 lacks objectives for restoration work, which would help maintain those densities. Alternatives 2, 3, and 4 provide desired conditions and objectives that ensure appropriate snag densities are maintained. This would help ensure the viability for all species impacted by departed snag densities. Alternatives 2, 3, and 4 are the best options for increasing the viability of at-risk species impacted by out-of-reference snag densities.

See appendix E for plan components addressing snag densities.

Issue D - Uncharacteristic Fire (Risk of Catastrophic Fire)

Fire plays a critical role in maintaining the health of an ecosystem. Vegetation communities (ERUs) in the Santa Fe NF are characterized by various fire regimes and depend on certain fire-return intervals to maintain reference conditions for numerous vegetative characteristics (e.g., seral state, CWD; see vegetation section). Two frequent-fire systems (PPF, MCD) that make up half of the land area of the Santa Fe NF, historically experienced frequent, predominantly low-severity fires with patches of mixed-severity effects. However, long term, historic fire suppression policies in the western United States have resulted in excessive stocking levels and fuel loads in many frequent-fire systems (see vegetation analysis), creating conditions for uncharacteristic fires to occur. Uncharacteristic fire can be defined as fire that burns at higher-intensity or over longer durations at larger scales than what would typically occur under reference conditions. Mixed- to high-severity fires causing extensive ecological (and often socio-economic) damage are characterized as catastrophic fires. Objectives for vegetation treatments, particularly those in MCD and PPF, are designed to reduce the risk of uncharacteristic and catastrophic fire occurrence on the forest and surrounding lands.

Uncharacteristic fire often creates unfavorable forest conditions for at-risk species. It also can potentially wipe out isolated or small populations of at-risk species. Currently, 24 at-risk species may be impacted by uncharacteristic fire (table 57), but each is impacted in different ways.

Uncharacteristic Fire Analysis

Metric: Vegetative Fire Class Regime
Current at-risk species affected by uncharacteristic fire include: American marten, Arizona willow, boreal owl, Gunnison's mariposa lily, Holy Ghost ipomopsis, Jemez Mountain salamander, large yellow lady's-slipper, Lewis's woodpecker, Lilljeborg's peaclam, masked shrew, Mexican spotted owl, New Mexico Meadow jumping mouse, northern goshawk, northern leopard frog, Pecos fleabane, Rio Grande sucker, Rio Grande cutthroat trout, Rio Grande chub, snowshoe hare, spotted bat, tufted sand verbena, water shrew, and wood lily.

Table 57. At-risk species impacted by uncharacteristic fire and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
American marten												X	X
Arizona willow													X
Boreal owl												X	
Gunnison's mariposa lily						X							
Holy Ghost ipomopsis				X				X					

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
Jemez Mountain salamander				X	X			X					
Jemez woodland snail			X	X				X					
Large yellow lady's-slipper					X							X	
Lewis' woodpecker								X					
Lilljeborg's peaclam													X
Masked shrew													X
Mexican spotted owl				X	X			X					X
NM Meadow jumping mouse													X
Northern goshawk				X	X			X					
Northern leopard frog													X
Pecos fleabane												X	
Rio Grande chub													X
Rio Grande cutthroat trout													X
Rio Grande sucker													X
Snowshoe hare												X	
Spotted bat					X							X	
Tufted sand verbena			X								X		
Water shrew													X
Wood lily								X					

Note: Columns displaying X's indicate impact of the species in that ERU.

Mixed- to high-severity fire may naturally occur in patches in frequent-fire ERUs (e.g., PPF, MCD). Small-scale instances of high-severity fire are natural and often are beneficial to wildlife by creating openings within the canopy. These openings increase heterogeneity and biodiversity on the landscape by forming early seral habitats that are important for raptors (e.g., northern goshawks and Mexican spotted owls), woodpeckers, songbirds, small mammals, ungulates, and several plant species. Uncharacteristic fire, however, is large-scale, stand-replacing fire that does not normally occur as a part of the fire regime for the ERU involved. Often, the risk of uncharacteristic fire is associated with frequent-fire ERUs (e.g., MCD, PPF) that have an above average fuel load indicative of out-of-reference conditions, and is not as strongly associated with infrequent-fire ERUs with naturally occurring stand-replacement fires over long timespans (e.g., SFF, MCW) unless the area burned is larger than patch sizes described within the natural range of variation. When it occurs in forested or woodland systems, a stand-replacing fire kills all, or nearly all, of the vegetation present on site through the combination of crown fires consuming all photosynthetic material and live buds, and surface fires penetrating the soil with extreme heat. When fires occur over large areas with high severity, they may be termed catastrophic due to adverse and potentially long-lasting ecological (and socio-economic) effects. Large, high-severity patches or stand-replacing fires affect more than one at-risk species. Effects of uncharacteristic and catastrophic fire can be grouped as follows:

> *Catastrophic Fire in Frequent-Fire Forested Systems* – Due to the excessive fuel-loads resulting from fire-suppression, large-scale, high-intensity, stand-replacing fires in PPF and MCD can completely eliminate or severely alter ecological conditions required by at-risk species (***WL7***). This is uncharacteristic of these systems and has the potential to affect the Holy Ghost ipomopsis, Jemez Mountain salamander, Jemez woodland snail, Lewis' woodpecker, Mexican spotted owl, and the northern goshawk.
>
> *Catastrophic Fire in Forested Systems* – Although variably sized patches of high-intensity, stand-replacing fire is considered natural in non-frequent fire forested systems like MCW and SFF, these fires can still completely eliminate or severely alter ecological conditions required by at-risk species (***WL7***). This can affect American marten, boreal owl, large yellow lady's-slipper, Pecos fleabane, snowshoe hare, and spotted bat.
>
> *Uncharacteristic Fire in Non-Forested systems* – Due to the excessive fuel-loads resulting from fire-suppression, uncharacteristic fire can occur even in non-forested systems. This can alter vegetation types and ecological conditions for those species within those systems (***WL7***). This can affect masked shrew, New Mexican Meadow jumping mouse, and water shrew.
>
> *Altered Soil Conditions* – The Arizona willow, Holy Ghost ipomopsis, Jemez Mountain salamander, Jemez woodland snail, and wood lily are all dependent upon specific soil conditions. ***Soil conditions such as pH, moisture level, and nutrients, would be negatively impacted in the event of a long lasting, high-intensity fire and subsequently decrease the viability of at-risk within those soils[WL84].***
>
> *Excessive Erosion and Siltation in Riparian Areas* – When an uncharacteristic fire occurs, the bare ground that remains is vulnerable to erosion during high wind or rain events. The displaced soil then moves downhill and often ends up in riparian areas where the excessive siltation can cause population declines in aquatic species (***WL11***). This can affect the Rio Grande chub, Rio Grande cutthroat trout, Rio Grande sucker, Lilljeborg's peaclam, and northern leopard frog.

Since risk of uncharacteristic fire is closely associated with reference vegetative conditions, effects of management actions will be similar to those in the seral state analysis.

Effects Common to All Alternatives

The natural range of variation calls for a fire return interval in some forested systems to be in the range of hundreds of years (MCW, SFF). This results in variably sized patches of stand-replacing fire in those systems which is completely natural. Regardless, these stand-replacing fires can still greatly impact at-risk species. Since no management action is anticipated within MCD and SFF the likelihood of a stand-replacing fire within those systems remains the same throughout all alternatives. The impact to at-risk species should an uncharacteristic fire erupt will also be the same (***WL7, WL11, and WL84***).

Alternatives 1, 2, 3, and 4:
See seral state analysis for effects to vegetative conditions. Restored vegetation will restore fire regimes.

Uncharacteristic Fire Summary:
Alternative 1 provides direction for forest conditions dealing with uncharacteristic fire primarily through the timber and fuels program. Forest conditions within frequent-fire systems are moving toward desired conditions but at an extremely slow rate (see Veg analysis). Alternatives 2, 3, and 4 provide objectives and guidelines that result in positive trends toward desired vegetative conditions and decrease the likelihood that ecological conditions required by at-risk species will be negatively impacted by uncharacteristic fire. Alternatives 3 and 4, however, introduce additional issues and threats to at-risk species by means of obtaining those seral state conditions (fire and mechanical treatments). Alternative 3 increases the risk of uncharacteristic fire under certain conditions while alternative 4 increases ground and soil disturbance and likelihood of increased intrusive human activity. Both of these alternatives therefore may negatively impact at-risk species and decrease their viability. Alternative 2 is the best option for increasing the viability of at-risk species impacted by uncharacteristic fire.

See appendix E for plan components addressing uncharacteristic fire.

Issue E – Invasive Vegetative Encroachment

When nonnative plant species appear on the landscape native species must compete for available resources. A naturally aggressive plant may be especially invasive when it is introduced to a new habitat. Increased resource availability and altered disturbance regimes associated with human activities often differentially increase the performance of invaders over that of natives (Daehler 2003), this places undue stressors on native populations, especially at-risk plant species. Invasive vegetative encroachment can also impact animal species as well. Small mammals and even fish are dependent upon certain vegetation types and can be impacted if invasive plants alter the composition of their native habitats (Crowl 2008, Rahel et al. 2008)).

Currently, 14 at-risk species (39 percent) may be impacted by invasive vegetation encroachment in the forest, these occur in 4 terrestrial ERUs (SFF, MCW, PJO, and PJG) as well as in riparian areas (RIP) (table 58).

Knowing where the at-risk species that are impacted by invasive vegetative encroachment exist is critical in order to address this issue. Invasive vegetation encroachment is primarily documented in the forest through surveys and observation by forest personnel. Although the type of invasive vegetation is often dependent upon the ERU in which it is found, the primary invasive plants known in the Santa Fe NF include: Bull and Canada thistle (*Cirsium* spp.), Nodding plumeless thistle (*Carduus nutans*), Russian olive (*Elaeagnus angustifoilia*), Saltcedar *(Tamarix spp.)*, and Siberian elm (*Ulmus pumila*). These six invasive plant species contribute to 94 percent of the known invasive encroachment in the forest (table 59).

Since at-risk species can be linked with specific ERUs, information about acres of invasive plant encroachment can be used as an indicator for ecological conditions required by some at-risk species. ERUs that may be highly impacted by invasive vegetation encroachment are likely to provide poorer ecological conditions for at-risk species while ERUs with minimal invasive encroachment are likely to provide better ecological conditions for at-risk species.

Table 58. At-risk species impacted by invasive vegetative encroachment and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
American marten												X	X
Arizona willow												X	X
Chama blazing star							X						
Greene's milkweed							X			X			
Large yellow lady's slipper					X							X	
Masked shrew												X	X
NM Meadow jumping mouse													X
Pecos fleabane												X	
Rio Grande chub													X
Rio Grande cutthroat													X
Rio Grande sucker													X
Snowshoe hare												X	
Springer's blazing star							X						
Water shrew													X

Note: Columns displaying X's indicate impact of the species in that ERU.

Table 59. Inventoried acres of invasive plants in the Santa Fe NF (Santa Fe NF Assessment 2016)

Common Name	Scientific Name	Forest (acres)
Bull thistle	*Cirsium vulgare*	3,224
Canada thistle	*Cirsium arvense*	5,466
Cheatgrass	*Bromus tectorum*	76
Common mullein	*Verbascum thapsus*	21
Dalmation toadflax	*Linaria dalmatica*	21
Diffuse knapweed	*Centaurea diffusa*	114
Hardheads	*Acroptilon repens*	87
Nodding plumeless thistle	*Carduus nutans*	3,154
Poison hemlock	*Conium maculatum*	22
Russian olive	*Elaeagnus angustifolia*	1,759
Tamarisk (saltcedar)	*Tamarix ramosissima*	1,940
Scotch thistle	*Onopordum acanthium*	481
Siberian elm	*Ulmus pumila*	2,401
Spotted knapweed	*Centaurea stoebe*	323
Total		***19,089***

Invasive Vegetative Encroachment Analysis

Metric: Acres of Invasive Vegetation Treated

Fourteen at-risk species may be impacted by invasive vegetation encroachment, this includes: American marten, Arizona willow, Chama blazing star, Greene's milkweed, large yellow lady's-slipper, masked shrew, New Mexico meadow jumping mouse, Pecos fleabane, Rio Grande chub, Rio Grande cutthroat trout, Rio Grande sucker, snowshoe hare, Springer's blazing star, and water shrew. At-risk small mammal species are impacted by invasive vegetation when the invasive plants diminish or remove native vegetation the animals rely upon for foraging or nesting. At-risk plants on the other hand are impacted when invasive plants compete for available resources such as water, soil nutrients, and sunlight. Seven of the species utilize four upland ERUs as habitat, five species use only riparian (RIP) areas, while two species utilize both upland and riparian ERUs.

Eight upland ERUs (ALP, CPGB, JUG, MCD, MSG, PPF, PJS, SAGE) do not contain any at-risk species impacted by invasive vegetative encroachment and will not be analyzed as part of the at-risk species analysis. Invasive vegetation is still a concern within these ERUs, but it is not contributing to decreased viability of at-risk species. Currently, five ERUs (SFF, MCW, PJO, PJG, and RIP) have invasive vegetative encroachment that may be impacting at-risk species. The effects of the alternatives to address invasive encroachment are analyzed below.

Alternative 1 – 1987 Forest Plan

Although the no-action alternative allows for the removal of invasive vegetation for the protection of native species, there is little direction for the removal of nonnative invasive vegetation in ERUs that are impacted by this issue (SFF, MCW, PJO, PJG and RIP). The current Forest Plan only mentions the active control of invasives in the Jemez National Recreation Area and the Pecos Wild and Scenic River Management Areas. Guidelines in other Management Areas prohibit the introduction on nonnative plant or animal species but there are no objectives for the removal of invasive plants nor are there restoration objectives, which would help restore native plants. Outside of the management areas there is no specific guidance for where management should take place. It discusses ways to prevent nonnative introduction but does not treat the existing conditions. ***Invasive plants communities would continue to grow and native plants which provide nesting and foraging habitat for at-risk mammals would be diminished or replaced[WL24]. At-risk plants would continue to suffer since invasive plants would compete for available soil nutrients, water, and sunlight[WL25].*** At-risk species will continue to be impacted by invasive vegetation under this alternative. This alternative has the least effect on invasive vegetative encroachment and its impact to at-risk species (***WL24-25***).

Alternative 2 – Forest Plan

Desired conditions for nonnative invasive species can be found in appendix E. Although plan components specifically addressing invasive species are typically found in the Nonnative Invasive Species section, they can also be found in Vegetation, Riparian Management Zones, Fire, Water, Soil, Forestry, Aquatic Species, Terrestrial Species, At-Risk Species, and Dispersed Recreation sections as well.

The proposed action sets an objective of eradication or suppression of invasive species on 600 acres annually. Eradicating or suppressing invasive vegetation encroachment within ERUs would ensure the viability of species that are dependent upon appropriate habitat conditions. ***The native vegetation that small at-risk mammals require for nesting and foraging would not be diminished or replaced by invasive plant communities[WL26] while at-risk plant communities would not have to compete with invasive plants for soil nutrients, water, and sunlight[WL27].*** The following discussion demonstrates how the eradication or suppression of invasive vegetation would increase the viability for at-risk species.

Six at-risk species are negatively impacted by invasive vegetation encroachment within SFF, they are American marten, Arizona willow, large yellow lady's-slipper, masked shrew, Pecos fleabane, and snowshoe hare. The large yellow lady's-slipper is impacted by invasive vegetative encroachment within MCW. Three at-risk plant species are negatively impacted by invasive vegetation encroachment within PJO, they are Chama blazing star, Greene's milkweed, and Springer blazing star. Greene's milkweed is impacted by invasive vegetative encroachment within PJG. Eight at-risk species are negatively impacted by invasive vegetation encroachment within RIP, they are American marten, Arizona willow, masked shrew, New Mexico meadow jumping mouse, Rio Grande chub, Rio Grande cutthroat trout, Rio Grande sucker, and water shrew. The plant and animal species are primarily impacted by a variety of thistle, saltcedar, Russian olive, and Siberian elm. The objective of removing invasive species would be to improve the ecological conditions for at-risk mammal and plant species. Due to the amount of acreage treated, this alternative has the second greatest effect on invasive vegetative encroachment and its impact to at-risk species (***WL26-27***).

Alternative 3 - Natural Processes Emphasis

Under the natural processes emphasis alternative, the objective for annual invasive vegetation treatments decreases from 600 to 300 acres annually. Since eradication or suppression of invasive vegetative encroachment often requires direct human application and does not typically utilize prescribed fire, less acreage can be treated. The objective of removing invasive species would improve the ecological conditions for at-risk mammal and plant species. However, since the amount of acreage is reduced, this alternative has the third greatest effect on invasive vegetative encroachment and its impact to at-risk species (***WL26-27***).

Alternative 4 - Human Uses Emphasis

Under the human uses emphasis alternative, the objective for annual invasive vegetation treatments increases from 600 to 1,500 acres annually. Since eradication or suppression of invasive vegetative encroachment often requires direct human application and does not typically utilize prescribed fire, more acreage can be treated. The objective of removing invasive species would improve the ecological conditions for at-risk mammal and plant species. However, since the amount of acreage is increased, this alternative has the greatest effect on invasive vegetative encroachment and its impact to at-risk species (***WL26-27***).

Invasive Vegetation Summary:

Invasive vegetation encroach can seriously impact at-risk species by altering the composition of their native habitats or robbing the soil of critical nutrients and water for native plants. Alternative 1 provides guidance to prevent the introduction of invasive plant species but lacks objectives for removing invasive vegetation that has already established. It also does not provide focused guidance. Alternatives 2, 3, and 4 provide those same protections but also provides objectives to reduce the amount of invasive vegetation where it has already been established. Based on treated acreages, Alternative 4 is the best option for treating invasive vegetation and potentially increasing the viability of at-risk species followed by alternative 2, then 3.

See appendix E for plan components addressing invasive vegetative encroachment.

Issue F – Disconnected Floodplains (wet soils)

Floodplains are a key component in riparian areas. These are areas adjacent to river and stream systems that typically flood during high-water events. They are generally characterized by gradual slopes which results in the water spreading out over large areas (floodplains), thus, dispersing its energy minimizing its erosive nature. The conditions created by these events have resulted in vegetative communities specifically designed for wet-soil conditions. Due to changing vegetative conditions in riparian areas from excessive human uses (e.g., recreation, grazing) native vegetation is often diminished causing more severe erosion problems during high water events (Julien et al. 2005). This oftentimes causes the stream channel to downcut and directs more water through the channel resulting in even greater erosion. This results in streams and rivers with deep incised channels and steep banks where water cannot escape and disconnects the floodplains from the existing stream. This often causes impacts to terrestrial species dependent upon wet soil conditions and vegetation, as well as fish species within the stream and river systems (Magana 2013, Tronstad et al. 2003).

Currently, seven at-risk species (19 percent) may be impacted by disconnected floodplains in the forest; these occur in one terrestrial ERU (SFF) as well as in riparian areas (RIP) (table 60).

Disconnected floodplains are only associated with riparian areas, so the terrestrial ERUs will not be evaluated. Riparian areas that have disconnected floodplains (i.e., deep incised stream channels) are likely to provide poorer habitat conditions for at-risk species while areas with connected floodplains are likely to provide better habitat conditions for at-risk species. This assumption is supported by numerous species-specific studies (Cluer and Thorne 2013).

Table 60. At-risk species impacted by disconnected floodplains and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
Arizona willow												X	X
Masked shrew												X	X
NM meadow jumping mouse													X
Rio Grande chub													X
Rio Grande cutthroat trout													X
Rio Grande sucker													X
Water shrew													X

Note: Columns displaying X's indicate impact of the species in that ERU.

Disconnected Floodplain Analysis

Metric: Steam miles treated

Eight at-risk species may be impacted by disconnected floodplains, this includes: Arizona willow, masked shrew, New Mexico meadow jumping mouse, northern leopard frog, Rio Grande chub, Rio Grande cutthroat throat, Rio Grande sucker, and water shrew. All of these species utilize riparian areas and since floodplains are not considered in upland ERUs, the SFF will not be evaluated even though Arizona willow and masked shrew utilize this ERU. The effects of the alternatives to address disconnected floodplains are analyzed below.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative, there is direction to manage floodplains in accordance to legal requirements for wetlands, wild and scenic rivers, and other resources. There is also direction to identify and protect wetlands and floodplains from further degradation. This allows forest managers to address disconnected floodplains as needed but there are no objectives to restore disconnected floodplains on a more scheduled basis. Conditions outside the control of the Forest Service often influence the development and rate of restoration of floodplains. For example, flash flood events can scour channels of debris and cause greater incisions within the main channel, often resulting in greater disconnect. Due to currently altered stream conditions, the continued lack of overbank flooding leads to a change in vegetation type from riparian to upland or a loss or riparian soil types. Therefore, restoration of altered systems would prevent further degradation. Examples of restoration include beaver dam analogs and restored native vegetation both of which slow down and hold water. Although this alternative provides protections for existing floodplains, restoration of out-of-reference riparian areas is critical. Standards and guidelines directing where management would be most successful are lacking. If floodplains continue to become disconnected or remain disconnected and vegetation communities' change from wetland-based plant species to upland species***, wetland dependent plant species may be affected due to changing soil conditions and encroachment from upland plant species***[WL28]***. Small mammals dependent upon riparian areas and their native wetland plant communities may struggle due to lost foraging and nesting habitat***[WL29]***. Fish species that depend on slower moving, cleaner (less siltation) water may be affected as floodplains become more disconnected losing their ability to maintain the ecological conditions for these fish species***[WL30]***.*** At-risk species will continue to be impacted by disconnected floodplains. This alternative has the least effect on disconnected floodplains and its impact to at-risk species (***WL28-30***).

Alternative 2 – Forest Plan

Riparian areas are referred to as riparian management zones (RMZs) and are specifically addressed in the new forest plan (proposed action). In addition to RMZs having their own specific desired conditions, the Aquatic Species and Habitat section also describes in detail how these areas should look, function, and be restored, this includes floodplains. The entire suite of plan components addressing this issue can be found in appendix E. Although plan components specifically addressing disconnected floodplains are typically found in the Riparian Management Zone and Aquatic Species and Habitat sections they can also be found in Vegetation, Forestry, Water, At-Risk Species, Range, and Roads sections as well.

The proposed action provides desired conditions that define specific conditions as they pertain to RMZs, which includes floodplains it also sets an objective of restoring the composition and structure of 15 miles of stream every 10 years as well as 30 miles of aquatic habitat projects every 10 years. Restoring composition and structure of floodplains within RMZs would ensure the viability of species that are dependent upon those wet soil habitat conditions. The following discussion demonstrates how reconnecting floodplains would increase the viability for those at-risk species that are impacted when they are disconnected.

Seven at-risk species are negatively impacted by disconnected floodplains within Riparian (RIP) areas, they are: Arizona willow, masked shrew, New Mexico meadow jumping mouse, Rio Grande chub, Rio Grande cutthroat trout, Rio Grande sucker, and water shrew. The three at-risk mammals (mouse and shrews) are primarily impacted by the altered composition of their native habitat. When floodplains become disconnected, they oftentimes lose their wet-soil features, therefore, vegetative communities change. ***Floodplains that are connected, or become reconnected, will provide the foraging and nesting areas for the at-risk mammals dependent upon those wet-soil plant communities***[WL31]***.*** The Arizona willow is impacted by similar conditions when soils lose their wet-soil characteristics since they are dependent upon year-round water availability. ***Connected floodplains ensure the wetland soil conditions***

required by some at-risk plant species[WL32]***.*** The three at-risk fish species are impacted by disconnected floodplains in a much different way. Since they are dependent upon water conditions within their habitat, they are oftentimes impacted when vegetative communities along streambanks change. Native plants historically provided shade and stabilized streambanks which kept water temperatures cool. Besides temperature, the fish can also be impacted by the changes of in-stream characteristics such as flow and turbidity. These factors are increased during high-water events due to the impact from disconnected floodplains. ***Connected floodplains maintain native wetland plant communities that provides shading, filtration, and other ecological conditions required by at-risk fish species***[WL33]***.*** The desired conditions and objectives for the restoration of disconnected floodplains would restore the departed habitat for the mammals, improve soil conditions for the plants, and restore desired stream conditions. This alternative has the second greatest effect on disconnected floodplains and its impact to at-risk species (***WL31-33***).

Alternative 3 - Natural Processes Emphasis
Under the natural processes emphasis alternative, the objective for annual riparian area treatments increases from 15 miles of stream restoration (composition and structure) in the RMZ every 10 years to 30 miles. It also increases the objectives for aquatic habitat restoration projects from 30 miles every 10 years to 60 miles. The objectives of restoring disconnected floodplains would improve the ecological conditions for at-risk mammal, plant, and fish species. This alternative has the greatest effect on disconnected floodplains and its impact to at-risk species (***WL31-33***).

Alternative 4 - Human Uses Emphasis
Under the human uses emphasis alternative, the objective for riparian treatments decreases from 15 stream miles of restoration every 10 years to 10 miles. Instead of restoring composition and structure of floodplains the focus of the restoration is on invasive plant control. It also completely removes all objectives for aquatic habitat restoration projects. Since the restoration objectives of composition and structure are removed, it is unlikely riparian areas will move toward desired conditions and at-risk species will continue to be negatively impacted. Since composition and structure restoration objectives are removed but invasive plant control objectives remain, this alternative has the third greatest effect on disconnected floodplains and its impact to at-risk species (***WL28-30***).

Disconnected Floodplain Summary:
Disconnected floodplains can seriously impact at-risk species by altering the composition of their native habitats for mammals, robbing the soil of critical nutrients and water for native plants, and altering the water characteristics required by certain fish species. Alternative 1 protects the current floodplains and allows for restoration work but does not have any objectives setting a schedule to restore areas that have already been altered. Specific guidance to where management would be most successful is lacking. Alternatives 2 and 3 provide desired conditions and objectives that restores floodplain connection at an advanced rate. Alternative 4 attempts to slow the degradation of riparian areas but does not address returning areas that are already impacted through restoration of stream composition and structure. Alternative 3 is the best option for increasing the viability of at-risk species impacted by disconnected floodplains followed by alternative 2.

See appendix E for plan components addressing disconnected floodplains.

Issue G - Limited or Specific Soil Conditions

Soils are complex and dynamic system that consists of a mineral component, organic matter, air, water, and various soil organisms resulting from interaction between parent material, climate, topography, and organisms throughout time and space. Soils store water, supply nutrients for plants, and provide a medium for plant growth. Soils also provide habitat for a diverse number of invertebrates and belowground organisms. Due to their slow rate of formation, soils are essentially a non-renewable resource. Unfavorable soil conditions often decrease viability of at-risk species dependent upon specific soil type or condition. Most at-risk species reliant upon soil conditions are plants, however, some invertebrates also have an affinity for certain soil types.

Soil condition is based on three soil functions: (1) the ability of the soil to resist erosion, (2) the ability of the soil to infiltrate water, and (3) the ability of the soil to recycle nutrients. The loss of soil productivity through a reduction in soil function is due to a lack of effective vegetative ground cover and organic matter (Wainwright et al. 2000, Seybold et al. 1999). This has resulted in unstable soils with reduced nutrient cycling. Soils in reference condition (satisfactory rating) provide the necessary ecological conditions for species dependent upon them. Soils that are out of reference are classified as impaired, unsatisfactory, or unsuited depending upon the degree in which they are impacted.

Currently, six at-risk species (17 percent) may be impacted by impaired, unsatisfactory, or unsuited soil conditions in the forest (four plants and two invertebrates). These occur in seven upland ERUs (JUG, MCD, PJO, PPF, PJS, PJG, and SAGE) (table 61).

Table 61. At-risk species impacted by departed soil conditions and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
Chaco milkvetch							X		X	X			
Chama blazing star							X						
Jemez woodland snail			X	X				X					
Ruidoso snaggletooth			X										
Springer's blazing star							X						
Tufted sand verbena			X								X		

Note: Columns displaying X's indicate impact of the species in that ERU.

Soils that are in impaired, unsatisfactory, or unsuited condition are likely to provide poorer habitat conditions for at-risk species while soils in satisfactory (in-reference) condition are likely to provide better habitat for at-risk species.

Soil Conditions Analysis

Metric: Soil Condition
Six at-risk species may be impacted by out-of-reference soil conditions: Chaco Milkvetch, Chama Blazing Star, Jemez Woodland Snail, Ruidoso Snaggletooth, Springer's Blazing Star, and Tufted Sand

Verbena. These species utilize seven upland ERUs. Five ERUs do not contain species impacted by soil condition (ALP, CPGB, MCW, MSG, and SFF) and are not considered in the analysis. The effects of the alternatives to address soil conditions are analyzed below.

Table 62. Upland ERUs impacted by departed soil conditions used by at-risk species

ERU Name	Satisfactory	Impaired	Unsatisfactory	Unsuited
Juniper Grass	55%	0%	7%	38%
Mixed Conifer - Frequent Fire	90%	0%	10%	0%
Piñon Juniper Grass	25%	0%	52%	23%
Piñon Juniper Sagebrush	19%	0%	55%	26%
Piñon Juniper Woodland	57%	0%	30%	13%
Ponderosa Pine Forest	74%	0%	25%	1%
Sagebrush Shrubland	27%	0%	73%	0%

The ERUs listed in table 62 contain at-risk species that are limited by soil conditions. Their level of Satisfactory condition (in-reference) ranges from a high of 90 percent in MCD to a low of 19 percent in PJS. For a more information about soil condition ratings, please refer to the Soil section. Another consideration when managing for at-risk species is their dependence upon specific soil types. For example, some invertebrates require specific soil characteristics that are primarily found in limestone outcroppings (table 63). When conducting management activities in these areas is extremely important to protect at-risk species that are dependent upon these soil types.

Table 63. At-risk species and the soils with which they are associated

Soils	Chaco Milkvetch	Chama Blazing Star	Jemez Woodland Snail	Ruidoso Snaggletooth	Springers Blazing Star	Tufted Sand Verbena
Limestone outcroppings			X	X		
Gypseous soils						X
Sandstone blended with Todilto gypsum	X					
Shales and clays of the Mancos and Chinle formations		X				
Volcanic pumice and unconsolidated pyroclastic ash					X	

Note: Columns displaying X's indicate soils associated with that species.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative there is little to no direction for improving and maintaining the condition of soils and how to achieve desired conditions through objectives, standards, and guidelines. Guidance on soils is occasionally incorporated within the water and air resources. For example, the no-action alternative simply states that activities should "…maintain the quality of air, soil, and water resources." Although the current Forest Plan recommends meeting state water quality standards there is no direction for soil standards. Therefore, ***soils will continue to lose their ability to cycle nutrients, absorb and hold water, and resist erosion and ultimately impact at-risk plants and invertebrates***[WL34]**.** There are also no protections for species within specific soil types. At-risk species will continue to be impacted by unsatisfactory soil conditions. This alternative has the least effect on maintaining or restoring soil conditions and its impact to at-risk species (***WL34***).

Alternative 2 – Forest Plan
Soils are specifically addressed in the new forest plan (proposed action). The proposed action also sets standards and guidelines to improve soil conditions by requiring Best Management Practices (BMPs) when management activities occur and by reducing soil impacts from ground-disturbing activities. Also, vegetative restoration would be the most impactful management activity to restore soil conditions and there are numerous objectives for vegetative restoration (see Veg and At-Risk Seral State section). Besides restoring and preventing further degradation of soils, some soils provide unique ecological conditions for at-risk plant and invertebrate species. For example some species will only thrive on specific soil types (table 63). Guidelines within the At-Risk section require protecting small or isolated populations. The entire suite of plan components addressing this issue can be found in Appendix E. Although plan components specifically addressing soils are typically found in the Soil section they can also be found in Vegetation, Fire, Forestry, Water, At-Risk Species, and Range sections as well.

There are six at-risk species dependent upon specific soil conditions within seven different ERUs (table 61). Since they are endemic to those specific locales, there is a guideline within the At-risk species section that protects small or isolated populations of at-risk species. ***Small populations of at-risk plant and invertebrate species would be protected from soil compaction, erosion, and degradation of soil characteristics if ground-disturbing activities are limited in the soil-types in which they occur***[WL35]***.*** Besides protecting small populations, restoration objectives in forested and non-forested ERUs would help restore soil characteristics. ***Ecological conditions such as nutrient load and water retention for plant and invertebrate species would be improved by restored vegetative conditions***[WL36]***.*** The objectives and guidelines in the proposed action would help protect invertebrate and plant species within these ERUs. This alternative has the greatest effect on maintaining or restoring soil conditions and its impact to at-risk species (***WL35-36***).

Alternative 3 - Natural Processes Emphasis
Under the natural processes emphasis alternative more emphasis is placed on natural processes such as fire to achieve desired conditions, with less emphasis on mechanical treatments. Under this alternative, acreage objectives for vegetative treatments in certain ERUs increase substantially (see At-Risk Seral State analysis) which should have a positive effect on soil conditions since they are most positively impacted by improvements in vegetative conditions. Although the effects to the soils and the species dependent upon those soils will be the same, two of the ERUs, MCD and PPF, are exposed to a higher risk of uncharacteristic fire which could seriously impact soil conditions within those ERUs. ***At-risk plants, amphibians, and invertebrates that are dependent upon specific soil conditions would be negatively impacted in the event of a long-lasting, high-intensity fire due to the fire's capacity to alter soil characteristics***[WL37]***.*** There are also seven at-risk species within MCD and PPF that may be negatively impacted by uncharacteristic fire, they are: Holy Ghost ipomopsis, Jemez Mountain salamander, Jemez woodland snail, Lewis's woodpecker, Mexican spotted owl, northern goshawk, and wood lily. Habitat components for at-risk species within PPF and MCD may be obliterated by a large-scale fire. Depending on the scale and the location of the fire, the viability of these species may decrease. Due to the increased likelihood of uncharacteristic fire within MCD and PPF, this alternative has the second greatest effect on maintaining or restoring soil conditions and its impact to at-risk species (***WL7, WL11, WL35-37, and WL84***).

Alternative 4 - Human Uses Emphasis
Under the human uses emphasis alternative more emphasis is placed on human uses such as mechanical treatments to achieve desired conditions, with less emphasis on prescribed fire. Under this alternative, acreage objectives for vegetative treatments in certain ERUs varies only slightly from the proposed action, therefore, the effects to the soils and the species dependent upon those soils will be the same. However, increased human activity associated with mechanical treatments increases the potential for ground and soil disturbance (Threat J) and increases the amount of intrusive human activity (Threat K) in both non-forested and forested ERUs which could negatively impact at-risk species (see Threats J and K). Therefore, this alternative has the third greatest effect on maintaining or restoring soil conditions and its impact to at-risk species (***WL35-36, WL47-48, and WL51-56***).

Soil Condition Summary:
At-risk species often rely on specific soil conditions. Alternative 1 lacks direction to improve soil conditions and offers little protections for at-risk species reliant on specific soil characteristics. Alternatives 2, 3, and 4 provide objectives and guidelines that would help restore soil conditions and protect species that rely on those conditions. However, alternative 3 increases the risk of uncharacteristic fire, while alternative 4 increases ground/soil disturbance and the likelihood of increased intrusive human disturbance. Both of these alternatives therefore may negatively impact at-risk species. Alternative 2 is the best option for increasing the viability of at-risk species that require specific soil conditions followed by alternative 3, then 4.

See appendix E for plan components addressing soil conditions.

Issue H - Specific Ecological Features

Specific ecological features sometimes limit the distribution and viability of at-risk species, especially if a species requires certain geophysical features (e.g., rock formations) (Reynolds 1983, Peery et al. 1999). For example, some bird species require specific rock or cliff formations for nesting, some plants require certain soil characteristics from specific geologic formations, and some fish and amphibians require specific water conditions (e.g., temperature, flow, etc.). Each of these examples are highly species-specific and are generally not required by a large number of plants and animals.

Currently, 19 at-risk species (53 percent) require specific ecological conditions that are not otherwise addressed by general habitat conditions related to vegetation. These occur in the following ERUs (table 64).

Since some ecological features are extremely species specific, they will be discussed in detail below. These would be considered fine-filter approaches.

Special Ecological Feature Analysis
Metric: Species specific (see below)
Eighteen at-risk species may be impacted by specific ecological features that may be out-of-reference or facing other impacts: American peregrine falcon, black swift, Chaco milkvetch, Chama blazing star, Gunnison’s mariposa lily, Jemez woodland snail, masked shrew, Mexican spotted owl, New Mexican meadow jumping mouse, northern goshawk, northern leopard frog, Rio Grande chub, Rio Grande cutthroat trout, Rio Grande sucker, Ruidoso snaggletooth, Springer’s blazing star, tufted sand verbena, water shrew, and western burrowing owl. These species utilize all the forest’s ERUs except for alpine and tundra (ALP).

Table 64. At-risk species requiring specific ecological features and the ERUs with which they are associated

At-Risk Species	Alpine and Tundra (ALP)	Colorado Plateau / Great Basin Grassland (CPGB)	Juniper Grass (JUG)	Mixed Conifer-Frequent Fire (MCD)	Mixed Conifer with Aspen (MCW)	Montane / Subalpine Grassland (MSG)	Piñon Juniper Woodland (PJO)	Ponderosa Pine Forest (PPF)	Piñon Juniper Sagebrush (PJS)	Piñon Juniper Grassland (PJG)	Sagebrush Shrubland (SAGE)	Spruce-Fir Forest (SFF)	Riparian (RIP)
American peregrine falcon				X	X			X					
Black swift												X	X
Chaco milkvetch							X		X	X			
Chama blazing star							X						
Gunnison's mariposa lily						X							
Jemez woodland snail			X	X				X					
Masked shrew													X
Mexican spotted owl				X	X			X					
NM meadow jumping mouse													X
Northern goshawk				X				X					
Northern leopard frog													X
Rio Grande chub													X
Rio Grande cutthroat trout													X
Rio Grande sucker													X
Ruidoso snaggletooth			X										
Springer's blazing star							X						
Tufted sand verbena			X								X		
Water shrew													X
Western burrowing owl		X	X				X		X	X			

Note: Columns displaying X's indicate species needing specific ecological features in that ERU.

Many of the ecological features required affect more than one at-risk species, and therefore, can be grouped as follows:

Specific nesting requirements – Multiple at-risk bird species require specific geologic or vegetative structural features to ensure reproductive success. The American peregrine falcon often nests in high seemingly inaccessible cliff faces nearby MCD, MCW and PPF. The black swift is known to nest in cliffs within riparian areas with remarkable waterfall features. Their only known nesting site in the forest is associated with Jemez Falls but another known site (Nambe Falls) is extremely close to forest property so the swifts often use the nearby forest for foraging and courtship. Mexican spotted owls are found throughout MCD, MCW, and PPF, however, they are often found to nest in cavities in vertical canyon walls. Northern goshawk, on the other hand, are very specific in the forest's structural requirements within MCD and PPF. This means they have very specific nesting requirements such as tree size and spacing. Lastly, the western burrowing owl is dependent upon abandoned prairie dog colonies to provide nesting habitat for this ground dwelling bird. Availability of all of these nest sites, with minimal disturbance, is paramount for the continued viability of these bird species. ***If specialized nesting sites for bird species are not afforded protections to allow the bird to breed and nest without disturbance, populations of at-risk bird species may decline*[WL38]*.***

Free-flowing cold water conditions – This not only impacts at-risk fish species but is also known to impact multiple at-risk small mammals. When it comes to fish, the Rio Grande cutthroat trout requires clear, cold, highly oxygenated water, clean gravel substrates, a network of pools and riffles, and an abundance of food (typically aquatic and terrestrial invertebrates). The Rio Grande sucker and chub require similar water characteristics although not as specific as the cutthroat. The three small mammals, masked shrew, water shrew, and New Mexico meadow jumping mouse are also extremely sensitive to high-quality cold-water systems similar to the characteristic mentioned above. They also depend on specific wetland vegetation that is only associated with riparian areas. Availability of high-quality cold-water systems is paramount for the continued viability of these fish and mammal species. ***At-risk fish species that require free-flowing, cold water characteristics such as temperature, dissolved oxygen, and an adequate number of riffles and runs, may experience population declines if these conditions are not available*[WL39]*.***

Standing water or slow-moving water conditions – The northern leopard frog requires seeps, springs, slow-moving streams, or other perennial water as habitat and for over-wintering. During summer months they can be found in wet meadows or other habitats near standing water, but these habitats are often limited in the Santa Fe NF. The limited supply of this habitat coupled with out-of-reference conditions is a concern for the viability of this species. ***At-risk amphibian species that require slow-moving or standing water for breeding sites and laying eggs may experience population declines if these conditions are not available*[WL40]*.***

Aspen Glades – The Gunnison's mariposa lily occupies aspen glades in MSG. The limited supply of this habitat coupled with out-of-reference conditions is a concern for the viability of this species. ***Continued encroachment from tree and shrub species in aspen glades may reduce populations of at-risk plant species dependent upon the open the glade habitat*[WL41]*.***

Soils from Specific Geologic Formations – Multiple plant and invertebrate species are endemic to very specific soils types that are only associated with certain geologic formations. Chaco milkvetch, Ruidoso snaggletooth, and Jemez woodland snail are associated with limestone outcroppings. Chama blazing star is associated with gray to red shales of Mancos and Chinle soil formations, Springer's blazing star only occurs on pumice deposits in the Jemez Mountains, and tufted sand verbena requires gypsum or strongly gypseous soils. Degraded or absent soil conditions effect a number of at-risk species (***WL34-37***). These specific soil conditions were analyzed in the previous Limited Soil section (Issue G.) and will not be re-analyzed.

The effects of the alternatives to address the specific ecological conditions are analyzed below.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative ecological features can be protected but there is little to no direction for addressing specific ecological conditions required by groups of at-risk species. The current forest plan seeks to identify, protect and enhance habitat that contains threatened, endangered, and sensitive species of plants but offers few forestwide standards or guidelines to protect ecological features that are required by other species. The no-action alternative is often species specific (e.g., Mexican spotted owl and goshawk guidelines) and unless management is directed for that single species, it does not protect those ecological features. For example, if management may impact an ecological feature required by a particular species, but that species is not present, those ecological features may not be protected. Without standards and guidelines to protect ecological features required by at risk species, those species may experience population declines due to impacts to those features. This alternative has the least effect on maintaining special ecological features and its impact to at-risk species (***WL34, WL38-41***).

Alternative 2 – Forest Plan
Protecting specific ecological conditions for at-risk species is specifically addressed in the new forest plan (proposed action). Guidelines addressing ecological features for *nesting requirements* call for management activities along cliff faces, rock features, and other known nesting sites to be conducted outside of nesting season to avoid impacts. ***Ecological features and nesting sites for at-risk bird species that are left undisturbed during the nesting will result in greater nesting success and maintained or increased populations***[WL42]***.*** Stream restoration objectives and guidelines within the proposed action promote the *free-flowing cold-water conditions* required by at-risk fish and mammal species. For example, projects and management activities within aquatic and riparian systems should be designed or managed to maintain high-quality aquatic habitats that are described in the desired conditions. ***Cold-water stream conditions that increase or maintain necessary vegetation, water temperatures, flow, and pool-to-riffle ratios will result in sustained populations of at-risk fish and mammal species***[WL43]***.*** Guidelines within the proposed action also protect free *standing water or slow-moving water conditions* for the betterment of species. For example, projects that withdraw water from surface water features or groundwater must ensure that water is maintained at levels that will protect aquatic species, their habitats, and water quality. ***If standing or slow-moving water conditions are maintained, at-risk amphibians species will have adequate places for reproduction and egg-laying and will result in sustained populations***[WL44]***.*** Restoration objectives in non-forested ERUs which includes MSG and subsequent *aspen glades* can ensure woody encroachment does not displace at-risk plant species (***WL15***). The proposed action also thoroughly addresses specific soil conditions (see Issue G) and the effects from addressing this issue (***WL35 and WL36***). The entire suite of plan components addressing this issue can be found in Appendix E. Although plan components specifically addressing specific ecological conditions are typically found in the At-Risk Species section they can also be found in Vegetation, Riparian Management Zones, Fire, Forestry, Water, Aquatic Species and Habitats, Terrestrial Species and Habitats, Range, Roads, and Minerals sections as well.

Protecting and restoring specific ecological conditions would help ensure the viability of species that are dependent upon those species-specific conditions. The objectives and guidelines in the proposed action would help protect ecological features required by at-risk species. This alternative has the greatest effect on maintaining special ecological features and its impact to at-risk species (***WL42-44***).

Alternative 3 – Natural Processes Emphasis
Under the natural processes emphasis alternative more emphasis is placed on natural processes such as fire to achieve desired conditions, with less emphasis on mechanical treatments. Though there are similar effects from protecting key ecological features, the added risk of uncharacteristic fire in MCD and PPF may impact the viability of at-risk species within those ERUs. The resulting impacts from large-scale high-intensity fire may also impact riparian areas caused by subsequent erosion. Due to the increased likelihood of uncharacteristic fire within MCD and PPF, this alternative has the second highest likelihood of increasing the viability of at-risk species (***WL7, WL11, WL37, WL42-44, and WL84***).

Alternative 4 - Human Uses Emphasis
Under the human uses emphasis alternative more emphasis is placed on human uses such as mechanical treatments to achieve desired conditions, with less emphasis on prescribed fire. Under this alternative the effects from protecting key ecological features would be the same as the proposed action, however, there

is added effects from increased amounts of intrusive human activity (Threat K). Therefore, this alternative has the third highest likelihood of increasing the viability of at-risk species (***WL42-44 and WL51-56***).

Ecological Feature Summary:
At-risk species often rely on specific ecological conditions. Alternative 1 lacks direction to maintain and protect specific ecological features forestwide and often focuses on individual species management as opposed to ecological conditions. Alternatives 2, 3, and 4 provide various objectives and guidelines that result in the protection or enhancement of these features. This would increase the viability for all species impacted by these conditions. Alternatives 3 and 4, however, introduce additional threats to at-risk species by increasing the risk of uncharacteristic fire as well as increasing the amount of intrusive human disturbance (Threat K) in the forest. Both of these alternatives therefore may negatively impact other at-risk species and decrease their viability. Alternative 2 is the best option for increasing the viability of at-risk species that require specific ecological conditions, followed by alternative 3, then 4.

See appendix E for plan components addressing specific ecological features.

Summary of Issues Related to Ecological Conditions

Some at-risk species are affected only by issues associated with ecological conditions that are out of reference or at a scale where additional threats cause concern for their continued persistence in the forest. For example, natural or unnatural disturbance could have widespread or significant negative impacts to isolated or endemic populations. Viability of these species is addressed through coarse filter plan components that strive to achieve and maintain the necessary ecological conditions those species require. Eleven at-risk species in the forest are secured by addressing ecological conditions only (see table 65). Note: Most other species are affected by a combination of ecological and anthropomorphic issues and threats.

The remaining 25 at-risk species not listed in table 65 will be positively impacted by improving ecological conditions in the forest; however, they require additional fine-filter approaches to secure persistence in the forest. This means threats beyond habitat are having negative impacts on the species and affecting their viability. We must address those additional threats through fine-filter approaches.

Threats to At-Risk Species Related to Forest Activities

Threats I through N deal with unnatural (human-caused) threats that negatively impact at-risk species. These threats are typically addressed through fine-filter plan components within the proposed action and alternatives.

Threat I – Nonnative Competition and Predation (Aquatic)

Negative impacts to at-risk species may occur when nonnative invasive species are introduced, intentionally or unintentionally, into aquatic systems where at-risk species exist and competition and prey behavior results in population declines of the native populations (Dukes and Mooney 2004). Nonnative invasive species in the Santa Fe NF include but are not limited to American bullfrogs, white sucker, brown trout (*Salmo trutta)* and rainbow trout (*Oncorhynchus mykiss*; Ficetola et al. 2007). It is well-known that rainbow and brown trout often out-compete native Rio Grande cutthroat trout (Krueger and May, 1991) in areas where they were introduced, and there may also be a risk of predation or competition on the at-risk Rio Grande sucker and chub by these or other nonnative fish species (Rees and Miller 2005a; Rees and Miller 2005b). These nonnative fish, in particular the brown and rainbow trout, were introduced in waters of the Santa Fe NF for socioeconomic benefit. Similarly, nonnative American bullfrog were known to out-compete northern leopard frogs (Blaustein and Keisecker 2002, Walker and

Steffen 1997). These are just examples of the types of negative consequences associated with invasive species that were introduced into aquatic systems.

Table 65. Summary of ecological conditions affecting viability of at-risk species

At-risk species affected primarily by issues associated with ecological conditions	Ecological conditions impacting viability
American marten (*Martes caurina*)	Coarse woody debris departure, uncharacteristic fire, invasive vegetation encroachment
Arizona willow (*Salix arizonica*)	Seral state and coarse woody debris departure, uncharacteristic fire, invasive vegetation encroachment, disconnected floodplains
Boreal owl (*Aegolius funereus*)	Uncharacteristic fire
Gunnison's mariposa lily (*Calochortus gunnisonii*)	Seral state departure, uncharacteristic fire, specific ecological conditions
Holy Ghost ipomopsis (*Ipomopsis sanctispiritu*)	Uncharacteristic fire
Jemez woodland snail (*Ashmunella ashmuni*)	Seral state departure, uncharacteristic fire, specific soil and ecological conditions
Lewis's woodpecker (*Melanerpes lewis*)	Seral state and snag density departure, uncharacteristic fire
Mexican spotted owl (*Strix occidentalis lucida*)	Seral state and snag density departure, uncharacteristic fire, specific ecological conditions
Snowshoe hare (*Lepus Americana*)	Coarse woody debris departure, uncharacteristic fire, invasive vegetation encroachment
Tufted sand verbena (*Abronia bigelovii*)	Seral state departure, uncharacteristic fire, specific soil and ecological conditions
Wood lily (*Lilium philadelphicum*)	Seral state departure, uncharacteristic fire

Ranking of alternatives' ability to provide the means to address the issues:

Alternative 2 provides the best guidance to move toward desired ecological conditions. Alternatives 3 and 4 provide guidance to move toward desired conditions, but often introduce additional threats to achieve those conditions. Alternative 1 provides the least amount of guidance to move toward desired ecological conditions.

Alternative 2 is the best option for providing viability for at-risk species affected primarily by issues associated with ecological condition.

Nonnative Competition and Predation (Aquatic) Analysis:

Metric: Miles of streams with nonnative species

Currently, four at-risk species (11 percent) may be negatively impacted by aquatic invasive competition and predation, they include: Northern leopard frog, Rio Grande sucker, Rio Grande cutthroat trout, and Rio Grande chub. The effects of the alternatives to address aquatic invasive competition and predation are analyzed below.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative there is little direction for addressing aquatic predation within the Santa Fe NF waterways and riparian areas. The current Forest Plan provides direction on fisheries management in the Rio Chama Wild and Scenic River Management section but no other forestwide guidance for aquatic predation is offered. The management direction for the Rio Chama seeks to provide a quality fishing experience, with brown trout as the target management species. Flow management recommendations should also support natural reproduction of the brown trout species. There is also a standard that states the put and take rainbow trout fishery in the upper three miles of the Chama, where fishing pressure is greatest, will continue. Much of the direction within the no-action alternative is to provide fishing opportunities within specific stream section but there is little forestwide direction. ***At-risk fish and amphibian species will continue to be directly impacted by nonnative species from predation or through the diminished resources from competition***[WL45]***.*** Populations of at-risk species impacted by aquatic predation and competition will continue to struggle. Therefore, this alternative has the least effect on reducing nonnative aquatic competition and predation and its impact to at-risk species (***WL45***).

Alternative 2 – Forest Plan

Specific forestwide management of invasive aquatic predation is addressed in the new forest plan (proposed action). Although plan components specifically addressing invasive aquatic predation and competition are typically found in the Aquatic Species and Habitats and At-Risk Species sections, they can also be found in the Riparian Management Zones and Water sections as well. The entire suite of plan components addressing this threat can be found in appendix E.

A guideline directly addressing nonnative aquatic predation is found in the At-Risk Species section. It directs that all authorized activities should be designed and implemented to address threats to at-risk species and their habitats, including, but not limited to the prevention of introduction of invasive, competing, or predatory species that are directly and negatively impacting at-risk species populations. There is also an objective to complete aquatic restoration on priority projects that restore 30 miles of aquatic habitat (e.g., increase pool quantity, provide stream cover, remove or install of fish barriers, restore beaver populations, treating invasive aquatic species, etc.) every 10 years to benefit aquatic species. ***Management actions to install fish barriers and remove invasive aquatic species will directly benefit at-risk fish species by eliminating or reducing impacts from nonnative predation and competition***[WL46]***.*** This action takes an active role to not only prevent invasive aquatic predation and competition but will actively seek to reverse these threats in areas that have already been negatively impacted. This alternative has the second greatest effect on reducing nonnative aquatic competition and predation and its impact to at-risk species (***WL46***).

Alternative 3 - Natural Processes Emphasis

Under the natural processes emphasis alternative, the same set of desired conditions and guidelines as the proposed action are proposed. This alternative, however, places more emphasis on the restoration of natural processes to the landscape, which includes increased ecological objectives. The objective in the Aquatic Species and Habitat section doubles from 30 miles over 10 years to 60 miles. The effects from this alternative will be the same as the proposed action. However, since the amount of stream miles treated increases (doubles), this alternative has the greatest effect on reducing nonnative aquatic competition and predation and its impact to at-risk species (***WL46***).

Alternative 4 - Human Uses Emphasis

Under the human uses emphasis alternative, the same set of desired conditions as the proposed action are proposed. This alternative, however, places more emphasis on human uses, therefore there is no objective to restore ecological conditions in waterways previously impacted by nonnatives. At-risk species would continue to be impacted by this threat. This alternative, along with alternative 1 (no-action), has the least effect on reducing nonnative aquatic competition and predation and its impact to at-risk species (***WL45***).

Nonnative Competition and Predation Summary:

Nonnative aquatic predation and competition can seriously impact at-risk species. Alternative 1 lacks forestwide direction to remove nonnative aquatic species where they impact at-risk populations. It also encourages maintaining nonnative populations in specific aquatic systems. Alternatives 2 and 3 provide guidelines and objectives that not only ensures nonnative aquatic species are not introduced into areas that contain at-risk species but actively seeks to remove theme from areas where they are causing impacts. Alternative 4 has no restoration objectives, therefore, has similar effects as alternative 1. Alternative 3 is the best option for increasing the viability of at-risk species impacted by nonnative aquatic predation and competition, followed by alternative 2, then alternatives 1 and 4.

See appendix E for plan components addressing aquatic invasive depredation and competition.

Threat J - Ground or Soil Disturbance (Livestock Grazing, Roads, and Trails)

Ground or soil disturbance can impact at-risk species in a multitude of ways. It can occur from a variety of human uses such as livestock grazing, road and trail use and development, activity and machinery used for restoration activities, as well as increased human traffic from recreationists. All of these activities can have negative effects including direct species mortality (e.g., trampling, human-caused mortality- plant picking/wildlife handling), soil compaction and erosion, the latter of which can lead to increased siltation in waterbodies and related increases in turbidity or sedimentation.

Soil compaction may cause reduced soil productivity (Burger et al. 2010), restrict root growth, or alter soil characteristics necessary for at-risk plants, thus inhibiting their potential for growth (Anderson et al. 2005). Invertebrates and amphibians can also be impacted by this issue when soil characteristics are altered, or soil is compacted. Compaction mostly occurs when roads or trails are created, especially non-system roads or trails that may enter into areas where at-risk species are present.

Another means by which ground and soil disturbance can impact at-risk species is through erosion and subsequent siltation of waterways. When soil is disturbed, such as when heavy equipment and machinery are used for timber harvesting, road constructions or decommissioning, facility construction, etc. occur, the likelihood of erosion increases, especially if there are uncharacteristic weather events such as high wind or excessive rains. If ground disturbance occurs near a waterway, this can ultimately lead to excessive siltation when the exposed soils are carried into the water. This increased siltation adversely affects water quality and aquatic habitat by making water more difficult to clean, decreasing the oxygen supply to fish and amphibians, and decreasing habitat diversity and availability (Henley et al. 2000; Postel and Thompson 2005). It may also impair the ability of aquatic species to forage (Meehan 1991).

Since restoration activities often results in conditions that move vegetation closer to reference conditions it is assumed that short-lived ground disturbance such as thinning projects or prescribed fire do not negatively impact species especially when the end result is improved ecological conditions (unless it destroys an isolated or small population or results in changed seral conditions that no longer support the species). However, activities that result in long-term impacts to the soil can negatively impact species that were present, this includes construction of roads or trails, the development of unauthorized trails, and excessive trailing from livestock use. The latter has been identified as a potential threat to some rare and endangered plant and animal species (Prendusi et al 1996, Frey 2005, Decker 2006), as livestock grazing can result in soil compaction, disturbance, and erosion, which can contribute to siltation in waterbodies. Large ungulate activity (including elk and deer) in riparian areas can also result in excessive herbivory. These impacts can negatively impact riparian obligate species such as the New Mexico meadow jumping mouse (USFWS 2020). However, livestock management on the Forest has been shifting to an adaptive management approach since 2005, which allows stocking levels to change in response to changing ecological conditions. Additionally, infrastructure helps keep cattle dispersed across the forest to avoid long-term, concentrated impacts to ecological health. It is assumed that livestock on the forest will be managed so that ecological conditions move toward desired conditions. The potential effects of livestock on soil erosion, stream channel incision, and soil compaction is fully analyzed in the Watershed and Water Resources section of this document (section 3.4.4.1.2.4 see Indicator: Livestock Grazing Activities).

Other than road or trail creation and livestock activity, management actions that may increase ground and soil disturbance may include log landings for forestry activities as well as recreational and range improvements (e.g., campgrounds, picnic areas, mineral and feed sites for livestock; Green 1998). Although recreation activity can have significant negative impacts when unmanaged, regulated use can often mitigate their impacts. Since some at-risk populations may be isolated and small, even the smallest of footprints may impact their viability if it occurs in a highly sensitive area (e.g., Holy Ghost Canyon).

Ground or Soil Disturbance Analysis:

Metric: Miles of Roads Decommissioned or Added (constructed or reconstructed) and Recreational Trail Miles Decommissioned or Added (constructed or reconstructed)

Currently, 15 at-risk species (42 percent) may be negatively impacted by ground or soil disturbance, they include: Arizona willow, Chaco milkvetch, Chama blazing star, Greene's milkweed, Heil's alpine whitlowgrass, Holy Ghost ipomopsis, large yellow lady's-slipper, New Mexico meadow jumping mouse, northern leopard frog, Pecos fleabane, Rio Grande sucker, Rio Grande cutthroat trout, Rio Grande chub, Ruidoso snaggletooth, and Springer's blazing star.

The effects of the alternatives on ground and soil disturbances that impact at-risk species are analyzed below, with a focus on the impacts of development, maintenance, or rehabilitation (including closing, decommissioning, and naturalizing roads) of roads and trails. The analysis does not assume other activities discussed above have no effect, rather it assumes they are typically less impactful or more difficult to quantify.

Roads are the dominant source of erosion and sediment in forests (Swank and Crossley 1988; MacDonald and Coe 2008). At-risk plant and invertebrate species are most effected by activities that disrupt soil characteristics while at-risk fish species are more likely to be impacted by siltation caused by excessive erosion. This erosion may be caused by the mere existence of roads and trails that are nearby waterways since they tend to alter the natural flow and absorption of water during natural rain events. Some road locations are in areas that are more sensitive than others, such as along riparian areas, or in areas of inherently unstable soils. ***The construction of roads and trails and other ground compacting activities could impact at-risk plant, invertebrate, and amphibian species through soil compaction which could crush individual plants or animals as well as alter soil characteristics making that area unsuitable for those species*[WL47]*. The creation, or non-maintenance, of roads can also result in erosion impacts which negatively effects waterways through siltation and can cause population declines in at-risk fish species*[WL48]*.*** Also, a large number of unmaintained non-system roads contribute to erosion and siltation. This is because non-system trails are not designed or engineered to mitigate impacts such as run-off and the resulting erosion.

Effects Common to All Alternative

For all alternatives, plan components require using site-specific BMPs and Soil and Water Conservation Practices (SWCP) (FSH 2509.22 R3) and there are additional specific directions about minimizing adverse impacts to soils and subsequent impacts to at-risk species (***WL47-48***). BMPs and SWCPs have been proven effective in mitigating ground disturbance and well as intercepting sediment in runoff. This would include reducing impacts to soil compaction (***WL47***).

Additionally, a standard or guideline exists in all alternatives to emphasize reconstruction and rehabilitation of existing roads over new road construction. ***Management activities that are designed to reduce the imprint of ground disturbance activities will lessen the negative impacts of soil compaction and erosion on at-risk species*[WL49]*.*** None of the alternatives have specific objectives, during the life of the plan, to construct new motorized routes or trails. Proposals for new development and the associated environmental effects will be considered through project-level planning.

An exception is within wilderness, where motorized and mechanized (e.g., bicycle) travel is prohibited, and motorized and mechanized roads and trails are not present; only walking trails are permitted. Although alternatives have different amounts of recommended wilderness, every alternative contains 314,172 acres of designated Wilderness in which no new roads will be built. Therefore, these designated areas lack the adverse effects to ground and soil disturbance caused by roads (***WL47-48***).

Alternative 1 – 1987 Forest Plan
The objectives for road decommissioning in alternative 1 are that 660 miles of road should be decommissioned over the first 10 years. This alternative also calls for 95 miles of road to be constructed in the same time period, leading to a net decrease of 565 miles of roads in the first 10 years. Components also direct the rehabilitation of temporary roads. This is the most road decommissioning (and road construction) of any alternative. The no-action alternative also allows for the construction and reconstruction of 16 miles of trails per year. However, under this alternative there is little guidance to address the impacts of roads and trails on at-risk species. There is guidance to “close or obliterate unnecessary roads” as they may impact wildlife habitat, but the only guidance regarding road construction is to avoid areas with elk calving.

The 1987 Plan also recommended 1,853 acres of wilderness, in which new road construction and motorized and mechanized use is prohibited. This is the second least amount of recommended wilderness out of all alternative, and therefore this alternative has the second lowest avoided impacts of road and trail management on ground or soil disturbance (***WL47-48***). The plan also proposed the Cañada Bonita Research Natural Area (323 acres), which similarly has restricted road construction and its associated effects (***WL47-48***).

Since alternative 1 does not address the impact of roads and trails (***WL47-48***) on populations of at-risk species those species threatened by this will continue to struggle. Additionally, the decommissioning objectives proposed under this alternative have only been minimally implemented across the forest, and nowhere near the objective scale, demonstrating that it is infeasible to accomplish with current levels of funding and staffing and negating the potential beneficial effects for reduced ground or soil disturbance (***WL49***). Therefore, this alternative has the least effect on reducing ground and soil disturbance and its impact to at-risk species (***WL47-48***).

Alternative 2 – Forest Plan
Under the proposed action, objectives for restoration activities include 100 miles of road decommissioning or mitigation within 10 years. Additionally, temporary roads that support ecosystem restoration activities, fuels management, or other short-term projects should be closed, decommissioned, or obliterated (restored to more natural vegetative conditions) upon project completion to protect watershed condition, minimize wildlife disturbance, and prevent illegal motorized use. There are also objectives to mitigate ecological damage at developed recreation sites and maintain at least 25 percent of system trails every three years.

Plan components and management approaches to address the impacts of road and trail management (either directly or by addressing ground-disturbing activities in general) can be found in multiple resource sections, including Water Resources, Riparian Management Zones, At-Risk Species, Soils, Forestry, Recreation, Roads, Special Uses, and Minerals. These help to mitigate negative effects of ground and soil disturbance on at-risk species (***WL49***). Common verbiage includes, “footprints of ground-disturbing activities should be as small as possible or located where ground disturbance has previously occurred.”

Areas that are restored to their reference state after disturbance are more likely to support the at-risk species that inhabited those areas[WL50].

Alternative 2 recommends 25,868 acres of recommended wilderness. This comprises 1.67 percent of the forest and will not substantially increase viability for species within those areas in terms of the impacts of road and trail management on ground or soil disturbance (***WL47-48***), although it is the second highest amount of recommended wilderness among alternatives. Alternative 2 also includes the Caja del Rio Wildlife and Cultural Interpretive Management Area, which limits ground or soil related road impacts (***WL47-48)*** through a guideline that restricts the construction of most permanent or temporary roads.

Since plan components in the proposed action seek to reduce the amount of ground and soil disturbance as well as the rehabilitate areas that do get disturbed, the viability for the 15 at-risk species impacted by excessive ground and soil disturbance would increase under this action. This alternative has the greatest effect on reducing ground and soil disturbance and its impact to at-risk species (***WL49-50***).

Alternative 3 - Natural Processes Emphasis

The natural processes emphasis alternative has the same set of objectives and guidelines as the proposed action therefore the beneficial and negative effects (***WL47-50***) would be the same, but the magnitude of the objectives are increased in scale. Plan objectives for restoration activities include 250 miles of road decommissioning within 10 years and, like alternative 2, guidelines require temporary roads to be closed, decommissioned, or obliterated upon project completion to protect watershed condition, minimize wildlife disturbance, and prevent illegal motorized use. An additional guideline within the Roads section limits the construction of permanent or temporary roads to those required for a permitted activity or to help meet desired ecological conditions. Guidelines also specify that roads would be constructed and maintained at the lowest maintenance level required for their intended purpose.

In addition, alternative 3, recommends 270,130 acres of recommended wilderness which represents 17.48 percent of the forest. Due to the added protections of recommended wilderness management and reduced area for potential road construction and its effects (***WL47-48***), this may increase the viability of at-risk species within those areas. In addition, alternative 3 includes the Caja del Rio, Wetland Jewels, and Calaveras Management Areas, each of which has standards or guidelines that disallow new road construction within their boundaries. The Wetland Jewels Management Area has an additional objective for restoration that requires road decommissioning, which could have long-term beneficial effects (***WL50)***.

The combination of these plan components would minimize the adverse effects of roads. This alternative, along with alternative 2, has the greatest effect on reducing ground and soil disturbance and its impact to at-risk species (***WL49-50***).

Alternative 4 - Human Uses Emphasis

The human uses emphasis alternative places more emphasis on human uses, therefore road maintenance is emphasized with the potential to increase road use, with no restoration objectives or components for road decommissioning that could mitigate adverse effects (***WL47-48***). Objectives in alternative 4 direct forest managers to maintain 100 miles of road within 10 years. Temporary roads would be considered for inclusion into the system to support multiple-use activities and access to the forest as an alternative for decommissioning.

This alternative also includes the addition of two motorized recreation management areas on the Española and Jemez Ranger Districts.

The added footprints of increased road activity (ground and soil disturbance) may lead to the negative impacts to the plant, invertebrate, and fish species. Therefore, alternative 4, along with alternative 1, has the greatest potential to impact at-risk species through ground and soil disturbance (***WL47-48***).

Ground or Soil Disturbance Summary:
Ground and soil disturbance can seriously impact at-risk species by crushing or altering soil characteristics for at-risk plant and invertebrate species. This same disturbance may also result in excessive erosion leading to siltation of waterways and thus negatively impacting at-risk fish species. As road and trail management is the most direct way to measure the degree of ground or soil disturbance occurring on the forest, this metric was chosen for the analysis.

Alternatives 1 and 4 allow for the construction of new roads, which would negatively impact at-risk species (***WL47-48***). Alternatives 2 and 3 provide guidelines and objectives in multiple resource areas that reduce the footprint of ground-disturbing activities and often require rehabilitation measures when possible, such as road rehabilitation (including closing, decommissioning, and naturalizing roads). Alternatives 2 and 3 are the best options for increasing the viability of at-risk species impacted by ground and soil disturbance (***WL49-50***).

See appendix E for plan components addressing ground and soil disturbance.

Threat K - Intrusive Human Activity

Intrusive human activity often creates issues for at-risk species where recreational activities impact biological function. It consists primarily of activities that disrupt critical life stages of at-risk species such as reproduction, nesting/calving, or even feeding, especially during times of high stress (e.g., breeding season, winter) (Cole 2003, Leung and Marion 2000). Harassing activities include but are not limited to human presence, indiscriminate shooting, harassment from people and domestic dogs, and picking or digging of plants (Keller and Bender 2007). At-risk species in the Santa Fe NF are known to be negatively impacted by these activities.

Intrusive Human Activity Analysis:
Metric: Recreational Use Metrics
Currently, 17 at-risk species (47 percent) may be negatively impacted by intrusive human activity, they include: American peregrine falcon, black swift, Gunnison's prairie dog, Heil's alpine whitlowgrass, Holy Ghost ipomopsis, large yellow lady's-slipper, masked shrew, New Mexico meadow jumping mouse, northern leopard frog, Pecos fleabane, Rio Grande chub, Rio Grande cutthroat trout, and Rio Grande sucker, spotted bat, water shrew, western burrowing owl, and white-tailed ptarmigan.

Since human activities vary greatly, each species may be impacted by different activities. Impacts from human activities can be grouped as follows:

Cliff disturbance from recreational climbing. This activity often disturbs cliff dwelling birds during the nesting season. It may also impact bat species that utilize cliff areas for roosting. American peregrine falcon and spotted bat may be negatively impacted by this activity. Many of these sites used by birds and bats are limited and few other viable options exist. ***Human activity that disrupts breeding, nesting, or roosting of at-risk birds and bats would decrease survival and reproduction due to site abandonment and expended energies finding suitable replacement sites***[WL51]**.**

Recreational Shooting. Although most at-risk species fall outside the bounds of legal hunting regulations, Gunnison's prairie dogs are subject to being targeted for recreational shooting. Prairie dogs are listed as non-game animals by the New Mexico Department of Game and Fish and may be taken on Forest Service lands open to hunting. Although most people target the more common black-tailed prairie dog, Gunnison's prairie dogs may occasionally be targeted. Western burrowing owls have also been targeted in the forest, possibly mistaken for prairie dog since they use their abandoned burrows. ***Recreational shooting of at-risk species causes direct mortality or nest/den abandonment*[WL52]*.***

Excessive Riparian Use. Water availability is limited in the Southwest; therefore, riparian areas and other bodies of water naturally attract wildlife. These areas also generally tend to see an increased amount of use by humans as well as livestock. Black swift, masked shrew, New Mexico meadow jumping mouse, northern leopard frog, large yellow lady slipper, and water shrew may be impacted by activities within riparian areas adjacent to streams and rivers. Rio Grande chub, Rio Grande sucker, and Rio Grande cutthroat trout may also be impacted by these increased activities. ***Human activity that disrupts breeding, nesting, or foraging of at-risk birds and mammals would decrease survival and reproduction due to abandonment and expended energies finding suitable replacement sites*[WL53]*.***

Increased Alpine Use. High peaks are often a natural draw for humans. Although alpine-tundra areas make up only a very small portion of the Santa Fe NF, they also see an extraordinary amount of human-use. This increased human activity may impact species in different ways. White-tailed ptarmigan can be impacted by increased human use in ski areas as well as through the construction of snow catchment fences. Heil's alpine whitlowgrass, on the other hand, is only located in a small area near Truchas Peak and is threatened by trampling from hikers, climbers, horseback riders, and occasional livestock. ***Human activities that disrupt foraging or nesting of ground-dwelling at-risk birds would decrease survival due to site abandonment and expended energies finding suitable replacement sites*[WL54]*. Trampling of at-risk plants by humans or livestock would cause direct mortality through crushing of individual plants or through compaction of the soil*[WL55]*.***

Picking or digging or plants. Besides being nice to look at, some people enjoy picking or digging of plants, especially if they have bright and showy flowers. Some may even seek certain plants for cultural or medicinal uses. Since at-risk plant species often require specific soil conditions, their range is sometimes quite limited making them susceptible to over-harvest. Large-yellow lady's-slipper, with its bright showy yellow flower, and Holy Ghost ipomopsis may be negatively impacted by this activity. ***Excessive picking or digging of at-risk plants that are highly endemic may significantly reduce populations*[WL56]*.***

Recreational Off-Road Vehicle Use or Other Heavy Equipment Use (e.g., mechanical thinning). Trampling of plants or soil compaction may occur in many forms, one of which is through the use of off-road vehicles or heavy equipment. This may potentially have negative impacts on at-risk species. For example, Pecos fleabane is an at-risk species that is primarily located on Elk Mountain and is impacted by off-road vehicle use since it occurs in naturally disturbed areas, especially along roadsides (***WL55***).

The forest is managed not just for wildlife but for human use as well. Occasionally the two conflict and certain allowances must be made. In the case of at-risk species, specific plan components may be required to limit the amount of intrusive human activity, especially if it decreases viability of at-risk species. The effects of the alternatives to address intrusive human activities in the forest are analyzed below.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative there is some direction to reduce the amount of human disturbance to wildlife, but it is not directed toward at-risk species. For example, there is guidance that seeks to administer activities in known turkey and raptor nesting areas so as not to disrupt nesting success.

Additional plan guidance calls for coordination with other uses to minimize pronghorn disturbance. Most of the direction within alternative 1 is to minimize disturbance to high-profile game species, although amendments do provide direction for the Mexican spotted owl and northern goshawk. Since the current forest plan does not address forestwide impact of human disturbance of at-risk species, negative impacts to at-risk species would continue. This alternative has the third greatest effect on reducing intrusive human disturbance and its impact to at-risk species (***WL51-56***).

Alternative 2 – Forest Plan

Specific forestwide management direction for minimizing human disturbance to at-risk species is addressed in the new forest plan (proposed action). A guideline in the At-risk section to address *cliff disturbance from recreational climbing* directs that management activities along cliff faces, rock features, and other known nesting sites should avoid impacts during nesting season. ***At-risk bird and bat species that remain undisturbed during critical seasons will experience higher nesting success rates[WL57].*** A guideline to address *recreational shooting* recommends closing areas (through closure orders) where recreational shooting is causing harm to at-risk species. ***At-risk bird and mammal species will see less mortality from recreational shooting in areas that have been closed to shooting[WL58].*** Multiple guidelines in various resource areas *address excessive riparian use* and seek to reduce the amount of human disturbance around waterways. For example, management activities (e.g., recreation, permitted uses, structural developments such as livestock water gaps, pipelines, or other infrastructure) within the RMZ should occur at levels or scales that move toward desired conditions for water, soils, aquatic species habitat, and vegetation. ***Reduced human activities in riparian areas that contain at-risk bird and mammal species will result in higher survival due to less human disturbance on breeding and foraging activities[WL59].*** A guideline in the At-risk section helps reduce impacts from *high alpine use* by avoiding or mitigating actions that reduce long-term nesting success or directly harm populations of at-risk bird species in alpine and tundra habitats. ***At-risk ground nesting birds that undisturbed will be able to secure food sources more easily and expend less energies in the harsh alpine climate[WL60].*** Another guideline limits activities around and protects small or isolated populations of at-risk species and will address the trampling, *picking, or digging or plants*. ***At-risk plants species will see less mortality in areas where restrictions reduce the likelihood of trampling, digging, or picking[WL61].*** When it comes to *recreational off-road vehicle (ORV) use*, there is a guideline in the Roads section that directs to close and rehabilitate temporary roads that support ecosystem restoration activities, fuels management, or other short-term projects upon project completion to protect watershed condition, minimize wildlife disturbance, and prevent illegal motorized use. This action will benefit multiple at-risk species (***WL61***). Although plan components specifically addressing human disturbance are typically found in the At-Risk section, they can also be found in the Riparian Management Zones, Water, Terrestrial Species and Habitats, Soil, Recreation, Roads, Minerals, and Designated Area sections as well. The entire suite of plan components addressing this threat can be found in appendix E.

Recommended wilderness often lessens the human-caused impacts on at-risk species since less human disturbance occurs and impacts from large-scale management decrease. Alternative 2 recommends 25,868 acres of recommended wilderness. This comprises 1.67 percent of the forest and will not substantially increase viability for species within those areas.

The guidelines in the proposed action would help protect at-risk species that are negatively impacted by those disturbances. This alternative has the second greatest effect on reducing intrusive human disturbance and its impact to at-risk species (***WL57-61***).

Alternative 3 - Natural Processes Emphasis
The natural processes emphasis alternative places more emphasis on the restoration of natural processes to the landscape and reduces the amount of human impact. Under alternative 3, increased objectives for decommissioning roads for restoration purposes may further decrease the likelihood of expanding motorized recreation in the life of this plan and decrease intrusive human activity. Also, no new trails may be built. This alternative also calls for a significant expansion (17.48 percent) in the amount of recommended wilderness which would also drastically reduce human intrusion. This alternative will likely decrease the amount of human disturbances and the effects to wildlife species but on a much larger scale. This alternative has the greatest effect on reducing intrusive human disturbance and its impact to at-risk species (***WL57-61***).

Alternative 4 - Human Uses Emphasis
The human uses emphasis alternative places more emphasis on human uses. Increased objectives for road and trail maintenance may increase the likelihood of expanding motorized recreation in the life of this plan. A management area with a motorized recreation focus is proposed in this alternative and objectives for trail maintenance increase. There is also consideration for new trails (including a trail plan) and standards or guidelines that allow for single-use trails. These plan components are designed to increase access to the forest and promote human uses. Emphasis on increasing human use and activities will likely increase the amount of human disturbances and its effects to wildlife species. This alternative has the least effect on reducing intrusive human disturbance and its impact to at-risk species (***WL51-56***).

Intrusive Human Activity Summary:
Intrusive human disturbance can seriously impact at-risk species by interfering with crucial life-cycle needs. Although alternative 1 addresses game and other high-profile species, it lacks direction to address the impacts of human disturbance on at-risk species. Alternatives 2 and 3 provide desired conditions, standards, and guidelines in multiple resource areas that reduce the amount of human disturbances on at-risk species, with the greatest benefit occurring in alternative 3. Alternative 4 may increase the amount of human activity in the forest by promoting more socioeconomic endeavors (recreation, minerals, motorized use, etc.). Alternative 3 is the best option for increasing the viability of at-risk species impacted by intrusive human disturbance followed by alternatives 2, 1, and 4, respectively.

See appendix E for plan components addressing intrusive human activity.

Threat L – Unnatural Disease (Introduced or Spread)

Unnatural mortality in wildlife may occur when pathogens are introduced and resultant disease causes population declines of native populations, especially at-risk species. Disease creates a characteristic set of signs and symptoms that may affect the whole body or any part of a plant or animal. It usually results in mortality or decreased vigor in species that are impacted by disease outbreaks (Frick et al. 2016). Although some diseases may be naturally occurring, their potential to impact large portions of a population appears to be a function of systems that have had their resiliency compromised. Historically, many populations were widespread and redundant (many scattered small populations) which made them more resilient to disease. If a disease event were to occur, nearby populations could then move in to bolster surviving individuals to quickly restore the population. Populations that have now become more isolated cannot respond as quickly and may ultimately suffer from reduced gene flow (Keesing et al. 2006, Hoenig et al. 2017).

Another factor associated with disease is unnatural spread. This can occur when human activities move pathogens faster and over greater distances than what naturally occurs. For example, pathogens found in one water body, may take a long time to, or may never, impact another water body that is a significant distance away. Currently, with increased human travels from one location to another, the likelihood of infecting other areas increases significantly. It is well documented that many pathogens were introduced into new areas through human activities such as boating, spelunking, and other recreational activities (Johnson and Padilla 1996).

Some of the diseases that were known to occur in the Santa Fe NF include but are not limited to Chytrid fungus, sylvatic plague, whirling disease, and West Nile virus. At-risk species are sometimes impacted by these diseases in the forest.

Unnatural Disease Analysis:
Metric: Unnatural Disease Outbreak Events
Currently, four at-risk species (11 percent) may be negatively impacted by unnatural disease outbreaks, they include: Gunnison's Prairie Dog, Jemez Mountain Salamander, Northern Leopard Frog, and Rio Grande Cutthroat Trout. The effects of the alternatives to address unnatural disease outbreaks are analyzed below.

Alternative 1 - 1987 Forest Plan
Under the no-action alternative there is some direction for addressing unnatural disease spread within the Santa Fe NF. For example, the current forest plan directs managing affected forest resources to minimize the likelihood of unacceptable outbreak conditions of insects and diseases. There is also direction to evaluate the need to control insect or disease outbreaks by mechanical, biological, or chemical methods. Although this provides general guidance there is no mention to focus efforts where disease may be impacting at-risk species. ***If disease outbreaks or unnatural spread occurs at-risk species susceptible to the introduced pathogens will experience population declines or reduced vigor***[WL62]***.*** Since this alternative does not address disease spread impacting at-risk species it is likely they will continue to be impacted. This alternative has the third greatest effect on reducing unnatural disease spread and its impact to at-risk species (***WL62***).

Alternative 2 –Forest Plan
Specific forestwide management to protect against unnatural disease spread is addressed in the new forest plan (proposed action). Standards and guidelines throughout various resource areas provide guidance on the introduction of pathogens leading to disease. For example, in the Riparian Management Zone section a standard directs that ground-disturbing activities within riparian areas and wetland ecosystems must take measures to avoid introducing new or spreading existing invasive species and pathogens. Similar standards and guidelines can be found in the Fire, Water, At-risk, Invasive Species, Soil, Forestry, Recreation, Facilities, and Minerals sections as well. The entire suite of plan components addressing this threat can be found in appendix E.

Since some at-risk species are more susceptible to certain diseases, specific plan components were developed to address those issues. The Jemez Mountain salamander and northern leopard frog are susceptible to Chytrid fungus, therefore, guidance is provided in the Fire section states that measures should be taken to prevent entrapment of fish and aquatic organisms and the spread of parasites or disease (e.g., Chytrid fungus, Didymo, and whirling disease), when drafting (withdrawing) water from streams or other waterbodies during fire management activities. This same guideline will help protect Rio Grande cutthroat trout from whirling disease. Strategies to consider alternative measures to projects that may decrease the likelihood of disease introduction or spread to at-risk species (e.g., do not dip firefighting buckets in waterbodies where Didymo or whirling disease is known to exist or install drinkers instead of earthen tanks to prevent the spread of Chytrid fungus) are also offered. There is also guidance to coordinate with New Mexico Department of Game and Fish and consider "dusting" prairie dog colonies with flea-controlling powder to reduce the spread of sylvatic plague. ***At-risk species that are not exposed***

to unnatural disease spread or are treated for known pathogens will have increase survival over exposed or untreated populations[WL63]***.*** These actions takes an active role to not only prevent unnatural disease outbreaks but will actively seek to reduce the effect in areas that have already been negatively impacted. This alternative has the greatest effect on reducing unnatural disease spread and its impact to at-risk species (***WL63***).

Alternative 3 - Natural Processes Emphasis

The natural processes emphasis alternative places more emphasis on the restoration of natural processes to the landscape. Since plan components in this alternative do not differ from the proposed action the effects will be the same as the proposed action. This alternative, along with alternative 2, has the greatest effect on reducing unnatural disease spread and its impact to at-risk species (***WL63***).

Alternative 4 - Human Uses Emphasis

The human uses emphasis alternative places more emphasis on human uses. Although most plan components in this alternative do not differ from the proposed action, the emphasis on increasing human use and activities will likely increase the amount of unnatural disease spread to at-risk species especially to the aquatic species since riparian areas typically receive the greatest amount of human-use (e.g., spreading disease from one water body to another). The effects of this action will be similar to alternative 1, but on a much larger scale. This alternative has the least effect on reducing unnatural disease spread and its impact to at-risk species (***WL62***).

Unnatural Disease Summary:

Unnatural disease spread can seriously impact at-risk species by decreasing vigor in species that are impacted by disease outbreaks. Alternative 1 addresses unnatural disease spread, but there is little focus on its impact to at-risk species. Alternatives 2 and 3 provide guidelines and objectives that not only ensure diseases are not introduced into areas that contain at-risk species, but actively seeks to reduce the impact of diseases where it has been detected. Alternative 4 may decrease the viability of at-risk species impacted by unnatural disease spread, especially in high-use riparian areas. Alternatives 2 and 3 are the best options for increasing the viability of at-risk species impacted by unnatural disease spread followed by alternatives 1 and 4, respectively.

See appendix E for plan components addressing introduced disease or unnatural spread.

Threat M – Human-made Features (Mortality or Altering Behavior)

Negative impacts to at-risk species may occur when human-made structures result in direct mortality of at-risk species either by entrapment or collision (Bevanger 1994, Martin 2011). Obstructions may consist of obstacles or barriers that may prevent animals from moving from one place to another to fulfill basic life-cycle needs or may actually cause direct mortality due to collision and forceful striking (e.g., wind turbines, cell towers, facilities, or fences), prolonged entanglement (e.g., barbed wire), or entrapment (e.g., water troughs). Manville (2005) estimates that collisions with communication towers, powerlines, and wind turbines results in nationwide bird mortality totaling in the millions. Whyte (1988) congruently documents within the historical the propensity for small mammals and amphibians to be entrapped within water catchment structures. Species that are known to be at-risk in the Santa Fe NF are occasionally known to be impacted by human-made features.

Human-made Feature Analysis:

Metric: Infrastructure Construction

Currently, five at-risk species (14 percent) may be negatively impacted by human-made features, they include: American peregrine falcon, Gunnison's prairie dog, northern goshawk, northern leopard frog, and pinyon jay. Since there are various human-made features, each species may be impacted by different features. Impacts from these features can be grouped as follows:

Collision. This threat often impacts migratory birds. The American peregrine falcon and northern goshawk were known to collide with cell towers and wind turbines. Bird mortality has also been reported from collision with buildings covered in reflective glass, this can also impact pinyon jay. ***Collisions with human-made structures may cause direct mortality of at-risk birds[WL64].***

Entanglement. Unused or downed barbed wire has been known to entangle birds. Peregrine falcon, northern goshawk, and pinyon jay may accidentally get entangled in unused barbed wire if left in the forest. ***Entanglement in wire or fencing may cause direct mortality of at-risk birds[WL65].***

Entrapment. Most situations where entrapment and mortality occur is a result of water catchment structures (e.g., human-made water troughs). Due to steep sides and smooth surfaces, small mammals and amphibians may fall in and be unable to escape. Gunnison's prairie dog and northern leopard frogs are at-risk from becoming entrapped in such structures. A less obvious entrapment structure are open pipes and air vents that may result in a bird or mammal falling in without a means to escape. Pinyon jays may be at-risk for becoming entrapped in open vents. ***Entrapment in human-made structures such as water features or pipes may cause direct mortality of at-risk bird, mammal, or amphibian species[WL66].*** The effects of the alternatives to address human-made features are analyzed below.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative, there is little to no direction for addressing human-made features that affect at-risk species. There is mention of providing non-game entrance and escape ramps on water developments intended for livestock or wildlife use but no other guidance on human-made features is provided. Since it does not thoroughly address features that are likely to cause negative impacts it is likely that at-risk species will continue to be affected. This alternative has the least effect on reducing impacts from human-made features and its impact to at-risk species (***WL64-66***).

Alternative 2 – Forest Plan

Specific forestwide management to address human-made features which impact at-risk species is addressed in the Forest Plan (proposed action). Both the Aquatic and Terrestrial Species and Habitat sections contain standards and guidelines that provide specific direction. For example, human-made structures (e.g., instream structures, fencing) should be maintained to support the purposes for which they were built or removed when no longer needed. Another guideline directs that human-made structures (e.g., fences, steel posts, vent pipes) should be constructed and maintained to minimize wildlife mortality (e.g., capped fence posts) and removed when no longer needed. There is also specific guidance that requires constructed water features (e.g., water tanks, cattle guards) to provide safe access and escape for wildlife. There are also explicit plan components addressing wildlife and infrastructure design within the Range, Recreation, Facilities, Special Uses, and Minerals sections as well. For example, the Facilities section has a guideline that requires infrastructure design, construction, reconstruction, and maintenance should prevent or mitigate impacts to terrestrial and aquatic species. ***Reducing the amount, or mitigating the impacts, of human-made structures that cause collision, entanglement, or entrapment of at-risk species will decease mortality of the species affected by human-made structures[WL67].*** The entire suite of plan components addressing this threat can be found in appendix E. The specificity given within these plan components will reduce the mortality to at-risk species impacted by human-made features. This alternative has the greatest effect on reducing impacts from human-made features and its impact to at-risk species (***WL67***).

Alternative 3 - Natural Processes Emphasis

The natural processes emphasis alternative places more emphasis on the restoration of natural processes to the landscape. Since plan components in this alternative do not differ from the proposed action the effects will be the same as the proposed action. This alternative, along with alternative 2, has the greatest effect on reducing impacts from human-made features and its impact to at-risk species (***WL67***).

Alternative 4 - Human Uses Emphasis

The human uses emphasis alternative places more emphasis on human uses and allows for more construction of infrastructure. Although most plan components in this alternative do not differ from the proposed action, the emphasis on increasing human use and activities will likely increase the number of human-made features in the forest. However due to plan components that require specific standards of construction, and the minimal amount of infrastructure that may be added, at-risk species should be minimally impacted. Therefore, alternative 4 has the third greatest effect on reducing impacts from human-made features and its impact to at-risk species (***WL67***).

Human-made Feature Summary:

Human-made features can impact at-risk species through collision, entanglement, or entrapment. Alternative 1 does not address many of the human-made features that affect wildlife and is unlikely to increase the viability of at-risk species impacted by this threat. Alternatives 2 and 3 provide guidelines and objectives that not only ensure human-made features are constructed with standards that minimize wildlife mortality, but actively seek to remove human-made features that are no longer needed. Although alternative 4 may increase the number of human-made features in the forest, standards in construction should reduce their impact on wildlife. Alternatives 2, 3, and 4 are the best options for increasing the viability of at-risk species impacted by human-made features.

See appendix E for plan components addressing human-made features.

Threat N – Chemical Applications (e.g., pesticides or chemical fire retardants)

Some chemical applications pose a concern to at-risk species populations. It is well known that many bird species are highly susceptible to pesticides (Peakall 1970). Pesticides were shown to cause reproductive failure in Peregrine Falcons (Cade et al. 1968) as well as many other species (Davidson 2004). Though pesticide use is highly regulated in the forest, impacts from off the forest may still be an issue. A greater risk from direct chemical impact in the forest may come from the use of chemical fire retardant used to fight forest fires (Adams and Simmons 2013). Johnson and Sanders (1977) noted the toxicity of fire retardant to freshwater fishes. Issues with aquatic at-risk species may arise if excess amounts of chemical fire retardant are applied in riparian areas or other bodies of water. At-risk species in the Santa Fe NF are known to be negatively impacted by certain chemical applications.

Pesticide or Chemical Retardant Analysis:

Metric: Allowed use of chemicals

Currently, six at-risk species (17 percent) may be negatively impacted by the use of some chemical applications (e.g., pesticides or chemical retardant); they include: Peregrine falcon, Lilleborg's Peaclam, northern leopard frog, Rio Grande chub, Rio Grande cutthroat trout, and Rio Grande sucker. The peregrine falcon is the only at-risk species where pesticide use may become an issue, however, project-specific NEPA analysis would prevent negative impacts from pesticide use in the forest; therefore, analysis will not be provided since the plan does not permit general use of pesticides. The remaining at-risk species are all aquatic and may be impacted by excessive amounts of chemical fire retardant. The effects are analyzed below.

Alternative 1 – 1987 Forest Plan

Under the no-action alternative there is specific direction to follow integrated pest management procedures. This calls for project-level decisions to be made regarding the use of pesticides. For example, pesticides used for pest control will contain appropriate and necessary monitoring procedures and mitigation measures in their project plans. Of concern within this alternative is the direction that calls for the "*judicious use of pesticides*" as means to fulfill forest prescriptions. Regarding the application of fire retardant, the only mention of avoiding riparian areas and other waterbodies focuses on wild segments of wild and scenic designated rivers. Since this alternative does not provide clear direction to reduce the risk of chemical applications on at-risk species it is likely that they will continue to be impacted. ***At-risk fish, amphibians, and invertebrate may be negatively impacted by chemical poisoning from fire retardants***[WL68]***.*** This alternative has the least effect on reducing impacts from chemicals and its impact to at-risk species (***WL68***).

Alternative 2 – Forest Plan

Specific forestwide plan components to address chemical applications is addressed in the new forest plan (proposed action). A guideline in the Fire section directs that fire management activities should be coordinated with specialists of resources that may be impacted. This will allow for special considerations in areas where fire retardant may impact populations of at-risk species. ***If at-risk fish, amphibians, and invertebrate species are not exposed to fire retardants they will not suffer from effects caused by chemical poisoning***[WL69]***.*** It must be noted that the impacts from fire suppression must be weighed against the impacts of uncharacteristic fire. Also, post-fire restoration and recovery should be provided where critical resource concerns merit rehabilitation for protecting critical or endangered species habitat or protecting other highly valued resources such as drinking water. This alternative also recommends strategies to work with agencies, organizations, Tribes, and other entities to actively pursue actions designed to reduce the impacts of pollutants from sources within and outside the forest. Additional plan components addressing chemical applications are found within the Riparian Management Zone, Aquatic Species and Habitats, At-Risk Species, Soil, Air, Forestry, and Roads sections as well. The entire suite of plan components addressing this threat can be found in Appendix E. The specificity given within these plan components will reduce the mortality to at-risk species impacted by chemical applications. This alternative has the greatest effect on reducing impacts from chemicals and its impact to at-risk species (***WL69***).

Alternative 3 - Natural Processes Emphasis

The natural processes emphasis alternative places more emphasis on restoring natural processes to the landscape, which includes increasing the amount of prescribed fire that increases the likelihood of uncharacteristic fire in MCD and PPF. Although most plan components in this alternative do not differ from the proposed action, the emphasis on increasing the amount prescribed fire may increase the chance that chemical retardants will be applied. This alternative has the third greatest effect on reducing impacts from chemicals and its impact to at-risk species (***WL68)***.

Alternative 4 - Human Uses Emphasis

The human uses emphasis alternative places more emphasis on human uses. Although most plan components in this alternative do not differ from the proposed action, the emphasis on increasing human use and activities will likely increase the amount of chemical applications. For example, an objective to increase the amount of treatment on invasive plant species jumps from 600 acres annually to 1,500 acres annually. However, due to plan components that require specific standards for application of chemicals, at-risk species would be impacted similar to the proposed action (***WL69***). This alternative, along with alternative 2, has the greatest effect on reducing impacts from chemicals and its impact to at-risk species (***WL69***).

Chemical Application Summary:
Some chemical applications can seriously impact at-risk species by causing mortality or decreased vigor when excessive amounts are applied. Alternative 1 provides minimal guidance on the impact of chemical applications to at-risk species and is unlikely to increase the viability of at-risk species impacted by this threat. Alternatives 2 and 4 provide desired conditions, guidelines, and objectives that not only ensure chemical applications are applied appropriately so as to minimize wildlife mortality, but also actively seek to restore areas where excessive amounts were applied due to other resource needs (fire). Alternative 3 may increase the amount of chemical applications (fire retardant). Alternatives 2 and 4 are the best options for increasing the viability of at-risk species impacted by chemical applications followed by alternatives 3 and 1, respectively.

See appendix E for plan components addressing chemical applications.

Summary of Threats Related to Management Activities

Degraded ecological conditions are known to impact at-risk species, but sometimes additional threats affect viability. These threats often come from management activities or unnatural conditions and occasionally they are the primary cause of concern for some at-risk species. Management of these species is typically addressed through fine filter plan components that eliminate or mitigate those specific threats. The persistence of three at-risk species in the forest are secured by addressing human-made threats only (table 66).

Table 66. Summary of human-made threats affecting viability of at-risk species

At-risk species affected primarily by issues associated with human-made threats	Management actions impacting viability
Gunnison's prairie dog (*Cynomys gunnisoni*)	Intrusive human behavior (recreational shooting), unnatural disease spread, human-made features
Heil's alpine whitlowgrass (*Draba heilii Al-shebaz*)	Ground and soils disturbance(roads and trails), intrusive human activity
Pinyon jay (*Gymnorhinus cyanocephalus*)	Human-made features

Ranking of alternatives' ability to provide the means to address the issues:
Alternative 3 provides the best guidance for addressing human-made threats, especially with emphasis on more natural processes and limiting man's impact. Alternatives 1, 2, and 4 provide guidance to move toward desired conditions but not to the degree of alternative 3.

The remaining 22 at-risk species not listed in table 65 or table 66 will be positively impacted by a combination of coarse-filter and fine-filter approaches.

At-Risk Wildlife Summary
The viability of at-risk species in the forest is secured through coarse-filter approaches primarily affecting issues associated with ecological conditions; fine-filter approaches primarily affecting threats from human-made sources; or as in most cases, a combination of the two approaches. The following summarizes the effects of all alternatives and identifies the most critical plan components contributing to the viability of each species. See table 67 for specific threats to each species.

American marten (*Martes caurina*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. Alternative 3 increases the potential of uncharacteristic fire, therefore, alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: American Marten)

American peregrine falcon (*Falco peregrinus anatum*): Alternative 1 provides desired conditions for vegetative conditions within their habitats and offers some guidance to protect against human disturbance within eyries (e.g., recreational climbing). Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide multiple protections against human disturbance. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: American Peregrine Falcon.)

Arizona willow (*Salix arizonica*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. Alternatives 2 and 3 provide the greatest amount of riparian improvement. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Arizona Willow.)

Black swift (*Cypseloides niger*): Alternative 1 provides desired conditions for vegetative conditions within their habitats but offers little guidance to protect ecological features critical for at-risk species. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide multiple protections against human disturbance. Alternative 4 increases the potential of negative human influences, therefore, Alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Black Swift.)

Boreal owl (*Aegolius funereus*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. Alternative 3 increases the potential of uncharacteristic fire, therefore, Alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Boreal Owl.)

Chaco milkvetch (*Astragalus micromerius*): Alternative 1 provides desired conditions for vegetative conditions but does not offer much guidance to protect against human caused impacts (e.g., recreational use, trampling). Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They provide multiple protections against human-caused mortality. They also provide explicit guidance regarding management of recreational use within areas containing small populations of at-risk species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Chaco Milkvetch.)

Chama blazing star (*Mentzelia conspicua*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They provide multiple protections against human caused mortality. It also provides explicit guidance regarding management of recreational use within areas containing small populations of at-risk species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Chama Blazing Star.)

Greene's milkweed (*Asclepias uncialis*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also protect isolated or endemic populations from human-caused disturbance. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Greene's Milkweed.)

Gunnison's prairie dog (*Cynomys gunnisoni*): Alternative 1 provides desired conditions for vegetative conditions within their habitats but does not offer much guidance to protect against human caused mortality (ex. recreational shooting). Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions and provide multiple protections against human caused mortality. They also provide explicit guidance regarding management of disease (e.g., sylvatic plague). Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Gunnison's Prairie Dog.)

Gunnison's mariposa lily (*Calochortus gunnisonii*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. Alternatives2, 3, and 4 also protect isolated or endemic populations from huma-caused disturbance and will provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Gunnison's Mariposa Lily.)

Heil's alpine whitlowgrass (*Draba heilii Al-shebaz*) Alternative 1 provides desired conditions for vegetative conditions but does not offer much guidance to protect against human caused impacts (ex. recreational use, trampling). Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions and provides multiple protections against human-caused mortality. It also provides explicit guidance regarding management of recreational use within areas containing small populations of at-risk species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Heil's Alpine Whitlowgrass.)

Holy Ghost ipomopsis (*Ipomopsis sanctispiritu*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. Guidance also requires we follow the latest recovery plan for listed species. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. Alternative 3 increases the potential of uncharacteristic fire, therefore, alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Holy Ghost Ipomopsis.)

Jemez Mountain salamander (*Plethodon neomexicanus*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. Guidance also requires we follow the latest recovery plan for listed species. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. The greatest amount of restoration work is scheduled within frequent-fire systems (PPF). Alternative 3 increases the potential of uncharacteristic fire, therefore, alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Jemez Mountain Salamander.)

Jemez woodland snail (*Ashmunella ashmuni*): Alternative 1 provides desired conditions for vegetative conditions but there is little guidance on soil conditions. Alternatives 2, 3, and 4 provide desired conditions for soil conditions and guidance on management activities that may affect soil conditions. The action alternatives also provide guidance to reduce human impacts on small isolated populations of at-risk species. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Jemez Woodland Snail.)

Large yellow lady's-slipper (*Cypripedium parviflorum*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They provide multiple protections against human-caused mortality. It also provides explicit guidance regarding management of recreational use within areas containing small populations of at-risk species. Alternative 3 increases the potential for uncharacteristic fire, while alternative 4 increases the potential of negative human influences, therefore, alternative 2 provides the greatest benefit. (For the entire list of plan components addressing this species see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Large Yellow Lady's Slipper.)

Lewis's woodpecker (*Melanerpes lewis*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. The greatest amount of restoration work is scheduled within frequent-fire systems (PPF). Alternative 3 increases the potential of uncharacteristic fire, therefore, alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Lewis's Woodpecker.)

Lilljeborg's peaclam (*Pisidium lilljeborgi*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. Alternative 3 increases the potential for uncharacteristic fire, while alternative 4 increases the potential of negative human influences, therefore, alternative 2 provides the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Lilljeborg's Peaclam.)

Masked shrew (*Sorex cinereus*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide 2, 3, and 4 for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. Alternative 3 increases the potential for uncharacteristic fire, while alternative 4 increases the potential of negative human influences, therefore, alternative 2 provides the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Masked Shrew.)

Mexican spotted owl (*Strix occidentalis lucida*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. It also has specific guidance within Mexican spotted owl activity centers. Guidance also requires we follow the latest recovery plan for listed species. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. The greatest amount of restoration work is scheduled within frequent-fire systems (PPF). Alternative 3 increases the potential of uncharacteristic fire, therefore, alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Mexican Spotted Owl.)

New Mexico meadow jumping mouse (*Zapus hudsonius luteus*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. There is also guidance on the application of herbicides for invasive plant control. Guidance also requires we follow the latest recovery plan for listed species. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. Alternative 3 increases the potential for uncharacteristic fire, while alternative 4 increases the potential of negative human influences, therefore, alternative 2 provides the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: New Mexico Meadow Jumping Mouse.)

Northern goshawk (*Accipiter gentilis*): Alternative 1 provides desired conditions for vegetative conditions within their habitats and offers some guidance to protect against human disturbance within activity centers. There are also specific structural components required within their activity centers. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide multiple protections against human disturbance. Alternative 3 increases the potential for uncharacteristic fire, while alternative 4 increases the potential of negative human influences, therefore, alternative 2 provides the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Northern Goshawk.)

Northern leopard frog (*Lithobates pipiens*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. They also provide explicit guidance regarding management of disease (e.g., chytrid fungus). Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Northern Leopard Frog.)

Pecos fleabane (*Erigeron subglaber*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. Alternatives 2, 3, and 4 also protect isolated or endemic populations from human-caused disturbance. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Pecos Fleabane.)

Pinyon jay (*Gymnorhinus cyanocephalus*): Alternative 1 provides desired conditions for vegetative conditions within their habitats but does not offer guidance to protect against human caused impacts (e.g., infrastructure). Fuelwood collection with PJ is managed by specific guidance within management areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions and provide explicit guidance regarding infrastructure design that may impact at-risk species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Pinyon Jay.)

Rio Grande chub (*Gila Pandora*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. Guidance is also given for more specific management or water characteristics. They also provide explicit guidance regarding management of invasive species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Rio Grande Chub)

Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. Guidance is also given for more specific management or water characteristics. They also provide explicit guidance regarding management of invasive species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Rio Grande Cutthroat Trout.)

Rio Grande sucker (*Catostomus plebeius*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. Guidance is also given for more specific management or water characteristics. They also provide explicit guidance regarding management of invasive species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Rio Grande Sucker.)

Ruidoso snaggletooth (*Gastrocopta ruidosensis*): Alternative 1 provides desired conditions for vegetative conditions but there is little guidance on soil conditions. Alternatives 2, 3, and 4 provide desired conditions for soil conditions and guidance on management activities that may affect soil conditions. Alternatives 2, 3, and 4 also provide guidance to reduce human impacts on small isolated populations of at-risk species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Ruidoso Snaggletooth)

Snowshoe hare (*Lepus Americana*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. Alternative 3 increases the potential of uncharacteristic fire, therefore, alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Snowshoe Hare.)

Spotted bat (*Euderma maculatum*): Alternative 1 provides desired conditions for vegetative conditions within their habitats. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide multiple protections against human disturbance especially around caves and abandoned mine sites. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Spotted Bat.)

Springer's blazing star (*Mentzelia springeri*): Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They provide multiple protections against human-caused mortality and explicit guidance regarding management of recreational use within areas containing small populations of at-risk species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Springer's Blazing Star.)

Tufted sand verbena (*Abronia bigelovii*): Alternative 1 provides desired conditions for vegetative conditions but there is little guidance on soil conditions. Alternatives 2, 3, and 4 provide desired conditions for soil conditions and guidance on management activities that may affect soil conditions. Alternatives2, 3, and 4 also provide guidance to reduce human impacts on small isolated populations of at-risk species. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Tufted Sand Verbena.)

Water shrew (*Sorex palustris*): Alternative 1 provides desired conditions for vegetative conditions within riparian areas. There is also guidance on the application of herbicides for invasive plant control. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. They also provide standards and guidelines to help direct management within riparian systems. Alternative 3 increases the potential for uncharacteristic fire while alternative 4 increases the potential of negative human influences, therefore, alternative 2 provides the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Water Shrew.)

Western burrowing owl (*Athene cunicularia hypugaea*): Alternative 1 provides desired conditions for vegetative conditions within their habitats but does not offer much guidance to protect against human caused mortality (e.g., recreational shooting). Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions and provide multiple protections against human-caused mortality. They also provide explicit guidance regarding management of disease (e.g., sylvatic plague), which protects the prairie dogs that provide nesting sites for the owls. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Western Burrowing Owl).

White-tailed ptarmigan (*Lagopus leucurus*): Alternative 1 provides desired conditions for vegetative conditions but does not offer much guidance to protect against human caused impacts (e.g., recreational use, trampling). Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions and provide multiple protections against human-caused mortality. It also provides explicit guidance regarding management of recreational use within areas containing small populations of at-risk species. Alternative 4 increases the potential of negative human influences, therefore, alternatives 2 and 3 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: White-tailed Ptarmigan.)

Wood lily (*Lilium philadelphicum*) Alternative 1 provides desired conditions for vegetative conditions and guidance for timber and fuel management within specific management areas. Alternatives 2, 3, and 4 provide desired conditions for vegetative conditions as well as objectives that ensure movement toward desired conditions at a steady rate. The greatest amount of restoration work is scheduled within frequent-fire systems (PPF). Alternative 3 increases the potential of uncharacteristic fire, therefore, alternatives 2 and 4 provide the greatest benefit. (For the entire list of plan components addressing this species, see Santa Fe NF FEIS Volume 2, Appendix E, At-Risk Species Crosswalk: Wood Lily.)

Conclusion

All alternatives provide viability for at-risk species (tables 67 and 68) but some alternatives provide greater improvements to ecological conditions affecting those species. Alternative 1 lacks direction to address the issues and threats that are negatively impacting at-risk species and decreasing their viability. There is some guidance to offer protections for at-risk species, however, there is no emphasis to improve conditions or increase viability for at-risk species. Though some at-risk species may see minimal gains, it is uncertain whether ecological conditions for at-risk species will see considerable improvement under the no-action alternative. Alternative 2 thoroughly addresses the primary issues and threats that are currently impacting at-risk species. Numerous plan components within multiple resource areas are integrated in this alternative to provide maximum resource benefit to at-risk species. Alternative 2 is reasonably expected to increase the viability of at-risk species across the forest. Alternative 3 also addresses the issues and threats of at-risk species, however, there is slight concern regarding the use of prescribed fire in highly departed frequent-fire forested systems (MCD and PPF), particularly under accentuating conditions like prolonged drought. This may have negative impacts to some at-risk species. Alternative 4 would also address issues and threats of at-risk species; however, there is much more concern with negative impacts to some species with the increased human uses. Alternative 2 is the best option for increasing viability of at-risk species in the forest.

Table 67. SPECIES COMPARISON – AT-RISK WILDLIFE, Viability Rating for Each Species by Alternative.
Comparison of the effectiveness of alternatives in addressing issues and threats for at-risk species. Determinations were made based on the primary issues or threats affecting the species. The following key describes how each alternative is likely to affect the viability of each species.

Symbol	Description
√√	Alternative addresses all the issues and threats affecting the species. Habitats and populations are maintained or increased. At-risk species will persist and significant gains to populations or required ecological conditions is highly likely.
√	Alternative addresses most issues and threats affecting the species but not all. Habitats and populations are maintained and possibly increased. At-risk species will persist and significant gains to populations or required ecological conditions is likely.
---	Alternative is neutral and maintains current conditions. At-risk species will persist but significant gains to populations or required ecological conditions is unlikely.

Alternatives were analyzed as to how each addresses the issues and threats that impact at-risk species. These include the ecological conditions required by the various species as well as unnatural impacts created by our management or other human-made activities. Often, when we address one issue or threat, we may introduce another as an added effect. For example, many at-risk species are impacted by out-of-reference seral state in frequent fire systems. This issue can be addressed through restoration efforts. We can restore much more habitat to its desired conditions through the use of prescribed fire than we can through mechanical means (the difference between alternatives 3 and 4), however; the additional use of fire exposes more of these areas to the increased risk of uncharacteristic fire. Uncharacteristic fire in frequent-fire systems can be an even greater negative effect on at-risk species than departed seral state. Another example is at-risk species that are impacted by human disturbance. People are naturally drawn to riparian areas, so alternative 4, which increases human use and access, may have more negative effects on species that are riparian-dependent.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
At-risk species impacted by ecological Issues only				
American marten (*Martes caurina*) - A primary issue to the persistence of American marten is the build-up of coarse woody debris in the SFF. An uncharacteristic fire within this ERU could eliminate much of the remaining habitat available for martens. Another issue may be the introduction of invasive vegetation (thistle) which is altering the composition of its native habitat. Due to its isolated range within the Santa Fe NF an uncharacteristic fire or increased encroachment of invasive species puts American marten at-risk for persistence in the forest.	---	√√	√	√√
Arizona willow (*Salix arizonica*) - A primary issue to the persistence of Arizona willow is the build-up of coarse woody debris in the SFF. An uncharacteristic fire within this ERU could seriously reduce the distribution and number of specimens of this plant in the forest. Other threats may be the introduction of invasive vegetation (thistle), which is altering the composition of its native habitat, and hydrological alterations or disconnections	---	√√	√√	√
Boreal owl (*Aegolius funereus*) - This species is at the southern-most extension of its range and although it has been found on surveys, recent large wildfires have reduced the Spruce-Fir ERU in these local zones. An uncharacteristic fire within this ERU could eliminate much of the remaining habitat for boreal owls.	---	√√	√	√√
Gunnison's mariposa lily (*Calochortus gunnisonii*) - The lily occupies meadows and aspen glades in upper montane coniferous forest (MSG), one of the habitats presumably very vulnerable to climate change. The lack of disturbance also continues to limit the amount of MSG sites that are reinitiated back to an early, low-seral state. Based on the current disturbance regime, modeled future conditions indicate that limited fire occurrence in this ERU will continue leading to degraded conditions in MSG.	---	√√	√√	√√
Holy Ghost ipomopsis (*Ipomopsis sanctispiritu*) - Endemic species found only in the Holy Ghost Canyon in the Sangre de Cristo mountain range. An uncharacteristic fire could eliminate this entire species. Recreational impacts also present a threat. Management of the ipomopsis must follow the USFWS Recovery Plan.	√	√√	√	√√

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
At-risk species impacted by ecological Issues only (continued)				
Jemez woodland snail (*Ashmunella ashmuni*) – This species is associated with limestone outcropping in Juniper grassland, Ponderosa pine and Mixed conifer (dry) ERUs, all of which are in moderate to high departure with no significant improvement predicted. The snails are a moisture dependent species so climate change may significantly impact this species.	---	√√	√√	√√
Lewis's woodpecker (*Melanerpes lewis*) - Vulnerable to loss of nesting sites (large snags) and to degradation of riparian habitats by drought and overgrazing. Large wildfires in the Jemez Mountains have negatively affected the Ponderosa Pine ERU large tree and large snag special features needed by this species. Current Ponderosa pine forest landscapes have changed significantly toward single-storied, closed-canopy seral states.	---	√√	√	√√
Mexican spotted owl (*Strix occidentalis lucida*) - The Mexican spotted owl requires a variety of mixed conifer habitats, proximity to riparian areas, standing large snags for roosting and nesting, or cavities in vertical canyon walls. Management of the owl must follow the USFWS Recovery Plan.	√	√√	√	√√
Snowshoe hare (*Lepus Americana*) - A primary issue to the persistence of snowshoe hare is the build-up of coarse woody debris in the SFF. An uncharacteristic fire within this ERU could eliminate much of the remaining habitat available for snowshoe hare. Another threat may be the introduction of invasive vegetation (thistle), which is altering the composition of its native habitat.	---	√√	√	√√
Tufted sand verbena (*Abronia bigelovii*) - This species is generally scattered along outcroppings of gypsum or strongly gypseous soils. Although geologic features such as gypseous soils should remain in low departure from reference conditions, in general, these habitats are considered at risk for significant increased drying and prolonged drought from climate change.	---	√√	√√	√√
Wood lily (*Lilium philadelphicum*) – This plant is associated with the Ponderosa Pine ERU which is in high departure from reference condition. Issues include large wildfires such as those that have affected the Jemez Mountains in the past few decades.	---	√√	√	√√
At-risk species impacted by human-made threats only				
Gunnison's prairie dog (*Cynomys gunnisoni*) - Threats include recreational shooting (NMDGF has no regulations against shooting prairie dogs) and sylvatic plague. Due to the species' decreased range in the Santa Fe NF, sylvatic plague can be a limiting factor and eliminate colonies in one season preventing them from reaching a sustainable population and colonizing areas formerly occupied.	---	√√	√√	√
Heil's alpine whitlowgrass (*Draba heilii Al-shebaz*) - Although this species' alpine-tundra habitat has changed little from reference condition, it is threatened by trampling of hikers, climbers, horseback riders, and occasional livestock. It was found above timberline in the Pecos Wilderness. Identification and awareness of this plant is needed, so it can be identified and impacts to it can be avoided or mitigated, in particular for trail maintenance projects.	---	√√	√√	√
Pinyon jay (*Gymnorhinus cyanocephalus*) - Although predicted to remain in low departure from reference conditions PJ habitats are predicted to have the greatest variation among zones when it comes to climate change vulnerability. Though the exact cause of Piñon jay decrease is unknown, it may be due to their reliance on piñon trees, which were significantly impacted by recent drought conditions in the forest. Human-made structures may cause mortality.	---	√√	√√	√
At-risk species impacted by a combination of issues and threats				
American peregrine falcon (*Falco peregrinus anatum*) - is known as single pairs or very limited numbers within all the local zones where it nests in suitable cliffs and rock outcrops. Threats include disturbance, eggshell thinning from accumulated pesticides, and disturbance from recreational activities.	√	√√	√√	√
Black swift (*Cypseloides niger*) - nest behind or near waterfalls or caves. Although little is known of this species, its spruce-fir habitat remains highly vulnerable to predicted climate change. Primary threats include recreational climbing and harassment at nest sites. Due to its primary existence at only two geographical sites within the Santa Fe NF the species can be seriously impacted by management or other recreational activities that occur in the forest.	---	√√	√√	√

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
At-risk species impacted by a combination of issues and threats (continued)				
Chaco milkvetch (*Astragalus micromerius*) - Current departure from desired condition within their ERUs may result in significantly increasing stress and decreasing vigor for this species. Their habitats are considered at risk for significant increased drying and prolonged drought increasing the stress from other threats (fire and grazing) as well. The Navajo Nation cited increasing threats from trampling, off-road vehicle use, and mining activities.	---	√√	√√	√
Chama blazing star (*Mentzelia conspicua*) - Is usually found on the key ecosystem characteristic of gray to red shales of Mancos and Chinle soil formations. Invasive species have impacted the understory composition. Partial reductions in vegetative cover can be attributed to the substantial increases in CWD loadings. Other threats include habitat disturbance from recreation, sagebrush mowing, and road construction and maintenance	---	√√	√√	√
Greene's milkweed (*Asclepias uncialis*) – Seral state departure is low in in piñon-juniper woodland habitat; however, there is some departure in composition due to introduced nonnative species. Understory composition has been impacted by invasive species. It has also been influenced by drought and other disturbances that have reduced vegetative ground cover and increased the proportion of bare soil. Partial reductions in vegetative cover can be attributed to the substantial increases in CWD loadings.	---	√√	√√	√
Jemez Mountain salamander (*Plethodon neomexicanus*) - Threats include habitat loss from severe wildfire and other activities that alter hydrology or disease including chytrid fungus. Management of the salamander must follow the USFWS Recovery Plan.	√	√√	√	√√
Large yellow lady's-slipper (*Cypripedium parviflorum*) - A primary threat to the persistence of this species is the build-up of coarse woody debris in the SFF. An uncharacteristic fire within this ERU could seriously reduce the distribution and number of specimens of this plant in the forest. Other threats may be introduced of invasive vegetation that is altering the composition of the species' native habitat. Trampling, picking or digging up plants are also recognized threats. Activities impairing the more mesic conditions and wetter habitats and features it prefers may also degrade habitat and population viability.	---	√√	√	√
Lilljeborg's peaclam (*Pisidium lilljeborgi*) - is found in only one high-elevation lake in the Pecos Wilderness. Its highly restricted range invariably places this species vulnerable to extinction in the Santa Fe NF. Threats include siltation into the lake or use of chemical retardant for fire suppression that could wash into the lake. The forest surrounding the lake is prone to potential uncharacteristic fire,	---	√√	√	√
Masked shrew (*Sorex cinereus*) – This species hunts insects and small mammals along banks of cold streams, in wet meadows, or under logs in cold spruce forest and riparian areas. Most of these ERUs' current ecological conditions in the Santa Fe NF are departed from reference, because of changes in vegetative composition and hydrology. Negative impacts to the masked shrew include sedimentation caused by grazing, fuelwood gathering, wildfire, recreation, motorized travel, and changes in hydrology.	---	√√	√	√
New Mexican meadow jumping mouse (*Zapus hudsonius luteus*) - The major threats faced are the degradation of riparian habitat caused by actions such as legacy grazing, post-wildfire flooding events, and unmanaged recreation. Management of the mouse must follow the USFWS Recovery Plan.	√	√√	√	√√
Northern goshawk (*Accipiter gentilis*) – This species is a forest habitat generalist that uses a wide variety of forest ages, structural conditions and successional stages, most of which are departed from reference condition in the Santa Fe NF because of fire suppression activities and in some cases, stand-replacing fire. They remain extremely vulnerable to uncharacteristic fire, which can greatly alter or reduce optimal habitat. Several nest sites and post-fledging areas have been lost or abandoned because of stand-replacing fires.	√	√√	√	√
Northern leopard frog (*Lithobates pipiens*) - This riparian species requires springs, slow streams, or other perennial water as habitat and for overwintering. Characteristics of quality northern leopard frog habitat are currently highly departed, while potential to return to reference conditions remains unknown. Ongoing threats include degradation of habitat caused by grazing, chytrid fungus, or siltation due to uncharacteristic fire and poor road management	---	√√	√√	√

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
At-risk species impacted by a combination of issues and threats (continued)				
Pecos fleabane (*Erigeron subglaber*) - The largest known population on Elk Mountain also has the highest known impacts (road, radio tower grazing, and recreational ORV use). It is now known to be very narrowly endemic and subject to high risk of climate change in spruce fir habitats. A primary threat to the persistence of Pecos fleabane is the build-up of coarse woody debris in the SFF. An uncharacteristic fire within this ERU could seriously reduce the distribution and number of specimens of this plant in the forest. Other threats may be the introduction of invasive vegetation that is altering the composition of its native habitat.	---	√√	√√	√
Rio Grande chub (*Gila Pandora*) - Populations can be threatened by habitat degradation that includes habitat loss, modification, and fragmentation as well as from interactions with nonnative species. Impacts in the Santa Fe NF include degraded stream and riparian habitat as well as water quality and quantity as a result of inadequately maintained roads and trails, water diversions, livestock grazing, and recreational use. Catastrophic fire and other extreme events such as drought and floods can also impact the species.	---	√√	√√	√
Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*) - Populations of Rio Grande Cutthroat in the Santa Fe NF are isolated in high-elevation streams above natural and human-made barriers, which prevent the upstream movement of nonnative trout that hybridize with, compete with, and prey upon native cutthroat trout. Rio Grande cutthroat trout are further threatened by degraded stream and riparian habitat as well as water quality and quantity as a result of inadequately maintained roads and trails, water diversions, livestock grazing, and recreational use. Uncharacteristic fire and other extreme events such as drought and floods also threaten the trout.	---	√√	√√	√
Rio Grande sucker (*Catostomus plebeius*) - Impacts in the Santa Fe NF include degraded stream and riparian habitat as well as water quality and quantity as a result of inadequately maintained roads and trails, water diversions, livestock grazing, and recreational use. Uncharacteristic fire and other extreme events such as drought and floods can also impact the species. Competition and predation with nonnative species can be extensive threats to Rio Grande Sucker populations through predation from brown trout and by hybridizing and competing for food resources with the white sucker.	---	√√	√√	√
Ruidoso snaggletooth (*Gastrocopta ruidosensis*) – This species lives in plant and leaf litter near limestone outcrops in juniper grasslands (JUG) only on the east side of the Sangre de Cristo Mountains. Its highly restricted range invariably makes this species vulnerable to persistence in the Santa Fe NF. It can be affected by prescribed burning and trampling.	---	√√	√√	√
Spotted bat (*Euderma maculatum*) - They are believed to require key ecosystem characteristics of accessible rock crevices to roost in, which are limited or unknown in the forest. Recreational climbing is known to impact this species due to disturbance at roost sites. Large wildland fires can threaten this species if uncharacteristic fires remove large portions of the landscape.	---	√√	√√	√
Springer's blazing star (*Mentzelia springeri*) - occurs only in the Jemez Mountains on pumice deposits. Seral state departure is low in Piñon-Juniper Woodland habitat; however, there is some departure in composition from introduced nonnative species. Understory composition has been impacted by invasive species. Influenced by drought and other disturbances that have reduced vegetative ground cover and increased the proportion of bare soil. Partial reductions in vegetative cover can be attributed to the substantial increases in CWD loadings. Trampling or road maintenance can be a threat.	---	√√	√√	√
Water shrew (*Sorex palustris*) - is a riparian dependent shrew found in clear, cold high-elevation streams. Most of these ERUs' current ecological conditions in the Santa Fe NF are departed from reference, because of changes in vegetative composition and hydrology. Negative impacts to the water shrew include sedimentation caused by grazing, fuelwood, wildfire, recreation, motorized travel, and changes in hydrology.	---	√√	√	√
Western burrowing owl (*Athene cunicularia hypugaea*) – is found in the Colorado Plateau Great Basin Grassland ERU. This ERU is considered highly departed from reference condition thereby a greater risk to the species. The owls nest and roost in recently abandoned burrows dug by mammals, including ground squirrels, prairie dogs, and badgers. These burrows may soon become unsuitable for nesting.	---	√√	√√	√

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
At-risk species impacted by a combination of issues and threats (continued)				
White-tailed ptarmigan (*Lagopus leucurus*) - Uses the Alpine and Tundra ERU. The birds rely on alpine meadows with short vegetation consisting of sedges and herbaceous broad-leaved plants for nesting and brooding. Threats include degradation of habitat by grazing and recreation. Use of New Mexico's limited alpine tundra habitat by livestock plus increased human use including wilderness hiking, ski area developments, construction of snow catchment fences, and microwave relay stations, are among the threats to the state's remnant ptarmigan population.	---	√√	√√	√

Table 68. ALTERNATIVE COMPARISON – AT-RISK WILDLIFE, Viability Rating* for Each Issue and Threat by Alternative.

This is defined by how well each alternative increases the viability for at-risk species by addressing the ecological conditions impacting the species. (Viability Rating: 2 = highest/fastest improvement, 1 = moderate/continued improvement, 0 = lowest/no or minimal improvement)

Issue or Threat	Alternative 1 1987 Forest Plan	Alternative 2 Forest Plan	Alternative 3 Natural Processes	Alternative 4 Human Uses
Coarse Filter				
A. Highly Departed Seral State	0	2	1	1
B. Highly Departed Coarse Woody Debris	0	1	2	1
C. Highly Departed Snag Density	0	2	2	2
D. Risk of Catastrophic Fire	0	2	1	1
E. Invasive Vegetation Encroachment	0	1	1	2
F. Disconnected Flood plains (wet soils)	0	1	2	1
G. Limited or Specific Soil Conditions	0	2	1	1
H. Specific Ecological Features	0	2	1	1
Fine Filter				
I. Invasive Competition and Predation	0	1	2	0
J. Ground or Soil Disturbance	0	2	2	0
K. Intrusive Human Activity	0	1	2	0
L. Unnatural Disease (Intro or spread)	0	2	2	0
M. Manmade Features	0	2	2	1
N. Chemical Applications	0	2	1	2
Overall At-Risk Viability Rating	**0**	**1.64**	**1.57**	**0.93**

* Highest number denotes best option for increasing or maintaining viability of at-risk species.

3.5.4.3 Indicator: Wildlife Connectivity

Wildlife connectivity is the premise that terrestrial and aquatic animals are able to move freely about their environment in order to access necessary resources or seek other individuals within their species for the purpose of fulfilling basic life-cycle needs. Connectivity may be negatively impacted by two primary issues, physical obstructions and impaired ecological conditions. Physical obstructions tend to be more species specific and usually impact large terrestrial animals that travel great distances to secure resources or aquatic animals that are restricted to linear waterways. Migrations, which are considered significant movements of animals (outside normal daily movements), usually occur seasonally, but may take place within a very short period of time. Physical obstructions include but are not limited to human developments, major roadways or high concentrations of roads, impassable fencing, high-density energy development operations (e.g., oil wells, wind farms, etc.), dams or other aquatic barriers, or any other obstacle that impedes an animal's movements. The obstructions may block an animal's movements entirely or cause the animal to expend additional and much needed resources circumnavigating the obstruction. When an animal is unable to move freely about their environment, connectivity is compromised and the animals may be negatively impacted, thus, decreasing their viability in the forest.

Ecological conditions, or condition of the habitat, may be an equally or more important aspect of wildlife connectivity but is often disregarded since it is not as obvious as highly visible obstructions. The reason ecological habitat conditions may be more important to wildlife connectivity is because it affects all wildlife, not just large terrestrial animals. Animals have evolved in their habitats, usually under reference vegetative conditions, this includes specific habitat features. These conditions may have influenced the development of long- and short-range migration routes. For example, amphibians travelling from one ephemeral pond to another may only travel a short distance but may need specific conditions within the habitat that connects each component of their life history needs. Soil moisture or bare patches may be key components that influence movement. Without optimal conditions (reference conditions), movement may be hindered, and connectivity broken. Therefore, altered, or out-of-reference conditions, may impacts a species' vagility (ability to move or migrate) and may be a larger concern for a majority of species within the forest. Other secondary impacts of loss of connectivity include impairment of pollinator movement among populations of plant species, through disruption of both plant and pollinator (shelter and foraging) sustaining habitat with long term effects on gene flow and viability.

Effects Common to All Alternatives

Physical Obstructions

Certain human-made features may physically obstruct or alter the travel routes for some wildlife species and therefore, must be addressed or mitigated if its impact is significant enough to decrease the viability of a species. These physical obstructions include but are not limited to:

Developments (facilities/infrastructure) may impact animal movements both on and off the forest. Though the U.S. Forest Service has little control over what developments occur off the forest, developed recreational sites and facilities can directly impact wildlife movements. High-density energy developments within the forest can also have the same effect. ***Large developments such as towns or energy developments may interrupt or alter migration routes of large mammals, as well as birds, impacting their ability to find necessary food resources throughout the year [WL70]. Small developments such as recreational sites may impact isolated populations of small terrestrial animals if it separates them from necessary resources[WL83].***

Roads may impact animal movements both on and off the forest. Though the Forest Service has little control over road development and maintenance off the forest, Forest Service roads may directly impact wildlife movements in the forest. ***Roads may interrupt movements of multiple terrestrial species by creating an impassable barrier for smaller animals or influence movement behavior of larger animals [WL71]. Roads are especially harmful to amphibian and fish species when a road blocks aquatic passage or wetland connectivity preventing species from securing life-cycle needs or mating[WL82].***

Fencing may impact animal movements in the forest. ***Some larger terrestrial animals have a difficult time accessing food and cover due to fencing and their inability or reluctance to jump the fences. In some situations where narrow gauge fencing is used, smaller terrestrial animals may also be impacted[WL72].***

Utilities/Right-of-ways which may impact animal movements in the forest. ***Smaller terrestrial animals may be restricted from obtaining necessary food and cover resources due to their reluctance to cross large linear openings since it exposes them to a risk from predators[WL73].***

Ecological Conditions (Habitat Conditions)

In-reference ecological conditions are critical for connectivity to be maintained for all wildlife. Optimum habitat conditions address the issue of scale and accommodates species that still require free movement but not necessarily on the macro-scale where large-human-made features become an obstruction. For example, New Mexico Meadow Jumping mice require continuous native wetland herbaceous cover along riparian areas to move linearly along streams without overexposing them to predation.

Habitat Conditions are a function of four variables for the purpose of this analysis (see All Wildlife section). Two of the variables, extent and distribution, are unlikely to change throughout the life of a forest plan or as a result of management activities. This leaves *quality of habitat,* which is measured primarily in seral state departure, and how likely habitats are to see periodic disturbance. ***In-reference vegetative conditions will provide optimum wildlife connectivity for all species since they will be able to easily move about and obtain the necessary resources required for their basic life-cycle needs[WL74].*** More specific effects of maintaining ecological conditions for wildlife can be found in ***WL1-6, WL10, WL21-23, WL31, WL39, WL43, and WL47-50***.

Large scale development and infrastructure both within (ex. towns, private land inholdings) and in the forest are unlikely to change significantly throughout the life of the plan. These developments will continue to impact wildlife connectivity (***WL70***).

Alternative 1 – 1987 Forest Plan

Under the no-action alternative there is little to no reference or direction to address wildlife connectivity. Individual components impacting connectivity are addressed in the following manner:

Physical obstructions are rarely addressed and certain physical obstructions such as fencing are promoted to protect other forest resources (e.g., cultural sites, range, recreation sites) without regard for its impact on wildlife species. There is, however, guidance to provide elk-friendly wildlife crossing when designing range fences. The no action alternative does provide some direction on roads since there is guidance to "close or obliterate unnecessary roads" as they may impact wildlife habitat. However, road design does not address or mitigate the impact it has on connectivity, especially for aquatic species passage. Lastly, there is no direction for developments (infrastructure or energy) or utilities to consider wildlife connectivity in their design or approval. Wildlife will continue to be affected by physical obstructions with little direction to remove or mitigate those impacts. (***WL71-73, WL82-83***).

Habitat conditions under the No-Action alternative are analyzed in detail under the All Wildlife section of this chapter. Seven ERUs (AT, JUG, MCW, PJO, PJS, PJG, and SFF) received a habitat quality score of moderate to high (2+). These ERUs should provide excellent habitat for all the wildlife in the forest, therefore, wildlife connectivity in these areas should be unimpeded provided there are no physical obstructions (***WL74***). Two ERUs (MSG and SAGE) received a habitat quality score of low to moderate (1.5), therefore, some wildlife species may begin to be affected by deteriorating habitat conditions. Wildlife connectivity in these two ERUs may begin to become impeded. Four ERUs (CPGB, MCD, PPF, and RIP) received the lowest habitat quality rating (1). Wildlife within these ERUs are most likely to be negatively impacted by the poor quality of habitat. It is likely wildlife connectivity is negatively impacted within these ERUs.

Since this alternative does not provide clear direction to address wildlife connectivity it is likely that species will continue to be negatively impacted by wildlife connectivity issues (physical obstructions and poor habitat conditions). ***When physical obstructions and ecological conditions are deteriorated wildlife connectivity is compromised and wildlife species will have a harder time moving about their environment and will need to expend more energy to acquire the food resources or to find necessary cover or breeding habitat***[WL75]***.*** This alternative has the third greatest effect on wildlife connectivity (***WL71-73, WL75, WL82-83***).

Alternative 2 – Forest Plan

Specific forestwide plan components to address wildlife connectivity are integrated throughout multiple resource areas in the Forest Plan (proposed action). In fact, there are over 170 individual plan components that address wildlife connectivity (see Appendices Volume 1, Appendix E, Section C). Most of the plan components refer to restoration efforts which will improve habitat conditions making it easier for animals to move about. There are however certain plan components specifically addressing wildlife connectivity. For example, direction is provided to design infrastructure so as not to disrupt habitat connectivity. There are also numerous desired conditions that reference maintaining connectivity. Plan components addressing wildlife connectivity are found within all sections of Vegetation, Riparian Management Zones, Fire, Water, Soil, Aquatic Species and Habitats, Terrestrial Species and Habitats, Partnerships, Range, Recreation, Roads, Cross Boundary Management, Lands, Minerals, and Designated Areas sections as well. The entire suite of plan components addressing this issue can be found in appendix E. The specifics for addressing physical obstructions and ecological conditions are as follows:

Physical Obstructions may develop from management actions from multiple resources; however, they are specifically addressed so as not to hinder wildlife movement. For example, an objective in the Range section provides direction to remove fencing that is no longer necessary or non-functional while a standard in the same section requires that new or reconstructed fencing must allow for wildlife passage, except where specifically intended to exclude wildlife (such as elk exclosure fence) or to protect human health and safety, while maintaining its effectiveness for livestock management. Another guideline in the Roads section requires that construction or maintenance roads and trails intersecting fish-bearing streams should accommodate aquatic organism passage. A subsequent guideline in the Lands section requires that special use permits for roads, utilities, and communications sites should maximize use of existing infrastructure and utility corridors before new uses are authorized. Its intent is to minimize natural resource impacts including wildlife movements.

Ecological Conditions (Habitat Conditions) – In-reference ecological conditions are critical for connectivity to be maintained for all wildlife. The proposed action provides specific objectives in the Vegetation section to help increase the rate in which out-of-reference ERUs move toward reference conditions (see Seral State analysis). Since wildlife depend on other habitat features see also Special Ecological Feature analysis.

When physical obstructions do not hinder movement and ecological conditions are in-reference wildlife connectivity is optimum and wildlife species will need to expend less energy to acquire the food resources or to find necessary cover or breeding habitat[WL76]. The proposed action provides clear direction to improve wildlife connectivity. This alternative has the second greatest effects on improving wildlife connectivity for terrestrial and aquatic species (***WL74 and WL76***).

Alternative 3 - Natural Processes Emphasis

The natural processes emphasis alternative places more emphasis on the restoration of natural processes to the landscape which includes increased ecological objectives. Although there is added risk for uncharacteristic fire, especially in PPF and MCD, if ecological conditions are restored on a larger scale, wildlife connectivity will see the greatest improvements. This alternative has a threefold increase in the amount of Recommended Wilderness. Since these areas are managed in a more natural state and restrict the type of human activities within, they would promote increased wildlife connectivity since newly created barriers would not likely hinder movement. This alternative also creates Wetland Jewel Management Areas, which sets higher objectives for stream restoration in priority watersheds and limits development within those areas. Due to the increased amount of restoration objectives and increased amounts of Recommended Wilderness and other wildlife-friendly management areas, this alternative has the greatest effect on wildlife connectivity for terrestrial and aquatic species because the potential for physical obstructions will decrease and ecological conditions will increase. (***WL74 and WL76***).

Alternative 4 - Human Uses Emphasis

The human uses emphasis alternative places more emphasis on human uses. This alternative has the least amount of restoration objectives to improve ecological conditions, therefore, wildlife connectivity will remain an issue in areas where ecological conditions are not conducive to wildlife movement. Also, although most plan components in this alternative do not differ from the Forest Plan, the emphasis on increasing human use and activities will likely increase the amount of physical obstructions. For example, this alternative has a guideline that allows for conversion of temporary roads to permanent roads which is to promote greater human access. Also, there are no Recommended Wilderness Areas proposed in this alternative. There is, however, a Motorized Recreation Management Area suggested in this alternative. This will greatly increase physical obstructions (roads and trails) and could potentially cause ecological conditions to deteriorate further disrupting wildlife connectivity. The Motorized Recreation Management Area, with its increased human activity would have the same effect of a large-scale development and hinder the movement of both large and small terrestrial animals in those areas. Due to its potential to increase physical barriers within the forest and its impact on ecological conditions this alternative has the greatest negative effect on wildlife connectivity (***WL71-73, WL75, WL82-83***).

Wildlife Connectivity Summary:

Providing wildlife connectivity is critical for maintaining all wildlife species in the forest. There are multiple issues that decrease wildlife connectivity including physical obstructions and out-of-reference ecological conditions (table 51). Physical obstructions that may block migratory routes of large terrestrial mammals or aquatic organisms need to be properly designed or removed when no longer functioning as intended. Likewise, maintaining ecological conditions that are in-reference is critical for allowing all species, regardless of the scale of their movement needs, the opportunity to move freely about the forest to meet all their life-cycle needs. Alternative 1 provides minimal guidance on maintaining wildlife connectivity and is unlikely to provide for the movement needs of all forest species. Alternative 2 provides desired conditions, guidelines, and objectives that not only ensure wildlife connectivity, but also seeks to restore connectivity where physical obstructions or out-of-reference conditions exist. Alternative 3 provides the same benefits as alternative 2 but may restore connectivity at a higher rate due to its emphasis on natural processes and increased amounts of recommended wilderness areas and other wildlife-friendly management areas. Alternative 4 offers the same plan components as alternative 2, however, due to the increased emphasis on human uses, it is likely that physical obstructions and out-of-reference ecological conditions may increase, thus reducing wildlife connectivity. Alternative 3 is the best option for increasing wildlife connectivity in the forest followed by alternatives 2, 1, and 4, respectively (table 69).

See appendix E for plan components addressing wildlife connectivity.

Table 69. ALTERNATIVE COMPARISON – WILDLIFE CONNECTIVITY
Wildlife Connectivity Issues – includes Physical Obstructions and Ecological Conditions
(Protection Rating: 2 = highest/best, 1 = moderate/medium, 0 = lowest/poor)

Issues Affecting Wildlife Connectivity	**Alternative A** 1987 Forest Plan	**Alternative B** Proposed Action	**Alternative C** Natural Processes	**Alternative D** Human Uses
Physical Obstructions				
Development (facilities/infrastructure)	0	2	2	0
Roads	0	1	2	0
Fencing	0	1	2	0
Utilities/Right-of-ways	1	2	2	0
High Density Energy Development	1	2	2	0
Ecological Conditions (Habitat Condition)				
Habitat (Vegetative) conditions	0	2	2	1
Overall Wildlife Connectivity Rating	0.33	1.67	2.0	0.16

* Highest number denotes best option for increasing or maintaining wildlife connectivity.

3.5.4.4 Regional Forester's Sensitive Species Analysis

The regional forester's sensitive species (RFSS) program is the Forest Service's dedicated initiative to conserve and recover plant and animal species according to Forest Service policy (FSM 2670). The Santa Fe NF improves habitat and restores ecosystems for sensitive species through vegetation treatments and management practices. Sensitive species are those plant and animal species identified by a regional forester for which population viability is a concern, as evidenced by the following:

- Significant current or predicted downward trends in population numbers or density
- Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Regionally sensitive species found in the Santa Fe NF and considered in this analysis are found in table 70 through table 75. Additional information on each RFSS species and its status in the forest can be found in the Regional Forester's Sensitive Species List Reference Document for the Santa Fe NF (USDA Forest Service 2013b). The tables display each sensitive species in the Santa Fe NF, its habitat and the primary threats and issues impacting those species, the effects of the alternatives, and the reasoning for the determination.

Environmental Consequences to Sensitive Wildlife Species

Effects of a new forest plan described for all wildlife habitat and populations in the forest also apply to sensitive species. All the action alternatives would provide desired conditions and standards and guidelines that would promote the persistence of sensitive species and in most cases, increased viability. Due to the lack of data for some species (ex. Preble's shrew and robust larkspur), it is impossible to say certainty what the population effects will be, however, we can draw conclusions to effects on the habitat.

The method employed to achieve desired conditions may impact the rate at which they are achieved. For example, larger acreages may be treated using prescribed fire (alternative 3) as opposed to mechanical treatments (alternative 4). However, since both alternatives are still moving toward desired conditions, it should not impact the end-result of the persistence of sensitive species in the forest. However, the varying approaches of the action alternatives (natural processes versus human uses emphasis), may negatively impact sensitive species if the management actions used to achieve desired conditions introduce other issues and threats associated with each individual species. For example, mechanical treatment may improve vegetative (habitat) conditions for numerous sensitive bird and mammal species, however, ground-disturbing activities as a result of mechanical treatments may negatively impact sensitive plant or invertebrate species in that area.

As with all large-scale management plans than seek to restore and provide healthy and robust wildlife populations, the focus must remain on providing quality habitat and addressing threats when they are known. The analysis provided in the at-risk species section (table 51) identifies primary issues and threats for at-risk species. These same issues and threats were identified for all sensitive species in table 70 through table 75 (Column 2). Although an individual species may have many threats and issues that affect its persistence in the forest the most impactful issues are addressed in the table. All other threats and issues that were identified in table 51 are also addressed but may not be listed below. All habitat calculations between alternatives were based on vegetative objective treatments. Additional improvements are possible (e.g., invasive plant species removal, infrastructure design improvements) but these will have insignificant forestwide effects.

The effects common to all species apply to the sensitive species described in this section. For purposes of this analysis, the affected environment includes the species actually found in the national forests and the habitats they occupy or are suitable for occupation. The list of species in the project area was developed from the 2013 list of sensitive animals and plants (USDA Forest Service 2013b).

Amphibians

Effects to sensitive amphibian species are listed in table 70. The Forest Plan (alternative 2) is not expected to decrease population viability or cause a trend toward Federal listing.

Table 70. Sensitive species: Effects to amphibians

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Northern leopard frog *(Rana pipiens)*	Associated with water. Impacted by departed conditions of riparian areas and other water resources. Their habitats are also at-risk from large uncharacteristic fires. Direct mortality and decreased vigor caused by invasive predation and competition from bull frogs (*Lithobates catesbeianus*) as well as from chytrid fungus (*Batrachochytrium dendrobatidis*). May also become trapped in human-made water features. (Potential available habitat in the Santa Fe NF: 57,608 acres. Current amount of habitat in reference condition: 28,804 acres)	The no-action alternative allows for improvements to riparian vegetative conditions which would provide the greatest benefit for improving habitat for the northern leopard frog. The risk of predation from bull frogs and the potential for the spread of Chytrid fungus would continue to impact the frog. (Annual amount of habitat improvement: <50 acres)	Increased objectives for riparian areas and water resources would improve habitat conditions. Plan components designed to address entrapment in water features, invasive predation, and disease spread (Chytrid fungus) would minimize mortality. Alternative 4 may increase risk of disease spread due to increased human activity. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the northern leopard frog. The proposed action and alternatives address the primary threats to this species, which are changes in wetlands, especially the alteration of marshy ponds to reservoirs; existence of nonnative predatory fish; natural local extinctions as ponds dry up during years of low precipitation; disease spread and predation and competition by introduced bullfrogs (Biota Information System of New Mexico). .

Birds

Effects to sensitive bird species are listed in table 71. The Forest Plan (alternative 2) is not expected to decrease population viability or cause a trend to Federal listing.

Table 71. Sensitive species: Effects to birds

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
American peregrine falcon *(Falco peregrines anatum)*	Habitat includes high cliffs with horizontal breaks for nest ledges. Susceptible to nest disturbance from recreational climbers. May also be impacted by large energy developments or utilities (ex. wind turbines, cell towers). Historically were impacted by pesticides. (Potential available habitat in the Santa Fe NF: 236,132 acres. Current amount of habitat in reference condition: 61,392 acres)	Most of the direction is to minimize human disturbance to high-profile game species. There is also little to no direction for addressing human-made features that impact birds. The viability of the falcon is unlikely to increase under this alternative. (Annual amount of habitat improvement: 11,361 acres)	Specific forestwide management direction for minimizing human disturbance to at-risk species is addressed in the proposed action, with cliff disturbance being specifically addressed. There are also plan components that attempt to reduce collision by birds by providing guidance on infrastructure design. With its emphasis to encourage human uses, Alternative 4 may not be as beneficial to the falcon. (Annual amount of habitat improvement: Alt 2: 42,750 acres, Alt 3: 106,700 acres, Alt 4: 32,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the American peregrine falcon. The proposed action and alternatives maintain or improve the habitat and address the two primary threats to peregrine falcons, cliff disturbance and collisions with human-made structures.
Bald eagle *(Haliaeetus leucocephalus)*	Habitat includes riparian areas along major river corridors, but winter habitat is not always associated with riparian areas. May be impacted by large energy developments or utilities (ex. wind turbines, cell towers). Historically were impacted by pesticides. Since bald eagles are dependent upon large bodies of water, they are not typically found on the Santa Fe NF but may occasionally be seen along the Rio Grande. (Potential available habitat in the Santa Fe NF: 57,608 acres. Current amount of habitat in reference condition: 28,804)	There is little to no direction for addressing human-made features that impact birds. Also, there is specific direction to follow integrated pest procedures. This calls for project-level decisions to be made regarding the use of pesticides. (Annual amount of habitat improvement: <50 acres)	There are plan components that attempt to reduce collision by birds by providing guidance on infrastructure design. Specific forestwide plan components address chemical applications in the proposed action. With its emphasis to encourage human uses, Alternative 4 may not be as beneficial to the persistence of the eagle. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the bald eagle. The proposed action and alternatives maintain or improve the habitat and address the two primary threats to bald eagles, collisions with human-made structures and pesticides.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Boreal owl *(Aegolius funereus)*	Habitat includes high-elevation mature spruce-fir forests. Greatest risk to boreal owl may be loss of habitat due to large scale uncharacteristic fire which may occur in SFF. (Potential available habitat in the Santa Fe NF: 195,166 acres. Current amount of habitat in reference condition: 89,777 acres)	The no-action alternative allows for restoration in the forested ERUs, however, SFF are not highly departed. (Annual amount of habitat improvement: 1,680 acres)	The action alternatives provide numerous restoration objectives however, since SFF are not highly departed it is unlikely management actions will be directed in these ERUs. (Annual amount of habitat improvement: Alt 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the boreal owl. The proposed action and alternatives maintain or improve the habitat and address the primary threat to boreal owls, uncharacteristic fire.
Burrowing owl (Western) *(Aegolius funereus)*	Prairie dog towns are found in various PJ and grassland ERUs. Some grassland habitats may be highly departed which could impact the prairie dogs, a species which is critical for the owls for suitable den sites. Recreational shooting may also be a concern since prairie dogs are often targeted. Owls have been recorded being shot and it is believed they were accidentally mistaken for prairie dogs. (Potential available habitat in the Santa Fe NF: 69,820 acres. Current amount of habitat in reference condition: 32,815 acres)	The no-action alternative does allow for improvements to seral state condition but provides little to no direction in grassland systems. This would benefit the owl since they are dependent upon the prairie dogs for burrows. It also does not address recreational shooting. (Annual amount of habitat improvement: 866 acres)	The action alternatives contain specific restoration objectives for non-forested ERUs in which prairie dogs are found, thus improving habitat which will secondarily benefit the owl. There is also specific direction for closures should recreational shooting become an issue for the owl. With its emphasis to encourage human uses, Alternative 3 may not be as beneficial to the owl since it may increase the likelihood of shooting. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the burrowing owl. The proposed action and alternatives maintain or improve the habitat and address the primary threats to burrowing owls, including recreational shooting and maintaining prairie dog populations for use of their burrows.
Gray vireo *(Vireo vicinior)*	Habitat includes juniper grasslands with shrub component. May be impacted by departed habitat conditions. Recent breeding bird surveys show an increasing trend in Gray Vireo populations and surveys suggest they do not appear to be at risk in the forest. (Potential available habitat in the Santa Fe NF: 199,386 acres. Current amount of habitat in reference condition: 117,638 acres)	The no-action alternative allows for improvements to seral state condition which would provide the greatest benefit for improving habitat for the vireo. (Annual amount of habitat improvement: 2,076 acres)	The action alternatives contain specific restoration objectives for non-forested ERUs in which Gray vireos are found. Although the vireos are not at-risk in the forest, the habitat in which they rely should not trend away from desired conditions. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the gray vireo. The proposed action and alternatives maintain or improve the juniper grasslands that as necessary for the vireo's persistence.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Northern goshawk *(Accipiter gentilis)*	Habitat includes most mature forested habitats except piñon-juniper. Goshawks are mostly impacted by departed habitat conditions and are highly dependent upon specific structural features required for nesting sites. Large uncharacteristic fires may also impact the birds. (Potential available habitat in the Santa Fe NF: 26,858 acres. Current amount of habitat in reference condition: 3,760 acres)	The no-action alternative provides direction through an amendment for the protection and development of structural components required for goshawks nesting territories. (Annual amount of habitat improvement: 11,361 acres)	The action alternatives not only carry forward the structural guidance for nesting territories but also provide specific restoration objectives for forested ERUs utilized by the goshawk for foraging. There is also guidance to reduce the likelihood of uncharacteristic fires. (Annual amount of habitat improvement: Alt 2: 42,750 acres, Alt 3: 106,700 acres, Alt 4: 32,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the northern goshawk. The proposed action and alternatives maintain or improve structural components required by goshawks for nesting and improve habitat conditions for foraging this will increase the viability of goshawks in the forest.
Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Occurrences associated with large blocks of mature riparian cottonwood-willow woodlands and dense mesquite associations. Cuckoos are usually impacted by highly departed riparian conditions, especially if cottonwood stands are lacking. Due to the dependency of large blocks of cottonwood stands along riparian areas, cuckoos are not known to reside on the Santa Fe NF. (Potential available habitat in the Santa Fe NF: 2,248 acres. Current amount of habitat in reference condition: 877 acres)	The no-action alternative allows for improvements to riparian vegetative conditions which would provide the greatest benefit for improving habitat for the cuckoo. (Annual amount of habitat improvement: <50 acres)	The action alternatives provide specific restoration objectives within riparian areas. There is also guidance to follow the most recent Recovery plan for T&E species. Although the cuckoo is not known to use the Santa Fe NF, restored vegetative conditions may result in the bird expanding its range and using areas where desired conditions are obtained. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a loss of viability** for the western yellow-billed cuckoo. The proposed action and alternatives maintain or improve the riparian habitat that is required by the cuckoo.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
White-tailed ptarmigan *(Lagopus leucurus)*	Habitat includes alpine areas and other high-elevation sites. Ptarmigan may be impacted by loss of herbaceous cover in alpine areas and are susceptible to disturbance from human activities. (Potential available habitat in the Santa Fe NF: 137,274 acres. Current amount of habitat in reference condition: 137,274 acres)	The no-action alternative allows for maintained or improved conditions within alpine-tundra habitats. Also, most of the direction within this alternative is to minimize human disturbance to high-profile game species. (Annual amount of habitat improvement: 0 acres)	The action alternatives contain specific desired conditions for the alpine and tundra habitats in which ptarmigan are found, however, alpine habitat is not departed therefore no restoration work is anticipated. Specific forestwide management direction for minimizing human disturbance to at-risk species is also addressed in the proposed action. (Annual amount of habitat improvement: Alt 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the white-tailed ptarmigan. The proposed action and alternatives maintain or improve the alpine habitats and address the two primary threats to ptarmigan, loss of herbaceous cover and human disturbance.

Mammals

Effects to sensitive mammal species are listed in table 72. The Forest Plan (alternative 2) is not expected to decrease population viability or cause a trend to Federal listing.

Table 72. Sensitive species: Effects to mammals

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Cinereus (masked) shrew (*Sorex cinereus cinereus*)	Habitat includes riparian areas in sub-alpine coniferous forest in Sangre de Cristo, Jemez, and San Juan Mountains unusually above 9,500 feet. Masked shrews are impacted by highly departed riparian habitats since they are dependent upon native herbaceous cover and clean free-flowing water. May also be at-risk from large uncharacteristic fire, invasive species encroachment (plants), and human activities along riparian areas. (Potential available habitat in the Santa Fe NF: 268,533 acres. Current amount of habitat in reference condition: 104,728 acres)	The no-action alternative allows for improvements within riparian habitats. Although there is limited means to conduct restoration work with prescribed fire, fire suppression is emphasized under this alternative. Little guidance is provided regarding human disturbance except as it applies to game species. (Annual amount of habitat improvement: 1,730 acres, mostly SFF)	The action alternatives contain specific restoration objectives for riparian areas (riparian management zones) as well as for water, and recreation (human disturbance). With its emphasis to encourage human uses, Alternative 3 may not be as beneficial since it may increase human disturbance in riparian areas. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the masked shrew. The proposed action and alternatives maintain or improve the riparian habitats and will also reduce the potential for uncharacteristic fire.
Preble's shrew (*Sorex preblei*)	Found near permanent or intermittent streams in arid to semi-arid shrub or grassland or lesser into conifer forest. May be impacted by departed conditions but not much is known regarding the status of this shrew in the forest (only two documented observations). (Potential available habitat in the Santa Fe NF: 76,940 acres. Current amount of habitat in reference condition: 30,007 acres)	The no-action alternative allows for improved conditions within riparian areas within grasslands or semi-arid shrubland. (Annual amount of habitat improvement: <50 acres)	The action alternatives contain specific restoration objectives in riparian areas as well as for other habitats in which they may be found. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Preble's shrew. Although there is not much information available about the current status of the shrew in the forest, the proposed action and alternatives maintain or improve the riparian habitats for the shrew.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
American water shrew (*Sorex palustris navigator*)	Habitat includes permanent streams, seldom below 8,000 feet. Water shrews are impacted by highly departed riparian habitats since they are dependent upon native herbaceous cover and clean free-flowing water. May also be at-risk from large uncharacteristic fire, invasive species encroachment (plants), and human activities along riparian areas. (Potential available habitat in the Santa Fe NF: 76,940 acres. Current amount of habitat in reference condition: 30,007 acres)	The no-action alternative allows for improvements within riparian habitats. Although there is limited means to conduct restoration work with prescribed fire, fire suppression is emphasized under this alternative. Little guidance is provided regarding human disturbance except as it applies to game species. (Annual amount of habitat improvement: <50 acres)	The action alternatives contain specific restoration objectives for riparian areas (riparian management zones) as well as for water, and recreation (human disturbance). With its emphasis to encourage human uses, Alternative 4 may not be as beneficial since it may increase human disturbance in riparian areas. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the American water shrew. The proposed action and alternatives maintain or improve the riparian habitats and will also reduce unnecessary stressors caused by external influences (human disturbance). The increased restoration through the proposed actions will also improve upland characteristics and reduce the potential for uncharacteristic fire.
Spotted bat (*Euderma maculata)*	Habitat includes rock cliffs and vertical canyons. Human activities around roost sites may impact spotted bats. A large stand-replacing fire in its SFF and MCW feeding grounds could also impact the bats. (Potential available habitat in the Santa Fe NF: 73,448 acres. Current amount of habitat in reference condition: 35,255 acres)	Most of the direction within the no-action alternative is to minimize human disturbance to high-profile game species. There is also little to no direction for addressing other ecological or human-made features that may impact the bat or specific desired conditions for SFF and MCW. (Annual amount of habitat improvement: 1,680 acres)	Specific forestwide management direction for minimizing human disturbance to at-risk species is addressed in the proposed action, with cliff disturbance being specifically addressed. There are also plan specific desired conditions for the habitats in which the bats are found. (Annual amount of habitat improvement: Alt 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the spotted bat. The proposed action and alternatives maintain or improve the habitats and address the cliff disturbance to spotted bats.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	Habitat includes caves, mines or abandoned buildings. No recorded observations in the forest but bat may be impacted by activities around known roost sites. Dependent upon the availability of inactive or abandoned mines. (Potential available habitat in the Santa Fe NF: 302,622 acres. Current amount of habitat in reference condition: 145,259 acres)	Most of the direction within the no-action alternative is to minimize human disturbance to high-profile game species. There is also little to no direction for addressing other ecological or human-made features that may impact the bat (ex. abandoned mines). (Annual amount of habitat improvement: 1,680 acres)	Specific forestwide management direction for minimizing human disturbance to at-risk species is addressed in the proposed action, with cliff disturbance being specifically addressed. There are also plan components that attempt to consider human-made features that impact at-risk species. (Annual amount of habitat improvement: Alt 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Pale Townsend's big-eared bat. The proposed action and alternatives maintain or improve the habitats and address the cave disturbance to the bats.
American marten (*Martes americana origenes*)	Habitat includes high-elevation spruce-fir forests. Dependent upon availability of coarse woody debris which serves as an important area for foraging and denning. May be impacted by stand-replacing fire in the SFF habitats. (Potential available habitat in the Santa Fe NF: 269,093 acres. Current amount of habitat in reference condition: 113,019 acres)	The no-action alternative allows for restoration in the forested ERUs, however, SFF are not highly departed. (Annual amount of habitat improvement: 1,730 acres, mostly SFF)	The action alternatives provide numerous restoration objectives however, since SFF are not highly departed it is unlikely management actions will be directed in these ERUs. (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the American marten. The proposed action and alternatives maintain or improve the habitats and address the threats of coarse woody debris build-up and uncharacteristic fire.
Gunnison's prairie dog (*Cynomys gunnisoni*)	Habitat includes mountain meadows, valley floors, and plains. One of the primary issues impacting prairie dogs is their susceptibility to Sylvatic plague. When populations become disjunct or isolated due to poor habitat conditions, the disease could be devastating to those isolated populations. (Potential available habitat in the Santa Fe NF: 143,072 acres. Current amount of habitat in reference condition: 67,244 acres)	The no-action alternative allows for improved conditions within prairie dog habitats. However, there is no mention of ways to address recreational shooting and Sylvatic plague. (Annual amount of habitat improvement: 866 acres)	The action alternatives contain specific desired conditions for each ERU in which prairie dogs are found. There is also specific direction for addressing recreational shooting and disease issues which may impact at-risk species. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for Gunnison's prairie dog. The proposed action and alternatives maintain or improve the habitats and address issues associated with recreational shooting and Sylvatic plague.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
New Mexico meadow jumping mouse (*Zapus hudsonius luteus)*	Occurs in dense mid-elevation riparian long grass habitats. NM Meadow Jumping mice require healthy high-altitude riparian systems. May be impacted by encroaching invasive vegetation and degraded water conditions including disconnected floodplains. Can also be impacted by increased activities around waterways and the impacts from large-scale fires. (Potential available habitat in the Santa Fe NF: 28,884 acres. Current amount of habitat in reference condition: 11,265 acres)	The no-action alternative allows for improvements within riparian habitats. Although there is limited means to conduct restoration work with prescribed fire, fire suppression is emphasized under this alternative. Little guidance is provided regarding human disturbance except as it applies to game species. (Annual amount of habitat improvement: <50 acres)	The action alternatives contain specific desired conditions for riparian areas (riparian management zones) as well as for water, and recreation (human disturbance). There is also guidance to follow the most recent Recovery plan for T&E species. With its emphasis to encourage human uses, Alternative 4 may not be as beneficial since it may increase human disturbance in riparian areas. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a loss of viability** for the New Mexico meadow jumping mouse. The proposed action and alternatives maintain or improve the riparian habitats and will also reduce unnecessary stressors caused by external influences (human disturbance). The increased restoration through the proposed actions will also improve upland characteristics and reduce the potential for uncharacteristic fire.
American pika (*Ochotona princeps saxatilis)*	Habitat includes talus slopes in Pecos Wilderness in Santa Fe NF and locations within and outside Pecos Wilderness on the Carson NF. Pikas do not tolerate warm temperatures and may be impacted by issues such as woody or invasive encroachment which alters their natural foraging habitat. (Potential available habitat in the Santa Fe NF: 86,432 acres. Current amount of habitat in reference condition: 86,432 acres)	The no-action alternative allows for maintained or improved conditions within alpine-tundra habitats. Also, most of the direction within this alternative is to minimize human disturbance to high-profile game species. (Annual amount of habitat improvement: 0 acres)	The action alternatives provide desired conditions for the alpine and tundra ERU and objectives that ensure invasive vegetation is eradicated or suppressed. Alternative 4 has the highest objectives for invasive plant control but alpine and tundra may not be the primary focus for control. (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the American pika. The proposed action and alternatives maintain or improve the alpine habitats and address the primary threat of invasive encroachment.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Goat Peak pika (*Ochotona princeps nigrescens*)	Habitat includes talus slopes in the Jemez Mountains around the Valles Caldera National Preserve and west side of Los Alamos County. Pikas do not tolerate warm temperatures and may be impacted by issues such as woody or invasive encroachment which alters their natural foraging habitat. (Potential available habitat in the Santa Fe NF: 7,396 acres. Current amount of habitat in reference condition: 7,396 acres)	The no-action alternative allows for maintained or improved conditions within alpine-tundra habitats. Also, most of the direction within this alternative is to minimize human disturbance to high-profile game species. (Annual amount of habitat improvement: 0 acres)	The action alternatives provide desired conditions for the alpine and tundra ERU and objectives that ensure invasive vegetation is eradicated or suppressed. Alternative 4 has the highest objectives for invasive plant control but alpine and tundra may not be the primary focus for control. (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Goat Peak pika. The proposed action and alternatives maintain or improve the pika's habitats and address the primary threat of invasive encroachment.

Invertebrates

Effects to sensitive invertebrate species are listed in table 73. The Forest Plan (alternative 2) is not expected to decrease population viability or cause a trend to Federal listing.

Table 73. Sensitive species: Effects to invertebrates

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Reason for Determination
Ruidoso snaggletooth (*Gastrocopta ruisdsensis*)	Found on bare soil, under stones, and in thin accumulations of grass thatch and juniper litter on mid-elevation carbonate cliffs and xeric limestone grasslands along the eastern slopes of the Sangre de Cristo and Sacramento mountains in eastern New Mexico, where the only extant occurrences are. May be impacted by ground-disturbing activities within areas that contain these specific soil qualities. (Potential available habitat in the Santa Fe NF: 2,255 acres. Current amount of habitat in reference condition: 1,240 acres)	The no-action alternative allows for improvements to the snaggletooth's habitat but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species. (Annual amount of habitat improvement: 866 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. There is also direction for identifying and avoiding small at-risk populations. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Ruidoso snaggletooth. The proposed action and alternatives maintain or improve the habitats and provide guidance for not only avoiding areas where the snaggletooth is found but also minimizing ground-disturbing activities which could have negative impacts on the invertebrates.
Lilljeborg peaclam *(Pisidium sanguinichristi)*	Found in only one high elevation lake in the Pecos Wilderness and is found in no other place in New Mexico. May be susceptible to a uncharacteristic fire as well as the chemical retardants if they get into the waterway. (Available habitat in the Santa Fe NF: <50 acres)	The no-action alternative allows for improvements to the peaclam's habitat and provides some guidance on the impact of chemical applications to the habitat of at-risk species (fire-section). (Annual amount of habitat improvement: 0 acres)	The action alternatives provide guidelines and objectives that not only ensure chemical applications are applied appropriately to minimize wildlife mortality but also actively seek to restore areas where excessive amounts were applied due to other resource needs (fire). (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Lilljeborg peaclam. The proposed action and alternatives maintain or improve the habitat and provides guidance for reducing the likelihood of contaminating the only waterbody in which they are found. The increased restoration efforts will also reduce the potential for uncharacteristic fire.

Fish

Effects to the sensitive fish species are listed in table 74. The Forest Plan (alternative 2) is not expected to decrease population viability or cause a trend to Federal listing.

Table 74. Sensitive species: Effects to fish

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Rio Grande sucker *(Catastomus plebius)*	Populations are found on the Santa Fe NF in mid to high elevation cold-water streams. Impacted by degraded water conditions that are usually caused by out-of-reference riparian (vegetative) conditions. Disconnected floodplains and increased human activities may also impact the fish. There may also be effects from predation by introduced nonnative aquatic species. (Potential available habitat in the Santa Fe NF: 329 stream miles. Current amount of habitat in reference condition: 230 acres)	The no-action alternative lacks objectives to restore riparian areas that have already been altered but it allows for improvements within riparian habitats. Nonnative fish introduction is actually encouraged for fishing opportunities. (Annual amount of habitat improvement: 0 stream miles)	The action alternatives contain specific desired conditions for riparian areas (riparian management zones) as well as for water, and recreation (human disturbance). With its emphasis to encourage human uses, Alternative 4 may not be as beneficial since it may increase human disturbance in riparian areas and result in the spread of nonnative aquatics. (Annual amount of habitat improvement: Alt 2: 4.5 stream miles, Alt 3: 9 stream miles, Alt 4: 0 stream miles)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Rio Grande sucker. The proposed action and alternatives maintain or improve the riparian vegetation and water characteristics that is required by the sucker. They also reduce impacts caused by external influences (nonnative aquatics). The increased restoration through the proposed action will also improve upland characteristics and reduce the potential for uncharacteristic fire, which could impact fish habitats downstream.
Rio Grande chub *(Gila pandora)*	Populations are found on the Santa Fe NF in mid to high elevation cold-water streams. Impacted by degraded water conditions that are usually caused by out-of-reference riparian (vegetative) conditions. Disconnected floodplains and increased human activities may also impact the fish. There may also be effects from predation by introduced nonnative aquatic species. (Potential available habitat in the Santa Fe NF: 329 stream miles. Current amount of habitat in reference condition: 230 acres)	The no-action alternative lacks objectives to restore riparian areas that have already been altered but it allows for improvements within riparian habitats. Nonnative fish introduction is actually encouraged for fishing opportunities. (Annual amount of habitat improvement: 0 stream miles)	The action alternatives contain specific desired conditions for riparian areas (riparian management zones) as well as for water, and recreation (human disturbance). With its emphasis to encourage human uses, Alternative 4 may not be as beneficial since it may increase human disturbance in riparian areas and result in the spread of nonnative aquatics. (Annual amount of habitat improvement: Alt 2: 4.5 stream miles, Alt 3: 9 stream miles, Alt 4: 0 stream miles)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Rio Grande chub. The proposed action and alternatives maintain or improve the riparian vegetation and water characteristics that is required by the chub. They also reduce impacts caused by external influences (nonnative aquatics). The increased restoration through the proposed action will also improve upland characteristics and reduce the potential for uncharacteristic fire, which could impact fish habitats downstream.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*)	Populations are found on the Santa Fe NF in high-elevation cold-water streams. Impacted by degraded water conditions that are usually caused by out-of-reference riparian (vegetative) conditions. Disconnected floodplains and increased human activities may also impact the fish. There may also be effects from predation by introduced nonnative aquatic species. (Potential available habitat in the Santa Fe NF: 329 stream miles. Current amount of habitat in reference condition: 230 acres)	The no-action alternative lacks objectives to restore riparian areas that have already been altered but it allows for improvements within riparian habitats. Nonnative fish introduction is actually encouraged for fishing opportunities. (Annual amount of habitat improvement: 0 stream miles)	The action alternatives contain specific desired conditions for riparian areas (riparian management zones) as well as for water, and recreation (human disturbance). With its emphasis to encourage human uses, Alternative 4 may not be as beneficial since it may increase human disturbance in riparian areas and result in the spread of nonnative invasive aquatic species. (Annual amount of habitat improvement: Alt 2: 4.5 stream miles, Alt 3: 9 stream miles, Alt 4: 0 stream miles)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Rio Grande cutthroat trout. The proposed action and alternatives maintain or improve the riparian vegetation and water characteristics that is required by the cutthroat trout. They also reduce impacts caused by external influences (nonnative aquatics). The increased restoration through the proposed action will also improve upland characteristics and reduce the potential for uncharacteristic fire which could impact fish habitats downstream.

Plants

Effects to the sensitive plant species are listed in table 75. The Forest Plan (alternative 2) is not expected to decrease population viability or cause a trend to Federal listing.

Table 75. Sensitive species: Effects to plants

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Tufted sand verbena *(Abronia bigelovii)*	Generally scattered along outcroppings of gypsum or strongly gypseous soils. Only documented in a few locations in the forest. May be impacted by ground-disturbing activities within areas that contain these specific soil qualities. May also be impacted by large-scale fire which can wipe-out isolated pockets of these plants. (Potential available habitat in the Santa Fe NF: 9,566 acres. Current amount of habitat in reference condition: 5,452 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species. Although there is limited means to conduct restoration work with prescribed fire, fire suppression is emphasized under this alternative. (Annual amount of habitat improvement: 866 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. There is also direction for identifying and avoiding small at-risk populations and reducing the risk of uncharacteristic fire. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the tufted sand verbena. The proposed action and alternatives maintain or improve the habitats for the verbena and provides guidance for avoiding areas where the verbena is found and minimizes ground-disturbing activities which could have negative impacts on the plants.
Greene's milkweed *(Asclepais uncialis)*	Occurs in low numbers where it is found. It has been reported from only one location in the southeast local zone. Affected by out-of-reference conditions including encroachment from invasive vegetation. Also impacted by ground-disturbing activities. (Potential available habitat in the Santa Fe NF: 32,381 acres. Current amount of habitat in reference condition: 20,076 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species and little guidance for avoiding or minimizing impact to isolated populations. There is also little to no direction for controlling nonnative invasive vegetation. (Annual amount of habitat improvement: 2,076 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. They also have numerous objectives for preventing or reducing invasive plant encroachment. Alternative 4 has the highest objectives for invasive plant control. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Greene's milkweed. The proposed action and alternatives maintain or improve the habitats for the milkweed and provides guidance for reducing ground and soil disturbance. It also allows for invasive vegetation control which would benefit the milkweed in areas in which it is found.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Chaco milkvetch *(Astralagus micromerius)*	Found in outcroppings of sandstone that are blended with Todilto gypsum or limestone. Range is actually quite limited because of its spotty distribution across the landscape. May be impacted by ground-disturbing activities within areas that contain these specific soil qualities. (Potential available habitat in the Santa Fe NF: 107,691 acres. Current amount of habitat in reference condition: 63,538 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species. There is also minimal direction to protect or improve soil conditions required by the milkvetch. (Annual amount of habitat improvement: 2,076 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. There is also direction for identifying and avoiding small at-risk populations. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Chaco milkvetch. The proposed action and alternatives maintain or improve the habitats for the milkvetch and provides guidance for minimizing ground-disturbing activities, which could have negative impacts on the plants.
Pecos mariposa lily *(Calochortus gunnisonii)*	Occupies meadows and aspen glades in upper montane coniferous forest (MSG); 2,900 to 3,400 meters (9,500 to 11,200 feet). May be impacted by ground-disturbing activities within areas that contain these specific soil qualities. May also be impacted by large-scale fire which can wipe-out isolated pockets of these plants. (Potential available habitat in the Santa Fe NF: 51,987 acres. Current amount of habitat in reference condition: 20,795 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species. Although there is limited means to conduct restoration work with prescribed fire, fire suppression is emphasized under this alternative. (Annual amount of habitat improvement: 866 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. There is also direction for identifying and avoiding small at-risk populations and reducing the risk of uncharacteristic fire. (Annual amount of habitat improvement: Alt 2: 7,200 acres, Alt 3: 12,765 acres, Alt 4: 9,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Pecos mariposa lily. The proposed action and alternatives maintain or improve the habitats for the lily and provides guidance for minimizing ground-disturbing activities which could have negative impacts on the plants. They will also improve upland characteristics and reduce the potential for uncharacteristic fire.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Yellow lady's-slipper *(Cypripedium parviflorum)*	Only known from eight locations on the Santa Fe NF within the Spruce Fir Forest. Affected by out-of-reference conditions including encroachment from invasive vegetation. Impacted by ground-disturbing activities and susceptible to picking by people for its large showy yellow flower. (Potential available habitat in the Santa Fe NF: 73,448 acres. Current amount of habitat in reference condition: 32,255 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species and little guidance for avoiding or minimizing impact to isolated populations. There is also little to no direction for controlling nonnative invasive vegetation and addressing threats from human disturbance. (Annual amount of habitat improvement: 1,680 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. They also have numerous objectives for preventing or reducing invasive plant encroachment. Alternative 4 has the highest objectives for invasive plant control but may also increase the threat from human disturbance. (Annual amount of habitat improvement: Alt 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the yellow lady's-slipper. The proposed action and alternatives maintain or improve the habitats for the lady's-slipper and provides guidance for minimizing ground-disturbing activities. It also allows for invasive vegetation control which would benefit the lady's-slipper in areas in which it is found. The threat of people picking the flower should also be minimized.
Robust larkspur *(Delphinium robustum)*	Found in canyon bottoms and aspen groves in lower and upper montane coniferous forest; 2,200-3,400 m (7,200-11,200 ft). No known populations in the forest. Some species of Delphinium are poisonous to cattle, so the genus as a whole is sometimes targeted for poisonous weed control. (Potential available habitat in the Santa Fe NF: 103,163 acres. Current amount of habitat in reference condition: 51,582 acres)	The no-action alternative allows restoration efforts but there is minimal to no guidance on the impact of chemical applications to at-risk species. (Annual amount of habitat improvement: 1,680 acres)	The action alternatives provide guidelines and objectives that ensure chemical applications are applied appropriately so as to minimize exposure by wildlife. (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the robust larkspur. The proposed action and alternatives maintain or improve the habitats for the larkspur and reduces the threat of chemical applications.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Heil's alpine whitlowgrass *(Draba heilii)*	Found in high alpine meadows above timberline, only one known location in the forest. May be impacted by ground disturbance and other intrusive human activities. (Potential available habitat in the Santa Fe NF: 20,795 acres. Current amount of habitat in reference condition: 20,795 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species and little guidance for avoiding or minimizing impact to isolated populations. There is also little to no direction for addressing threats from human disturbance. (Annual amount of habitat improvement: 0 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. Alternative 4 may also increase the threat from human disturbance. (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Heil's alpine whitlowgrass. The proposed action and alternatives maintain or improve the habitats for the whitlowgrass and provides guidance for reducing ground and soil disturbance. It also minimizes the amount of human disturbance.
Pecos fleabane *(Erigeron subglaber)*	Known to be very narrowly endemic and subject to high risk of climate change in spruce fir habitats. Departed habitat conditions including invasive encroachment as well as ground-disturbing activities may impact this species. (Potential available habitat in the Santa Fe NF: 5,493 acres. Current amount of habitat in reference condition: 2,527 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species and little guidance for avoiding or minimizing impact to isolated populations. There is also minimal for controlling nonnative invasive vegetation. (Annual amount of habitat improvement: 1,680 acres)	The action alternatives provide standards and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. They also have numerous objectives for preventing or reducing invasive plant encroachment. Alternative 4 has the highest objectives for invasive plant control. (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Pecos fleabane. The proposed action and alternatives maintain or improve the habitats for the fleabane and provides guidance for reducing ground and soil disturbance. It also allows for invasive vegetation control, which would benefit the fleabane in areas in which it is found.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Wood lily *(Lilium philadephicum)*	Associated with the ponderosa pine but has never been found in abundance. Departed habitat conditions and large-scale fire could impact the lily. (Potential available habitat in the Santa Fe NF: 62,594 acres. Current amount of habitat in reference condition: 2,527 acres)	The no-action alternative allows restoration efforts but there is little guidance for desired conditions within PPF. Although there is limited means to conduct restoration work with prescribed fire, fire suppression is emphasized under this alternative. (Annual amount of habitat improvement: 7,065 acres)	The action alternatives contain specific desired conditions for PPF and has multiple objectives for restoration work. These objectives seek to improve vegetative conditions and may reduce the risk of uncharacteristic fire. (Annual amount of habitat improvement: Alt 2: 25,750 acres, Alt 3: 59,700 acres, Alt 4: 17,800 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the wood lily. The proposed action and alternatives maintain or improve the habitats for the lily and addresses the two primary threats to the Wood Lily, departed seral state conditions and uncharacteristic fire.
Chama Blazing Star *(Mentzelia conspicua)*	Found on the key ecosystem characteristic of gray to red shales of Mancos and Chinle soil formations in the piñon-juniper woodland. May be impacted by ground-disturbing activities within areas that contain these specific soil qualities. May also be impacted by invasive encroachment. (Potential available habitat in the Santa Fe NF: 3,195 acres. Current amount of habitat in reference condition: 2,268 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species and little guidance for avoiding or minimizing impact to isolated populations. There is also minimal direction for controlling nonnative invasive vegetation. (Annual amount of habitat improvement: 1,210 acres)	The action alternatives provide desired conditions, standards, and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. They also have numerous objectives for preventing or reducing invasive plant encroachment. Alternative 4 has the highest objectives for invasive plant control. (Annual amount of habitat improvement: Alt 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Chama blazing star. The proposed action and alternatives maintain or improve the habitats for the blazing star and provides guidance for reducing ground and soil disturbance. It also allows for invasive vegetation control which would benefit the blazing star in areas in which it is found.

Species	Habitat and Primary Threats and Issues	Alternative 1 1987 Forest Plan	Alternatives 2, 3, and 4 (Action Alternatives)	Effects Determination
Springer's blazing star *(Mentzelia springeri)*	Occurs only in the Jemez Mountains on pumice deposits. May be impacted by departed habitat conditions and ground-disturbing activities within areas that contain these specific soil qualities. May also be impacted by invasive encroachment. (Potential available habitat in the Santa Fe NF: 15,927 acres. Current amount of habitat in reference condition: 11,308 acres)	The no-action alternative allows restoration efforts but there is little guidance for addressing the impacts of ground and soil disturbance on at-risk species and little guidance for avoiding or minimizing impact to isolated populations. There is also minimal direction for controlling nonnative invasive vegetation. (Annual amount of habitat improvement: 1,210 acres)	The action alternatives provide desired conditions, standards, and guidelines in multiple resource areas that reduces the footprint of ground-disturbing activities. They also have numerous objectives for preventing or reducing invasive plant encroachment. Alternative 4 has the highest objectives for invasive plant control. (Annual amount of habitat improvement: Alts. 2, 3, and 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Springer's blazing star. The proposed action and alternatives maintain or improve the habitats for the blazing star and provides guidance for reducing ground and soil disturbance. It also allows for invasive vegetation control, which would benefit the blazing star in areas in which it is found.
Arizona willow *(Salix arizonica)*	Found only in very high elevation areas in wet open meadows and stream banks in the San Pedro Parks and Pecos Wilderness. May be impacted by departed habitat conditions, encroaching invasive vegetation, and degraded water conditions including disconnected floodplains. Can also be impacted by large-scale fires. (Potential available habitat in the Santa Fe NF: 14,119 acres. Current amount of habitat in reference condition: 5,930 acres)	The no-action alternative allows restoration efforts, but it lacks direction to prevent floodplains from being disconnected and does not have any objectives to restore areas that have already been altered. (Annual amount of habitat improvement: 1,730 acres, mostly SFF)	The action alternatives contain specific desired conditions for riparian areas (riparian management zones) as well as for water. With its emphasis to encourage human uses, Alternative 4 may not be as beneficial since it may increase human disturbance in riparian areas. (Annual amount of habitat improvement: Alt 2: 109 acres, Alt 3: 218 acres, Alt 4: 0 acres)	The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for the Arizona willow. The proposed action and alternatives maintain or improve the habitats for the willow and provides guidance on restoring the riparian vegetation and water characteristics. The increased restoration through the proposed action will also improve upland characteristics and reduce the potential for uncharacteristic fire which could impact riparian areas downgrade.

Environmental Consequences for Regional Forester's Sensitive Species – Alternative 1

The existing 1987 Forest Plan, as amended, was developed under the 1982 Planning Rule and would have impacts to sensitive species.

Key ecological conditions for sensitive species and key threats affecting those conditions are described below for all action alternatives which follows this section. Because the existing 1987 Forest Plan, as amended, was not explicitly developed using the coarse-filter, fine-filter approach (a key tenet of the species diversity requirements under the 2012 Planning Rule), alternative 1 would be largely limited to plan direction from the 1996 plan amendment, best management practices, and site-specific mitigations done at the project level.

Forested ERUs with Frequent-Fire Forest (PPF and MCD)

Primary threats common to species that use Frequent-Fire Forest include the departure of mature forest components which include the loss of, large trees and snags, down woody debris and loss of interlocking canopy which provide nesting, roosting and foraging habitat. Sensitive species that depend on fire adapted ecosystems would benefit from the 1996 plan amendment which includes standards and guidelines supporting a variety of structural stages, canopy cover, and distribution of snags, large trees, and coarse woody debris across the landscape.

Under the no-action alternative restoration work is conducted through timber and fuels management within frequent fire forested systems. Vegetative prescriptions vary tremendously by management areas. Areas with a heavy timber focus have very specific forest conditions they are trying to achieve while other areas have little to no vegetative direction at all. The current forest plan does allow for timber management and prescribed burning and promotes management to reduce hazardous fuels. Prescribed fire, using planned and unplanned ignitions, would continue to be used to enhance and accomplish resource objectives, particularly in fire dependent ecosystems. Forestry objectives under the current plan are more focused on timber production and reference practices that are less common today where focus is now on forest restoration. Although treatments will continue in both non-forested and forested ERUs, the rate of treatment often results in improvements that take in excess of 50 years (see vegetation analysis).

There are no restoration objectives in frequent-fire systems. It is unlikely ecological conditions within these systems will improve during the life of the plan. This will continue to negatively affect multiple ecological conditions within frequent-fire forested systems and potentially decrease the viability of sensitive species found within.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the sensitive species (i.e., Arizona willow, Chaco milkvetch, Chama blazing star, Greene's milkweed, Heil's alpine whitlowgrass, Pecos fleabane, Pecos mariposa lily, robust larkspur, Springer's blazing star, tufted sand verbena, wood lily, yellow lady's slipper), viability is unlikely to be maintained for each of these species dependent on Frequent Fire Forest communities under the no-action alternative. While individual animals could be impacted by the actions under this alternative, **the alternative may lead toward Federal listing of the above sensitive species.**

High-Elevation Forest (SFF, MCW) and Woodlands (PJO, PJS, PJG, JUG)

Primary threats common to these species that use High-Elevation Forest and Woodlands include the mature forest components which include the loss of large trees and snags, down woody debris, and loss of interlocking canopy which provides nesting, roosting, and foraging habitat. These species would benefit from desired conditions, standards, and guidelines that promote the retention of these features at different spatial scales across the landscape. Plan components for High-Elevation Forest and Woodlands would mitigate those risks.

Under the no-action alternative, there is little direction for restoration work within high-elevation forests and woodlands. Vegetative prescriptions vary tremendously by management areas. Most high-elevation forest and woodland systems have low to moderate departures from desired conditions, so there are no treatment objectives for these vegetation communities (see vegetation section). It is expected habitat condition would remain the same.

The current forest plan, as amended, does provide guidance for individual sensitive species, or requires protection for sensitive species that are addressed outside the plan through site-specific best management practices. For example, there is existing guidance for peregrine falcon to limit disturbance for essential nesting habitat and timing restrictions during the breeding season.

Fuelwood collection could impact sensitive species within these areas. Fuelwood is managed through the permit system in the forest. Allotted cords per year could be directed to areas to lessen the impact on sensitive species.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the above species, viability would be maintained for each of the sensitive species dependent on High-Elevation and Woodland communities under the no-action alternative. While individual animals could be impacted by the actions under this alternative, **the alternative would not lead toward Federal listing of the above sensitive species.**

Grasslands and Non-Forested ERUs (ALP, CPGB, MSG, SAGE)

Primary threats common to species that use Grasslands and other Non-Forested ERUs include conversion of grasslands to a higher woody component, invasive species encroachment, and inappropriate grazing practices.

The current plan has limited direction related to features needed by sensitive species that depend on Alpine and Tundra, grasslands, meadows, and sagebrush. These species and features are indirectly affected by standards and guidelines for recreational uses and Sustainable Rangelands and Livestock Grazing. Their main protection is the requirements to protect sensitive species which are addressed outside the plan and through site-specific best management practices. The quantity and quality of these ecosystems and associated habitat is not expected to change under the current forest plan. Specific guidance for sensitive species in these areas is provided but limited. For example, existing plan direction requires prairie dogs to be managed for viable populations on the Caja; however, there is no mention of disease, which is the species' primary limiting factor. There is no mention of white-tailed ptarmigan or other species dependent upon these systems.

Sensitive plant species (ex. Heil's alpine whitlowgrass and Pecos fleabane) found within non-forested vegetation which rely on soil moisture or rocky substrates would be provided through understory components specified through the 1996 plan amendment. The current plan also directs management to adhere to the Arizona Willow Conservation Agreement.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the above species, viability would be maintained for each of these species dependent on grasslands and non-forested vegetation systems under alternative 1. While individual animals could be impacted by the actions under this alternative, **the alternative would not lead toward Federal listing of the above sensitive species.**

Riparian and Aquatic Habitats

Primary threats common to species that use riparian areas and other aquatic habitats include out-of-reference vegetative conditions, altered water characteristics (e.g., temperatures, dissolved oxygen, flow, turbidity), invasive vegetative encroachment, and nonnative species predation and competition. Another effect to riparian and aquatic-dependent species is post-fire conditions. Post-fire conditions can affect downstream species populations. During storm events on recently burned areas, large quantities of sediment are frequently loaded into streams. When soil stability is impacted by fires, the increased sediment load can cover substrate, decrease pool depth, diminish suitable spawning habitat, and reduce fitness by decreasing the nutritional value of the food base.

Under the no-action alternative, there is some guidance for appropriate composition and structure within riparian areas. For example, a standard requires shrub and tree cover along bank lengths that is 80 percent of natural levels. While another standard requires at least three age classes of riparian trees and shrubs, with at least 10 percent of the cover in the seedling sapling stages and 10 percent in the mature and overmature stage. Where this alternative is lacking, however, is in objectives to begin trending toward desired conditions. Alternative 1 includes management objectives for rangeland, stream channel, aquatic habitat, and riparian area conditions, but does not contain components which direct restoration of these areas. In riparian areas where vegetative composition and structure (seral state) is not in reference condition sensitive species may not be able to forage, find protect cover, or move about their habitat as needed to secure basic life-cycle needs. Out-of-reference seral state within riparian areas will also negatively impact soil and water characteristics (e.g., temperature, flow, nutrient load) and may cause declines in aquatic species reliant upon those characteristics. Due to its lack of restoration objectives, it is unlikely ecological conditions within riparian areas will improve during the life of the plan. This will potentially decrease the viability of sensitive species dependent upon those conditions.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the above species, viability is unlikely to be maintained for each of these species dependent on riparian and aquatic habitats under the no-action alternative. While individual animals could be impacted by the actions under this alternative**, the alternative may lead toward Federal listing of the above sensitive species.**

Recommended Wilderness

If ecological conditions necessary for the viability of sensitive species are present, recommended wilderness often lessens the human-caused impacts on those same species since less human disturbance occurs and impacts from large-scale management decrease. Alternative 1 recommends 1,853 acres of recommended wilderness. This comprises 0.12 percent of the forest and will not substantially increase viability for species within those areas.

Environmental Consequences for Regional Forester's Sensitive Species Common to Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 are more strategic in nature and integrated than the current forest Plan, as amended (alternative 1). These alternatives include plan direction designed to maintain the diversity of plant and animal communities and support the persistence of native species within the plan area, subject to the extent of Forest Service authority and the inherent capability of the plan area.

Substantive differences among alternatives 2, 3, and 4 include objectives for ecological restoration in both forested and non-forested ERUs, the role of mechanical treatments and wildland fire as restoration tools, the amount of riparian/aquatic systems restored, and the amount of recommended wilderness being proposed. Current science recognizes both wildland fire and vegetation management as tools through which ecological integrity and resilience can be managed. These alternatives proactively incorporate this thinking and would provide for a substantial increase in both prescribed fire and unplanned natural ignitions that are managed for resource benefits. This would have positive effects for species that use Frequent-Fire Forest as well as riparian and aquatic associated species by decreasing the chance for stand-replacing wildfires, and thereby decreasing sedimentation from fire flood events.

Another substantive difference is the addition of fine-filter plan components that address species needs when coarse-filter (ecosystem level) plan components do not adequately provide for all their needs. These plan components are written in such a way that they benefit a multitude of species. Alternatives 2, 3, and 4 also make better use of partnerships and collaboration to maintain ecosystem integrity and resilience than the current forest Plan (alternative 1).

Forested ERUs with Frequent Fire Forest (PPF and MCD)

Primary threats common to species that use Frequent-Fire Forest include the mature forest components, which include the loss of large trees and snags, down woody debris and loss of interlocking canopy that provide nesting, roosting and foraging habitat.

Vegetative desired conditions for appropriate seral state distributions for each ERU can be found in the Plan (which is the proposed action, alternative 2). In addition to desired conditions there are large-scale vegetation objectives as well as standards and guidelines in the Timber and Range sections that are designed to move toward those conditions. Desired conditions define specific seral state conditions within each forested ERU. Alternative 2 sets a maximum objective within MCD and PPF of 280,000 to 350,000 acres of restoration work to be completed respectively, over a 10-year period. Alternatives 3 and 4 have varying acreages of restoration objectives based on the type of treatments applied (prescribed fire or mechanical). These objectives would help increase the rate at which desired conditions are achieved and ultimately improve conditions for the sensitive species reliant upon appropriate seral state conditions. Alternatives 2, 3, and 4 also provide desired conditions that define specific snag densities within each forested ERU; this includes specific measures of snags per acre. Since snag densities are currently at or near desired conditions, this objective would serve to maintain current conditions.

In summary, objectives and guidelines within alternatives 2, 3, and 4 would improve seral state condition in ERUs containing sensitive species, positively affecting multiple ecological conditions directly linked to seral state and potentially benefit numerous sensitive species found within.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the above species, viability would be maintained for each of these species dependent on Frequent-Fire Forest communities under the action alternatives. While individual animals could be impacted by the actions under these alternatives, alternatives 2, 3, and 4 **would not lead toward Federal listing of the above sensitive species.** Beneficial impacts would include improvements in ecological conditions for foraging, breeding, and dispersal.

High-Elevation Forest (SFF, MCW) and Woodlands (PJO, PJS, PJG, JUG)

Primary threats common to species that use High-Elevation Forest and Woodlands include the mature forest components that include the loss of large trees and snags, down woody debris, and interlocking canopy, which provide nesting, roosting, and foraging habitat.

Alternatives 2, 3, and 4 set objectives to restore a maximum of 50,000, over 300,000, and over 120,000 acres of wildlife habitat in Woodlands over a 10-year period, respectively. There are also timber objectives within woodland systems that promote the collection of fuelwood. These objectives would help increase the rate at which desired conditions are achieved and ultimately improve conditions for the sensitive species reliant upon appropriate seral state conditions. This would increase the viability of species that are negatively impacted by out-of-reference seral state conditions.

Alternatives 2, 3, and 4 also provide desired conditions that define specific CWD loads and snag densities within each forested and woodland ERU. This includes specific measures of tons of CWD per acre and snags per acre. They also set varying objectives for restoration work to be completed over a 10-year period that can be applied in these forest and woodland types. Since CWD loads and snag densities are currently at or near desired conditions, this objective would serve to maintain current conditions.

In summary, objectives and guidelines within alternatives 2, 3, and 4 would improve seral state condition in ERUs containing sensitive species. This would positively affect multiple ecological conditions directly linked to seral state and potentially benefit numerous sensitive species found within.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the above species, viability would be maintained for each of the sensitive species dependent on High-Elevation and Woodland communities under alternatives 2, 3, and 4. While individual animals could be impacted by the actions under these alternatives, **these alternatives would not lead toward Federal listing of the above sensitive species.**

Grasslands and Non-Forested ERUs (ALP, CPGB, MSG, SAGE)

Primary threats common to species that use Grasslands and other Non-Forested ERUs include conversion of grasslands to a higher woody component, invasive species encroachment, and inappropriate grazing practices.

Alternative 2 sets an objective of at least 2,500 to 50,000 acres of restoration work to be completed over a 10-year period within non-forested ERUs. Alternatives 3 and 4 have increasing acreages of restoration objectives based on the type of treatments applied (prescribed fire or mechanical). There is also an objective to restore 50,000 acres of wildlife habitat in that same time period that can be applied in these areas. These objectives will help increase the rate in which desired conditions are achieved and ultimately improve conditions for sensitive species reliant upon appropriate seral state conditions. This would increase the viability of species that are negatively impacted by out-of-reference seral state conditions.

Alternatives 2, 3, and 4 also set objectives for the eradication or suppression of invasive species. These alternatives have varying acreages of eradication objectives based on the type of treatments applied. Eradicating or suppressing invasive vegetation encroachment within ERUs would ensure the viability of species that are impacted by invasive encroachment and are dependent upon appropriate ecological conditions.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the above species, viability would be maintained for each of the sensitive species dependent on Grasslands and Non-Forested ERUs under alternatives 2, 3, and 4. While individual animals could be impacted by the actions under these alternatives, alternatives 2, 3, and 4 **would not lead toward Federal listing of the above sensitive species.**

Riparian and Aquatic Habitats

Primary threats common to species that use Riparian areas and other aquatic habitats include out-of-reference vegetative conditions, altered water characteristics (ex. temperatures, dissolved oxygen, flow, turbidity), invasive vegetative encroachment, and nonnative species predation and competition. Another effect to riparian and aquatic dependent species is post-fire conditions. Post-fire conditions can affect downstream species populations. During storm events on recently burned areas, large quantities of sediment are frequently loaded into streams. Once in the watershed, the increased sediment load can cover substrate, decrease pool depth, diminish suitable spawning habitat, and reduce fitness by decreasing the nutritional value of the food base.

Riparian areas are specifically addressed in alternatives 2, 3, and 4. In addition to riparian areas having their own specific desired conditions, the Aquatic Species and Habitat section also describes in detail how these areas should look, function, and be restored. Although plan components specifically addressing vegetation within riparian areas are typically found in the Riparian Management Zone and Aquatic Species and Habitat sections, they can also be found in Vegetation, Forestry, Water, At-Risk Species, Range, and Roads sections.

Alternative 2 provides desired conditions that define specific conditions as they pertain to riparian areas and sets an objective of restoring the composition and structure of 15 miles of stream every 10 years as well as 30 miles of aquatic habitat projects every 10 years. Alternatives 3 and 4 have varying lengths of stream mile objectives, commensurate with their focus. Standards and guidelines also direct activities to restore composition and structure within riparian areas. Restoring composition and structure within riparian areas would effectively reconnect floodplains and would increase viability of species that are dependent upon those ecological conditions. If seral state conditions are restored sensitive bird and mammal species would be able to forage, find protective cover, or move about their habitat as needed to secure basic life-cycle needs. The improved seral state conditions within riparian areas would also improve soil and water characteristics and increase the viability of sensitive plants and aquatic species that are dependent upon those conditions.

In summary, objectives and guidelines within alternatives 2, 3, and 4 will improve seral state condition in riparian areas. This will positively affect multiple ecological conditions required by sensitive bird, mammal, and aquatic species.

Determination: Based on the analysis of plan components and the amount of habitat provided for each of the above species, viability would be maintained for each of the sensitive species dependent on Riparian areas under alternatives 2, 3, and 4. While individual animals could be impacted by the actions under these alternatives, alternatives 2, 3, and 4 **would not lead toward Federal listing of the above sensitive species.**

Recommended Wilderness

If ecological conditions necessary for the viability of sensitive species are present, recommended wilderness often lessens the human-caused impacts on those same species since less human disturbance occurs and impacts from large-scale management decrease. Recommended wilderness is provided in two of the action alternatives. Alternative 2 recommends 25,868 acres of recommended wilderness. This comprises 1.67 percent of the forest and will not substantially increase viability for species within those areas. Alternative 3, however, recommends 270,130 acres, which represents 17.48 percent of the forest. Due to the added protections, this may increase the viability of sensitive species within those areas.

Summary of All Alternatives for Regional Forester's Sensitive Species

Alternatives 2, 3, and 4 would maintain viability of sensitive species (within the authority of the Forest Service); however, the rate and magnitude of change to wildlife ecological condition varies. Alternative 1 (the 1987 forest Plan) is limited in terms of its ability to positively affect species viability because it lacks clear desired conditions and guidelines developed using the best available science; it does not reflect the most current advances in scientific understanding and changes in social, economic, and ecological conditions that have occurred since it was signed and it is the least able to adapt to changing conditions. Alternative 1 also lacks forestwide language that directly addresses the significant threats of disease and invasive, nonnative animals, connectivity, altered hydrology, and restricted and endemic species that are naturally rare. Overall, this alternative would realize the least amount of restoration progress for the most wildlife species compared to the other alternatives. At best, species viability would be maintained for some sensitive species, but ecosystem recovery would be on a slower trajectory than for the action alternatives for most species.

Alternative 2 focuses on striking a balance between natural processes and human uses. This alternative has more clearly defined plan components than alternative 1 to better address wildlife species needs at multiple spatial scales. Under this alternative, species are generally protected through specific vegetation community, watershed, and management area direction. However, in some cases there is additional species-specific direction that provides even more emphasis and protection for sensitive species. Alternative 2 has the greatest ability for maintaining species persistence over time for the majority of species. This alternative, with balanced applications of prescribed fire and mechanical treatments, would move departed ecological condition of both forested and non-forested ERUs toward desired condition the fastest. Riparian conditions would also improve due to multiple objectives to restore composition and structure within those systems.

Alternative 3 would move ecological condition in forested and non-forested ERUs toward desired conditions faster than alternative 2 due to higher acreages that can be treated by prescribed fire. However, alternative 3 increases the risk of uncharacteristic fire and therefore the faster gains are counterbalanced with the additional risks of fire. Riparian and aquatic ecological conditions would move toward desired conditions at a faster rate than alternative 2 because restoration objectives increase substantially. Recommended wilderness within this alternative may increase the viability of sensitive species within those areas.

Alternative 4 would move ecological condition in forested and non-forested ERUs toward desired conditions slower than alternatives 2 and 3 due to lower acreages that can be treated by mechanical treatments. However, alternative 3 increases the amount of ground and soil disturbance as well as intrusive human activities. Therefore, gains in sensitive species protection and management are less than in alternatives 2 and 4. Riparian and aquatic ecological conditions would move toward desired conditions at a slower rate than alternatives 2 and 3 because restoration objectives decrease. The increased human-uses within this alternative also counterbalances gains made in riparian restoration.

3.5.4.5 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) enacted in 1918 established Federal prohibition, unless permitted by regulations, for "taking" of migratory birds, nest or eggs. Executive Order (EO) 13186 signed January 10, 2001 directed Federal agencies to avoid or minimize adverse impacts (to the extent practical) on migratory bird resources when conducting agency actions (among many items within the "Federal Agency Responsibilities" section of the EO. Pursuant to the EO, agencies were to develop Memorandum of Understanding (MOU) to strengthen and promote migratory bird conservation and collaboration with the U.S. Fish and Wildlife Service. The original 2008 MOU was extended and signed in 2016.

The Bald and Golden Eagle Protection Act (1940 as amended) protects eagles from actions of anyone (or entity) which would "take" eagles to the point of causing nest failure or reduce productivity (unless you or your entity have obtained a permit issued by the Secretary of the Interior).

High Priority Species – given the multitude of objectives, standards, and guidelines within the action alternatives that seek to move ERUs toward desired conditions and improve ecological conditions, viability of migratory birds should increase. Alternatives 2 and 3 provide the most improvements, followed by alternative 4.

Important Bird Areas (IBAs) – there are two IBAs within or near the forest including Chama River Gorge/Golondrino Mesa and the Caja del Rio. Ecological conditions within these IBAs would improve under alternatives 2, 3, and 4. The Caja del Rio IBA will receive added protections in alternative 2 as a designated management area with a focus on wildlife. This will decrease intrusive human activity and increase viability of birds within this IBA. The four IBAs surrounding the forest will not be negatively impacted by the action alternatives.

Over-Wintering Areas – given the multitude of objectives, standards, and guidelines within the action alternatives that seek to move ERUs toward desired conditions and improve ecological conditions, over-wintering areas of migratory birds should not be impacted.

Summary: The proposed action and alternatives **may affect individuals, but are not likely to result in a trend toward Federal listing or loss of viability** for migratory birds. The proposed action and alternatives maintain or improve the habitats for migratory birds and provides guidance for reducing impacts to ecological conditions required by migratory birds.

3.5.4.6 Cumulative Environmental Consequences for Wildlife, Fish, and Plants

To compare the effects of Santa Fe NF proposed management to the surrounding landscape, cumulative effects are evaluated considering the management actions of other entities of a similar planning scope within a relevant spatial and temporal context. The analysis area for wildlife includes the Santa Fe NF, relevant portions of New Mexico Department of Game and Fish, and Northern Region and Bird Conservation Regions 16 (Southern Rockies/Colorado Plateau). This encompasses the counties immediately adjacent to and/or surrounding the Santa Fe NF and is of a spatial extent that should account for effects on wide-ranging species such as big game and migratory birds: animals that can travel across numerous land jurisdictions. The analysis area encompasses similar habitat types as identified in the proposed action area and reflects similar ecological settings that wildlife species referenced in this report could or would use. These effects were evaluated for the life of the forest plan, approximately 10 to 15 years.

Forest Vegetation Systems

On all managed lands within the cumulative effects analysis area, past management actions, particularly timber harvest and fire suppression, have altered stand structure, composition, function, and connectivity of vegetation communities, particularly in valley-bottoms that were readily accessible and are now in the wildland-urban interface (***WL12-23***). This resulted in loss of habitat for species particularly within ponderosa pine forests and persistent piñon juniper woodlands and created additional habitat for species associated with grasslands or hay fields. In the future, increased urbanization and population growth of communities within and surrounding the Santa Fe NF is expected to lead to increases in forest land clearing and conversion of habitat on private lands; increased loss of open space and loss of connectivity due to development of agricultural lands; and greater need for structure protection with fewer firefighting resources available for other suppression activities. In the future, the development of private property has the potential to increase the disturbance or displacement of those species that are sensitive to human disturbance. For some species, private land development may cause them to shift habitat use to undeveloped lands in the BLM, the Forest, other private timberlands, or State lands. As a result of a growing human population, higher levels of recreational use (both motorized and non-motorized) in areas that previously had low levels of use could also affect species that are sensitive to disturbance during certain times of the year (***WL51-54, WL57-61, WL64-67***).

Timber harvest, fire suppression, thinning, planting, and wildfires are the past activities that have had the greatest influence on the amount and distribution of forested habitat on NFS lands as well as BLM, state, and private timber lands (***WL7***). These activities have created a variety of successional stages, structures, tree species mixes, and forest patterns that have been neutral for some wildlife species, beneficial to some wildlife species, and detrimental to others.

In the future, fuels reduction activities may occur on all land ownerships, particularly in the wildland-urban interface near private residences. In the past, decades of very active fire suppression led to a build-up of fuels at the same time as more people moved into areas adjacent to and intermingled with NFS lands on the Santa Fe NF. Fire suppression in the frequent-fire forest community (e.g., MCD, PPF), in particular, has changed stand structure and led to increased tree densities in forests that were historically more open. In western forests where fire is a dominant disturbance process, restoring a more open understory while maintaining a cohort of trees of large and very large diameter in perpetuity may be an appropriate method for achieving objectives related to wildlife and fire resiliency.

In the future, timber harvest occurring on private, state, BLM, or NFS lands may cumulatively affect the quantity and quality of wildlife habitat. The effects to wildlife are difficult to predict because they would depend on a wide variety of factors (e.g., whether habitat that is outside of historical conditions is restored, where wildfires and infestations of insects or diseases occur, the type and location of vegetation treatments). If harvesting moves vegetation toward desired conditions for wildlife, the effects would be beneficial. This could result in better retention of very large size class trees. In the wildland-urban interface, pre-commercial thinning, timber harvest, and prescribed burning would reduce stand densities, would increase survival of retained trees, and could increase the rate at which very large trees develop (***WL18***). On managed lands, active vegetation restoration actions could mimic natural disturbances in areas where natural disturbances are not compatible with multiple-use objectives of the forest plan or the objectives of other landowners.

Outside the wildland-urban interface, particularly in high-elevation forest communities, vegetation management standards promote the development of forests in the large and very large size classes containing spruce and subalpine fir in multistoried stands with a dense understory. These forests would be more susceptible to wildfire and would be likely to have higher levels of mortality due to insects and disease (especially for very large Douglas-fir and spruce) (***WL62***). The trend of loss of old-growth forest and the very large size class due to wildfire is likely to continue on all lands in these forest types in the future. The desired conditions for vegetation in the Forest Plan would maintain or improve the diversity of forested habitats on the Santa Fe NF.

Habitat conditions associated with snow that persists through the spring were not a concern in the past but have become a concern in recent decades due to changes in the timing of snowmelt that have been documented worldwide and in areas of the Santa Fe NF. The most important climate change predictions for this group of species are that the mean monthly minimum temperature (spring and autumn) and the mean monthly maximum temperature (winter) may rise above freezing more months out of the year. Seasonal precipitation is projected to be slightly higher in winter and spring. The combination of these two factors may be beneficial, neutral, or detrimental to these habitats, depending upon whether more precipitation falls as rain or as snow and at what elevations. If the temperature in winter or spring rises above freezing for a more prolonged period of time, snow will not persist as long. However, if increased precipitation falls as snow at high elevations, this could offset the increased melting.

Overall cumulative environmental effects of proposed management under all alternatives in the context of the larger landscape would contribute to the movement of vegetation toward desired conditions, and therefore, would improve ecological condition for wildlife species. Proposed management would contribute to landscape restoration, control of invasive species, a reduction in uncharacteristic wildfire across the broader landscape, and the resiliency and adaptability of vegetation communities to climate change. However, the landscape has become more fragmented because of activities that include urban development, ranching, and fire suppression. As a result, there has likely been a net loss of intact, potential habitat and an increased risk to viability for wildlife on adjacent lands; this trend is expected to continue in the future. Therefore, the Santa Fe NF will play an increasing role in the conservation of these habitats and associated wildlife species on national forest lands.

Non-Forested Vegetation Systems

Grass/forb/shrub habitats have shifted from where they occurred historically and are anticipated to continue to shift over time as human settlement and climate conditions change. In the distant past, Native Americans used prescribed fire to create and sustain persistent grass/forb/shrub habitats, especially in valley bottoms in the warm-dry and warm-moist vegetation types where some key wildlife species spent the winter. Subsequently, most valley bottom lands were converted to human developments or agricultural lands. If properly managed, livestock grazing is compatible with maintenance of grass/forb/shrub habitats. Some wildlife species have adapted to these changes and now use agricultural lands that provide grasses and forbs. Even where forested lands were not permanently converted to developments, wildfire exclusion has resulted in succession of grass/forb/shrub habitats, especially adjacent to communities (***WL12-23***).

Riparian and Aquatic

Historically, much of the private land in the valley bottoms of the Santa Fe NF was cleared for grazing and farming, reducing native riparian vegetation but maintaining open space used by wildlife.

Private land then became more valuable for residential and commercial development, resulting in less open space and less wildlife habitat for many species, especially along streams (***WL39-40***). This reduces the habitat connectivity in and between riparian areas and upland areas. Developments may also increase human disturbance or loss of wildlife due to vehicle collision as animals move from aquatic and riparian habitats to upland areas. In the future, loss of habitat associated with human developments on some private lands is likely to continue and may increase as the human population within and surrounding the Santa Fe NF grows (***WL43-46, WL77-82***).

Historically, wildfires were instrumental in slowing upland species encroachment and maintaining dense riparian shrub and deciduous tree communities, but the development of river valleys and adjacent private uplands has placed a high level of emphasis on fire suppression (***WL21***). As more people inhabit areas in and adjacent to riparian areas, there may be more clearing of fuels including riparian species for fire protection on private, NFS, BLM, or state lands. Drought, disease, insects, and/or wildfires may continue to have effects on riparian wildlife habitat on all lands (***WL62-63***).

Introduction of aquatic invasive species or contaminants in waterbodies resulting from recreational, agricultural, or industrial activities may have negative impacts on species associated with aquatic, wetland, and/or riparian habitats. The potential for introduction of disease and aquatic nuisance species exists on all lands within the cumulative effects analysis area, often as an indirect result of water-based recreation (***WL45-46***). Many management agencies have increased inspections and public education efforts in recent years to reduce these risks.

All Vegetation

Similar forest planning efforts are under way in three neighboring forests—the Rio Grande, Cibola, and Carson NFs. The Carson and Cibola National Forests are revising their land management plans (LMPs) in close coordination with the Santa Fe NF and efforts were made to foster cross-plan consistency where possible during plan development. The plans are based upon the same regional vegetative desired conditions, standards, and guidelines, for Ponderosa Pine and Mixed Conifer. The cumulative restoration activities from the action alternatives from these plans could have a pronounced effect on modifying stand structure to be less susceptible to stand-replacing fire in these vegetation types, while promoting resiliency with regard to climate change (***WL12-23***). Collectively, the net result of these revised LMPs should be positive and beneficial for wildlife species by ensuring the persistence of these habitats into the future and by providing continuity of suitable habitats. This should decrease the overall risk to species viability.

The action alternatives strive to create and maintain natural communities and habitats in the amounts, arrangements, and conditions capable of supporting viable populations of existing wildlife species within the planning area, while contributing to broader landscape-scale initiatives where appropriate. As such, species would be better distributed throughout their natural potential range. The adaptive management process and collaborative efforts with partners should also help to inform and realize these conditions on the ground.

Wildlife, Development, and Connectivity

Some wildlife species are especially at risk regarding development. For example: birds, bats, and wide-ranging species can be affected by transmission lines, turbines, roads, and other activities associated with renewable energy infrastructure (***WL64-67***). These types of activities, which occur on lands of different ownerships and jurisdictions, are anticipated to increase in the future. On the Santa

Fe NF, proposals for development would be dealt with on a case-by-case basis through special uses and the permitting process.

Blasting of cliffs or rock may occur in the future in relation to activities such as widening of highways, but the value of cliffs in providing habitat for bats and other cave-associated species is recognized, so the risk of cliff habitat loss is very low (***WL51***). There have been very few past impacts to high-elevation talus and boulder habitats in the forest because they are generally within wilderness and inventoried roadless areas.

Caving and rock-climbing are popular recreational activities in some areas and may increase in the future, but these activities require specialized training and/or equipment and they are not likely to increase as rapidly as other types of recreation. Recreational cave and mine exploration on all land ownerships can lead to an increased rate of the spread of diseases such as white-nose syndrome. There is a decontamination protocol in place for cavers on NFS lands, which should aid in slowing the spread on NFS lands, but diseases may continue to be spread elsewhere. Because both people and bats may carry diseases and travel long distances, disease can be spread across a wide area. Disease control requires a cooperative effort. Multiple agencies are monitoring bats, which will help support adaptive management and response to outbreaks (***WL51***).

In the past, many miles of road were built to access Federal, State, and private lands. Forest roads have resulted in direct loss of habitat for some wildlife species. For example, roads have made adjacent areas more accessible for removing gathered firewood, and the impact is greatest near communities (***WL70-71, WL82-83***). Forest roads have also increased human disturbance to some wildlife species. Many miles of forest roads have been decommissioned, closed with gates or berms, or rehabilitated in the last few decades. This has reduced the motorized access for legal hunting and trapping of some wildlife species, the mortality of some species, and the disturbance or displacement of some species. As on NFS lands, effects to wildlife associated with human use of roads will continue on other lands in the future. Administrative use of roads closed to the public, that otherwise may have little effect on wildlife, increases during emergency response situations, such as wildfire response, and during timber harvest preparation and implementation. Animals are likely to continue to be killed by vehicle collisions on highways surrounding the Santa Fe NF (***WL72-75***).

In the past, the invasion of forest lands by nonnative species has occurred due to a variety of activities, including road building, timber harvest, livestock grazing, and recreational activities (***WL74***). Multiple agencies, counties, and private organizations are involved in educating the public on the importance of preventing the spread of nonnative species, and many agencies engage in management actions to prevent or control infestations.

Existing collaborations between the forest and its partners generally encourage the protection of open lands and the preservation of the land's natural character within local and regional contexts. Cumulatively, these strategies should decrease the potential for future land fragmentation, while improving the overall integrity of the landscape. This should also provide for more resilience regarding climate change for those wildlife species that may need to adjust migration routes, foraging corridors, or breeding grounds.

Climate Change

In general, most climate modelers agree that the Southwest is trending toward prolonged drought. Future potential ecological effects in the Southwest may include an increase in more intense disturbance events such as wildfires, monsoons, and wind. Changing ecological conditions could provide greater opportunities for invasion by nonnative species and disease with the potential to negatively impact various species (***WL62-63***). General trends toward decreased moisture could limit overall forest productivity and associated changes in vegetation patterns could affect overall distribution and range of plant and animal species. Cumulatively these factors would likely impact biodiversity, however, to what extent is currently uncertain.

Summary

In summary, these cumulative effects, when combined with the preferred alternative, are expected to be beneficial for wildlife by providing more collaborative opportunities through partnerships and better coordination across the landscape. Alternatives 2 through 4 would have similarly positive effects. Alternative 1 (no action) would make the least contribution to cumulative wildlife benefits.

3.6 Soils

This section analyzes the soil resource by describing the current soil condition and projected trends in soil condition by alternative. It also describes the potential effects to soil conditions associated with management activities.

The Santa Fe NF uses soil condition as a descriptive indicator of general soil health. Soil condition is based on the primary soil functions of soil hydrology, soil stability, and nutrient cycling. The current soil condition rating is based on how departed soils are from the reference condition. The projected trends in soil condition are based on estimates of vegetative ground cover, soil productivity, and organic matter.

3.6.1 Affected Environment

Soils are a complex and dynamic system that consists of a mineral component, organic matter, air, water, and various soil organisms resulting from interactions between parent material, climate, topography, and organisms throughout time and space. Soils store water, supply nutrients for plants, and provide a medium for plant growth. Soils also provide habitat for a diverse number of belowground organisms. Due to their slow rate of formation, soils are essentially a non-renewable resource.

Soils are described, characterized, and classified in Terrestrial Ecosystem Survey of the Santa Fe NF (Miller et al. 1993). Ecological map units are created for soils based on the climate, vegetation, geology, and landforms of the forest. The forest uses ground cover and vegetation canopy cover for each mapping unit to establish a resource value rating for soil and plant health for many management activities (e.g., analysis and monitoring of restoration treatments and grazing allotment management). The Terrestrial Ecosystem Survey is expected to be updated in the next 10 to 15 years.

Soils of the Santa Fe NF are highly variable ranging from shallow to deep, fine to loamy, and skeletal (over 35 percent of soil volume contains rocks) to non-skeletal. They occur on all slopes ranges from nearly level to very steep. The parent material types include igneous (e.g., granite, tuff), metamorphic (e.g., gneiss) and sedimentary (e.g., sandstone, siltstone). Soils developed in parent material such as andesite and basalt tend to have more clay content because these parent materials are high in clay-forming minerals. Conversely, soils formed from rhyolite and tuff parent materials are lower in clay content since these parent materials have a lower percentage of clay-forming minerals. Sedimentary limestone and dolomite parent materials result in the presence of calcareous soils.

3.6.1.1 Soil Condition

Soil condition is an evaluation of soil quality based on an interpretation of factors that affect vital soil functions. Soil quality is the capacity of the soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health (Doran and Parkin 1994).

Soil condition is based on three soil functions: (1) the ability of the soil to resist erosion, (2) the ability of the soil to infiltrate water, and (3) the ability of the soil to recycle nutrients. Soil condition provides an overall picture of soil health vital in sustaining ecosystems. Soil condition rates soils as they currently exist, and reflects the effects of management and disturbance history—soils were generally assumed to be in satisfactory soil condition under reference conditions.

The Terrestrial Ecosystem Survey identifies soil condition by ecological map unit and predicted soil loss. Current soil condition in this assessment reflects conditions from 1993, when the Terrestrial Ecosystem Survey was published. Since then, significant changes have occurred across the landscape because of natural disturbances (e.g., fire and drought), management (e.g., timber), and human-caused disturbance (e.g., user-created trails). Satisfactory soil conditions have likely decreased, and unsatisfactory conditions have likely increased, in areas where disturbances have occurred.

Soil Condition Categories

The Santa Fe NF encompasses a broad range of ecosystems. These ecosystem types are mapped using the ecological response unit (ERU) framework. ERUs are mapped ecosystem types that are based on biophysical themes that represent the range of conditions that exist under natural disturbance regimes. Each ERU is assigned a soil condition category which is an indication of the status of soil functions for that area. Soil condition categories reflect soil disturbances resulting from management or natural and human caused disturbances. Current management activities provide opportunities to maintain or improve soil functions that are critical in sustaining soil productivity. The following is a brief description of each soil condition category:

- **Satisfactory:** Indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of soil to maintain resource values and sustain outputs is high.
- **Impaired:** Indicators signify a reduction of soil function. The ability of soil to function properly has been reduced or there exists an increased vulnerability to degradation. An impaired rating should signal to land managers a need to further investigate the ecosystem to determine causes and degrees of decline in soil functions. Changes in management practices or other preventative actions may be appropriate.
- **Unsatisfactory:** Indicators signify that loss of soil function has occurred. Degradation of vital soil functions results in the inability of soil to maintain resource values, sustain outputs, and recover from impacts. Soils with an "unsatisfactory" rating are candidates for improved management practices or restoration designed to recover soil functions.
- **Unsuited:** Areas rated unsuited are those where geologic erosion rates are greater than soil formation rates (naturally erodible). Soils are inherently unstable and may occur on steep slopes. These soils are generally associated with badlands and other miscellaneous areas.

Currently, approximately 77 percent of the Santa Fe NF is rated in satisfactory soil condition, 18 percent unsatisfactory and 5 percent unsuited (table 76) (Miller et al. 1993). Most areas that currently have an unsatisfactory soil condition would most likely have historically been in a satisfactory soil condition.

Table 76. Soil condition class percentages[20] for each ERU in the Santa Fe NF

ERU Code	ERU Name	Satisfactory	Impaired	Unsatisfactory	Unsuited
	Upland ERUs				
ALP	Alpine and Tundra	16%	0%	84%	0%
CPGB	Colorado Plateau/Great Basin Grassland	71%	0%	29%	0%
JUG	Juniper Grass	55%	0%	7%	38%
MCD	Mixed Conifer - Frequent Fire	90%	0%	10%	0%
MCW	Mixed Conifer w/Aspen	100%	0%	0%	0%
MSG	Montane/Subalpine Grassland	87%	0%	13%	0%
PJG	PJ Grass	25%	0%	52%	23%
PJS	PJ Sagebrush	19%	0%	55%	26%
PJO	PJ Woodland	57%	0%	30%	13%
PPO	Ponderosa Pine Forest	74%	0%	25%	1%
SAGE	Sagebrush Shrubland	27%	0%	73%	0%
SFF	Spruce-Fir Forest	100%	0%	0%	0%
	Riparian ERUs				
R1900	RMAP Herbaceous	100%	0%	0%	0%
R2300	RMAP Narrowleaf Cottonwood/Shrub	96%	0%	2%	2%
R2600	RMAP Rio Grande Cottonwood/Shrub	93%	0%	5%	2%
R2800	RMAP Upper Montane Conifer/Willow	96%	0%	4%	0%
R2900	RMAP Willow - Thinleaf Alder	92%	0%	5%	3%
R3500	RMAP Ponderosa Pine/Willow	59%	0%	41%	0%

Eight of the 11 upland ERUs have a majority of satisfactory soil conditions. These ERUs are spruce-fir forest, ponderosa pine forest, pinon-juniper (PJ) woodland, montane/subalpine grassland, mixed conifer w/aspen, mixed conifer—frequent fire, juniper grass, and Colorado Plateau/Great Basin grassland. All of the riparian ERUs have a majority of satisfactory soil conditions (6 out of 6). The most productive soils (satisfactory soil condition) are within ERUs that produce high amounts of organic matter to ensure stability of the soil and support nutrient cycling. Soil organic matter generates numerous benefits for the soil resource including; improving water infiltration, soil aeration, and water holding capacity. Organic matter is an energy source for microorganisms and supplies nutrients for plant growth (Magdoff 2004). These benefits can provide maintenance of ecosystem productivity and site diversity.

The greatest areas of unsatisfactory soil condition are found in alpine and tundra, PJ grass, PJ sagebrush, and sagebrush shrubland ERUs. The loss of soil productivity through a reduction in soil function is due to a lack of adequate vegetative ground cover and organic matter. Reduced vegetative cover in alpine and tundra areas has resulted in unstable soils with reduced nutrient cycling. The pathway that nutrients are delivered back into the soil (nutrient cycling) is of high importance to a functioning system. Release of nutrients by mineralization of soil organic matter is important in the

[20] The soil condition percentages may different from soils in the final assessment report for the Santa Fe NF, due to the ERU map has been updated to include the Alpine and Tundra ERU and exclude private in-holdings within Santa Fe NF boundary.

short-term nutrient cycling, but in the long run the organic matter and the nutrients it contains must be replenished or soil fertility will be depleted (Brady and Weil 2008).

A riparian ERU, RMAP (Regional Riparian Mapping Project) ponderosa pine/willow, has high percentage of unsatisfactory soil condition. These riparian types make up a very small portion of the Santa Fe NF, but are responsible for a disproportionate amount of the ecological biodiversity and productivity. Riparian area soils show a need for improvement.

Substantial portions of the juniper grass, PJ grass, PJ sagebrush and PJ woodlands ERUs are considered inherently unstable soils (unsuited soil condition). Inherently unstable soils are those in which their geologic formation and geomorphic properties are naturally active, and soil erosion has existed historically and will continue. Approximately 5 percent of the total area in the Santa Fe NF is rated in unsuited soil condition. Soil erosion hazard influences soil condition; an inherently unstable soil is more vulnerable to soil condition impairment than an inherently stable soil.

Maintaining satisfactory soil condition is essential for ecological sustainability and long-term soil productivity. Unsatisfactory soil condition (18 percent of Santa Fe NF) reduces the ability and potential of the soil to grow plants and sustain productive, diverse vegetation. Focused restoration treatments and very long periods of recovery time would be needed to return these soils to a productive state (USDA Forest Service 2013d).

3.6.1.2 Soil Crusts

An important component that affects soil condition are biological soil crusts. Macrobiotic crusts are the community of organisms, including cyanobacteria, green algae, microfungi, mosses, liverworts and lichens, living at the surface of soils (USGS 2006) which contribute carbon to the underlying soils through photosynthesis (Rosentreter et al. 2007). Mosses and other crust forming organisms are found in wetter environments, but are less important to overall soil productivity. Biological soil crusts are commonly found in semiarid and arid environments (Johnston 1997) and have been observed in coarse textured soils, predominantly in PJ woodlands in the forest and to a limited extent in other vegetation types dryer than PJ woodlands. On the Santa Fe NF, biological soil crusts play an important role in maintaining productivity of the Colorado Plateau/Great Basin grasslands and PJ woodland ecosystems.

Biological soil crusts are well adapted to severe growing conditions such as drought and desiccating winds (Rosentreter et al. 2007), but are poorly adapted to compressional disturbances. Domestic livestock and elk grazing, and recreational activities (hiking, biking, and off-road driving) place a heavy toll on the integrity of soil crusts. Disruption of the crusts decreases organism diversity, soil nutrients, stability (and increased soil loss), and organic matter and soil productivity. Studies of trampling disturbance have noted that losses of moss cover, lichen cover, and cyanobacterial presence can be severe. Such rates of crust loss can increase runoff by half and the rate of soil loss up to six times without apparent damage to vegetation (Belnap et al. 2001). Ungulate grazing in ERUs where crusts are present, poses an unquantifiable risk to soil productivity, ecosystem diversity, and species that depend on these habitats for survival.

According to Belnap et al (2001) and Johansen et al (1993), biological soil crusts are generally killed by high intensity ground fires. Frequent burning prevents recovery of lichens and mosses, leaving only a few species of cyanobacteria (Whisenant 1990). Damage and recovery of biological soil crusts depends on pre-fire conditions and fire behavior. Historic burning patterns left small patches of unburned land between bunchgrasses, or at larger scales, left patches of unburned shrubs across the landscape. This left a mosaic of successional stages and provided regeneration material for fire damaged areas (Whisenant 1990; Peters and Bunting 1994). Today, there are more uncharacteristic fires and increasing in size and severity.

3.6.1.3 Past Management Impacts on Soil Condition

Historically (pre-European settlement) and without human-caused disturbances, soil loss, soil compaction, and nutrient cycling would probably have been within functional limits to sustain soil function and maintain soil productivity for most soils that are not inherently unstable. The exception would have been during cyclic periods of drought and possibly localized areas impacted through native human populations and non-domestic animal herbivory. Natural floods would have had a limited effect on the extent of soil loss, only causing accelerated erosion adjacent to stream channels or floodplains. Natural fires would have had a limited effect on the extent of soil loss, only causing accelerated erosion in localized areas where total consumption of the litter layer or canopy occurred. Drought may have reduced the amount of protective vegetative ground cover resulting in accelerated erosion during prolonged rainstorms.

Much of the current soil condition is related to past management in the forest. Soil condition is affected by activities that occur or re-occur at the same place over time. Permanent loss of soil productivity has and still could affect the level of future goods and beneficial uses of the forest in the future. Management activities that have affected soil condition include timber harvesting, prescribed fires, road construction and use, recreation facility construction, recreation use, and livestock grazing. Some examples of impacts that have affected current soil condition include the following:

- Heavily compacted soils from forest restoration treatments, grazing, and recreation activities have caused or may cause reduced productivity for decades (Burger et al. 2010).
- Land-disturbing activities, such as timber harvesting, road construction, and facility construction, caused erosion of topsoil at rates greater than the soil's natural ability to replace it (soil loss tolerance rate), resulting in the permanent loss of soil productivity, as soils are considered a non-renewable resource (Renard et al. 1997).
- From 1902 to 1987, as more livestock numbers and acres were grazed, range condition (and soil condition) declined; and as fewer number and acres were grazed, range condition improved.
- According to Gori and Bate (2007) livestock and large wildlife grazing removed fine fuels needed to carry surface and mixed-severity fires that likely maintained the more open structure and composition of piñon-juniper savannas and shrub woodlands historically.
- Road corridors that make up the forest's road system resulted in loss of soil productivity.
- Mineral extraction pits and mines resulted in permanent loss or reduction in soil productivity.
- Uncharacteristic wildfire resulted in erosion rates well beyond tolerance erosion rates.
- Footprints of administration and recreation sites (both developed and heavily used dispersed sites) have reduced soil productivity.
- Permanent special use sites, such as communication towers and buildings eliminated soil productivity.

There are activities that have improved soil condition and removed risk to soil productivity, such as:

- Prescribed fire has removed fuels and undesirable plant material, which impede vegetation growth and condition.
- Dense forest, woodland, and invaded grassland canopy treatments have reduced light and water competition for desired understory grasses and shrubs.
- Channel restoration projects have restored bank and vertical streambed stability, and have re-established ground water table levels that resulted in increased vegetation and soil productivity.
- Closure of maintenance level 1 roads and decommissioning or removal of unneeded roads has resulted in revegetation of old roadbeds.

3.6.2 Methodology and Analysis Process

This section describes the methodology and analysis processes used to determine the environmental consequences on soil condition from implementing the alternatives. Environmental consequences are not site-specific at the broad forest planning level, and are described with qualitative descriptions supported by past studies and observations.

This qualitative analysis describes the current soil condition and projected trends in soil condition by alternative. It also describes the potential effects associated with management activities that could affect soil condition.

Soil condition is based on the primary soil functions of soil hydrology, soil stability, and nutrient cycling as described by technical guidance (USDA Forest Service 2013d). The current soil condition rating is described in the Terrestrial Ecosystem Survey of the Santa Fe NF (Miller et al. 1993) and based on how departed soils are from the historic range of natural variability. The projected trends in soil condition were based on estimates of vegetative ground cover, soil productivity, and organic matter. Each vegetation type (ERU) was examined to see whether soil conditions would generally trend toward, away, or remain static with the implementation of treatments by alternative. The analysis is based on the Vegetative Dynamic Digital Tracking (VDDT) modeling results for each vegetation type using the range of acres proposed to be treated by alternative (low, midpoint, high) and estimates of soil cover and organic matter retention.

3.6.2.1 Assumptions

In this analysis for this resource, the following assumptions have been made:

- The alternatives are compared using the average treatment level.
- Soil and Water Conservation Practices would be applied to all management activities as described in FSH 2509.22.
- Data used in this analysis represents forestwide conditions and may not represent soil condition at any given point on the landscape. It is important to realize that many differences in soils and related disturbances can occur within short distances. Overall accuracy of mapping and information provided by the Terrestrial Ecosystem Survey and soil condition protocol is considered reliable at the ecological unit or landscape level. However, on-site inspection should be conducted for site-specific project assessments.
- On the Santa Fe NF, the first major component or ecological type of each terrestrial ecosystem was used in the soil analysis, except when the first component is a miscellaneous area (e.g., rock outcrop, badland, rubbleland, or riverwash). If the first major component of a map unit is a miscellaneous area then the second major component was analyzed.

- The current departure from desired condition is based on the ground cover (bare soil and litter) departure rates for each ERU.

3.6.2.2 Indicators used

Soil Condition

Existing soil condition is assessed and projected trends in soil condition would be predicted by alternative and identified plan components.

Soil condition is based on three soil functions including (1) the ability of the soil to resist erosion, (2) the ability of the soil to infiltrate water, and (3) the ability of the soil to recycle nutrients. Vegetative ground cover and herbaceous understory would be indicators to determine change to soil condition.

Changes in soil condition trend by acres treated and by the ability of management objectives to meet or move toward desired conditions according to alternative. Many factors are considered in the determination of soil condition trend. The amount and type of ground cover play a large role in determining soil condition. Ground cover affects soil functional elements by providing resistance to soil erosion, and enhancing nutrient cycling and water infiltration by decreasing overland flow rates. A major consideration in predicting ground cover conditions is to compare the current departure of existing vegetative conditions (see “Vegetation and Fire”) and model predictions to see whether vegetative conditions are moving toward desired conditions (DC), away, or remain static. Ground cover conditions that fall within DC for vegetation generally reflect satisfactory soil ground cover conditions.

Soil Crust

The presence or absence of biological soil crusts helps to determine the condition and productivity of the soil. Damage to the soil crust is detrimental to soil composition, function, and productivity. In the analysis below, the negative or positive effects of Forest management and other practices on soil crusts are identified to ascertain whether these practices are moving conditions closer to or away from the desired conditions defined in the Forest Plan.

Impacts from Management Activities and Uses

Several forest practices have impacts on soil condition, function, and productivity and were used to analyze the effects by alternative. They are:

- Mechanical treatments
- Wildland fire treatments
- Roads
- Grazing activities
- Special uses

3.6.3 Drivers and Stressors

Land-use forest practices affect soil functions, and these functions are intertwined, making it difficult to discuss them separately. Management actions such as timber harvesting, road management, fuel management, recreation, and grazing can have negative effects including compaction, erosion, and loss of organic matter; all of which can impair the majority of soil functions. While these effects have not been eliminated in current practices, the Forest Service has decreased these types of effects substantially. This reduction of negative effects, coupled with soil restoration activities, may increase the capacity of soils to support multiple uses and provide ecosystems services over the long term.

3.6.3.1 Climate Change

The relationship between soil and climate change is interconnected. First, climate change may affect the soil resource. In return, soils have the ability to either store or release greenhouse gases; thereby, potentially influencing climate change. The potential impacts of climate change on the forest soil resource are not well known at this time. Warmer winters may result in large areas where winter operations are constrained by poor road conditions. Increased frequency and severity of summer droughts could threaten vegetation cover through increased wildfires, and pathogen and insect activity.

3.6.4 Environmental Consequences

The Santa Fe NF uses soil condition as a descriptive indicator of general soil health. In this analysis, the expected trends in soil condition are described for each alternative for comparison. The general effects to soil function of common management activities follow, such as: forest restoration activities (mechanical and wildland fire treatments), roads, recreation, grazing, special uses, and climate change.

3.6.4.1 Indicator: Soil Condition Trend

The projected trends in soil condition based on estimates of vegetation ground cover, soil organic matter content, and potential soil loss are summarized for each ERU in current conditions for each alternative. Departure is the relative difference between satisfactory and either impaired or unsatisfactory condition.

Alternative 1 - 1987 Forest Plan

1987 Forest Plan guidance for vegetation and soils result in soil condition trending away from desired conditions and could result in additional areas with ***reduced soil function and increased vulnerability to degeneration Reduced soil function will diminish productivity of areas and their ability to support and sustain vegetation appropriate to ERUs. In addition, lower infiltration rate of the compacted soils will result in lower soil moisture retention and higher erosion rates. The compacted soils will be more vulnerable to invasion by nonnative species*** [SE1].

Effects common to alternatives 2, 3, and 4

By the forest setting objectives and standards in each Alternative toward moving ERUs toward Desired Conditions, all action alternatives should improve or at least not result in further degradation of soil condition would trend toward desired conditions, or would remain static in most cases. Soil function is sustained and functioning properly and normally in most ERUs. ***Satisfactory soil condition would provide resistance to soil erosion, and enhance nutrient cycling and water infiltration*** [SE2] by decreasing overland flow rates.

Infrequent fire forest ERUs, such as ponderosa pine and mixed conifer – frequent fire, the desired condition for understory composition would favor a mix of grass or forb cover with light litter cover over the thick litter cover found in closed forest conditions. In closed forest ERUs (spruce fir and mixed conifer with aspen), litter is the dominant ground cover, and vegetative states other than those caused by high-severity wildfire or mechanical disturbance would result in an adequate cover composition and amount, resulting in static trends (ground cover percentage is generally near 100 percent). In woodland and tree invaded grassland types, open canopy conditions would favor grass-forb cover verses bare ground conditions found in closed canopy woodlands. ***The lack of effective vegetative ground cover and organic matter would reduce the soil function which negatively impacts the soil condition reducing nutrient cycling and decreasing water infiltration rates***[SE3]. Soil that has no effective ground cover has a higher risk of losing the topsoil where majority of the nutrients are stored to maintain plant life (***nutrient loss***[SE4]).

The montane/subalpine grassland ERU has a stable soil condition in the action alternatives. Alpine and tundra, sagebrush shrubland and PJ sagebrush ERUs have a high risk of soil loss affecting the soil condition ***(SE1,3)*** by remaining departed from the desired condition. Within the sagebrush shrubland, the removal of encroached trees would improve the soil vegetative ground cover, which in turn, would improve soil condition (***SE2)*** The PJ woodland ERU is moving toward desired soil condition with a ***reduction in soil loss which increases soil function and productivity***[SE5].

Riparian area soil conditions are tied closely to proper functioning condition, where riparian areas that are functioning properly have satisfactory soil condition (***SE2, 5***). These soils have adequate vegetation to withstand bank erosion from high flows and trap sediment to form stable floodplains. Riparian areas functioning at-risk or not functioning, generally do not have stable, productive soils ***(SE1, 3-4)***. In these unstable conditions, ground cover and vegetation are usually not adequate protection for soils against high flows, and would result in impaired soil condition (***SE1, 3-4***). Soil conditions trends in riparian areas are therefore tied directly to predicted riparian area trends (see Riparian Areas).

Although the general trend is toward better soil conditions in the action alternatives, there are subtleties in how each ERU responds in each alternative (table 77).

Alternative 2 – Forest Plan

The grasslands, woodlands, open forest and riparian ERUs would move toward desired soil condition. Alternative 2 uses a mix of mechanical and wildland fire treatments to meet the desired vegetation objectives which would most effectively achieve long-term desired soil condition by restoring desired structure and compositions to forests, woodlands, and grasslands. There are less direct and indirect effects affecting the soil condition allowing the soil to recover to the desired satisfactory soil condition (***SE2, 5***).

Alternative 3 - Natural Processes Emphasis

In alternative 3, objectives heavily based on fire would result in these ERUs moving away from desired conditions because the risk of uncharacteristic wildfire increases. ***Severe fire damages soil condition by removing vegetation and increasing erosion potential and topsoil loss, leading to water quality degradation and reduced site productivity*** [SE6]. The woodland ERUs would have an increase in soil loss (***SE4, 6***) and would have a higher risk of soil heating on reburn areas. The juniper grass ERU would trend away from desired condition due to the reduction in ground cover and organic matter (***SE3-4, 6***). The Colorado Plateau/Great Basin grassland and PJ grass ERUs would move toward desired soil condition with improvements on soil vegetative ground cover ***(SE2, 5***).

Alternative 4 - Human Uses Emphasis

Vegetation objectives for thinning acres in the ponderosa pine (PPF), mixed conifer frequent-fire (MCD), and juniper grass ERUs would move toward desired soil condition by increasing growing space in the understory and alleviating some of the competition for water resources by the residual vegetation (***SE2, 5***). While Colorado Plateau/Great Basin grassland and PJ grass ERUs would move away from desired soil condition with an increased risk for soil loss ***(SE1, 3-4***). The woodland and juniper grass ERUs would have improvement on soil vegetative ground cover and organic matter, providing protection and soil nutrients. The Colorado Plateau/Great Basin grassland ERU has a higher risk of losing vegetative ground cover and organic matter affecting soils productivity and function due to the sensitivity of these systems to machinery.

3.6.4.2 Indicator: Soil Crusts

Macrobiotic crusts are affected directly through physical damage and alteration of habitat. Compressional forces compact the soils, reducing air space and channels for water infiltration, which negatively affects hydrologic function and could provide less water and nutrients to biological soil crusts.

Effect common to all alternatives

Ongoing improved cattle management in the forest would benefit biological soil crusts. The Forest Plan has desired conditions for sustainable grazing practices and Plan objectives for the restoration of degraded areas. ***The reduction in grazing pressure, due to estimated increases in forage production, would benefit soil crusts and provide for more productive soils*** [SE7]. Wildland fire can kill biological soil crusts and can alter soil properties (***SE3-4, 6***). Individual ground-disturbing projects, including prescribed fire, require site-specific analysis to mitigate effects to biological soil crusts, especially in the woodland and grassland ERUs.

Alternative 1 – 1987 Forest Plan

The 1987 Forest Plan does not recognize the importance of protecting biological soil crusts to maintain soil productivity. ***The disturbance to and removal of biological soil crust decreases organism diversity, soil nutrients, soil stability, and organic matter. In addition, the soils can no longer support diverse ecosystems*** [SE8], especially given that biological soil crust recovery time is highly variable.

Effects common to alternatives 2, 3, and 4

A desired condition and guidelines for biological ***soil crusts should result in better protection of soil crusts necessary to maintain soil productivity, soil organism diversity, and soil stability to ensure ERUs can reach Desired Conditions*** [SE9]***. The biological soil crusts provide moisture and nutrients for plants to germinate and grow to support native riparian plant communities***, ***allowing for more diverse ecosystems*** [SE10].

Table 77. Estimated trends in soil condition, relative to desired conditions, during the planning period of each ERU by alternative

ERU Code	ERU	Current Departure from DC	Alternative 1 1987 Forest Plan	Alternative 2 Forest Plan	Alternative 3 Natural Processes Emphasis	Alternative 4 Human Use Emphasis
Upland ERUs						
ALP	Alpine and Tundra	Moderate	Away; High risk of soil loss and declining soil condition.	Static; High risk of soil loss and declining soil condition.	Static; High risk of soil loss and declining soil condition.	Static; High risk of soil loss and declining soil condition.
CPGB	Colorado Plateau/ Great Basin Grassland	Moderate	Away; High risk of soil loss and declining soil condition.	Toward; Removal of encroached trees improves soil vegetative ground cover. Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Removal of encroached trees improves soil vegetative ground cover. Decrease in soil loss and slight increase in satisfactory soil condition.	Away; Reduction in soil vegetative ground cover and organic matter. Increase in soil loss and decrease in satisfactory soil condition.
JUG	Juniper Grass	Low	Static; Stable soil condition.	Toward; Removal of encroached trees improves soil vegetative ground cover. Decrease in soil loss and slight increase in satisfactory soil condition.	Away; Reduction in soil vegetative ground cover and organic matter. Increase in soil loss and increase risk of soil heating due to reburning.	Toward; Removal of encroached trees improves soil vegetative ground cover. Decrease in soil loss and slight increase in satisfactory soil condition.
MCD	Mixed Conifer - Frequent Fire	Low	Static; Stable soil condition	Toward; Reduced surface fuel loads. Greatly improved soil vegetative ground cover and organic matter. Decrease in soil loss and protection from uncharacteristic wildfire.	Away; Reduced surface fuel loads. Increase in soil loss and increase risk of soil heating due to reburning.	Toward; Reduced surface fuel loads. Slightly improved soil vegetative ground cover and organic matter. Increase in soil loss and decrease in satisfactory soil condition.
MCW	Mixed Conifer w/Aspen	Moderate	Static; Stable soil condition.	Static; Stable soil condition.	Static; Stable soil condition.	Static; Stable soil condition.
MSG	Montane/Subalpine Grassland	Moderate	Static; Stable soil condition.	Static; Stable soil condition.	Static; Stable soil condition.	Static; Stable soil condition.
PJG	PJ Grass	Moderate	Away; High risk of soil loss and declining soil condition.	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Greatly improved soil vegetative ground cover and organic matter. Increase in soil loss and slight increase in satisfactory soil condition.	Away; Increase in soil loss and decrease in satisfactory soil condition.
PJS	PJ Sagebrush	Moderate	Away; High risk of soil loss and declining soil condition.	Static; High risk of soil loss and declining soil condition.	Static; High risk of soil loss and declining soil condition.	Static; High risk of soil loss and declining soil condition.

ERU Code	ERU	Current Departure from DC	Alternative 1 1987 Forest Plan	Alternative 2 Forest Plan	Alternative 3 Natural Processes Emphasis	Alternative 4 Human Use Emphasis
PJO	PJ Woodland	Low	Away; High risk of soil loss and declining soil condition.	Toward; Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Decrease in soil loss and slight increase in satisfactory soil condition.
PPF	Ponderosa Pine Forest	Low	Away; High risk of soil loss and declining soil condition	Toward; Greatly improved soil vegetative ground cover and organic matter. Decrease in soil loss and protection from uncharacteristic wildfire.	Away; Decrease in satisfactory soil condition. Increase in soil loss and increase risk of soil heating due to reburning.	Toward; Slightly improved soil vegetative ground cover and organic matter. Increase in soil loss and decrease in satisfactory soil condition.
SAGE	Sagebrush Shrubland	High	Away; High risk of soil loss and declining soil condition.	Static; Removal of encroached trees improves soil vegetative ground cover. High risk of soil loss and declining soil condition.	Static; Removal of encroached trees improves soil vegetative ground cover. High risk of soil loss and declining soil condition.	Static; Removal of encroached trees improves soil vegetative ground cover. High risk of soil loss and declining soil condition.
SFF	Spruce-Fir Forest	Low	Static; Stable soil condition.	Static; Stable soil condition.	Static; Stable soil condition.	Static; Stable soil condition.
Riparian ERUs						
R1900	RMAP Herbaceous	Moderate	Static; Stable soil condition	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Away; Decrease in soil vegetative ground cover and organic matter. Increase in soil loss and declining soil condition.
R2300 & R2600	RMAP Narrowleaf Cottonwood/Shrub & RMAP Rio Grande Cottonwood/Shrub	Low	Static; Stable soil condition	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Away; Decrease in soil vegetative ground cover and organic matter. Increase in soil loss and declining soil condition.
R2800 & R2900	RMAP Upper Montane Conifer/Willow & RMAP Willow - Thinleaf Alder	Low	Static; Stable soil condition	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Static; Stable soil condition
R3500	RMAP Ponderosa Pine/Willow	Low	Away; High risk of soil loss and declining soil condition	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Toward; Slightly improved soil vegetative ground cover and organic matter. Decrease in soil loss and slight increase in satisfactory soil condition.	Static; High risk of soil loss and declining soil condition.

3.6.4.3 Indicator: Impacts from Management Activities and Uses

Mechanical Treatments

Mechanical treatments may impact soil condition through soil compaction and removal of ground cover. ***Soil compaction decreases soil water infiltration and nutrient intake*** [SE11], while ***the removal of ground cover damages soil crusts and increases the risk for soil erosion, causing degraded water quality*** [SE12]. The amount of soil compaction is dependent on harvest methods, amount of slash on site, operator technique, and soil conditions and properties (Page-Dumroese et al. 2010).

Ground cover is usually disturbed during mechanical treatments (including the removal of vegetation), and may, therefore, result in some exposure of mineral soil (***SE1, 5***). Although direct timber harvesting operations may result in some local soil movement, soil displacement and soil erosion are expected to be minor because adequate ground cover and topsoil would remain intact.

Effect common to all alternatives

Plan components require using site-specific BMPs and Soil and Water Conservation Practices (SWCP) (FSH 2509.22 R3) and there is additional specific directions about minimizing adverse impacts to soils. BMPs and SWCPs have been proven effective in mitigating ground disturbance and well as intercepting sediment in runoff. This would include reducing impacts to soil compaction and allow better soil infiltration ***(SE2***).

Alternative 1 – 1987 Forest Plan

Mechanical treatments of vegetation would continue at approximately the current rate since the current plan has no plan objectives for this type of work in any specific ERUs. Without specific decadal acreage objectives for mechanical treatments, it is unlikely vegetation or soil desired conditions would be met. The soil condition would either remain static or trend away from desired conditions.

Plan standards direct avoiding treatments using large equipment on slopes steeper than 40 percent and soils with a low revegetation potential (***minimizing effects SE1, 3-4, 11-12***).

Effects common to alternatives 2, 3, and 4

Timber harvesting operations can result in increased soil compaction, rutting, soil displacement, and erosion (***SE11-12***). Soil structure can be altered from repeated traffic of heavy equipment. Within the soil resources section, desired conditions describe productive and functioning soils without erosion. Guidelines direct avoiding or mitigating adverse impacts such as soil compaction and soil loss or restoring areas where impacts do occur.

In addition, a guideline specifies that large woody material should be retained after management activities such as thinning. Along with a desired condition that promotes vegetative cover, litter, and large woody debris; slash distribution in harvest units following timber harvesting helps protect exposed mineral soils from raindrop impacts and erosion.

Avoiding activities that concentrate where soils have a severe erosion hazard rating, are poorly drained or saturated, or have unsatisfactory soil condition will help to minimize negative impacts ***(SE1, 3-4, 11-12)***. Timber harvesting operations in these areas could produce irreversible soil damage and reforestation would be uncertain.

Alternative 2 – Forest Plan

Specific objectives for mechanical treatments in mixed conifer – frequent fire (1,000 to 8,000 acres) and ponderosa pine (1,500 to 10,000 acres) ERUs would most effectively achieve long-term desired condition for soils by improving vegetation, and as a result, improve the long-term ecological function and suitability of soils (***SE9-10***). There would be a moderate risk of short-term soil damage from mechanical treatments, because of equipment travel, skid trails, and landing need (***SE1, 3, 11-12***). Depending on the method of disposal and quantity of slash and woody materials that are removed, nutrients available to plants and soils may decline. However, the ground cover would gradually move toward reference conditions as vegetation objectives are completed.

Alternative 3 - Natural Processes Emphasis

Though this alternative has objectives for the least amount of mechanical harvest treatments and the least amount risk to damage soil, it is unlikely to achieve vegetation desired conditions in mixed conifer – frequent fire and ponderosa pine ERUs. There will be little to no impacts on soil compaction and ground cover removal with minimal use of mechanized equipment. This would reduce the degree of soil compaction from equipment travel, skid trails and landing needing compared to alternatives 2 and 4. This would allow more water and nutrients to be retained in soils for plants (***SE2, 5, 9-10***).

Alternative 4 - Human Uses Emphasis

This alternative has an objective for the greatest acres of mechanical harvest treatments in mixed conifer – frequent fire (5,000 to 20,000 acres) and ponderosa pine (8,000 to 23,000 acres) ERUs of all alternatives, and thus, the greatest risk to soil compaction, soil loss, and ground cover removal due to the increase in equipment travel, skid trails, and landing needs (***SE11-12***). Compacted soils have problems infiltrating water and nutrient cycling in the soils, creating complications for successful natural regeneration.

Wildland Fire Treatments

Effects of wildland fires (planned and unplanned ignitions) used for resource benefit may include negative effects on soil physical, chemical, and biological properties (***SE1, 3-4, 6***). The initial wildland fire severity, weather and time influences the reburn severity; and reburn severity can directly affect soil properties (table 78). ***The heavier accumulation of surface fuels and vegetation prior to reburning could heat soil excessively during the subsequent burn decreasing the potential for soils to revegetate by killing seed sources, volatizing nutrients causing long term diminished productivity, and altering soil structure increasing the potential for soils to erode, causing extensive damage to the soil*** [SE13]***.*** Research has shown that initial fires burning with moderate to high severity led to an increase in standing snags and shrub vegetation, which increased the probability of high-severity reburns when coupled with severe fire weather conditions (Holden et al. 2010). Conversely, initial fires burning with low severity tended to reburn at a low severity (Holden et al. 2010).

Soil structure is the most important soil physical characteristic that affects soil hydrologic function and soil stability since the organic matter component, which improves aggregate stability, porosity, and water infiltration rates, can be lost at relatively low burn temperatures. ***The loss of soil structure increases the bulk density of the soil and reduces its porosity, thereby reducing soil productivity and making the soil more vulnerable to post-fire runoff and erosion*** [SE14].

The most basic soil chemical properties affected by soil heating during fires are also due to loss of organic matter (Neary et al. 2005). Soil organic matter plays an important role in nutrient cycling and exchange, and water retention in soils. When organic matter is combusted, the stored nutrients are either lost to the atmosphere or are changed into highly available forms that can be taken up readily by microbial organisms and vegetation. Those available nutrients not immobilized are easily lost by leaching or surface runoff and erosion. Nitrogen is the most important nutrient affected by fire, and it is easily lost from the site at relatively low burn temperatures. The amount of change in organic matter and nitrogen is directly related to the magnitude of soil heating and the severity of the fire. High- and moderate- severity fires cause the greatest losses in soil organic matter and nitrogen. ***Nitrogen loss by volatilization during fires is of particular concern on low-fertility sites because nitrogen can only be replaced by nitrogen-fixing organisms*** [SE15].

Table 78. Wildland fire severity characteristics and soil effects by fire severity

	Low Severity	Mixed Severity	High Severity
Wildland fire characteristics	Reduces fuel loading either for pre- or post-restoration treatment. Removes some ladder fuels. Reduces risk of crown fire. Reburn areas should remain in low severity.	Some moderate and high severity in patches to improve structural diversity, and open canopy. Allows for regeneration of shade-intolerant species and restores ecologic condition in most vegetation types. Reburn areas have a higher probability to burning at moderate and high severity under certain fire weather and vegetation conditions.	Some high severity in small stands to improve structural diversity and open canopy. Allows for regeneration of shade-intolerant species and restores ecologic condition in select vegetation types. Reburn areas where initial fire was severe show a higher probability of reburning at high severity under certain fire weather and vegetation conditions.
Effect to soils	Little to no effect to soil loss and soil functioning condition at all scales.	Little to moderate effect on soil loss, soil chemical, physical and biological function.	Soil chemical, physical and biological functions may be adversely affected and require rehabilitation treatments. Moderate to high effect on soil loss and soil function.

Cations[21] are not easily volatilized and usually remain on the site in a highly available mineral form. An abundance of cations can be found in the thick ash layers (or ash-bed) remaining on the soil surface following high-severity fires. Soils that are inherently low in nutrients, and thin soils, are most impacted by high-severity fires as nutrients are lost. These fragile soils would be identified at the project level and protection measures would be prescribed.

Soil biological processes are also affected by fire. Soil microorganisms response to fire would depend on numerous factors, including fire severity, site characteristics, and pre-burn vegetation community composition. However, some generalizations can be made. First, most studies have shown strong resilience of microbial communities to fire. Re-colonization to pre-burn levels is common, with the amount of time required for recovery generally varying in proportion to fire severity. Second, the effect of fire is greatest at the forest floor (litter and duff). Fires that do not entirely consume the forest floor and soil humus are recommended (Neary et al. 2005).

[21] Soil cations are ions with fewer electrons than protons, giving them a positive charge. These constitute some of the most important soil nutrients. The amount of cations available for exchange between the soil and the soil solution available to plants is a measure of soil fertility. Examples of cations are ions of calcium, magnesium, phosphorous, potassium, copper, zinc and other elements.

Effect common to all alternatives

All alternatives propose the use of wildland fire for fuel reduction and ecosystem restoration. The use of prescribed fire allows the manager the opportunity to control the severity of the fire and to avoid creating large areas with high soil burn severity *(*minimizing effects ***SE6, 14-15)***. Fire treatments range from low-intensity broadcast burning for ground fuel reduction, to mixed or high-intensity treatments (in patches) that are designed to kill overstory vegetation to reduce the amount of canopy cover to a desired level.

Alternative 1 - 1987 Forest Plan

In alternative 1, there are no objectives for wildland fire. While a standard exists to use fire to establish resource objectives, especially in fire dependent ecosystems, there are many standards and guidelines that focus on fire suppression. This focus on suppression and the lack of objectives for fire does not move toward desired condition for soils because it does not sufficiently reduce the risk of uncharacteristic wildfire (***SE6, 14-15***) at the landscape level.

Effects common to alternatives 2, 3, and 4

In all the action alternatives, guidelines promote as much use of naturally ignited fires (by lightning) as possible. Prescribed fires burn under strict conditions and prescriptions that should not result in large areas of high burn severity that would be detrimental to soil physical, chemical, or biological properties and result in loss of soil productivity. In contrast, natural ignitions may have higher acreages of high-severity burn (***SE6, 14-15***). Therefore, the mix of prescribed fires and natural ignitions in each alternative may influence the proportion of fires that burn at high severity and the magnitude of burns on soils.

Alternative 2 – Forest Plan

Alternative 2 incorporated specific objectives of acres for fire in mixed conifer – frequent fire (5,000 to 20,000 acres) and ponderosa pine (15,000 to 25,000 acres) ERUs for restoration, which may include fire in non-forested ERUs. Increases in natural or prescribed fire, particularly associated with the objectives have the possibility to have short-term localized adverse effects to soils, including removal of vegetative ground cover, rutting, compaction, and erosion (***SE11-12***). These adverse effects are generally short-lived and mitigated through implementation of BMPs and SWCPs.

Alternative 3 - Natural Processes Emphasis

The fire objectives in alternative 3, mixed conifer – frequent fire (10,000 to 80,000 acres) and ponderosa pine (25,000 to 90,000 acres), are about triple those in alternative 2 for restoration and may include fire in non-forested ERUs. Increases in natural or prescribed fire, particularly associated with the objectives have the possibility to have short-term localized adverse effects to soils, including removal of vegetative ground cover, rutting, compaction and erosion (***SE11-12)*** These adverse effects are generally short-lived and mitigated through implementation of BMPs and SWCPs. The large acreages for fire in the objectives, coupled with only minimal mechanical treatments of already departed vegetative conditions, would increase the need to use naturally ignited fires, and therefore, the likelihood of mixed and high-severity burns (***SE14-15***). As described earlier, ***high-severity burns can negatively impact soil condition, altering soil structure and chemical properties, removing ground cover, causing soil loss and reduced soil function*** [SE16] (table 78). Alternative 3 may require more soil rehabilitation post-fire.

Alternative 4 - Human Uses Emphasis

In contrast, the minimal amount of fire in alternative 4, would have the lowest acreages of mixed and high-severity burns in mixed conifer – frequent fire (2,500 acres) and ponderosa pine (2,300 acres) ERUs.

This may include fire in non-forested ERUs. Where wildland fires do not occur, fuel loading would increase over time, leaving the management area at higher risk of uncharacteristic wildfire (***SE6, 14-16***).

Roads

Effects of the road system on soils are a net loss of soil productivity (***SE11-12)*** within the road corridor, including cut and fill slopes. Roads are the dominant source of erosion and sediment in forests (Swank and Crossley 1988; MacDonald and Coe 2008). Some road locations are in areas that are more sensitive than others, such as along riparian areas, or in areas of inherently unstable soils. There is a large number of non-system roads that are contributing to loss of soil productivity as well.

New road construction is generally not required for timber harvesting within planning areas, however, the re-opening of maintenance level 1 roads (e.g., those roads placed in storage, or closed between intermittent uses) dramatically increases the amount of open roads and, potentially, the amount of soil erosion that occurs during the life of a project. Temporary road construction results in removal of vegetation along the road corridor, exposes mineral soil, and results in soil compaction along the roadbed (***SE3-4, 11-12***). Typically, there is increased erosion from roads during the first 2 years following road construction or reopening (MacDonald and Coe 2008; Megahan 1974). Slope failures and mass movement of soils may occur as a result of road construction. ***New roads or re-opening closed roads may also provide an environment conducive to the invasion and establishment of invasive plant species, which alter nutrient cycling patterns and change vegetation composition in ways that may degrade soil condition*** [***SE17***]. New temporary roads would be closed, obliterated, and revegetated following use. Road design, avoidance of problem soils, appropriate design features, implementation of BMPs for road construction and maintenance, and road closures would be implemented in order to minimize adverse impacts to soils (***SE1, 3-4, 11-12, 17)***.

Effect common to all alternatives

The use and implementation of BMPs and SWCPs in all alternatives would allow general recovery (e.g., stabilize and revegetation) of soils affected by maintenance level 1 roads. In all alternatives, a standard or guideline exists to emphasize reconstruction and rehabilitation of existing roads over new road construction.

Alternative 1 - 1987 Forest Plan

In alternative 1 there is no plan guidance for temporary, decommissioning and maintaining roads. The use of roads and the need for reopening maintenance level 1 roads is estimated to be lowest under alternative 1 because fewer acres are being treated using mechanical and wildland fire. This would have the lowest short-term soil effects related to road usage (***SE3-4, 11-12***).

Effects common to alternatives 2, 3, and 4

Alternatives 2, 3, and 4 have a forestwide guideline that directs the closure of temporary roads after the projects they are designed for are completed and should result in fewer roads and road impacts over the long term. Objectives for vegetation treatments (both mechanical and fire) in these alternatives may require more maintenance level 1 and temporary roads than alternative 1, and therefore have a greater magnitude of temporary effects to soils (***SE3-4, 11-12***).

Road maintenance can lead to increases in soil erosion and sediment production. During road maintenance activities, soil may be displaced and exposed. However, mitigation measures designed to stabilize the road surface would reduce adverse effects.

Alternative 2 – Forest Plan

Alternative 2 has a mix of mechanical and fire treatments, therefore, there will be fewer effects (***SE3-4, 11-12, 17)*** associated with re-opening maintenance level 1 roads and building temporary roads than alternative 4.

Decommissioning roads allows the soils to recover to a more natural state over time while vegetation growth is enhanced. Decommissioning, closing, and restoring roads would restore soil productivity to soils no longer productive (***SE2, 5***). This will help increase the percentage of soils across the Santa Fe NF in satisfactory condition. Installation of hardened crossings will further decrease sedimentation directly into streams and lead to satisfactory soil conditions in riparian areas as well as better functioning stream channels (***SE2, 9-10***).

Alternative 3 - Natural Processes Emphasis

Alternative 3 has more fire treatments than mechanical treatments, therefore there will be less effects (***SE3-4, 11-12, 17)*** associated with re-opening maintenance level 1 roads and building temporary roads than alternative 2.

Decommissioning roads allows the soils to recover to a more natural state over time while vegetation growth is enhanced. Decommissioning, closing, and restoring roads would restore soil productivity to soils no longer productive (***SE2, 5***). This will help increase the percentage of soils across the Santa Fe NF in satisfactory condition. Installation of hardened crossings will further decrease sedimentation directly into streams and lead to satisfactory soil conditions in riparian areas as well as better functioning stream channels ***(SE2, 9-10***).

Alternative 4 - Human Uses Emphasis

Alternative 4 would have the greatest effects (***SE3-4, 11-12, 17)*** associated with re-opening maintenance level 1 roads and building temporary roads. Mechanical treatments are likely to require more roads than fire treatments, so alternative 4 has the greatest percentage of mechanical restoration treatments and would require more maintenance level 1 and temporary roads.

Recreation Activities

Effects of recreational uses shown to impact soils include off-road motor vehicle use, camping, hiking, mountain biking, and horseback riding. All these activities may result in erosion, compaction, and loss of vegetative ground cover [SE18]***.*** These impacts tend to be minor and may occur on only a small percentage of the planning area.

Effect common to all alternatives

Plan components require implementing site-specific BMPs and SWCPs for recreation projects to minimize adverse impacts to soils (***SE8, 18***). Recreation use and demand is estimated to increase proportionately for all alternatives with the increase in population growth.

Alternative 1 - 1987 Forest Plan

The current plan does not provide guidance on increased recreation use. Alternative 1 would continue to allow motorized cross-country travel and would increase the potential for sedimentation delivery to streams, reduce soil productivity due to compaction and erosion, and destroy vegetative ground cover ***(SE3-4, 11-12).*** Cross-country motorized travel could destroy biological soil crust (***SE8***).

Effects common to alternatives 2, 3, and 4

The action alternatives would eliminate motorized cross-county travel. Erosion and sediment transport would be reduced as disturbed areas revegetate and there would be less physical impact to biological soil crust (***SE9-10***).

Alternative 4 - Human Uses Emphasis

Alternative 4 is the only alternative to allow recreation sites to be expanded or new sites developed, which causes the most impacts to soils during construction (***SE3-4, 8, 11-12, 18)***.

Grazing Activities

Effect common to all alternatives

Improper livestock grazing management has the potential to reduce soil condition directly through hoof compaction, and indirectly from the removal of protective vegetative cover which stabilizes and returns nutrients to the soil. ***The effects of grazing on soil condition include reduced soil hydrologic function in highly compacted areas where cattle congregate and walk in trails, and reduced soil stability from loss of ground cover wherever over-utilization of available forage occurs*** [SE19]. Exposed soils can indirectly affect riparian areas and streams through soil runoff, erosion and sediment delivery. Livestock grazing is not considered detrimental where sufficient herbaceous material remains to protect the soils during periods of intense summer rainfall, or during spring snowmelt ***(SE10, 19)***.

Differences in soil condition as related to grazing impacts between alternatives are indirectly tied to the level of restoration treatments provided under each alternative. As noted in the Vegetation section, the overstory canopy cover targeted in the desired conditions provides the potential for an increase in understory vegetation as treatments are implemented (and sometimes recur over time (e.g., fire)) and as treated areas are maintained. This ***increased understory response would indirectly reduce grazing pressure and would allow range managers flexibility in management to favor rehabilitation or rest in areas that are currently not in satisfactory soil condition, such as found in riparian, grassland, and woodland vegetation*** [SE20]. Direct impacts to soils from livestock grazing are analyzed at the project level, where effects are mitigated and monitored.

Alternative 1 – 1987 Forest Plan

Under current grazing management, alterative 1 has the lowest potential for improving rangeland resources and associated vegetative cover ***(SE7, 9-10)***, since current management is resulting in fewer acers restored than proposed under the action alternatives.

Effects common to alternatives 2, 3, and 4

The action alternatives provide forestwide guidelines that would protect against long-term impacts to soil resources ***(SE1, 3-4, 8, 19***). The action alternatives would improve forage conditions overall ***(SE7)*** and would mitigate impacts to soil condition from grazing cattle and wildlife (***SE19***). The more forage in uplands provide for impact reduction to sensitive areas, such as riparian areas ***(SE2, 10, 20***). The reduction in livestock grazing pressure would benefit soil biological crusts (***SE7, 9-10***). Site-specific BMPs and SWCPs provide protection from the effects of livestock grazing and are prescribed in project-level analysis.

Alternative 2 – Forest Plan

Alternative 2 provide the most opportunity for soil condition improvement or protection because of predicted forage increases in all open canopy vegetation types, as well as direct improvement opportunities for riparian areas (***SE2, 10, 20***). The soils will have good infiltration supporting adequate vegetation for livestock grazing and less overland flow of sediment.

Alternative 3 - Natural Processes Emphasis

Alternative 3 provides the moderate amount opportunity for soil condition improvement or protection because of predicted forage increases in all open canopy vegetation types, as well as direct improvement opportunities for riparian areas (***SE2, 10, 20***).

Alternative 4 - Human Uses Emphasis

Alternative 4 provides upland improvement in open forest and woodland vegetation types, however, provides for little forage improvement in grassland or riparian vegetation types. Soils will not have adequate vegetation to support livestock grazing due to lack of water infiltration and nutrients, and an increase in overland flow. Riparian areas and streams will be the most heavily impacted by grazing pressure under alternative 4 (***SE3-4, 8, 11-12, 19***).

Special Uses

Effect common to all alternatives

Terms and conditions of special use permits would require site-specific BMPs to provide for maintenance of soil productivity under all alternatives. Therefore, there are no anticipated effects to soil condition from permitted special use activities.

Climate Change

Based on current climate models, some of the climate change factors that may influence soil condition include the following:

- More extreme natural ecological disturbance events, including wildfires, intense rain, flash foods, and wind events (Swetnam et al. 1998) ***(SE6, 13-16)***
- Greater vulnerability to invasive species, including insects, plants, fungi, and vertebrates (Joyce et al. 2007) (***SE17***)
- Long-term shifts in vegetation patterns (Westerling et al. 2006; Millar et al. 2007)
- Cold-tolerant vegetation moving upslope, or disappearing in some areas; migration of some plant species to the more northern portions of their existing range (Clark 1998)
- Potential decreases in overall forest productivity due to reduced precipitation (USDA Forest Service 2008a)
- Potential lower vigor and productivity of forage plants, and thus overall soil conditions. ***(SE6, 8, 19)***
- Potential decreased forage production and shortened growing and grazing season. (***SE19***)
- Potential flashfloods and increased risk of animal disease can adversely affect the livestock industry (Joyce et al. 2001) dependent upon the Santa Fe NFs' forage resources. ***(SE20)***
- Potential decline in soil condition if adjustments to livestock numbers based on allowable forage are not made in response to productivity decreases from climate change. ***(SE20)***

In light of the changes indicated above, there is a need to reduce vulnerability by maintaining and restoring resilient native ecosystems.

Alternative 1 – 1987 Forest Plan

Under alternative 1, forest restoration activities are occurring at a slower rate than proposed under the action alternatives. As a result, larger landscapes are at increased risk of climate-related disturbances (***SE6, 13-16).***

Effects common to alternatives 2, 3, and 4

Restoring and maintaining resilience in forest, woodland, grassland, shrubland, and riparian ecosystems are part of the basic elements of forestwide desired conditions, objectives and management approaches provided for in alternatives 2, 3, and 4. Restoring and maintaining resilience would ***improve the potential for ecosystems to retain or return to desired conditions after being influenced by climate change related impacts and variability***[SE21]. Management practices (e.g., thinning for age class diversity and structure, and reclaiming and restoring native grasslands) that sustain healthy plant and animal communities, and provide adequate nutrients, soil productivity, and hydrologic function ***promote resilience and reduce opportunities for disturbance and damage***[SE22].

3.6.4.4 Cumulative Environmental Consequences

Cumulative environmental consequences to soils are considered to occur on-site and are affected by activities that occur or re-occur at the same place over time (***SE6, 18, 19***). Cumulative effects of multiple activities in the same area, such as within a watershed, depend upon the intensity of the activity and condition of the baseline environment.

Past, present, and future actions in the forest that contribute cumulatively to soils conditions include (1) ground-disturbing actions, including road, timber management and harvest, (2) grazing, (3) nonnative species proliferation, and (4) wildfire. The types of effects associated with these activities were discussed above under the effects of the alternatives. Site-specific evaluations of cumulative soils impacts will be done on a case-by-case basis during future environmental analysis of individual projects.

Potential additive effects on soils in watersheds are possible during the life of the revised plan. All 4th-, 5th-, and 6th- hydrologic unit code watersheds, even those that are only partially on National Forest System lands, are within the area of potential effect. The following paragraphs highlight how specific activities in the Santa Fe NF, together with similar activities on other lands within the same watershed, might cumulatively affect soil condition.

Wildland Fire Treatments (including Forest Thinning)

The majority of the Santa Fe NF is composed of ERUs with very short fire return intervals (7 to 10 years). Wildfire suppression (Covington and Moore 1994) since the establishment of the Santa Fe NF and historic over-grazing (Dunmire 2013) have resulted in overly dense forests, which carry crown fire and severely burn soils. The absence of wildfire in the ecological regime of Forest watersheds has had a negative effect on soil condition because of increased soil burn severity impairing soil productivity and increases in soil erosion (Keane et al. 2002). Forest management across every alternative, to varying degrees, would allow for some use of wildland fire and prescribed fire. Cumulatively, re-introducing fire to the landscape should have some beneficial effects (avoiding and minimizing adverse effects) on soil condition by mitigating extreme fire behavior that could create higher severity soil burns and consequent erosion.

Forest thinning within and around the Santa Fe NF includes both hand thinning and mechanical treatments. Cumulative adverse effects to soil condition and soil crusts include soil compaction, reduced infiltration, erosion and sedimentation that will ultimately diminish soil productivity at affected sites. Forest management would use best management practices to mitigate these impacts. Over time, forest thinning activities should result in forests more resilient to disturbance by wildfire, which should cumulatively benefit soil condition.

Recreation Activities

Recreation activities on and off-Forest lands that will impact soils include motorized vehicle use, dispersed camping and user created trails for both motorized and non-motorized use, mountain biking, and horseback riding. All of these activities may result in erosion, compaction and loss of vegetative ground cover (***SE 18*).** At a cumulative scale, these impacts tend to be minor to the soil resource. Forest planned restoration of dispersed recreation areas and required implementation of site-specific BMPs and SWCPs for recreation projects to minimize adverse impacts to soils (***SE8, 18***) will improve site-specific soil condition.

Grazing

Livestock (both sheep and cattle) grazing has occurred within and around the Santa Fe NF for the past 400 years. Prior to becoming the Santa Fe NF (in 1915), grazing was intensive (between 1870 and 1890 the number of livestock in New Mexico increased from 300,000 to 2,300,000 animals; Peterson, 1950 in Vogt 2018) and combined with a drying climate, resulted in a reduction in vegetative ground cover (especially native grasses) and riparian woody species (DeBuys 1985; Dunmire 2013; Leopold 1951). Subsequent soil loss, channel incision, and degraded watershed function are present not only in the forest, but also on surrounding lands (Dunmire 2013; DeBuys 1985; Leopold 1951). Best management practices to mitigate adverse impacts to soils primarily through ground cover retention requirements have since been implemented in the Santa Fe NF; the forest intends to manage livestock grazing on National Forest System lands to sustain soil condition. Thus, while grazing by other non-forest entities may adversely impact soil condition, these effects would not be exacerbated by planned Forest Service actions.

3.7 Air Quality

Air quality has long been recognized as an important resource on national forests. The public values the fresh air and sweeping views that national forests can provide. Poor air quality can also impact other values that the public cares about such as forest health, water quality, and fisheries.

Air quality in the Santa Fe NF, and its importance to humans and the environment, can be measured in the forest in three important ways: concentrations of pollution in the air, visibility, and deposition of pollution onto the forest. The Forest Service has specific responsibilities under each of these areas to ensure that the specific actions that the agency takes in the forest comply with all air quality regulations. The Forest Service is also responsible for monitoring impacts in the forest, and communicating those impacts to regulatory agencies and other Federal land management agencies for pollution that originates off the Santa Fe NF.

3.7.1 Standards and Regulations

3.7.1.1 Ambient air quality

In general, ambient air quality refers to how much pollution is in the air we breathe. The basic framework for controlling air pollutants in the United States is mandated by the Clean Air Act, originally adopted in 1963, and amended in 1970, 1977, and 1990. The purpose of the Clean Air Act is to protect and enhance air quality, while at the same time ensuring the protection of public health and welfare. The Act established National Ambient Air Quality Standards (NAAQS), which represent maximum air pollutant concentrations which would protect public health and welfare. The pollutants regulated by the NAAQS are called criteria air pollutants and include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), and particulate matter (PM_{10} and $PM_{2.5}$).

The U.S. Environmental Protection Agency (EPA) established NAAQS for specific pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of NAAQS:

1. The primary standards represent the maximum allowable atmospheric concentrations that may occur and still protect public health and welfare, and include a reasonable margin of safety to protect the more sensitive individuals in the population.
2. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

State agencies are given primary responsibility for air quality management as it relates to public health and welfare, and are further responsible for developing their state implementation plans to identify how NAAQS compliance will be achieved. If an area in a state has air quality worse than the NAAQS, that area becomes a non-attainment area. The state is then required to develop a SIP to improve air quality in that area. Once a non-attainment area meets the standards, the area can be designated as a maintenance area.

State standards, established by the New Mexico Environmental Improvement Board and enforced by the New Mexico Environment Department, Air Quality Bureau (NMED-AQB), are termed the New Mexico Ambient Air Quality Standards (NMAAQS). The NMAAQS must be at least as restrictive as the NAAQS. NMAAQS also include standards for total suspended particulate matter, hydrogen sulfide, and total reduced sulfur for which there are no national standards.

The NMED-AQB enforces air pollution regulations and sets guidelines to attain and maintain the national and state ambient air quality standards within the state of New Mexico, except for tribal lands and Bernalillo County, which maintain separate jurisdictions.

3.7.1.2 Visibility and Regional Haze

Subsequent amendments to the Clean Air Act (1977 and 1990) established prevention of significant deterioration regulations that apply to designated pristine natural areas nationwide; pollutants that contribute to regional haze and visibility impairment, especially sulfates and nitrates; and wet and dry deposition of chemical elements and compounds that can adversely affect natural resources in forest ecosystems (e.g., acid precipitation and eutrophication).

Natural events that decrease visibility include volcanic and seismic activity, wildfires, high winds, tornadoes, and hurricanes, among others. Natural visibility conditions and efforts to attain the national visibility goal of “no anthropogenic [human-made] impairment” by 2064 are defined in the Regional Haze Rule (40 CFR 51 subpart (iii)(F)) and further documented in state implementation plans.

New Mexico has developed Regional Haze State Implementation Plans documenting how the state plans to make visibility improvements to reach natural conditions. The plan is designed to remediate current impairments of visibility, including smoke and smog, and to prevent future impairment. The State Implementation Plans establish acceptable levels of criteria pollutants that affect visibility, such as particulate matter, and other chemical elements and compounds, such as mercury (Hg), sulfates (SO_4) and nitrates (NO_3).

The forest's responsibility with regard to visibility involves coordination with the EPA, and State, county, and tribal air regulatory agencies in managing and mitigating the emissions of air pollutants resulting from Forest Service activities, such as the application of planned fire ignitions. If conditions prescribed by the Regional Haze Rule and the New Mexico regional haze state implementation plan are met, visibility is expected to improve over time in and outside of the Santa Fe NF.

3.7.1.3 Smoke Management

Smoke management is administered by the New Mexico Air Quality Bureau. The Forest Service complies with the New Mexico State Smoke Management Program, which is described in New Mexico Section 309(g) Regional Haze State Implementation Plan (New Mexico Environment Department 2011). New Mexico's administrative code (20.2.65 New Mexico Administrative Code, Smoke Management) stipulates that all burners must comply with requirements of the Clean Air Act and Federal Regional Haze Rule, as well as all city and county ordinances relating to smoke management and vegetative burning practices. There are specific requirements for prescribed fires and wildfires managed for multiple objectives that exceed 10 acres, which include registering the burn, notifying State and nearby population centers of burn date(s), visual tracking, and post-fire activity reports (emissions tracking also applies to wildfires greater than 100 acres that are fully suppressed) (20.2.65 New Mexico Administrative Code, Smoke Management).

3.7.2 Air Quality Conditions and Trends

3.7.2.1 Regional Emissions

Air quality effects on national forests are generally traceable back to the original source of emissions; therefore, air emissions information provides an overview of the magnitude of air pollution and is important in understanding air quality in the forest. Also, trends in precursor emissions would be expected to track with trends in the Santa Fe (e.g., visibility, acid deposition, etc.). For example, improving visibility conditions in Class I (defined below) areas would generally be associated with corresponding decreases in emissions for visibility precursor pollutants.

Emissions information is generally tracked for criteria pollutants or those that contribute to the secondary formation of regulated pollutants, such as carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), volatile organic compounds (VOCs), and particulate matter (PM). Volatile organic compounds emissions do not have a health-based standard, but are involved in the atmospheric chemical reactions that lead to ozone (O_3), which does. Ozone pollution is of added concern, because it can stress sensitive ecological systems. PM emissions are generally broken into two categories based on size: Fine PM represents the particulate matter emissions sized at or below 2.5 microns in diameter ($PM_{2.5}$). Coarse PM represents the particulate matter emissions sized at or below 10 microns (PM_{10}), but above 2.5 microns, in diameter. Smaller-sized particles have greater health-related impacts because t they are more easily inhaled into the lungs.

In general, most emissions in the plan area are decreasing or stable, with the exception of coarse and fine particulate matter, which are increasing, primarily as a result of fugitive dust and smoke from wildfires.

3.7.2.2 Nonattainment Areas and NAAQS

An area for which monitoring of ambient air indicates a violation of one or more primary NAAQS is labeled as "nonattainment." "Maintenance areas" are those that were at one time classified as nonattainment and currently meet the NAAQS. A strategy to ensure continued maintenance of their attainment status is prescribed in an EPA-approved planning document unique to each "maintenance area." All other areas are either "attainment" or listed as "unclassified" because of a lack of monitoring data.

The EPA reports nonattainment areas annually in the *Federal Register* (40 CFR 81 – Designation of Areas for Air Quality Planning Purposes) and on its website. State and local air monitoring stations measure ambient concentrations for all primary pollutants.

At the present time, the plan area attains all national and New Mexico ambient air quality standards. (USDA Forest Service 2016a)

3.7.2.3 Class I Areas and Visibility

The 1977 Clean Air Act amendments established provisions to facilitate the prevention of significant deterioration of air quality in areas currently attaining the NAAQS. They also contained requirements pertaining to pollution sources in nonattainment areas for NAAQS. A nonattainment area is a geographic area that does not meet one or more of the Federal air quality standards. Initial classifications of attainment areas were either class I or class II. Class I areas include international parks, national wilderness areas exceeding 5,000 acres in size, national monuments exceeding 5,000 acres in size, and national parks exceeding 6,000 acres. Class II areas comprise all the remaining areas that are not Class I.

The Clean Air Act affords Class I areas the highest level of protection from air quality degradation. It requires that projects with the potential to affect Class I areas be designed to minimize or avoid deterioration of ambient air quality and air quality related attributes. The 1977 amendments established major permit review requirements for new pollutant sources to ensure the future attainment and maintenance of the NAAQS in Class I areas.

Visibility is a highly important attribute of Class I areas, and the reduction of haze is a management objective for improving and maintaining visibility in these areas. Such areas in and near the Santa Fe include the Pecos Wilderness, San Pedro Parks Wilderness, Bandelier National Monument, and Wheeler Peak Wilderness.

Visibility refers to the conditions that allow the appreciation of the inherent beauty of landscape features. Visibility data are collected at stations operated as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program sponsored by the EPA and other government agencies (FED 2015). Visibility generally relates to the quality of visitors' visual experience in the forest where the presence of air pollution degrades the visual quality of a particular scene. In the Clean Air Act, a national visibility goal was established to return visibility to "natural background" conditions no later than 2064.

One of the most basic forms of air pollution—haze—degrades visibility and aesthetic vistas in many American cities and scenic areas. Haze results when sunlight encounters tiny pollutant particles in the air, which reduce the clarity and color of what we see, particularly during humid conditions. Chemical compounds in fine particles that most impair visibility are sulfates, nitrates, organic compounds, elemental carbon (or soot), and soil dust. Fine particles ($PM_{2.5}$) are more efficient at impairing visibility than coarse particles (PM_{10} and larger) (USDA Forest Service 2002). Because of the arid climate in the Southwest, generally favorable weather patterns, and fewer industrial sources of pollutants than elsewhere, visibility is generally better than in most other areas of the United States. Nevertheless, with population growth and more vehicles on the road, the natural range of visibility in the western United States has decreased from 140 miles to a range of 35 to 90 miles.

Wildfires and windblown dust are natural sources of emissions that affect visibility. Windblown dust originates from motor vehicle travel (especially on dirt roads), agriculture, off-highway vehicle use, and planned fire ignitions. Wildland fires are the result of natural ignitions (lightning) or human-caused ignitions. Depending on its severity, timing, duration, and type and condition of vegetation consumed, wildfires of extreme intensity often increase smoke and haze well above natural levels.

In response to amendments to the Clean Air Act in 1977, which required the development of Federal and State Implementation Plans for the protection of visibility in Class I areas, an IMPROVE network was established in 1985. IMPROVE implemented an extensive long-term monitoring program to define current visibility conditions, track changes in visibility, and determine causal mechanism for visibility impairment in national parks and wilderness areas.

Visibility-related data is collected by IMPROVE at two monitoring stations near the Santa Fe: San Pedro Parks and Bandelier National Monument. Each site has shown similar improvement in the visibility conditions represented by the 20 percent most impaired days since about 2007, which is mostly reflected by reductions in sulfate, and may be a result of emissions control technology improvements at coal-fired electric generating stations in the Four Corners.

3.7.2.4 Atmospheric Deposition and Critical Loads

Air emissions of nitrogen oxides (NO_x) and sulfur dioxide (SO_2) can lead to atmospheric transformation of these pollutants to acidic compounds (e.g., nitric acid and sulfuric acid) and the resultant deposition onto land and water surfaces in forested ecosystems. Documented effects of nitrogen and sulfur deposition include acidification of lakes, streams and soils, leaching of nutrients from soils, injury to high-elevation forests, changes in terrestrial and aquatic species composition and abundance, changes in nutrient cycling, unnatural fertilization of terrestrial ecosystems, and eutrophication of aquatic ecosystems.

Deposition impacts are generally described in terms of the “critical load,” defined as “the quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment are not expected to occur based on present knowledge” (National Atmospheric Deposition Program (NADP) 2011). In other words, the “critical load” determines the tipping point at which harmful effects attributable to deposition in a particular ecosystem start to occur. Critical loads have been established at some, but not all wilderness areas. For the New Mexico wilderness areas of interest, critical loads for nitrogen and acid deposition have been established based on a national assessment, although they lack some site-specific data for a more robust assessment (Pardo 2011, Pardo et al. 2011). Both direct measurements (deposition from the NADP network) and modeled results were used to assess potential impacts. This general approach has been applied to determine critical loads for nitrogen deposition, for some sensitive receptors in the forest, such as lichens, herbaceous plants and shrubs, forests, mycorrhizal fungi, and nitrate leaching.

Bandelier National Monument monitors for nitrogen and sulfur deposition as part of the NADP/National Trends Network, which monitors ambient precipitation chemistry nationwide. Sulfur and nitrogen deposition measurements were collected at the Bandelier National Monument station operated for the National Trends Network over the period 2004 to 2014 (CASTNET 2015).

Wet and dry deposition of sulfur and nitrogen has remained relatively constant over the period of record, although some year-to-year variability is noted (USDA Forest Service 2016a pp. 288-289). Generally, the observed deposition at Bandelier ranges between 5.0 to 10.0 kg/ha-yr. Nitrogen deposition makes up the bulk of the deposition and typically constitutes about 3 kg/ha-yr, while sulfur deposition is typically closer to 2 kg/ha-yr.

There is some indication that current levels of nitrogen deposition have exceeded critical loads and are significant enough to have resulted in impacts to lichen diversity and community structure and to a lesser degree, impacts to herbaceous plants and shrubs, and to forest and soil nitrate leaching. However, these results were based on modeled critical loads and have not been verified in the forest. The rate of deposition of nitrogen, which can lead to impacts affecting forest health, appear to be decreasing based on projected emissions at the state level.

3.7.3 Drivers and Stressors

Air quality and the values dependent on air quality in the Santa Fe NF are generally in good condition or are improving as most pollutants are decreasing as a result of stricter regulations. However, there are a few exceptions. Modeled critical loads from nitrogen deposition are also being exceeded, primarily for lichens; however, conditions are expected to continue to improve due to projected emissions. Of greater concern are impacts to visibility and ambient air quality conditions associated with particulate matter, which are expected to increase as a result of larger, more severe wildfires and increases in fugitive dust as the effects of climate change are realized.

3.7.4 Methodology and Analysis Process

3.7.4.1 Indicators

Emissions from Management Activities (predominately fire)

Potential indicators of effects to air quality from direction given in the current plan (no action), Forest Plan, and alternatives 3 and 4 include activities that could originate in the Santa Fe and could be sources of potential emissions.

Since air quality in the project area is considered to be very good, relatively small amounts of emissions from some activities would be negligible to the broader airshed. In addition, analysis for several types of emissions have high level of uncertainty; are relatively insignificant; and are unlikely to have a negative effect on any regulatory standards, visibility, or deposition of pollutants. Therefore, these emissions were not analyzed. They include:

- Vehicle emissions associated with roadwork, administrative use, on- and off-road travel, and recreational vehicle use release combustion gases (exhaust) and particulates to the air that contribute to ambient concentrations of pollutants regulated by the NAAQS. Most of these emissions are confined locally, are temporary, and are not expected to negatively affect ambient concentrations, which are very good.
- Mechanical treatment of vegetation is used to reduce high concentrations of fuels in the forest understory that, in turn, lowers the risk of severe wildfire and its effects on the health and safety of fire management personnel and improves habitat for a variety of species. It is often used in advance of planned fire ignitions to remove the woody debris and plant material on the forest floor. Operation of chainsaws and chippers to perform this work release exhaust and particulates to the air. Burning the larger branches, twigs, and other woody debris (referred to as “slash”) generates smoke, the effects of which are discussed below.
- Roadwork and mining quarries produce fugitive dust. These are likely to last for a very short period of time, a few months rather than years, and the dust would be isolated to very small areas and would not pose a threat to visibility or air quality standards. In addition, fugitive dust from the construction, operation, and maintenance of roads could be reduced by Federal contract

requirements dictating standard specifications and best management practices to reduce fugitive dust, if deemed necessary for a particular contract.

- Livestock produce methane (CH_4) and carbon dioxide (CO_2). These emissions from livestock are a relatively small source of emissions from the forest (an estimated equivalent to 0.04 percent of greenhouse gas emissions from fire over a 10-year average).

Oil and gas development and production occurs in the forest and includes a wide variety of operations including wells, gas lines, and storage tanks. These processes release several types of emissions including methane (a greenhouse gas); volatile organic compounds (VOCs), which are precursors to ozone; nitrogen oxides, and others. Generally, these emissions are controlled by best management practices required under individual leases and by state and Federal law. At current levels of oil and gas development the direct and indirect emissions are insignificant and were also not analyzed.

Only emissions from planned fire ignitions are likely to have effects substantial enough to consider in the environmental consequences. Planned fire ignitions are used to mimic natural reference (pre-European settlement) fire conditions and move the ecosystem toward a desired vegetation condition that supports recurring, low intensity wildland fire. Both planned and unplanned fire ignitions release smoke in amounts relative to the amount of fuels consumed, type of fuels, moisture, area burned, and duration, and in which combustion gases and various diameter particulates are released to ambient air. The forest coordinates with NMED to ensure that every planned fire ignition is in compliance with the Smoke Management Program. The purpose of the Smoke Management Program is to ensure that any planned fire emits pollutants in concentrations that will not adversely impact air quality by defining the size of the burn area and weather conditions under which burning is acceptable.

Consume, version 4.2, was used to model smoke emissions from the three alternatives and the no action-current plan. Consume is a fuels model commonly used to estimate smoke emissions. Basic input data, such as fuel types, the type of fire (prescribed fire or wildfire), the condition of the unit (has it been mechanically treated), and environmental conditions (fuel moisture) are entered into the model. The model then estimates emissions for a variety of pollutants, such as $PM_{2.5}$ and CO_2. For this analysis, the alternatives were modeled based on median objectives for treatment between alternatives over 10 years, as well as the 10-year average of accomplishments for the no action (current plan). Median acres of three main fuel types: dry mixed conifer, ponderosa pine, and non-forested, were modeled for each alternative. Alternatives were varied by acres for prescribed fire and those acres that were harvested and then treated with prescribed fire, and wildfire. Fuels moistures were used consistent with conditions in which prescribed fire or wildfires would take place. For each fuel type, it was assumed that fire suppression and grazing had affected the fuel loads, by increasing the standing biomass in each fuel type, from a natural fire regime that would have reduced the biomass available to burn. A complete set of assumptions and outputs for all pollutants modeled is in the project record.

Carbon sequestration

Forests play an important role in carbon sequestration, which is the direct removal of carbon dioxide (CO_2) from the atmosphere through biologic processes, such as forest growth. ***Carbon sequestration by forests mitigates greenhouse gas emissions by offsetting losses through removal and storage of carbon*** (USDA Forest Service 2016a) [AQ9]. Over at least the past several decades, temperate forests have provided a valuable ecosystem service by acting as a net sink of atmospheric carbon dioxide, partly offsetting anthropogenic emissions (Millar and Stephenson 2015). Carbon dioxide uptake by forests in the conterminous United States offset approximately 16 percent of our national total carbon dioxide emissions in 2011 (U.S. Environmental Protection Agency 2013). Forests and other ecosystems generally act as carbon sinks because, through photosynthesis, growing plants remove CO_2 from the atmosphere and store it (USDA Forest Service 2015). Keeping forests as forests is one of the most cost-effective carbon storage measures. Restoration—bringing badly disturbed forests and grasslands back to producing a full range of environmental services—is another (USDA Forest Service 2015).

The fire emissions presented in that indicator represent estimated direct emissions from treatment options, and not the indirect and avoided emissions associated with any alternative. For example, the PM emissions do not represent the emissions from a wildfire that could occur after treatment occurs which would result in less emissions due to the removal of material that produces emissions from treatment. It also doesn't represent the emissions that could occur from a wildfire in an area that has not had treatment that would likely result in greater emissions due to the similar fuel loading, but hotter and dryer conditions that are likely to occur during a wildfire. Due to the high level of uncertainty in these scenarios, no quantitative analysis was conducted but these effects can be described qualitatively, especially for CO_2 emissions where the indirect effects are more certain.

3.7.5 Environmental Consequences

3.7.5.1 Indicator: Emissions from fire

Effects Common to All Alternatives

Smoke from wildland fire is by far the most significant source of air quality impacts that originate in the forest. The predominant pollutant in smoke is fine particulate matter, both PM_{10} and $PM_{2.5}$. $PM_{2.5}$ in smoke is of paramount importance because these fine particles are known to lodge deep in the human respiratory system and some may even get into the bloodstream (US EPA 2018). Consequently***, fine particles from smoke emissions have significant impacts on the health and well-being of sensitive populations*** **AQ1**, such as the elderly, young children, and persons with lung disease or compromised immune systems. ***Carbon monoxide released by combustion generates localized increments to ambient air, which present a health and safety concern for fire personnel*** **AQ2**. ***Combustion also releases nitrogen oxides, which are chemical precursors to the formation of ozone, which is an ecological pollutant*** **AQ3**.

Under all alternatives, wildland fires will continue to occur in the Santa Fe and will be managed according to policy and guidance set forth under the alternative. ***Smoke from wildland fires may travel large distances, impairing local and regional visibility and degrading air quality far from their point of origin*** **AQ4**, depending on topography and atmospheric conditions—in particular, wind speed and direction. ***In the case of uncharacteristic wildfire, ambient concentrations of criteria pollutants may increase beyond the NAAQS in local areas and in locations much further away*** **AQ5**, regardless of which draft forest plan is in effect. Thus, any adverse health effects on sensitive populations (A1) would be equal for all alternatives. Further, all alternatives would be compliant with Federal and State air quality regulations.

Alternative 1 – 1987 Forest Plan

Under the current plan, the last 10-year average was used for number of acres treated by prescribed fire and wildfire in the forest. Based on these records, in the last 10 years (2008–2017) 139,190 acres were treated using prescribed and wildfire in the forest. Over that period, modeled emissions of $PM_{2.5}$ were approximately 12,500 tons per decade and CO_2 emissions were approximately 2.1 million tons per decade. To put these numbers in perspective, the $PM_{2.5}$ emissions are equivalent to the emissions of an average coal-fired power plant over a 10-year period (NADP 2011). Regarding the CO_2 emissions, a typical coal power plant generates approximately 3.5 million tons of CO_2 per year (Union of Concerned Scientists 2017), which is approximately two-thirds greater on an annual basis than the emissions over a 10-year period from wildland fire. This alternative has the second lowest loads of $PM_{2.5}$ (figure 24) and associated effects to public health ***(AQ1-2)***, NAAQS, and visibility ***(AQ4-5)*** and to CO_2 (figure 25) and its contribution to climate change (***AQ3***).

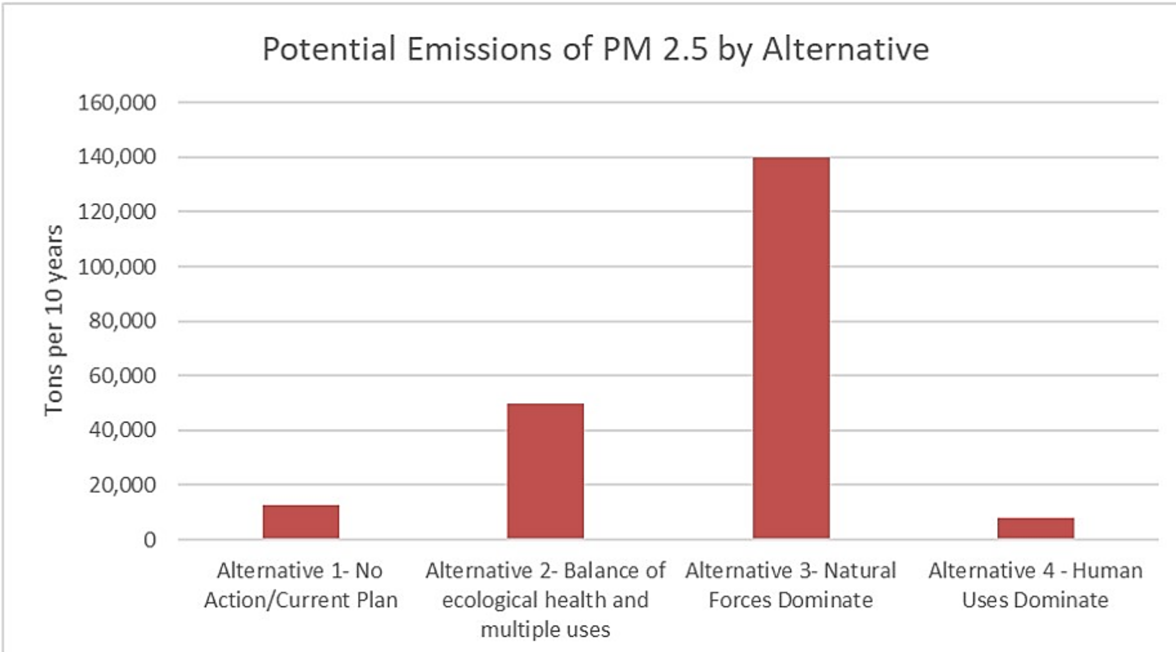

Figure 24. Potential emissions of fine particulate matter (tons of $PM_{2.5}$ per decade) among alternatives

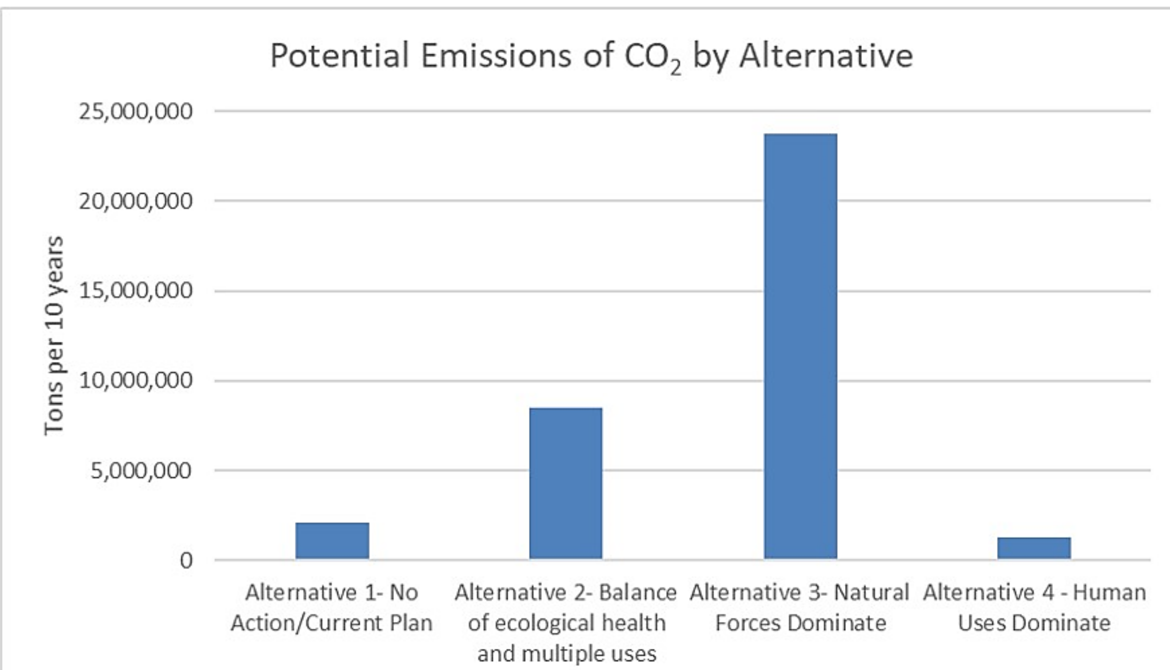

Figure 25. Potential emissions of carbon dioxide (tons of CO_2 per decade) among alternatives

Alternative 2- Forest Plan

Under alternative 2, the median number of acres planned to be treated by prescribed fire and wildfire in the forest were modeled. In this alternative, on average 480,650 acres would be treated using prescribed and wildfire in the forest. Over 10 years, the emissions are estimated to be approximately 50,000 tons of $PM_{2.5}$ and 8.5 million tons of CO_2. In relation to the current plan, this alternative produces approximately 4 times more emissions than the current plan (figure 24 and figure 25) and would have the second highest associated effects ***(AQ1-5)***.

Alternative 3 - Natural Processes Emphasis

Under alternative 3, the median number of acres planned to be treated by prescribed fire and wildfire in the forest were modeled. In this alternative, on average 1,189,900 acres would be treated using prescribed and wildfire in the forest. Over 10 years, the emissions are estimated to be approximately 140,000 tons of $PM_{2.5}$ and 23.8 million tons of CO_2. In relation to the current plan, this alternative produces approximately 11 times more emissions than the current plan (figure 24 and figure 25) and would have the greatest associated effects ***(AQ1-5).***

Alternative 4 - Human Uses Emphasis

Under alternative 4, the median number of acres planned to be treated by wildfire in the forest were modeled. In this alternative, on average 60,000 acres would be treated using wildfire in the forest. Over 10 years, the emissions are estimated to be approximately 7,812 tons of $PM_{2.5}$ and 1.2 million tons of CO_2. In relation to the current plan, this alternative produces approximately 40 percent less emissions than the current plan (see figure 24 and figure 25), and the least amounts of associated effects ***(AQ1-5).***

3.7.5.2 Indicator: Carbon sequestration

Effects Common to All Alternatives

For every direct emission of CO_2 from acres treated with fire (prescribed or natural caused), there are avoided indirect emissions that would result from a high-severity wildfire (Dore 2008). Even though practices such as thinning and prescribed fire may release carbon in the short term, they focus growth and storage for the future on trees that are at lower risk and are more resilient to disturbance (***AQ10)***. Previous research in a southwestern ponderosa pine forest demonstrated that a restored condition that is maintained by regular surface fire can store more carbon than a fire-suppressed condition when the effects of random wildfire are incorporated (Hurteau 2017). Further, high-severity fire has the potential to be a carbon source for decades post fire compared to 2 to 3 years post treatment from prescribed fire (***AQ12)*** (Dore 2008). Appropriate forest management and protection can substitute lighter, strategically placed, and more recoverable emissions for disturbance emissions (from unplanned fire) that would be more severe, extensive, and less reversible (U.S. Forest Service 2015). Because live trees continually sequester carbon and are a more stable carbon sink than dead biomass left on the site, treating stands is preferred for long-term mitigation of atmospheric carbon levels (***AQ13)*** (Vegh et al. 2013).

Additionally, reducing tree density through thinning has been shown to reduce drought stress and increase growth and carbon sequestration relative to a fire-suppressed condition during dry periods (Hurteau 2017). The restoration of forest structure and the maintenance of that structure with regular surface fire helped sustain the forest carbon sink, even under an increasingly hotter climate (***AQ11)*** (Hurteau 2017).

Alternative 1 – 1987 Forest Plan

Alternative 1 has no objectives for prescribed or wildfire in the forest and therefore would restore the least number of acres. The 10-year average of prescribed and wildfire in the forest would be neutral in terms of reducing CO_2 emissions, which is the second least carbon sequestration and associated effects (***A10-A13***) of all alternatives over the life of the forest plan. Further, this would also equate to the least avoided indirect emissions from high-severity wildfire and associated effects (***A12***) of all alternatives.

Alternative 2 – Forest Plan

The indirect effects of the proposed forest treatments in the management objectives for alternative 2 for emissions of $PM_{2.5}$ and CO_2 over time are uncertain but could be significant, especially in regards to the emissions of these pollutants produced from wildfire. Alternative 2 would restore approximately three and a half times more acres over a 10-year period than the current forest plan, which would result in second highest carbon sequestration and associated effects (***A10-A13***) of all alternatives over the life of the forest plan (Dore 2008). In this alternative the indirect effects would have a moderate amount of uncertainty in total emissions since it has a moderate amount of planned fire.

Alternative 3 – Natural Processes Emphasis

The indirect effects of emissions is highly uncertain but potentially significant in alternative 3. Alternative 3 would restore approximately eight and a half times more acres over a 10-year period than the current forest plan, which would result in the greatest carbon sequestration and associated effects (***A10-A13***) of all alternatives over the life of the forest plan (Dore 2008). In this alternative the indirect effects would have the least amount of uncertainty in total emissions since it has the most planned fire.

Alternative 4 – Human Uses Emphasis

The indirect effects of emissions is highly uncertain but potentially significant in alternative 4. Alternative 4 would restore approximately 4 times more acres over a 10-year period than the current forest plan, but approximately 2.5 times less with fire. This creates greater uncertainty in the indirect effects for this alternative in that those acres treated mechanically, but not burned, would pose a greater risk of high-severity fire and associated effects (***A12***) than acres that have had low to moderate intensity wildfire or prescribed fire on them, since more fuel would be left on those acres with mechanical treatments (***AQ13***). Therefore, since those acres would be at greater risk for high-severity fire and its associated effects (***A12***), this alternative would sequester the least CO_2 of all the alternatives. However, in this alternative the indirect effects would have the greatest level of uncertainty and have the potential to be significantly underestimated over the life of the plan.

3.7.6 Cumulative Effects

The following provides a qualitative assessment of the potential cumulative effects of forest plan direction for each alternative over a 15-year plan lifetime, inclusive of Santa Fe and nearby airsheds and Class I areas. Sources of pollutant emissions from the Santa Fe were listed above.

Non-Forest Sources of Emissions

Off-forest sources of emissions that may contribute additively to cumulative effects are those that would disturb soils, such as residential and commercial development, energy production and development, and road construction. Vehicle travel on adjacent roads and highways and agricultural activities (which produce exhaust gases and fugitive dust), industrial facilities from which point-source (e.g., smokestack) pollutant emissions are released, and smoke from fires on land under private or other agency jurisdiction also contribute to cumulative effects. Of these, the activities most likely to contribute to cumulative air quality, when considered additively with forest actions, are wildland fire on adjacent lands, fugitive dust, energy production, and vehicle emissions.

Population growth and development in New Mexico are expected to continue over the life of the Forest Plan. Areas adjacent to the Santa Fe NF, especially the Albuquerque and Santa Fe metropolitan areas, are expected to continue to increase in population. With projected growth, new construction of residential and commercial developments and roads are likely, and new ground disturbances would contribute additional fugitive dust to the ambient air (***AQ8***). Likewise, an influx of more people would trigger more vehicle travel on local roads, increasing exhaust and dust emissions in the area impacts. Future proposed actions in the Santa Fe NF would be evaluated to determine if, when added to non-forest sources, they would exacerbate attainment or increase haze and decrease visibility in both the local airshed and in Class I areas.

Industrial sources of air pollutants near the Santa Fe NF include power plants, factories, a smelter, and other facilities that release pollutants from a single point. Air emissions from each of these are regulated under permits by the state and local environmental agencies. Therefore, if new significant sources of this kind are proposed, the increment of criteria pollutants, greenhouse gases, and hazardous substances would be reviewed by regulators. Mitigation and monitoring would be required to ensure continued attainment of the NAAQS. No sources of industrial emissions are generated by forest activities. Therefore, the Santa Fe NF would not contribute to adverse impacts if new or expanded industrial sources are developed.

Planned and unplanned fire ignitions may produce smoke, from which primary, secondary, and hazardous pollutants are released to the atmosphere (***AQ1-6***). Planned ignitions are applied under the direction of a Federal, state, or local land management agency after consideration of variables such as weather, acreage to be treated, type and condition of fuels, and duration, among other factors. Authorization for planned ignitions by New Mexico is based, in part, on consideration of the potential for cumulative effects from smoke with other activities planned during a concurrent timeframe. Therefore, the potential for significant cumulative effects from planned ignitions is largely avoided or in some cases, mitigated by adherence to the Smoke Management Program in the state implementation plan.

The occurrence and extent of wildfire are not predictable, and when uncharacteristic fires occur, their high intensity may result in temporary violations of the NAAQS in the affected airshed(s). The effects of wildfires are not considered additive with planned forest activities because they are unplanned events.

3.7.6.1 Conclusion

Under each alternative the potential for significant air quality impact could occur, due to wildland fire ***(AQ1-6)***. Alternatives 2, 3, and 4 are improvements over the current plan in that added direction is included in all three that would improve the management of air quality in the forest in terms of impacts from wildland fire and monitoring of critical loads. Alternative 2 has potential direct emissions that are greater than the current plan but are less than alternative 3 and more than alternative 4. The direct effects from $PM_{2.5}$ and CO_2 would be greatest under alternative 3; however, the potential indirect effects from CO_2 emissions could be reduced significantly. Moreover, alternative 3 has the least amount of uncertainty in the total emissions since it has the most amount of planned fire. Alternative 4 has the least amount of direct emissions but has the greatest potential for indirect emissions and the most uncertain results. There are significant uncertainties between all alternatives in terms of the effects on air quality due to the unknowns such as climate and the amount of wildland fire that could occur.

3.8 Northern New Mexico Traditional Communities and Uses

This section provides an overview of the affected environment and an assessment of the potential impacts each alternative would have to Northern New Mexico Traditional Communities and Uses in the forest. A traditional community refers to a federally recognized tribe or a land-based rural community that has a long-standing history in and around the lands managed by the Forest Service. There are numerous small unincorporated communities within the boundaries of the Santa Fe NF, reservations of federally recognized tribes, and small incorporated towns and villages. The Santa Fe NF is a community forest, and each of these communities retains an identity geographically and historically rooted to the landscape.

Although all forests have a connection to their local communities, the depth of the relationship between local tribes and traditional communities to the Santa Fe NF transcends the modern period and goes back in time to the beginning of the Historic period for many of the small unincorporated and incorporated communities and back to time immemorial for federally recognized tribes. The forest plan's programmatic nature precludes description of site-specific activities; however, the range of activities proposed by the various alternatives has the potential to affect the resources and activities of traditional communities.

When referring to traditional communities, the forest plan distinguishes between federally recognized tribes and other land-based rural communities because of the unique relationship between the Federal government and federally recognized tribes.

3.8.1 Affected Environment

The Santa Fe NF manages the natural resources and landscapes that sustain northern New Mexico traditional communities, their cultures and traditions. Local heritage, culture, traditions, and values have been handed down over generations and predate acquisition of the area by the United States for many local rural communities, and long before Europeans entered the western hemisphere for tribal communities. Long-standing use of the forest and its natural resources are fundamental to the interconnected economic, social, and cultural vitality of many northern New Mexico inhabitants, including federally recognized tribes, Spanish and Mexican land grants-mercedes and acequias, grazing permit holders, and other rural historic communities. These important uses or "traditional uses" include:

- Use of common waters (e.g., acequias or irrigation ditches) for drinking, irrigating crops, and watering livestock.
- Use of common pasture for grazing of livestock.
- Use of wood products for fuelwood, building materials, and ceremonial use.
- Collection of soils (e.g., sand, adobe, micaceous clay) and rocks for building materials and other purposes (e.g., production of crafts and ceremonial use).
- Gathering of plants and plant products for various purposes (e.g., religious, medicinal, and consumption).
- Hunting and fishing for food and ceremonial purposes.
- Religious and ceremonial uses, including for cemeteries, pilgrimages, calvarios, and shrines.
- Recreational uses for weddings, family reunions, and dispersed camping.

Desires for the recognition and preservation of northern New Mexico traditional uses have been an integral part of managing the Santa Fe NF, which is reflected through various documents (e.g., 1987 Santa Fe Land and Resource Management Plan (1987 Forest Plan), 1972 Regional Forester policy memo, 1968 Hassell Report). The Forest Plan builds upon past initiatives and continues to recognize and support the traditional uses associated with the Santa Fe NF.

The Santa Fe NF continues to have strong cultural and historic significance to the many diverse peoples and communities who have called northern New Mexico home for many generations. The national forest contributes resources and uses that are important to federally recognized tribes and pueblos, land grant communities, acequia associations, traditional Hispanic communities, and many contemporary residents all with historic, cultural, and socio-economic connections to the forest. To this day, these traditional communities retain a strong connection to the land and rely upon the forest and its natural resources to sustain their cultural, spiritual, and economic way of life.

People in traditional communities continue to benefit directly and indirectly from a variety of ecosystem services that they obtain from the land. In addition to providing the necessary resources to sustain life, these landscapes also form an anchor for those communities, providing people with a sense of identity and their place in the world. Generations of families formed communities, adapted to their environment, and developed a way of life dependent upon and complimentary with the mountain, upland and lowland resources at hand.

3.8.1.1 Federally Recognized Tribes

For much of the span of human history in North America, the ancestors of Native Americans were the only people to occupy and use the lands that encompass the Santa Fe NF. Their use of the forest and the surrounding area began with the earliest human occupation of the Western Hemisphere and persists to the present day. The land-based cultures that exist today in northern New Mexico have relied on the forests, valleys, and water of these public lands spanning many generations.

The Federal Government has a responsibility to federally recognized tribes that arises from the United States' unique legal and political relationship with Tribes. It is a legally enforceable fiduciary obligation on the part of the United States to protect Tribal rights, lands, assets, and resources, as well as a duty to carry out the mandates of Federal law with respect to all federally recognized tribes. This responsibility requires the Federal Government to consider the best interests of the Tribes in its dealings with them and when taking actions that may affect them. In meeting these responsibilities, Forest managers consult with federally recognized tribes and pueblos as sovereign entities when proposed policies or management actions may affect their interests.

The government-to-government relationship between the Forest Service and federally recognized tribes is distinct from that of other interests and constituencies under a variety of Federal authorities. These authorities direct the agency to administer forest management activities and uses in a manner that is sensitive to traditional Native American beliefs and cultural practices, and are integral in our relationship with federally recognized tribes. The plan components in the Forest Plan are based upon policy and Federal laws and regulations (e.g., American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act, 2008 Farm Bill, Tribal Forest Protection Act).

The Forest Service manages a great diversity of landscapes and sites that are culturally important and are held sacred by federally recognized tribes. Specific locations and information about traditional uses in the forest are often held in confidence to protect these important values.

Relationships are maintained through consultation and engagement between the Tribes and the forest. This consultation is critical when proposed activities have a potential to affect Tribal interests, including natural or cultural resources of importance. The Santa Fe NF consults with federally recognized tribes and pueblos that have aboriginal territories within, and traditional ties to the land now administered by the forest. The Santa Fe NF maintains government-to-government relationships with many of these federally recognized tribes. The Santa Fe NF uses a variety of avenues to achieve meaningful consultation, with the preferred method being real-time, in-person dialogue between Tribal leaders and Forest line officers.

The Santa Fe NF shares a common boundary with the Jicarilla Apache Nation, the Pueblo of Santa Clara, the Pueblo of San Ildefonso, the Pueblo of Santo Domingo, the Pueblo of Jemez, the Pueblo of Nambe, the Pueblo of Tesuque and the Pueblo of Zia, and is near several other Tribal communities.

There are 31 federally recognized Native American tribes with which the Santa Fe NF routinely consults on a forestwide basis for Section 106 consultation. Twenty of the tribes are of Pueblo ethnic affiliation: Acoma Pueblo, Laguna Pueblo, Isleta Pueblo, Santo Domingo (Kewa) Pueblo, Cochiti Pueblo, the Hopi Tribe, Jemez Pueblo, Sandia Pueblo, San Ildefonso Pueblo, Tesuque Pueblo, Pojoaque Pueblo, Nambe Pueblo, Santa Clara Pueblo, Ohkay Owingeh Pueblo, San Felipe Pueblo, Santa Ana Pueblo, Zia Pueblo, Zuni Pueblo, Taos Pueblo, and Picuris Pueblo. Three tribes are of Athabaskan ethnic affiliation: the Jicarilla Apache, the Mescalero Apache Tribe, and the Navajo Nation. The Santa Fe NF also consults with the Ute Mountain and Southern Ute tribes of Colorado. Also included are tribes with ties to the western periphery of the forest with reservations in Texas and Oklahoma, including the Apache Indian Tribe of Oklahoma, the Comanche Nation, the Cheyenne-Arapaho Tribes of Oklahoma, the Ft. Sill Chiricahua-Warm Springs Apache Tribe, the Kiowa Tribe of Oklahoma, and the Wichita and Affiliated Tribes. While united by common origins, within each ethnic group there is tremendous cultural diversity.

Native Americans who have occupied and used the forest within the plan area understand their own history in ways that are distinct and sometimes different from that derived by Western scholarly traditions. The historical traditions of Native Americans with ties to the plan area are oral in nature, and historical knowledge is maintained by passing it from one generation to the next verbally rather than through written transcripts. Until recently, Native American societies tied to the plan area did not have written languages. A few groups, most notably the Navajo, have developed written forms of their language within the last 150 years. The majority of the Native American societies affiliated with the plan area, however, do not have a written form of their language. In some cases, the lack of written language is an intentional act, reflecting traditional beliefs that historical knowledge, along with other types of religious and sacred knowledge, should be restricted. The version of Native American history presented here reflects what has been written in English by Native writers or told to non-Native researchers.

For Native American groups in the Southwest, geographical features on the landscape are integral to their understanding of history and cultural identity. Vine Deloria, Jr. (Deloria 1994) described the Native American conception of history as being geographical rather than chronological, as spatial connections are more important for understanding cultural identity than a chronological sequence of events. In this conception of history, stories are linked with specific places in the landscape. Because of their permanence as geological features, these places are used to remember historical narratives and traditions, and thus, become a way of linking the present to the past (Ball 2000). For the Native American tribes that claim affiliation with the forest, there are numerous places within the plan area that link Native American oral histories to their traditional homeland in the Southwest, including such stories as group's creation stories. Although all Native American groups affiliated with the plan area have historical ties to the American Southwest, origin histories are diverse among the various groups.

3.8.1.2 Rural Historic Communities

A rural historic community refers to the many peoples of northern New Mexico whose families have strong historical ties to the land. The Santa Fe NF and use of its resources are integral to the subsistence, cultural, and social values that help define the people and communities. The founding of the community generally post-dates the entrance of Europeans in the area and predates the establishment of the Santa Fe NF, or is coincident with the historic development of extractive activities such as logging, mining, ranching, and farming. The community has a significant concentration of human activity, linkage, and continuity of land use on or immediately adjacent to the forest. The day-to-day occupational activities of rural historic communities are rooted in the pragmatic need to make a living and evolved on a specific landscape within or adjacent to lands now managed as the Santa Fe NF. Occupational, subsistence, and cultural-based activities associated with rural historic communities may include homesteading, livestock grazing, fuelwood gathering, logging, Christmas tree harvesting, medicinal plant collection, farming, and mining. Many of the communities within and adjacent to the forest occupy a small land base and have limited opportunities for growth of community facilities and uses (e.g., cemeteries, dumps, domestic water, wastewater, community centers). Acknowledging the importance of these activities and concerns to area families and communities is crucial for understanding their way of life and resolving disputes over public land and resource use. The use of the Santa Fe NF provides opportunities for community interaction and maintenance of traditional culture tied to community and family history. Accommodating tourism and outdoor recreation play some role in the economic vitality of rural historic communities, however, outside income from work in the urban sector of Los Alamos, Santa Fe or Albuquerque sustains many rural households. Regardless, families still living in these communities continue to look to the forest for additional economic opportunity and maintenance of traditional values within the community.

While the Santa Fe NF is often associated with the city of Santa Fe, there are many other smaller communities that rely upon the forest's many resources and uses. Regardless, what these communities have in common is a strong cultural and social tie to the lands in and around the Santa Fe NF. The two types of community organizations identified below (Land Grants- Mercedes and Acequias) are recognized by the State of New Mexico as subdivisions of the state.

Land Grants-Mercedes

From the late-1600s to mid-1800s, Spain (and later Mexico) made land grants or 'mercedes' to individuals, groups and towns to promote development in the frontier lands that today constitute the American Southwest. The two most common types of Spanish and Mexican land grants-mercedes made in New Mexico were "community land grants" and "individual land grants." Community land grants were typically organized around a central plaza, whereby each settler received an individual allotment for a household and a tract of land to farm, and "common land" was set aside as part of the grant for use by the entire community. Individual land grants, as its name suggests, were made in the name of specific individuals. Between 1689 and 1846, Spain and Mexico granted community and individual land grants-mercedes in what is now New Mexico and southern Colorado.

Many traditional Hispanic communities have ties to lands in the Santa Fe NF that were once common lands of community land grants-mercedes. The Santa Fe NF maintains relationships with several Spanish- and Mexican-era land grant-merced communities including former common lands now administered by the Forest Service. Common lands provided land grant-merced communities access to grazing land, stone and clay, wood, game, fish, medicinal plants, and other forest products—uses that continue today. Many land grants-mercedes are actively involved in the management and preservation of adjacent NFS lands for traditional and cultural use. Some have boards of trustees to fulfill this mission through a variety of activities, including managing, protecting, and regulating uses of common lands; preserving cultural and historic resources; and partnering with the Forest Service to plan and propose forest restoration projects on NFS lands.

Acequias

Acequias are community operated and organized water irrigation systems. Many of the State's acequia associations have been in existence since the Spanish Colonial period in the 17th and 18th centuries and were historically associated with land grants-mercedes. Acequia and community ditch associations are political subdivisions of the State of New Mexico and occupy a unique place in forest management (NMSA 1978 §73-2-28). Acequias that existed on unreserved public lands for use in connection with a valid water right, prior to the withdrawal of public lands to create the national forests, are afforded valid rights and status under NFS management. Much of the water diverted by acequias comes off of NFS lands and can be affected by forest management activities upstream. Acequias are still relevant and vital to water delivery and community organizing systems today. They serve as important water infrastructure for communities, and their associations are important community organizations throughout New Mexico.

3.8.2 Issues

The depth of history and peoples' ties to the land on the Santa Fe NF mean federally recognized tribes and other rural historic communities have long and complicated relationships with the lands they use that are currently managed by the National Forest System. Scoping for forest plan revision generated a number of issues relevant to the long-term planning in the forest. Although there are overlapping issues between federally recognized tribes and rural historic communities the nature of the issue may differ between the two.

Major issue areas included access, communication, preservation and protection, confidentiality and privacy, and respect for traditional practices. Both federally recognized tribes and other rural historic communities have a long and abiding connection to lands managed by the forest, and their identity comes from their relationship with those lands. Because of the history of land use, federally recognized tribes and rural historic communities have a continuing need for access to those lands for traditional practices and for the acquisition of resources important for the maintenance of their traditional practices and cultural identity. Federally recognized tribes continue to mention their relationship to the land extending from time immemorial, while members of historic rural communities know the history of their family's settlement of the land dating to entry of European populations in the area in the 16th century. Both have developed a cultural geography for places on forest lands important to them, although the specifics of cultural geography differ between federally recognized tribes and other rural historic communities. Cultural geography is tied to lifeways, and ceremonial practices are tied to the different ways communities use the land. Tribal communities have ceremonial and traditional systems arising from their communities' long history and in many cases, they will argue their life was formed by the land and their intrinsic relationship with it. Other rural historic community lifeways are tied to the documented history of land use resulting from settlement of the land as immigrant populations. Cross-over does exist between tribes and rural historic communities in terms of an appreciation of the land, but the use of the land may differ. The Federal Government's legal obligation to tribes in terms of land use requires consideration when considering land uses by tribes and other rural historic communities.

3.8.2.1 Access and Resource Procurement

During scoping for forest plan revision, the ability to access resources percolated to the top quickly in conversations with both tribes and rural historic communities. However, the reasons for access tended to vary. Both populations desired the forest to consider access regarding resource procurement. Federally recognized tribes were strongly concerned about access to locations of ceremonial practice and traditional materials associated with traditional practices, while rural historic communities placed emphasis on access to resources to maintain a traditional lifeway such as accessible firewood and access for livestock grazing. Both felt strongly that access was an issue when it came to providing access to traditional locations for elderly or less physically capable members of their communities.

3.8.2.2 Confidentially and Privacy

When mentioning access, tribes stressed the unique nature of their cultural practices which frequently involve activities that must remain confidential because the uninitiated are not able to practice ceremonies appropriately; activities must remain confidential to ensure a successful outcome; or the activities are intensely private and are not to be shared with outsiders. The issue of confidentiality for other rural historic communities involved a concern that places of traditional practice remain private and anonymous but did not stress the need for privacy. Federally recognized tribes also have recognition under Federal law of the need for confidentiality and privacy, requiring the forest to accommodate that need when requested. The intent of the regulation is to provide opportunities to federally recognized tribes to practice traditional activities without interference.

3.8.2.3 Communication

Members and leaders of both federally recognized tribes and rural historic communities raised the issue of communication at public meetings mostly in the context of being informed about forest management. For federally recognized tribes, they stressed the importance of being informed about Forest activities because of the potential for impacts to areas of importance to their community, and the potential for them to participate in the process of Forest management. Recent legislation enables federally recognized tribes to have a role in management on Federal lands adjacent to their reservation boundaries or lands with ancestral ties. Members of rural historic communities, especially those with land grant ties and a history of use of common lands in the forest, may have permitted uses in the forest or other land use authorizations that could be affected by Forest management. These relationships in the eyes of stakeholders in tribes and communities require focused communication regarding forest management that may affect their lifeway.

3.8.2.4 Preservation and Protection

Federally recognized tribes have a long-term connection to the land that extends back to time immemorial manifested in the physical remains of the sites, features, objects and places built, used and exploited by their ancestors. These include archaeological sites, systems of trails and access routes, the physical manifestation of traditional practices including rock piles, landmarks, alignments and landscape modifications, agricultural features and natural features. Many of these localities figure prominently in the traditional practices of tribal communities they are considered to be sacred or essential for ceremonial practice to such an extent they need to be protected from vandalism as well as unwarranted deterioration. There are also similar locations that retain value for the traditional practices of rural historic communities and are frequently tied to communal gathering localities tied to specific events, including traditional grazing localities (querencias), pilgrimages, plant collecting, agricultural activities (acequias). For both tribes and rural historic communities, the preservation and protection of these localities contributes to the long-term sustainability of their traditional lifeways.

3.8.3 Methodology and Analysis Process

3.8.3.1 Assumptions

The issues discussed above are representative of the concerns and issues raised by members and leaders of both federally recognized tribes and rural historic communities. The discussion assumes that differences exist between these communities, when in reality the lines between these communities is frequently blurred by the fact that both of these groups reside in the larger northern New Mexico landscape in which the Santa Fe NF is located. In many cases these groups share family members who participate in traditional practices of both groups. The most obvious difference between the two, however, is in the distinction between being a federally recognized entity for tribes versus the role of rural historic communities that lack Federal recognition. This distinction structures the nature of their relationship with the Forest Service. Although the Forest Service is required in the case of federally recognized tribes to address some aspects of the issues presented, in the case of rural communities the forest may or may not be required to address those issues for rural historic communities.

3.8.3.2 Analysis

No detailed analysis using specific metrics was conducted for comparing Plan alternatives among indicators. Instead we evaluated the changes in plan components across the alternatives with respect to the values within those alternatives that may affect the indicators given below.

3.8.3.3 Indicators

Indicators that assist in measuring effects were derived from the results of scoping as well as participation and documentation of issues raised during public meetings.

Indicator 1- Access and Resource Procurement

For Access and Resource Procurement, the change in the forest designated system of travel will provide an indicator of the level of access available. In addition, the amount of forest products made available across alternatives would provide an indication of the relative availability of resources. Any activity that provides for increased access to areas of the forest has the potential to positively address concerns expressed by tribes and rural historic communities. Increased access and vegetative management that provides for the sustainability of resources of concern to tribes and rural historic communities would positively affect the lifeways of those communities while the reverse would also be true.

Indicator 2- Confidentiality and Privacy

The ability for the forest to address confidentiality and privacy across alternatives may be related to accessibility primarily with regard to privacy. Any alternative offering less dense access across the forest is likely to result in a higher potential for privacy. Addressing confidentiality is more difficult to offer a measure for other than to rely on the protection of certain types of traditional information and location under existing Federal law. While increased access is a positive in many ways for communities, the increase in visitation by people from outside tribal and rural historic communities has the potential to negatively affect traditional practices.

Indicator 3- Forest Communication

Indicators of the effectiveness of forest communication may be discerned by tracking the number of public meetings and responses associated with forest activities as well as tracking participation of federally recognized tribes and rural historic communities in the environmental analysis process. That will be difficult to offer a measure across the alternatives, although the difference in degree of development across alternatives may be an indicator of the level of environmental analysis that will be required (i.e., more development associated with road construction or mechanized treatments for large-scale projects may require a greater degree of communication as well as a system for tracking).

Indicator 4- Preservation and Protection

Indicators of preservation and protection to resources can be derived from the potential for those resources to be disturbed by forest management activities. Under the resource analysis for cultural resources and archaeology, indicators included effects to resources from activities associated with resource management and effects to resources resulting from visitation or access to the forest for recreation and other activities.

3.8.4 Drivers and Stressors

The land and the resources provided by the lands that are integral to the lives of tribal and historic communities are enduring climatic driven changes. The arid climate of the southwest is predicted to become hotter and drier over time, enduring increasingly longer periods of drought. Climate change is anticipated to have lasting, large-scale impacts to a variety of ecological, social, and economic resources around the Santa Fe NF (Allen et al. 2005). Mean annual temperatures in the planning area have increased in the last several decades, mostly with increased nighttime temperatures. There has been a decrease in the amount of snow at low to mid-elevations, and an increase in year-to-year precipitation variability (wetter wet years and drier dry years) (Allen et al. 2005). At higher elevations, overall snowfall and spring snow-water equivalent (amount of water in snowpack) have remained steady in most southern areas, but snowmelt now occurs earlier in the year. Changes in temperature and in amounts and timing of precipitation have led to earlier peak stream flow rates in most streams, with higher spring flows and lower summer flows (Allen et al. 2005), and will have a major influence on fire across the western US, especially in mid-elevation forests (Westerling et al. 2006). The extent of these changes and the impact that climatic changes may have on the land and consequences that may arise for tribes and historic communities, remain unknown, but the results of climate change do have the potential to contribute to landscape conditions that may affect all the indicators derived for federally recognized tribes and rural historic communities.

3.8.5 Environmental Consequences

3.8.5.1 Indicator: Access and Resource Procurement

Alternative 1- 1987 Forest Plan

Under the no-action alternative, access and resource procurement would follow existing plan direction as well as direction based on the decision made for Travel Management in 2012 (USDA Forest Service 2012b). Under that decision, there is a mechanism for authorizing access under certain circumstances including for traditional use. Existing law and regulation provides direction that authorizes forest officials to close areas for traditional purposes if requested by federally recognized tribes. ***Forest access provides for the acquisition of Forest products such as fuelwood, pinon nuts, Christmas trees, mushrooms, wildlings, greenery, and medicinal plants, sustaining the continued cultural and traditional uses that involve these products*** [TCU1]***.*** This alternative would result in the second greatest number of open NFS roads for ease of Forest access, but the second lowest output of forest products (see Forest Products and Roads sections).

Alternatives 2, 3, and 4

All action alternatives in the plan have desired conditions for sustaining forest access for federally recognized tribes and rural historic communities ***(TCU 1)***. Access to locations and materials for traditional purposes is addressed in plan components, with a desired condition for forest resources that are important for cultural and traditional needs, subsistence, and economic support to be available and sustainable for use by tribal and historic communities. ***By providing sustainable forest resources, the forest helps to support traditional and cultural uses spanning centuries*** and ***contribute to local economies and livelihoods*** [TCU2]***.*** The mechanism for acquiring forest access (in restricted areas or by restricted methods) or some Forest products would be through authorizations and permits issued at Forest Service offices.

Alternative 2- Forest Plan

Alternative 2 allows for the second lowest NFS road mileage (reduced access) in the forest and for the second greatest expected quantities of forest products of all alternatives (see Forest Products and Roads sections). In alternative 2 there is a plan guideline that states ***temporary roads used for restoration and other activities should be closed, decommissioned or restored to natural conditions after use, which may negatively affect the lifeways of nearby tribes and historic communities by increasing the difficulty of accessing the forest, especially for the elderly or those not able to walk long distances*** [TCU4]***.***

The sustainability of traditional forest materials may be affected by treatments within certain ERUs with the long-term goal of restoring them to a desired condition to achieve restoration goals. Using a blend of mechanical techniques and fire will move vegetation to a condition that would improve habitat conditions for wildlife especially species of traditional concern to tribes and rural historic communities. ***Restoration of grazing land and other lands will improve grass and forb abundance providing for sustainable grazing practices tied to traditional ways of life in rural historic communities and to the sustainable presence of important species necessary for the practice of traditional activities within tribal communities*** [TCU5]. ***Improvements to vegetation resulting in improved habitat conditions would lead to the long term sustainability of wildlife populations used by tribal and traditional communities. The same would also be the case for improvement to grazing land resulting in long term sustainability of grazing practices for tribal and traditional communities***[TCU6]**.** The combination of vegetation treatments in alternative 2 would result in the greatest benefits to the ecosystem of all alternatives ***(TCU 5-6)***.

Alternative 3- Natural Processes Emphasis

Alternative 3 allows for the lowest NFS road mileage (reduced access) in the forest and for the lowest expected quantities of forest products of all alternatives (see Forest Products and Roads sections) ***(TCU 2-4).*** The pace of vegetation treatments from Plan objectives, relies on the use of both natural processes (predominantly fire) and the use of mechanical treatments in selected circumstances, may result in an increased pace of restoration with more ground disturbance. This alternative would have less ecological benefits ***(TCU 5-6)*** than alternative 2, but more than alternative 1 or 4.

Alternative 4- Human Uses Emphasis

Alternative 4 allows for the highest NFS road mileage in the forest and for the greatest expected quantities of forest products of all alternatives (see Forest Products and Roads sections). Under this alternative, the number of routes for access is likely to increase in numerous ways, as this alternative offers the highest degree of access without having to go through an additional process of authorization. This would provide tribal and traditional users easier access to conduct and participate in the traditional and cultural practices in the forest***. Increased access combined with vegetative management contribute to the sustainability of tribal cultural lifeways*** [TCU8]***.*** The intensity of vegetative treatments in Plan objectives for alternative 4 is greater and relies more heavily on the use of mechanical treatments. This intensive use of mechanical treatments may result in a faster pace of restoration but create more ground disturbance than other alternatives, leading to reduced ecosystem benefits ***(TCU 5-6)***. ***In the long term, this would result in more forage available for grazing and increased habitat disturbance for species important to tribal and traditional communities*** [TCU9]***.***

3.8.5.2 Indicator: Confidentiality and Privacy

Alternative 1 – 1987 Forest Plan

Under the current forest plan, existing laws and regulations for federally recognized tribes address confidentiality and privacy of traditional and cultural practices. The Forest Plan includes management direction that broadly guides forest activities to recognize the value of maintaining the traditional cultures of northern New Mexico. Due to the laws and regulations, confidentiality and privacy of traditional and cultural practices is largely protected, but this alternative does the least to supplement those laws and regulations or provide any additional protections. ***The lack of additional protections to confidentiality and privacy surrounding traditional and cultural practices, could degrade these experiences for some groups or may expose these practices to unwarranted users of the forest*** [TCU10].

Alternatives 2 and 3

Alternatives 2 and 3 are driven primarily by the goal of providing restoration of a sustainable ecosystem with differing emphases on the methods used to accomplish the restoration while providing for the wise use of Forest resources. For both alternatives, plan components recognize the importance of providing opportunities for privacy, maintaining confidentiality and protecting traditional resources of importance to sustain the traditional lifeways of federally recognized tribes and rural historic communities. Closing temporary roads would also address issues concerning confidentiality and privacy. ***Decreasing access by restoring or closing temporary roads, would result in a decrease in visitation by people from outside tribal and rural historic communities, helping to protect the privacy and confidentiality of many traditional or cultural practices in the forest*** [TCU11]***.***

Alternative 4 – Human Uses Emphasis

Desired conditions in the forest plan call for opportunities for solitude and privacy for traditional and cultural activities. Alternative 4 poses the largest degree of opposition to achieving this desired condition. Due to plan objectives for mechanically-based vegetation treatments, alternative 4 results in substantially ***increased mechanized activities that have the potential to adversely affect confidentiality and privacy, as additional temporary roads may open areas previously closed to Forest visitors*** [TCU12]. Additionally, the greater emphasis on recreation in this alternative would likely result in increased numbers of forest visitors. ***Increases in visitation by people from outside tribal and rural historic communities has the potential to negatively affect traditional practices, through unexpected breaches in privacy or confidentiality*** [TCU13]***.***

3.8.5.3 Indicator: Forest Communication

Alternative 1 – 1987 Forest Plan

The current Forest plan has forestwide management direction to provide information about Forest management to interested people and groups, as well as to openly involve the public in the planning process. Further, communication would be addressed under existing law and regulation for environmental analysis and decision making, and would also follow revised direction that has been developed since the current plan was implemented. Traditional communities have long expressed a desire for improved and expanded communication with the forest regarding issues that may affect their traditional lifeways. ***Maintaining lines of communication between the FS, tribes, communities, partners, and the public, helps to direct and focus management practices on public lands in order to better meet tribal and traditional community needs in the forest*** [TCU14].

Alternatives 2 and 3

Under alternatives 2 and 3 communication is likely to increase as the number of projects to achieve the aims of the alternative result in an increasingly collaborative environment as encouraged under the 2012 planning rule. The 2012 Planning Rule places a greater emphasis on collaboration, making collaboration and communication a higher priority for the action alternatives than it is in alternative 1. ***Increased communication would lead to stronger relationships between the FS and nearby tribes and historic communities, improving collaboration and protecting shared interests*** [TCU15]. These alternatives offer a blend of processes to achieve the desired conditions developed in the forest plan, requiring site-specific environmental analysis and triggering the required communication. Ultimately, plan components for these alternatives provide for conditions under which communication with federally recognized tribes and rural historic communities is enhanced, benefitting all groups involved.

Alternative 4 – Human Uses Emphasis

As with other action alternatives (2 and 3), communication is likely to increase as the number of projects to achieve the aims of the alternative results in an increasingly collaborative environment as encouraged under the 2012 Planning Rule ***(TCU 14-15)***. However, the pace of analysis and implementation of forest activities in this alternative may override the ability of tribes and rural historic communities to respond to all requests for information. ***Forest plan components provide for conditions under which communication with federally recognized tribes and rural historic communities is enhanced, but does not necessarily recognize the capacity of those communities to address requests, potentially resulting in communication barriers between these groups*** [TCU16].

3.8.5.4 Indicator: Preservation and Protection

Alternative 1 – 1987 Forest Plan

The current forest plan does not include direction regarding issues and mandates for cultural resource preservation and management that have arisen since 1987. It predates the passage of the Native American Graves Protection and Repatriation Act and the 1992 Amendments to the National Historic Preservation Act that articulated the nature of consultation with American Indian communities. Although the current plan lacks site protection, existing Federal law and regulation do provide guidance and direction on preservation and protection of significant sites. This level of preservation and protection for traditional and cultural practices is the lowest of all alternatives. When preservation and protection levels for traditional community practices are not adequate, connections between the people and the land may suffer. ***This causes social and cultural challenges such as damaging or eliminating natural elements of landscapes that hold cultural significance, which diminishes the traditional memory and knowledge within those communities and ultimately threatens the long term sustainability of traditional knowledge and practices*** [TCU17]***.***

Alternatives 2, 3, and 4

All action alternatives emphasize the protection and preservation of traditional resources, which are also covered under a variety of legal requirements. Plan components that promote a move toward restoring a sustainable ecosystem in the forest will also create an environment more conducive to the preservation and protection of traditional resources by stabilizing soils, improving vegetative cover, and treating watersheds. ***This provides a natural environment in which resources of value to communities and traditional practices can thrive and proliferate*** [TCU18]***.***

Alternative 4 – Human Uses Emphasis

Alternative 4 utilizes more intensive methods to achieve landscape restoration, including an increase in mechanized activities that have the potential to adversely affect the preservation of traditional resources. A heavy emphasis on mechanical treatments could degrade sites and leads to the lowest levels of ecosystem benefits of all alternatives ***(TCU18)***.

3.8.6 Cumulative Effects

For cumulative effects the temporal and spatial bounds include the boundary of the national forest and associated watersheds encompassing traditional lands used by federally recognized tribes and rural historic communities. The effects of past activities are generally discussed in the section on the Affected Environment.

The biggest challenge for determining cumulative effects to cultural resources concerns the potential for effects associated with forest and local area visitation—either for recreation or resource extraction—not previously accounted for or that remain unanalyzed. Many local communities, counties, and municipalities have planning documents that outline goals to increase tourism and outdoor recreation through marketing cultural and traditional aspects of local traditional communities. The State of New Mexico has also recently released a Statewide Comprehensive Outdoor Recreation Plan, Viva New Mexico. The recreation and tourism goals of this plan, as with other local plans, broadly align with the effort to sustain recreation and tourist-based economies described in the Plan. However, the push to draw visitors to the area and showcase traditional and cultural sites and lifeways, many of which have cultural significance to traditional communities, could have potential adverse effects to these traditional communities (***TCU10, TCU12, TCU13, TCU17***). The increase in the attraction of the southwest has the potential to affect management of resources and uses important to traditional communities across the forest (***TCU1, TCU13, TCU17***). Additionally, increased tourism may disrupt traditional practices or strain traditional ways of life as more people unfamiliar with the region come to visit and potentially stay (***TCU13***). For many traditional communities, the intrusion of visitors or the uninitiated has the potential to affect the outcome of traditional practices. ***The influx of people could lead to changes in demographics and economic opportunities that may have both beneficial and adverse effects to Northern New Mexico Traditional Communities***[TCU19] (see the Socioeconomics section).

Traditional cultural values and practices are supported by the policies and goals of counties within the analysis area, including support for cultural diversity, the maintenance of cultural resources, and the importance of forest products to their residents for traditional uses (see appendix I). For example, San Miguel County's Comprehensive Plan has a section on Forest Products and Forest Health recognizing the desire for fuelwood gathering opportunities within the county, and Mora County's Comprehensive Plan identifies the protection of historic and cultural ties to the land, including acequia infrastructure, as a goal. For communities and individuals who value these traditional resources and whose culture is tied to the land, these cumulative policies work with those outlined in the forest plan to support traditional communities (***TCU2, TCU4-6***) and ***promote broad acceptance and appreciation of diverse cultural identities and preserve a sense of place important for intergenerational cultural continuity***[TCU20].

Consistent management among the northern New Mexico national forests (Cibola, Santa Fe, and Carson) was recognized as an important way to improve the relationship between the Forest Service and traditional and tribal communities, as well as streamline multi-community and multi-forest communication, with associated positive effects (***TCU14***). In light of this, all three forests' plans recognize the value of cultural resources, uses, and practices important to tribes other traditional communities with historic, cultural, and social connections to lands managed by the forests (***TCU20***). Planning consistency among the three national forests also extends beyond traditional resources. There is a high level of consistency in plan direction for other sections that support the ability of northern New Mexico traditional communities to continue traditions and connections to the land, such as sustainable rangelands and livestock grazing, traditional use of forest products (fuelwood, construction materials, plants), vegetation management, and restoration of fire (***TCU2, TCU4-6, TCU18***).

Additionally, the importance of cultural and artistic outputs to the New Mexican economy (Mitchell et al. 2014) and brand enhance state-level support for the traditional communities. This importance also enhances support for traditional practices that create, drive, and inspire such outputs at the state level and in communities in and around the Santa Fe NF. So, while the estimated increase in visitation to the forest may put pressure on local practices and strain privacy needs (***TCU12, TCU13***), it may also increase cultural awareness and capitol (***TCU20***), as well as ***help support the cultural and artistic economies***[TCU21] so important to many New Mexican communities.

3.9 Cultural Resources and Archaeology

This section provides an overview of the affected environment and an assessment of the potential impacts each alternative could have to cultural resources and archaeology in the forest. The potential differences in treatments within ecological response units as indicated by activities associated with vegetation management activities (i.e., fire and fuels, range and watershed) across alternatives were used to consider effects to cultural resources from those activities. In addition, the potential for effects to cultural resources based on differences between alternatives for roads managements and recreation were also considered.

The National Historic Preservation Act directs agencies to manage effects to Historic Properties (including cultural sites) that reflect past use of the area, having value as defined by the National Register of Historic Places (also known as the “National Register”). The National Register sets criteria for eligibility for Historic Properties by their association with important events, association with important people in our history, distinctive historical or architectural style, and potential to provide information about the past. An historic property can be eligible under one or more of these criteria and is generally at least 50 years old. By definition, Historic Properties are cultural resources and archaeology that has the potential to be eligible for the National Register of Historic Places and can consist of, but are not limited to archaeological sites, historic buildings, traditional cultural places of significance to communities, cultural landscapes, monuments and cultural features that might be clustered in districts, individual sites, buildings, structures and other objects deemed worth of preservation for their historical significance.

Cultural resources are defined in the Forest Service Manual 2360, as “…an object or definite location of human activity, occupation, or use identifiable through field survey, historical documentation, or oral evidence. Cultural resources are prehistoric, historic, or archaeological sites, structures, places, or objects and traditional cultural properties.” Cultural resources include the entire spectrum of resources for which the Forest Service’s heritage program is responsible, from artifacts to cultural landscapes, without regard to eligibility for listing in the National Register of Historic Places (Forest Service Manual 2360). The process of determining the eligibility of a site to the National Register includes identifying historic properties through field inventory, evaluating sites for potential inclusion in the National Register, and then selecting sites to formally nominate to the National Register. Through this process, current and potential impacts to eligible properties are identified, and protection measures are designed and implemented.

3.9.1 Affected Environment

3.9.1.1 Existing Condition and Trends

The Santa Fe NF has a long legacy of human occupation and use, indicated by a large and diverse assemblage of cultural and historic resources. The plan area contains historic properties that demonstrate human occupation and use for approximately the past 12,000 years. Indigenous people have occupied the area for the full span of human occupation including ancestral populations and descendant populations with Pueblo and Athabaskan ethnicities along with other indigenous peoples who interacted with resident populations. Occupation and use of the plan area by Euro Americans and other peoples from the Old World has occurred over approximately the past 420 years. The plan area has been managed by the Forest Service for a little more than 100 years. Tribal, Hispanic, and Anglo-American traditional communities continue to use the plan area for economic, social, and traditional purposes.

To date, valid inventory surveys for cultural resource sites include about 16 percent of the Santa Fe, resulting primarily from pedestrian survey for cultural resources associated with large landscape management projects such as timber harvest and fuels management. Approximately 9,600 sites have been documented in the forest from approximately 3,800 different projects. Of the total number of sites, 54 sites are listed on the National Register of Historic Places and approximately 2,200 sites are eligible for the National Register, although 6,700 remain unevaluated.

Generally, site location is limited to areas suitable for habitation or resource procurement. The distribution of historic properties correlates regularly to major vegetation and ecological communities across the plan area specifically those with piñon-juniper and ponderosa pine included in the community. These correlations offer some support for making predictions about site location with regard to vegetation and ecological community. A large percentage of sites in the forest correspond to the Ponderosa Pine Forest or Mixed Conifer ERUs. The next largest number is in Piñon-Juniper Woodland ERU. In the southwestern United States, studies have shown that settlement generally occurred below 8,000 feet above mean sea level because sedentary agriculture is generally not practical at higher elevations because of a shorter growing season. Around 80 percent of recorded sites in the plan area occur below 8,000 feet including Pre-contact sedentary habitation sites on the west side of the forest including the Jemez Mountains, the Pajarito Plateau, and the Caja del Rio. A large percentage of these sites include small one- to four-room structures or field houses associated with large ancestral pueblo villages with large pueblo-style structures of anywhere from 50 to 2,000 rooms. There are more sites at elevations above 8,000 feet in the Jemez Ranger District than in the other districts.

Cultural and historic resources in the plan area tend to date to prior to A.D. 1600. All sites prior to A.D. 1600 are assumed to be indigenous Americans including a larger percentage associated with Ancestral Pueblo occupation and use, which should not rule out the presence of sites in non-Ancestral Pueblo contexts such as Athabaskan sites. Few sites date to the very earliest periods of human occupation of the area during the Paleoindian period between 12,000 and 9,000 years ago. Less than 4 percent of the properties in the plan area date to the Archaic era (6500 B.C. to A.D. 600). Almost all Archaic sites are found below 8,000 feet in elevation. Of those where the property type is known, the vast majority are chipped stone artifact scatters or the remains of temporary or seasonal encampments. The Jemez Ranger District has the greatest number of sites prior to A.D. 1600, and the Pecos/Las Vegas has the greatest number of historic period sites dating to after A.D. 1600. Few sites are representative of the earliest periods of Ancestral Pueblo occupation during the Developmental Period (A.D. 700-1150). During the Coalition Period (A.D. 1050-1300), the number of Ancestral Pueblo sites on the west side of the forest increased. The largest number of sites in the forest occurs during the Classic Period (A.D. 1300-1600). This large number of sites during the Classic Period shows that the forest had a dense occupation of Ancestral Pueblo people, reinforcing the connections of modern day Pueblo communities to these ancestral sites. Since 1598, when the Spanish entrada occurred, there has been continuous expansion of historic communities around all of the ranger districts in the forest, which is indicated in the archaeological site record by the presence of post-contact sites associated with occupation and use of the area by land grant communities and other settlements.

Nearly all cultural items collected during excavations by cultural resource consultants and permittees to the Santa Fe NF are currently curated at the Museum of New Mexico, which is the standard repository in New Mexico. The Museum of New Mexico also houses collections from past research surveys in the Santa Fe NF, including those conducted by museum personnel; collections are also housed at other institutions. Informal collection of artifacts accumulated during Forest Service permitted and sponsored projects have been curated and archived at the forest supervisor's office in Santa Fe. While the collection, curation, and archival of diagnostic surface artifacts was the norm from the 1970s through the early

1990s, this practice has since been virtually discontinued with reference to an informal non-collection policy for all but extraordinary situations. All relevant items that were archived in pre-1990 collections at the Museum of New Mexico have been repatriated to tribal governments in accordance with the Native American Graves Protection and Repatriation Act.

Many cultural resource sites in the Santa Fe NF have been negatively affected by past and ongoing activities. Cultural resources have been lost or damaged by past land management activities, including those dating from before national forest designation, from vandalism and visitor use, and as a result of natural events. Many activities were initiated prior to implementation of the National Historic Preservation Act of 1966, as amended. Adverse effects have decreased over time because today, significant sites are typically identified during project planning, allowing for design to avoid and mitigate potential effects before implementing an action.

During assessment and scoping for the forest plan, issues associated with cultural resources and archaeology included recognition that the Santa Fe NF has some of the highest site densities found on NFS lands in the United States, with only about 20 percent of the forest intensively inventoried to current standards. Having a high density of significant historic and cultural sites across the landscape makes the sites more vulnerable to effects resulting from human activities (both intentional and unintentional) and from natural processes. In addition to high site density, many of the sites or the landscapes in which they occur represent the remains of significant developments in the human history of the American Southwest. These sites reflect the ancestral settlement of Pueblos in the Northern Rio Grande, and are associated with modern Pueblo communities that continue to view the forest as part of their cultural landscape.

Aside from having one of the highest site densities in the Forest Service system, many sites in the Santa Fe NF are visible upon the surface of the land due to the exposed nature of southwestern soils, a general lack of ground cover, and an arid climate generally suitable for long-term preservation. As a result of high visibility and high site density in the Southwest, many cultural resources in the Santa Fe NF are vulnerable to effects from visitation (see Environmental Consequences). Consequently, the high cultural resource density in some areas of the forest also corresponds to areas that are anticipated to receive vegetation treatments at varying rates depending on Plan objectives outlined for all action alternatives (see Environmental Consequences).

3.9.2 Methodology and Analysis

3.9.2.1 Assumptions

The assessment of potential effects to cultural resources and archaeology incorporated the following assumptions:

- The ERUs are continuous across land jurisdiction within the administrative boundaries of the forest.
- ERUs with plan objectives for vegetation treatments have increased potential to adversely affect cultural resources within those areas.
- ERUs lacking objectives may have plan components with activities likely to affect cultural resources but not to the degree of those with objectives.
- The distribution of cultural resources inventory varies across ERUs.
- The number of sites within ERUs is representative only of sites that have been recorded within them during cultural resources inventory.
- ERUs with low inventory percentages may not represent the actual potential for sites in them.

- Proximity to roads bears some relationship to the potential for cultural resources to be visited, especially within the corridors specified in the motorized system of travel.

3.9.2.2 Indicators

To evaluate effects on cultural resources, we determined two indicators that would best portray differences across alternatives, primarily from activities associated with vegetation management and visitation or access. In addition, effects to cultural resources may also occur from other activities associated with the forest plan, resulting in secondary effects, such as wind and water erosion, associated with those activities.

Indicator 1

Effects to cultural resources resulting from Plan objectives for vegetation management.

Indicator 2

Effects to cultural resources resulting from visitation or access to cultural resources as a result of use of the forest for recreation and other activities.

3.9.2.3 Analysis

Vegetation treatments

The Forest Plan's focus on ERUs, as essential units of meaning for understanding forest management in the Santa Fe NF, provided the basis for analysis of the potential for forest activities to affect cultural resources and archaeology. For the analysis, the distinction was made between ERUs for which plan objectives were developed from those without. Although all ERUs had plan components, the difference between those having objectives and those not having objectives has the potential to affect cultural resources and archeology to different degrees in terms of the types of management proposed for the life of the plan. ERUs with objectives associated with vegetative management have the potential to affect cultural resources and archaeology because of the relative amount and focus of forest activities within those areas.

ERUs with objectives

Analysis of the effects of alternatives on cultural resources and archaeology depends on determining what resource has the most potential to receive management focus within an alternative. For cultural resources it is assumed that changes in the alternatives, with regards to management of vegetation, has the greatest potential to affect cultural resources and archaeology. In the forest, the ecological response units correspond to vegetative communities that have specific desired conditions defined in the forest plan. Those ERUs having current conditions that are the most departed from desired conditions were given Plan objectives for vegetation treatments to reduce the departure and return proper ecological function to these areas.

The Forest analyzed the number of times cultural resources and archaeology sites (collectively hereafter: sites) occurred within ERUs that had Plan objectives (see table 79). For the ERUs, the site occurrences represent every time a site occurred within an ERU, but was not necessarily the actual number of sites that occurred (i.e., in numerous cases, individual sites cross-cut multiple ERUs such that to count the number of site occurrences is not actually representative of the number of sites in an ERU, but rather the number of times that sites intersected an ERU). In addition, the table portrays the acreage for site occurrences within an ERU. Regardless of ERU type, the percentage of acreage of site occurrences is low, especially in ERUs with objectives (14.3 percent), and very low in ERUs without objectives (1.0 percent).

The seven ERUs listed in table 79 account for 66 percent of the total vegetation in the Santa Fe NF. Moreover, associated site occurrences account for 75.5 percent, meaning activities associated with vegetation management in those ERUs have the potential to affect a large percentage of sites occurring in the forest. Although management activities may occur in all ERUs, the focus of management activities, based upon Plan objectives are planned to occur in ERUs that coincidentally contain the greatest percentage of sites. Because of this, the greatest potential for site effects from management activities will occur within those ERUs.

Table 79. ERUs with objectives and site occurrences

Region 3 ERU Classification	Frequency of Site Occurrence in ERU	Site Occurrence Acres in ERU	Total ERU Acres
Colorado Plateau / Great Basin Grassland	237	847.8	41,685.5
Juniper Grass	810	3,833.4	97,668.8
Mixed Conifer - Frequent Fire	1,248	2,260.6	464,575.5
Montane / Subalpine Grassland	195	193.8	17,596.5
PJ Grass	393	1,058.9	43,335.8
Ponderosa Pine Forest	5,290	6,023.0	404,118.0
Sagebrush Shrubland	612	1,574.8	37,450.0
Total Acreage of sites in ERUs with objectives		15,792.3	
Total Sites Occurrences in Objective ERUS	8,785		
Total ERUs Acres with Objectives			1,106,430.2

ERUs without objectives

Although management activities may occur within ERUs without Plan objectives, there is a subtle distinction regarding the emphasis of activities. Other plan components guide management activities within these ERUs, but overall, there is less potential for there to be effects to cultural resources from vegetation management activities, because the bulk of activities will be in those ERUs with objectives as mentioned above. One major difference between site occurrences within ERUs with objectives and those without is the frequency of site occurrence. Site occurrence is much lower within ERUs without Plan objectives. Even though activities might be planned within ERUs without objectives the potential for effects greatly decreases.

Table 80. ERUs without objectives and site occurrences

Region 3 ERU Classification	Frequency of Site Occurrence in ERU	Site Occurrence Acres in ERU	Total ERU Acres
Mountain Mahogany Mixed Shrubland	1	1.0	5.5
Bristlecone Pine	2	0.2	2,781.4
Gambel Oak Shrubland	2	4.5	1,717.8
Historic Riparian - Agriculture	2	2.3	767.8
Shortgrass and Mixed Grass Prairie	4	3.8	1,165.2
Mixed Conifer w/ Aspen	6	1.2	4,770.4
Alpine and Tundra	8	14.8	5,969.5

Region 3 ERU Classification	Frequency of Site Occurrence in ERU	Site Occurrence Acres in ERU	Total ERU Acres
Ponderosa Pine / Willow	8	3.5	66.3
Upper Montane Conifer / Willow	8	4.8	495.0
Willow - Thinleaf Alder	126	89.4	6,959.1
Herbaceous (wetland)	130	158.7	14,426.9
Spruce-Fir Forest	142	200.7	250,618.6
Rio Grande Cottonwood / Shrub	158	301.0	7,493
Narrowleaf Cottonwood / Shrub	197	416.0	15010
PJ Sagebrush	297	528.9	30,424.1
PJ Woodland	1,760	4,082.8	231,585.9
Total Site Acres in Non-objective ERUs		5,813.8	
Total Site Occurrences in Non-objective ERUs	2,851		
Total ERUs Acres without Objectives			574,082.2

Visitation

To assess the potential for sites to be visited by the general public as a result of recreation or other activities in the forest, we analyzed the relationship of cultural resource location within 150 feet on either side of roads and highways providing public access to the forest. This analysis included the state highway system and the approved motorized system of travel in the forest.

Access to cultural resources poses the potential for effects resulting from visitation. The Santa Fe NF does not have data reflecting the amount of visitation to cultural resources other than observation. The system of motorized travel and state highways accessing the national forest intersects 4,412 separate site instances including many that are crossed by multiple roads. The analysis area for the motorized travel system and state highways for intersects with cultural resources included a 300-foot-wide corridor with 150 feet on either side of centerline. With a total of 10,279 sites included in the analysis, the results showed that approximately 43 percent of the documented cultural resources in the forest are within an accessible distance of any roadway designated for use.

3.9.3 Drivers and Stressors

Two broad classes of drivers with multiple stressors affect the management and preservation of cultural resources in the forest including ecological and socio-cultural drivers. Ecological drivers are natural processes that act upon the landscape with associated drivers such as climate change, geologic process and wildfire. Sociocultural drivers include population change, tourism, and criminal activities.

Stressors associated with natural drivers include drought, erosion, vegetative change, flooding, soil movement and weathering. Climate change has affected the degree of which each of these stressors acts upon cultural resources. In general, the effects of stressors are not considered to be beneficial and, in many cases, have been detrimental. Wildfire also results in many of the same stressors especially vegetative change, unstable soils, and erosion. Erosion, flooding, and soil movement are geologic processes that are triggered by other stressors that accompany climate change and wildfire. There is evidence for increasing heat and drought within the southwestern United States (CLIMAS). Although dry conditions are a fact of life in the arid Southwest, there is some indication the Southwest is in a mega-drought that began in the late 1990s. The drought is presumed to be driven by increasing temperature associated with climate change as indicators of overall forest environment change when measuring drought stress and tree mortality. Drought contributes to loss of vegetation and increased fire danger. Increased wildfire leads to soil instability and flooding. These stressors are interrelated with one contributing to the other in a feedback loop that ultimately leads to the potential for effects to cultural resources. Of these stressors, soil instability and flooding have the most potential to affect the condition of cultural resources. Cultural resources occur in and on soils. As soils become unstable and move the context of cultural resources on those soils deteriorates. The most obvious examples of the effects of such stressors in the Santa Fe NF include sites affected by the Las Conchas Fire in 2011. Cultural resources including historic sites in Pine and Bland Canyon as well as prehistoric sites on Sanchez Mesa were all severely changed by post-fire effects resulting from soil movement and flooding.

Changes in vegetative structure are associated with climate change, such as the decline of southwestern forests discussed in the *Nature* article above. In addition, Craig Allen in Fraser (2013) explains that the severe fires the forest has experienced since 1995 may result in permanent forest loss, leading to type conversion where ponderosa pine may, because of stressors associated with climate change, not repopulate the landscape and be replaced with shrub- and grasslands. The effect of this conversion on cultural resources has not been studied, but changes in vegetation may result in changes in soil and cover for cultural resources in the forest.

Aside from stressors influenced by climate change, background geological processes such as erosion and weathering may affect cultural resources. By its very nature, the Southwest climate is arid, leaving large portions of the landscape exposed to the forces of nature. Open-air sites, rock art sites and perishable sites can be affected by weathering factors such as wind and rain. The monsoon phenomenon’s frequent and violent storms often produce tremendous runoff that affects cultural resources by moving deposits of sediment and covering them with debris.

Sociocultural drivers include stressors primarily associated with human populations. Population growth in the greater Southwest is anticipated to increase significantly by 2030. In addition, the region of the Southwest in which the forest is located is a prime tourist destination. These two drivers result in a significant number of people in the immediate area of the forest. Plus, forest resources recreational, cultural and subsistence invite users to visit. An increase in the number of forest users leads to the potential for effects to cultural resources either from vandalism or unintentional effects. The stressors associated with these drivers include unmanaged site visitation, looting of sites by intentional digging, unintentionally damaging sites by trampling or taking cultural materials from the surface.

3.9.4 Environmental Consequences

For the forest to initiate vegetation management activities in compliance with Section 106 of the National Historic Preservation Act and its implementing regulations in 36 CFR 800, requires the forest to evaluate the potential for actions to adversely affect the significant qualities of those resources. As part of this consultation, the forest consults with the New Mexico State Historic Preservation Officer in the Historic Preservation Division, and with affiliated tribal communities and consulting parties that have traditional uses and resources in the forest. The evaluation of effects includes determining if a project would result in determinations of No Historic Properties Affected, No Adverse Effects, or Adverse Effects.

Any activity of the Federal Government that has the potential to affect cultural resources is considered an “undertaking.” Generally, projects or undertakings resulting in No Historic Properties Affected either have no identified historic properties, or effects to historic properties are avoided by activities associated with a project. To have No Adverse Effect, a project would have activities that have the potential to impact in some way, but ultimately would not alter the characteristics that make that historic property eligible for the National Register. Finally, projects that will alter or destroy the qualities that make historic properties eligible for the National Register have an Adverse Effect.

3.9.4.1 Effects common to all alternatives

Indicator: Vegetation Management

All alternatives have plan components for the use of some degree of mechanical treatments and fire to treat vegetative ecosystems in the forest, with the intent to restore desired forest structure and function and increase ecosystem resiliency. These treatments also serve to reduce the risk of uncharacteristic fire (burns large areas with exceedingly high severity) by reducing available fuels and decreasing the density of forests and woodlands. While these treatments have numerous effects on vegetation and the ecosystems in which they occur (see Vegetation and Fire FEIS), they would also have effects on cultural resources. ***Mechanical treatments impact cultural resources by compacting the ground in and around archaeological sites and by disturbing the distribution or arrangement of cultural deposits, artifacts, features and structures within sites, which affects the condition and information potential of the cultural resources on sites. Disturbance to these components of sites has the potential to adversely affect the integrity of sites for research purposes and may adversely affect communities with ancestral ties*** [CR1]***. Machinery used to conduct mechanical treatments may also alter the physical properties of artifacts*** [CR2]. ***These factors challenge our understanding of these areas and degrade qualities that make the sites eligible for inclusion on the National Register*** [CR3]***.***

The cultural resources in the Santa Fe NF have persisted through many fire cycles over time and are generally not highly damaged by low-severity fire that moves quickly across the landscape. ***Lower severity fires can damage cultural resources by altering their chemical or physical properties, such as charring exterior surfaces or promoting faster decomposition rates*** [CR4]. ***In some cases, lower severity fires can completely consume plant fibers, hair, or textiles ruining the important historical data they once held*** [CR5]. ***High-severity fire can be devastating to cultural resources, especially for perishable and fire-sensitive items such as wood, material, basketry, hides, leather, and plant residues or seeds*** [CR6]***. These extreme temperatures completely destroy or alter the physical characters of artifacts, which significantly alters informational context*** [CR7]***. These fires also affect the potential for dating features in a historical context by either altering their physical composition as in the realignment of radiometric iron in hearths or the deposition of recent carbon in archaeological contexts with the potential for C14 dating.*** [CR8]***.*** Furthermore, ***severe fire damages vegetation and ground cover, often leading to soil hydrophobicity, and thereby increasing erosion and water run-off which can move cultural materials from their origin***[CR9]***. Finally, management actions associated with wildfire suppression frequently lead to effects to cultural resources including the construction of fire line through sites, burning of perishable materials resulting from suppression ignition and other effects associated with the suppression of wildfire***[CR10]***.***

Indicator: Visitation

Visitors to the Santa Fe NF for any purpose have the potential to negatively affect cultural resources. Perhaps the largest impact is due to looting or vandalism of cultural sites and the artifacts within them. ***Looting and vandalism destroy the integrity of cultural sites and threatens the preservation of cultural heritage*** [CR11]. ***Visitation to cultural sites may also lead to the redistribution of artifacts which damages contextual information about the site*** [CR12]. ***Like humans, animals such as livestock which graze in the forest impact cultural sites through their visitation by causing soil compaction, erosion, and vegetative***

disturbance, or more directly by damaging artifacts through trampling and by changing the arrangement or distribution of artifacts **[CR13]**.

3.9.4.2 Alternative 1 - 1987 Forest Plan

Under alternative 1 there would be no change to the process of managing cultural and historic resources in the Santa Fe NF. The 1987 Plan provides specific direction regarding various facets of cultural resource management, including project clearance procedures, site protection, enhancement and interpretation, research, and curation of collections. Most of these elements are required by various laws, regulations, policies, and agreements, particularly the cultural resource protection compliance and clearance process specified by section 106 of the National Historic Preservation Act. The 1987 Plan provides for the management of effects to cultural and historic resources primarily through the concept of management areas. ***Forestwide management direction provides for inventory, protection, evaluation, nomination, interpretation and enhancement of cultural and historic resources*** **[CR14]*.*** Specific management areas require more focused management that provides for the preservation and enhancement of cultural and historic resources in specific areas of the forest while limiting or excluding other management activities within those management area including the exclusion of land-disturbing activities, which have the potential to adversely affect the qualities of cultural resources and archaeological sites that make them eligible for the National Register. ***Limiting activities that have the potential to adversely affect sites and cultural resources while promoting preservation and stabilization activities enables Forest users to visit and appreciate cultural resources and provides research opportunities*** **[CR15]** (e.g., human occupation in the Northern Rio Grande and Southern Rocky Mountains).

The 1987 Plan also sets annual accomplishments for enhanced and beneficial cultural resource management outside those required to meet compliance needs under National Historic Preservation Act. The 1987 Plan includes identification of sites through non-project inventory (section 110 of the National Historic Preservation Act), site stabilization and restoration, and public interpretation of historically significant sites. The 1987 Plan also allows for coordination of cultural resource management activities with the State Historic Preservation Officer, other State and Federal agencies and Native American (American Indian) groups. The 1987 Plan also specifically calls out for the coordination with Native American (American Indian) groups regarding other resource management activities.

The no-action alternative does not include direction regarding issues and mandates for cultural resource preservation and management that have arisen since 1987. It also does not address management of collected artifacts and cultural items, nor the need to have them catalogued and curated in accordance with current standards. Specifically, the plan predates the passage of the Native American Graves Protection and Repatriation Act and the 1992 amendment to the National Historic Preservation Act, the latter of which called attention to procedures for the identification of traditional cultural properties. While the 1987 plan is devoid of direction regarding compliance with many recent laws and regulations that protect cultural resources, Santa Fe archaeologists are cognizant of the latest regulations and ensure that their requirements are followed. Finally, most of the objectives for cultural resource management in the 1987 forest plan have been accomplished, have become standard operating procedures, or are now irrelevant. The no action alternative does not provide direction on managing resources in response to climate change. The results of climate change have the potential to contribute to changing landscape conditions that may affect the condition of cultural and historic resources.

The emphasis in the 1987 Plan does not differ significantly from the desired conditions for cultural resources and archaeology. In 1987, subsequent to the Save the Jemez lawsuit, the plan addressed many concerns in the lawsuit which were similar in content to the desired conditions proposed in this plan.

Cultural resource preservation and integrity, public interest and education, and heritage tourism were addressed in many of the standards and guidelines contained in management areas with cultural resource emphases.

Overall, it is expected that this alternative would have the lowest adverse effects ***(CR1-5)*** from vegetation treatments due to the small number of acres that are treated annually using mechanical methods and fire under this alternative. However, the risk for uncharacteristic fire would remain higher in this alternative than in alternatives 2 and 4 which incorporate higher acreages of fuel reduction treatments causing greater potential for adverse impacts ***(CR4-10)*** to cultural resources associated with fire. This alternative is also expected to have fewer adverse effects on cultural resources due to visitation ***(CR11-13)*** than alternative 4, which maximizes human uses in the forest.

3.9.4.3 Effects common to alternatives 2, 3, and 4

Alternatives 2, 3, and 4 are driven primarily by a goal to provide for the restoration of a sustainable ecosystem with differing emphases on the methods used (fire and mechanical treatments) to accomplish restoration, while providing for the wise use of forest resources. While these vegetation treatments are ecologically beneficial, the treatments pose an increased potential to negatively impact cultural resources and artifacts. ***Through conducting vegetation treatments, direct damage could occur to cultural resources or artifacts on the ground surface or those that reside shallowly beneath the surface, degrading their physical characteristics or affecting their potential to inform about past lifeways*** [CR16]***. Vegetation treatments may also expose unknown sites due to ground cover removal or soil disturbance, which could subject these sensitive areas to increased erosion, visitation, or vandalism*** [CR17]***.***

3.9.4.4 Alternative 2 - Forest Plan

Indicator: Vegetation Management, Fire and Roads in Restoration-Management direction under alternative 2 would accomplish restoration goals using a balance of mechanical treatments and fire primarily in the Dry Mixed Conifer, the Ponderosa Pine Forest, and other moderately to highly departed ERUs that make up over 50 percent of the forest acreage. Plan objectives show total treatment acres ranging from 25,000 to 180,000 acres of mechanical and 200,000 to 450,000 acres of fire over a 10-year period. Although legal requirements for compliance would be responsible for ensuring effects to cultural resources from prescribed fire are managed effectively, the potential exists for impacts on cultural resources from activities associated with vegetation management ***(CR1-5)***, especially as a result of non-compliance activities that degrade cultural sites ***(CR3)***. There may also be indirect effects associated with vegetation management using fire and mechanical treatments ***(CR9)***. The use of naturally occurring fire to accomplish vegetative objectives also requires some level of compliance with the forest's legal mandate. However, given the often urgent nature of suppression conflicting with need for the management of fire for resource benefit, there is some increased risk to cultural resources and archaeology through increased fire on the landscape ***(CR4-8)***. Even though this alternative incorporates more acres of fire than alternative 1, the adverse effects ***(CR6-10)*** should be lowest here due to the reduction of uncharacteristic fire risk through additional fuels treatments.

The primary intent of roads management associated with this alternative is to leave a manageable system for public and administrative access. Although there would be an emphasis on road decommissioning, the development and use of temporary roads in support of restoration activities does pose a potential for effects to cultural resources and archaeology. ***Damage caused by vehicles includes reduction of cultural deposits, displacement and damage to artifacts, and loss of soils and vegetation (Sampson 2007)*** [CR18]***.*** Increased access by temporary roads into the forest could also increase visitation to newly opened areas and have greater adverse effects on cultural resources ***(CR11-13, 16-17)***. Road decommissioning also requires evaluation of effects to cultural resources and archaeology under this alternative.

Indicator: Recreation and Forest Visitation-Under this alternative, there is a reduced likelihood for expansion of the motorized system of travel, limiting access to the forest on existing roads and trails designated in the forest visitor use map. This would limit the potential for effects to cultural resources and archaeology through visitation, making this alternative have less adverse effects than alternative 1 ***(CR11-12)***. However, plan direction would provide for design, construction, and maintenance of trails consistent with user demands, ***potentially leading to the expansion of the trail system. In high density areas, this would expose cultural resources and archaeological sites to damage and result in the loss of their cultural and research value*** [CR19].

3.9.4.5 Alternative 3 - Natural Processes Emphasis

Indicator: Vegetation Management, Fire and Roads in Restoration-Management under alternative 3 emphasizes the use of prescribed fire and managed wildfire to accomplish restoration goals with mechanical treatments used only in select situations. The reduction in mechanical treatments reduces the potential for effects to cultural resources and archaeology compared to alternatives 2 and 4 with an emphasis on the protection of values at risk ***(CR1-3, 16-17)***. However, the increase in fire acres, which are estimated to fall between 350,000 to 1,700,000 over 10 years, does greatly increase the potential to affect cultural resources from activities associated with prescribed fire, fire suppression, and from the management of wildfire ***(CR4-10)***. As with alternative 2, the effects of prescribed fire are evaluated through the compliance process leaving noncompliance activities or indirect effects as having the highest potential to affect. The use of naturally occurring fire to accomplish vegetative objectives also requires some level of compliance with the forest's legal mandate; however, given the emergency nature of suppression and the urgency associated with the management of fire for resource benefit, there is an increased risk to cultural resources and archaeology. The predominance of fire across the landscape in this alternative, combined with the lack of mechanical pre-treatments, yields the highest risk of all alternatives for uncharacteristic fire ***(CR6-10)***.

The primary intent of roads management associated with this alternative is to leave a manageable system for public and administrative access. The avoidance of permanent and temporary road construction in this alternative would reduce the potential for effects to cultural resources ***(CR18)***, more than all other alternatives.

Indicator: Recreation and Forest Visitation-Under this alternative, there is a reduced likelihood for expansion of the motorized system of travel limiting access to the forest on existing roads and trails designated on the forest visitor use map. This greatly limits the potential to effects to cultural resources and archaeology from the use of that system ***(CR18)***. Plan direction would ***emphasize the mitigation of ecological damage at developed recreation sites, potentially indirectly reducing effects to cultural resources and archaeology through restoring ground cover, stabilizing the soil, and restoring other site characteristics to natural conditions*** [CR20]. In addition, the closure and rehabilitation of some recreation sites, this alternative would reduce the potential for effects by increasing the difficulty of forest access, limiting visitation to areas in the forest with significant cultural resources and archaeology ***(CR11-12)***.

3.9.4.6 Alternative 4 - Human Uses Emphasis

Indicator: Vegetation Management, Fire and Roads in Restoration-Plan objectives under alternative 4 would accomplish restoration goals primarily using mechanical treatments and allowing the management of wildland fire when it is appropriate as opposed to suppression ***(CR1-5, 16-17)***. Although legal requirements for compliance would be responsible for ensuring effects to cultural resources from mechanical treatments are minimized, the potential exists for cultural resources and archaeology to be affected from noncompliance activities and ***indirect effects associated with the movement of machinery across the landscape that would degrade undiscovered cultural sites as machinery passes over and compacts the soil*** [CR21]. The increase in mechanical acres to between 130,000 and 400,000 acres over a 10-year period increases the likelihood of negative effects occurring, especially in ERUs with some of the highest densities of cultural resources and archaeology in the forest ***(CR1-3, 16-17)***. The use of fire in this alternative is limited enough that the potential for effects to cultural resources and archaeology is reduced ***(CR4-5)***. The potential for an increase in effects resulting from the lack of treatment of fuels does have the potential to affect cultural resources and archaeology resulting from uncharacteristic fire ***(CR6-10)***, though this risk is expected to be second lowest of all alternatives.

The increase in road maintenance and new road construction, both temporary and permanent, to provide for access to traditional uses as well as forest management activities increases the potential for cultural resources and archaeology to be affected under this alternative to the greatest extent of all other alternatives ***(CR18)***.

Indicator: Recreation and Forest Visitation-Under this alternative there is the greatest increased likelihood for expansion of the motorized system of travel, increasing access to the forest on existing roads and trails designated on the forest visitor use map. This increased access boosts the potential for effects to cultural resources and archaeology from use of that system and from increased visitation ***(CR11-12, 18)***. Plan direction would also provide for new construction of trails and developed recreation sites to accommodate the volume of visitors ***(CR19),*** increasing the potential for both direct ***(CR11-12)*** and indirect effects from visitation on cultural resources and archaeology, although planned construction would require compliance with appropriate laws and provide for the mitigation of effects.

3.9.4.7 Cumulative Effects

For cumulative effects, the temporal and spatial bounds include the boundary of the national forest and associated watersheds. It also encompasses the cultural areas located in associated watersheds. The span of time associated with cumulative effects is the anticipated life of the Forest Plan: 10 to 15 years. The effects of past activities were discussed in the Affected Environment section.

Outside of the effects described above from plan components that guide the management of many resources, the biggest challenge for determining cumulative effects to cultural resources concerns the potential for effects associated with Forest and local area visitation (either for recreation or resource extraction purposes) that were not previously accounted for or those that remain unanalyzed.
Many local communities, counties, and municipalities have planning documents that outline goals to increase tourism and outdoor recreation. The State of New Mexico has also recently released a Statewide Comprehensive Outdoor Recreation Plan, Viva New Mexico. The recreation and tourism goals of this plan, as with other local plans, broadly align with the support to sustainable recreation and tourist-based economies described in the Plan. However, the push to draw visitors to the area and showcase local amenities, many of which have cultural and archaeological significance, could have potential adverse effects. The increase in the attraction of the southwest has the potential to affect management of cultural resources and archaeology in the forest if visitation rates increase, elevating the potential for adverse effects ***(CR3, 11-12)***, such as increased risk of site degradation and cultural disruption.

Educational efforts by surrounding national parks, like Bandelier and Pecos National Historical Park, and museums, and the thriving cultural and artistic trade done by surrounding Pueblos may also help mitigate potentially negative effects of increased visitation to the area (***CR11, CR12, CR15, CR18, CR19***). These activities inform visitors to the region about how to responsibly interact with cultural and archaeological resources and provide visitors with ways to safely and legally view and appreciate cultural artifacts and art that reflect the region without resorting to theft, vandalism, or looting (***CR15***). However, these cultural attractions also play a role in the increasing popularity of the Santa Fe region as a destination, drawing in visitors that may increase pressure on cultural and archaeological sites, particularly those open to the public or near public access routes. As New Mexico, and particularly the counties and communities around the Santa Fe NF, encourage a recreation and cultural tourism-driven economy (see FEIS Volume 2, Appendix I, for an overview of state, county, and municipality planning documents), the landscape of cultural and archaeological resources could become more at risk of being "loved to death" (***CR11, CR12, CR18, CR19***).

Goals outlined by the New Mexico State Historic Preservation Plan (NMSHPP), such as their goal to foster stewardship of cultural sites, could aid the forest's efforts to protect sites of cultural and archaeological significance. The NMSHPP outlines objectives supporting this goal to protect archaeological sites and identify threatened areas via a number of collaborative strategies. The NMSHPP also describes goals to broaden preservations' relevancy, increasing dialogue among different preservationists and promoting responsible heritage tourism in lands around the Santa Fe NF. This work could bolster Forest efforts to educate the public about site protection and cultural sensitivity, helping to mitigate potential adverse effects from increased tourism and recreation (***CR11, CR12, CR18, CR19)***. Ongoing activity by the Santa Fe NF Site Stewards, a volunteer group that works closely with the Santa Fe NF Heritage Staff, may also mitigate potential negative impact (***CR11, CR12, CR18, CR19)*** from increased activity in the forest through monitoring of sites and increasing awareness of cultural heritage stewardship and preservation.

Travel management decisions in the Santa Fe NF and its sister forests—the Cibola and Carson—limit motorized activity by the public to designated routes. This provides additional protection to cultural and archaeological resources from impacts of motorized activity (***CR18***). Similarly, fire management efforts by all three national forests in partnership with surrounding communities and land-owners (e.g., Los Alamos National Laboratory and multiple Pueblo Nations) reduces cumulative risks to important cultural sites by implementing site treatments such as fuels reduction and black lining, due to fire moving across the landscape, or fire moving onto the forest from an adjacent property. As severe fire damage is a significant threat to cultural heritage and archaeological resources (***CR4-CR10***), collaborative fire management efforts increase landscape-scale preservation of these resources in the Santa Fe NF and across the State of New Mexico. While fire management efforts may present risks in and of themselves to cultural and archaeological resources (***CR10***), over the long term, a reduction in uncharacteristic fire risk across the region will also reduce the need for the most damaging types of fire management, such as digging fire lines and burning off fuels.

3.10 Forest Products

Forest products include large and small wood products (e.g., timber, vigas, latillas, posts, poles, fuelwood, and biomass) and special forest products: floral greenery, Christmas trees and boughs, mushrooms, wildlings (e.g., transplanted trees, shrubs, or herbaceous plants), cones, medicinal plants, cuttings, herbs, nuts, berries, and decorative wood. National Forest System (NFS) lands were reserved with the intent of providing these goods, including the production of a sustainable supply of forest products and services to satisfy public needs over the long term. The Santa Fe NF has been a key source of woody materials for a geographic area widely covered in grass- and shrublands throughout history. Wood from the forest has long provided heat, building and fencing materials to area residents, and during times of strong commercial timber production, wood products to markets much farther away. As conditions change, the services and products available in the forest have evolved but needs for these products have remained the same. According to public input, the two predominant issues that concern forest products are that: (1) access for mechanical treatments and timber extraction is maintained, and timber products are readily available to support local communities and their economies, and (2) access to the forest for the collection of forest products is integral to local traditional and cultural ways of life.

3.10.1 Affected Environment

The Santa Fe NF is approximately 1.6 million acres of land, with the overwhelming majority of acres occurring in forest and woodland vegetation types. These tree and shrub dominated areas include mixed conifer-frequent fire forests (MCD, 25.6 percent of Santa Fe NF acres), ponderosa pine forest (PPF, 24.0 percent), spruce-fir forest (SFF, 14.9 percent), persistent PJ woodland (PJO, 13.8 percent), juniper grass (JUG, 5.8 percent), PJ grass (PJG, 2.6 percent), mixed conifer with aspen (MCW, 2.4 percent), and PJ sagebrush (PJS, 1.8 percent). Many of these vegetation types are in moderate to high seral state departure from reference conditions, resulting in abnormally dense stands, shifted species compositions, and altered fire regimes (see Vegetation section). The vegetation types dominated by large conifer (and some hardwood) species (SFF, MCD, PPF, and MCW) supply the bulk of the merchantable timber and larger diameter wood products extracted from the forest, while the woodland and grassland types (PJG, PJO, and JUG) supply some smaller diameter wood products such as latillas and fuelwood.

Nationwide, the Forest Service sells timber for a variety of reasons, most commonly to support local mills and communities that were, in some cases, built around a specific forest's timber supply and to modify forest structure or composition to meet a variety of management goals (Gorte 2004). Timber sales on NFS land have been steadily decreasing since the late 1980s, when total production reached 11 billion board feet annually (General Accounting Office 1999). In contrast, just over 2 billion board feet were harvested during fiscal year (FY) 2004, at a total value of approximately $218 million; an additional $3.17 million in special forest products, including Christmas trees, fuel wood, piñon nuts, and other materials, were also harvested that year (Valles Caldera National Preserve 2004).

This pattern of reduced production is mirrored by the Santa Fe NF. Total timber volume sold in the forest peaked in the late 1970s and early 1980s at approximately 50 million board feet (MMBF). Volumes sold declined in the mid to late 1980s to approximately 25 MMBF and bottomed out in 1996 due to a six-month court injunction affecting all timber cutting within the Southwestern Region, including the Santa Fe NF. During the last decade output has been relatively stable at approximately 12 MMBF per year.

On the forest, as total timber volumes declined, the mix of products sold and removed has also changed drastically since the late 1970s. During the late 1970s and 1980s, the large majority of the total volume removed was in the form of sawlogs (logs cut into boards for lumber). From the mid-1990s up to today, the majority of material cut in the Santa Fe NF is in the form of fuelwood and miscellaneous products such as posts and poles, vigas, and latillas. Demand for fuelwood was relatively stable until 2008, in spite of an increase in the population of the towns and cities near the Santa Fe NF. In the last 5 years, annual fuelwood demand has increased to approximately 11,000 MMBF or 22,000 cords. This is likely because of the 2008 recession and increases in home heating fuel costs.

Miscellaneous forest products include vigas and poles, latillas, posts, and coyote fencing. Miscellaneous non-convertible products in the forest are predominantly Christmas trees and wildings (tree transplants). These small aspen, piñon, and ponderosa pine trees were dug up in the forest to be sold as landscape trees. Demand for miscellaneous products and transplants peaked in the 1990s and declined when the housing market in Santa Fe and Albuquerque flattened in the late 2000s.

Within the broader landscape, forest products generated from private lands have been equally volatile. Much of the private land is either marginal for producing timber (sawlogs) or has been cut over in the past, leaving them not well suited to be harvested for sawlogs in the future. Some logging has occurred on private land on the east side of the forest, north of Las Vegas, New Mexico, and areas north and west of Cuba, New Mexico. Some of the larger inholdings in the forest including the Bar-X-Bar in the Pecos/Las Vegas Ranger District and the Valles Caldera National Preserve (formerly the Baca Ranch) were extensively harvested. Harvests on the Baca Ranch averaged nearly 1,000 acres per year from 1936 to 1972, and then fell to only 2,700 acres between 1980 and 2000. In the absence of larger mills for sawlogs, much of the material harvested annually is in the form of fuelwood and other forest products. They have and continue to be produced from the broader landscape area with outputs varying based upon yearly demand, primarily affected by the price of home heating fuels.

Demand for timber and other forest products have been and will be directly related to a viable forest products industry. During the 1990s, when most of the larger mills in the area closed, the reliability of the supply of timber from the forest was often cited as the reason. Once there were fewer mills, the cost of hauling logs and smaller log size became an issue affecting potential bidders. Future opportunities for industry expansion will be affected by the ability to use small-diameter material, energy costs, transportation costs, treatment subsidy, and if emerging markets in bioenergy and bio-fuels become viable.

Small products demand has also been affected by the housing market. Demand for vigas, latillas, cedar posts and fencing declined with the reduction in new housing starts. However, demand for small products in the Santa Fe NF was not as affected by the appearance in the 1990s of “big box” home improvement stores, as it was to the local mills providing dimension lumber (2x4s). This is likely due to the unique nature of products cut and sold from the forest.

Current and future demands for forest products include a variety of factors that can influence the types of products available in the Santa Fe NF and how they change over time. The list below describes some of the specific relationships between those products and demands.

- **Fuelwood demand:** Personal use and commercial fuelwood demand from the forest is most affected by the cost of fuels used for heating homes (propane, natural gas, electricity) (Stoddard et al. 1979). Other factors include the weather during the fall firewood gathering season, the cost of gas and diesel (as a cost of transporting personal use firewood), and the availability of off-forest firewood from other sources, such as thinning and land clearing on private land or removing beetle-killed trees from bark beetle infestations in the early 2000s.
- **Public perception and opinion:** Global economy, demand for locally produced products, demand for green products, need for timber harvest being driven by a restoration need rather than economic need.
- **Restoration Need:** There is a need in the forest for restoration on a large scale. Nearly all restoration whether it is for watershed health, threatened and endangered species habitats, or resilience will include tree removal for density control.
- **Past and future catastrophic events:** Large-scale events such as the Las Conchas, Cerro Grande, and Viveash Fires and the widespread bark beetle mortality in the 2000s cost millions of dollars and influenced public opinion for years following these events. The cost of suppression of the Las Conchas Fire topped $48 million and estimates of the total costs including the resource rehabilitation within the fire and all other direct and indirect costs may be as high as $1.4 billion (Impact Datasource 2013).

- **Demand for ecosystem services:** The Santa Fe NF provides a number of ecosystem services. The Forest's watersheds capture, store, and release drinking water and water for agriculture. Wildlife, recreation and clean air are other services. Protecting these services from large-scale disturbance will involve removal of forest products as a byproduct of restoration. Both the existing Water Source Protection Fund in the Santa Fe Watershed and the Rio Grande Water Fund currently being developed recognize that some of the cost of providing and protecting these ecosystem services could be borne by the consumers.
- **Climate change:** Climate change has the potential to affect the need for timber sales in two ways. First, the need for forests that are resilient and adaptable to changing climate norms is cited as a need for restoration. Nearly all restoration prescriptions in the forest will require extensive timber removal. Second, carbon sequestration and carbon budgeting are becoming the linchpin for addressing the causes of climate change. Forests have the opportunity to sequester more carbon through active management and replace fossil fuels with a renewable (and carbon neutral) source of energy. On the supply side, the forest's ability to provide sawlogs and roundwood has been affected most by flat or reduced annual funding, increased cost of treatments and the forest's capacity to plan (National Environmental Policy Act) and prepare areas for harvest. Based upon forest-level growth projections and Forest Inventory and Analysis (FIA) data (Goeking et al. 2014), current harvest levels are a mere fraction of annual growth. There is a nearly unlimited supply of smaller material due to the lack of recent harvest and a restoration backlog. Projects like Southwest Jemez, and the infrastructure it is hoped they will generate, are hoped to address some of the restoration backlog. However, the combination of low value material and the high per acre cost of treatments may continue to limit the amount of material offered, cut, and sold from the Santa Fe NF as well as the surrounding forested areas.

Over the last 20 to 30 years, New Mexico's timber economy has declined steadily, both in harvest volume and processing capacity. However, as of 2002, it still provided significant economic value, with $47.7 million in sales of finished wood products and mill residues from a harvest of 74.4 MMBF (Morgan et al. 2006). The timber harvest contribution within the plan area holds to the same pattern. At current harvest levels, the sale and processing of forest products provides limited contribution to the economic stability of northern New Mexico. However, the New Mexico Natural Resource Assessment (EMNRD Forestry Division 2010) indicates that much of the plan area has high or high/medium potential for economic potential.

Currently, due to rising levels of forest restoration treatments such as the Southwest Jemez Restoration Project, local timber and forest product industries are beginning to grow. Timber-related jobs in the forest annually contribute $978,000 across 28 jobs. As more restoration treatments are implemented across the forest, the potential for industry growth heightens, offering more value as an ecological service that provides economic benefits for nearby communities.

3.10.2 Methodology and Analysis

3.10.2.1 Indicators

The key indicators that were used to measure effects by alternative include:

- Acres suitable for timber production
- Projected wood sale quantity (PWSQ), and projected timber sale quantity (PTSQ)

3.10.2.2 Timber Suitability

Timber suitability was determined using a myriad of resource data incorporated into GIS to apply criteria and identify lands suitable for timber production. Timber production is defined as the growing, tending, harvesting, and regenerating of trees to produce logs or other products for industrial or consumer use. Lands determined to be suitable for timber production are areas identified as capable of producing a regular, periodic output of timber, maintained in perpetuity, without impairment of the productivity of the land or inconsistency with other land management direction. Criteria for suitability are defined in the 2012 Planning Rule procedures at 36 CFR § 219.11 and Forest Service Handbook 1909.12, chapter 60. Lands not meeting the criteria defined in FSH 1909.12 or lands where laws, policies, or plan components (e.g., desired conditions) are not consistent with timber harvests meeting the definition above were deemed lands not suited for timber production. On lands not suited for timber production, some tree cuttings may still occur to increase safety in areas popular for recreational activities, and to improve stand structure, health, function, or composition in accordance with desired conditions. Data were developed using the latest, most relevant sources and requirements to match the criteria defined by resource specialists. A more detailed description of the timber suitability analysis can be found in Appendix C: Timber Suitability Analysis.

Sustained Yield Limit

The sustained yield limit (SYL) reflects the quantity of wood products that could be sustainably removed from the forest in perpetuity. Sustained yield limit was calculated for the Santa Fe NF using the number of acres calculated as "lands tentatively suitable for timber production," (2012 Planning Rule (36 CFR 219.11(d)(6)) and FSH 1909.12, Chapter 60, section 64.31) as determined through mapping GIS data layers (Appendix C). The tentatively suitable acreage (356,943 acres), consistent across alternatives, was further partitioned by ERU using GIS analyses and were multiplied by regional coefficients consistent with 2012 Planning Rule directives (same as quoted above). The sustained yield limit informs comparisons between PTSQ and PWSQ (described below) across alternatives but is not considered a separate indicator due to being consistent across all alternatives.

The sustained yield limit for the Santa Fe NF was calculated as 70.6 million cubic feet (MMCF) or 303.4 million board feet (MMBF) per decade (appendix C). This quantity of timber and associated wood products delineates the sustainable level for the Forest over the next 20 years. Quantities less than this threshold are anticipated to be sustainable in perpetuity unless forest growth stagnates or wildfire removes areas from production, while quantities above this threshold would only be feasible for short periods of time.

Projected Wood and Timber Sale Quantities (PWSQ, PTSQ)

Projected timber sale quantity (PTSQ) and Projected wood sale quantity (PWSQ) are the quantities of timber and other wood products that have the potential to be sold during the first two decades of the revised plan based on projected vegetation treatments outlined in plan objectives. The projected wood sale quantity includes all woody material likely to be sold from harvests whether or not the woody material meets utilization standards. The projected timber sale quantity is a subset of the projected wood sale quantity and is an estimate of the quantity of timber with the potential to be sold during the plan period if vegetation management objectives were met. The volume in the projected timber sale quantity is the volume that meets utilization standards and must be equal to or lower than the SYL for the forest. The estimation of these two quantities must be consistent with the plan components of the final plan or the unique mix of plan components in each alternative, and consistent with the fiscal and organizational capability of the unit. The planned management objectives for PTSQ and PWSQ are also limited based upon constraints described in FSH 1909.12, Chapter 60 Section 64.32. Both PTSQ and PWSQ were modeled using VDDT models with acres of proposed vegetation treatment inputs that differed for each alternative.

3.10.3 Environmental Consequences

3.10.3.1 Indicator: Timber Suitability

On the Santa Fe NF, acres are withdrawn from timber production for many reasons (e.g., National Wilderness Preservation System, inventoried roadless areas, research natural areas, and other designated areas). Of the remaining forested areas that are not withdrawn, a total of 356,943 acres have a reasonable assurance of successful regeneration following harvests and are considered acres that “may be suited” for timber production. These acres are consistent across alternatives.

Specific plan objectives and desired conditions for each alternative dictate the proportion of may be suited acres that are suited for timber production, which differ across alternatives (table 81).

Table 81. Timber suitability classification in the Santa Fe NF, acres by alternative

Land Classification Category	Alternative1	Alternative 2	Alternative 3	Alternative 4
A. Total National Forest System lands in the plan area	1,545,310	1,545,310	1,545,310	1,545,310
B. Lands not suited for timber production due to legal or technical reasons	1,188,367	1,188,367	1,188,367	1,188,367
C. Lands that *may* be suited for timber production (A–B)	356,943	356,943	356,943	356,943
D**. Total lands suited for timber production** because timber production is compatible with the desired conditions and objectives established by the plan	**326,779**	**356,716**	**0**	**357,011***
E. Lands not suited for timber production because timber production is not compatible with the desired conditions and objectives established by the plan	30,164	227	356,943	-68
F. **Total lands not suited** for timber production (B+E)	**1,218,078**	**1,187,942**	**1,545,310**	**1,187,890**

*In alternative 4, 68 acres (which surround a reservoir) are recommended to be removed from designated wilderness. In the event that Congress were to remove the wilderness designation from these acres, the suitable timber base would increase by this margin (to 357,011 acres- line D) above the may be suited base (line C); the difference in these two quantities is recorded as 0 in line E. However, until a Congressional decision would be made these acres will be remain as designated wilderness and be managed according to all relevant laws, policies, and regulations.

Effects common to all alternatives

The existing forest plan divided the entirety of Santa Fe NF into management areas, where management areas A, B, C, D, E, J, P, Q, and R had suitable timberlands. Management areas F- wild and scenic rivers, H- wilderness (also HF; HO), M- research natural areas, and several others (G, I, K, L, N, O, and S) do not contain suitable timber acres, due to Plan directives that restrict or ban timber harvesting activities within these areas. The three action alternatives in the Forest Plan delineate specific areas for management, due to unique desired conditions, but preserve the laws or restrictions and desired conditions that guide management on designated wild and scenic rivers, Research Natural Areas (RNAs), Inventoried Roadless Areas (IRAs), which do not vary by alternative. The revised plan also retains the laws, restrictions, and desired conditions for management of designated and recommended wilderness areas. Designated wilderness is constant across all alternatives, but recommended wilderness changes across alternative, the specific effects of which are discussed below. ***Broadly, designated areas are excluded from lands suited for timber production, resulting in fewer opportunities for timber***

production to support local and regional markets and contribute financially to area residents*[FP1]*. Alternately, ***areas that are determined suited for timber production can be treated to increase ecosystem resiliency while also providing a commercial timber product to generate revenue in the forest. Providing a suitable land base for timber has the potential to increase revenue to local and regional communities through the creation of more job opportunities and expanded timber-related industries*** [FP2]***. The creation or expansion of timber-related industry would also lessen fire suppression costs by encouraging the continued extraction of fuels that make fire suppression difficult, and could lessen smoke outputs during fires due to the lower availability of fuels left in the forest to burn*[FP3]*. Due to the overstocked nature of the forest's frequent fire ERUs, new industry that could utilize small diameter stems, would help to reduce these overstocked conditions, and increase forest health*** [FP4]***. Creating a market or increased demand for small-diameter stems would provide an alternative to the pile and burn method commonly used to remove these woody residues following non-commercial fuel reduction treatments, reducing smoke outputs that impact human health*** [FP5]***.***

Alternative 1 - 1987 Forest Plan

In total, there are 326,779 acres of land suited for timber production in alternative 1. This acreage is higher than alternative 3 and lower than alternatives 2 and 4, which increase human uses and the output of forest products in the forest. However, due to the low acreages for vegetation treatments given in Plan objectives (see section 3.3.5, table 22), it ***remains unlikely that any new timber markets would emerge, or any significant growth to existing markets would be made, resulting in little change to the demand for these products in the forest*** [FP6] and produce few associated beneficial effects ***(FP2-5)***.

Alternative 2 – Forest Plan

Alternative 2 has the second highest number of acres that are suitable for timber production at 356,716 acres. With a large proportion of vegetation treatments focused in ponderosa pine and mixed conifer, this alternative could increase timber revenue in the Santa Fe NF, provided suitable markets and industry are present ***(FP2-5).*** This alternative incorporates special management considerations for heritage areas, a research natural area, and a wildlife management area, as well as, recommends five additional areas (25,868 acres) for wilderness designation. All of these areas were removed when calculating acres for timber suitability. The additional wilderness recommendations do not largely influence the availability of forest products within the area since these areas largely overlap with existing inventoried roadless areas where commercial timber harvest is not allowed ***(FP1)***.

Alternative 3 – Natural Processes Emphasis

There are zero acres that would be suited for timber production under alternative 3, as Plan objectives call for natural processes such as fire to treat vegetation. Additionally, all acres (270,130 acres) determined to have high wilderness characteristics and inventoried roadless areas larger than 5,000 acres with low or moderate wilderness characteristics are recommended for wilderness designation under this alternative ***(FP1)***. ***The absence of suitable timberland would reduce income to local economies that receive any or all of their revenue from the sale of timber, such as logging companies or wood processing mills*** [FP7]. ***The absence of commercial timber production would also not support the establishment of new timber businesses in the region, reducing economic growth and potential gains*** [FP8]***.***

Alternative 4 – Human Uses Emphasis

Alternative 4 has the highest quantity of acres suitable for timber production at 357,011 acres ***(FP 2-5)***. Additionally, there are no additional acres proposed for wilderness designation under this alternative, ***maximizing the potential for the forest to contribute to existing timber industries, and for creating a***

positive feedback loop where increased supply drives increased demand and revenue for new or existing industries **[FP9].**

3.10.3.2 Indicator: Projected Wood and Timber Sale Quantities (PWSQ, PTSQ)

Projected wood sale quantities (PWSQ) and projected timber sale quantities (PTSQ) estimated for two decades within each alternative are given in table 82**.** Challenges for forest access, supply, material size, and the long distance between the Santa Fe NF and existing mill facilities has increased the difficulty and cost for local individuals and industries to acquire and utilize forest products from the Santa Fe NF. Consequently, the majority of local processing of wood products is currently for fuelwood. However, milling of timber resources for products is currently conducted by several local individuals and industries who manufacture items such as lumber, beams, vigas, latillas, posts, poles, and pellets, and others that use wood products for arts, crafts, flooring, and furniture. Current and projected sawtimber opportunities in the forest are predicted to remain at a small scale and will likely use a fraction of the estimated sustained yield limit of the forest under most alternatives.

Effects Common to All Alternatives

All alternatives contain plan directives to provide a sustainable supply of forest products with consideration to multiple-use objectives, consistent with desired conditions of other resources. Desired conditions promote the sustainable availability and removal of forest products, associated with silviculture treatments that reflect natural disturbance regimes and contribute to ecosystem integrity.

Forest products from the Santa Fe NF support traditional and cultural uses spanning centuries. Forest products also contribute to local economies and livelihoods, creating opportunities to sustain existing industries or develop new industries based on the availability of supplies and needs of the people. The utilization of forest products (e.g., latillas, vigas, posts, poles) and personal-use fuelwood is generally anticipated to remain consistent with current conditions into the future, with minimal increases due to population trends. The availability and accessibility of forest products may vary by alternative, though the demand for these products is not anticipated to change.

Table 82. A two-decade comparison of PTSQ* and PWSQ in the Santa Fe NF in millions of cubic feet (MMCF) by alternative in the Santa Fe NF

Sustained Yield Limit (SYL)	**73.1 MMCF (322.1 MMBF) per decade**							
	Alternative 1		**Alternative 2**		**Alternative 3**		**Alternative 4**	
	Decade 1	**Decade 2**	**Decade 1**	**Decade 2**	**Decade 1**	**Decade 2**	**Decade 1**	**Decade 2**
Timber Products								
Lands suited for timber production								
A1. Sawtimber (9”+ dbh)	4.7	5.4	13.8	15	0	0	43.6	24.7
A2. Other products (5-9” dbh)	1.4	1.8	4.4	4.4	0	0	14.1	9.5
Lands not suited for timber production								
B1. Sawtimber (9”+ dbh)	7.9	9.4	19.3	21.0	16.9	10.4	60.8	34.8
B2. Other products (5-9” dbh)	2.3	3.2	6.2	6.2	5.2	3.9	19.7	13.4
C. Projected Timber Sale Quantity (PTSQ) (A1+A2+B1+B2)	16.3 (55)	19.8 (65.6)	43.7 (145.8)	46.6 (158.5)	22.1 (74)	14.3 (45.9)	138.2 (461.5)	82.4 261.5)
Other Estimated Wood Products								
D1. Softwood fuelwood (5”+ dbh)	1.8	1.9	3.6	3.0	0.4	0.3	18.1	7.3
D2. Hardwood fuelwood (5”+ dbh)	0.8	0.9	3.3	3.1	1.2	0.8	14.1	6.4

	Decade 1	Decade 2	Decade 1	Decade 2	Decade 1	Decade 2	Decade 1	Decade 2
D3. Aspen (5”+ dbh)	1.2	1.2	2.2	3.3	1.5	0.9	6.0	5.3
E. Projected Wood Sale Quantity (PWSQ) (C+D1+D2+D3)	20.2	23.8	52.8	56.0	25.1	16.3	176.4	101.4

*PTSQ Million Board Feet (MMBF) equivalencies given in parentheses on line C

Timber harvest and other vegetation management activities may increase or decrease the potential availability of some special forest products. For example, ***group selection harvests combined with periodic selection or variable density thinning, would achieve restoration objectives, maintain habitat connectivity, and contribute a dependable flow of forest products to existing and prospective local economic infrastructure*** (Schmidt et al. 2008, North et al. 2009) [FP10]. ***Fuelwood may increase, either due to an increase in commercial firewood sales or as a byproduct of commercial timber sales*** [FP11]***,*** benefitting local citizens and recreational users at area campgrounds. ***Timber harvesting or non-commercial treatments would provide for an increased availability of sawtimber or forest products of varied sizes, but products that originate from small diameter stems would likely be the most widely available due to the abundance of this size class of trees on the landscape*** [FP12]***.***

The harvesting of timber or acquisition of other forest products benefits the economy and sustains important cultural and traditional uses by providing a sustainable and continuous supply of products to meet demands [FP13]. The removal of these products may also enhance ecological function in or surrounding treated areas ***(FP10)***. Furthermore, ***the removal and use of some forest products would reduce competition for resources, ease drought stress, and increase the health and vigor of residual trees, potentially leading to higher quality timber in the future*** [FP14] (see also “Vegetation and Fire”). ***Commercial or non-commercial thinning can reduce existing insect or disease infestations or lessen the risk for these events in the future*** [FP15]. However, the removal of forest products from the forest can also have negative implications ecologically, especially when removal involves using heavy machinery. ***Mechanized machinery used for commercial timber harvesting or non-commercial thinning can cause soil compaction, leading to reduced water infiltration rates, increased water runoff and soil erosion, and reduced soil productivity*** [FP16]. The use of mechanized machinery may also necessitate ***the reopening of or creation of new roads, leading to greater fragmentation of the landscape, which divides corridors for wildlife travel*** [FP17]***. Mechanical cutting practices may also negatively impact the aesthetic quality of an area in the short-term, yielding an un-natural appearance near areas of cuttings*** [FP18]***.***

Despite the potential for short-term negative impacts of mechanical harvesting, the long-term benefits of restoring structure and composition to forest stands typically outweighs the risks through increasing resiliency or resistance to disturbance. Further, accepting the trade-offs between negative short-term impacts of harvesting practices and consequences of long-term impacts from uncharacteristic (large and high-severity) wildfire in dry, frequent-fire forests (see Vegetation and Fire section for discussion of effects) must be considered when determining the best course of action for management toward desired conditions. Studies have shown that fuels reduction treatments (e.g., thinning) decrease risk of uncharacteristic, high-severity crown fire in mixed-conifer (Mason et al. 2007) and ponderosa pine (Pollet and Omi 2002, Stevens-Rumann et al. 2013) forests in the southwest and elsewhere in the western US, particularly when thinning treatments are combined with prescribed burns to reduce residual fuels (Fulé et al. 2002, Evans et al. 2011, Martinson and Omi 2013).

Alternative 1 – 1987 Forest Plan

Alternative 1 would retain forest product availability and use at roughly the same level as it has been since the implementation of the 1987 Forest Plan. Since this time fuelwood use has predominated in the Santa Fe NF. Under the current Forest plan, ***timber production was minimized leading to a reduction in local markets for timber products*** [FP19].

The PTSQ is estimated at 16.3 MMCF, which is well below the SYL (70.6 MMCF) of the Santa Fe NF. This suggests that this alternative is easily sustainable over the long-term but would not be effective at reducing the overstocked condition of the forest (***FP4, 10***). The PWSQ is estimated at 20.2 MMCF for the first decade of the revised plan. Levels of fuelwood production under this alternative would be expected to continue to meet the needs and expectations of Forest users. However, this alternative would be the second least effective alternative at encouraging economic growth to the forest or to surrounding local communities through the sale of forest products, providing for associated beneficial effects at smaller levels than those anticipated for alternatives 2 and 4 (***FP1-2***).

Alternative 2 – Forest Plan

Alternative 2 results in a greater availability and production of forest products than alternatives 1 and 3 for the coming decades. According to plan objectives for vegetation, alternative 2 increases targets for timber production by focusing treatments in ponderosa pine and mixed conifer forests. According to predictions given in table 82, PTSQ is more than doubled in alternative 2 compared to alternative 1. Further, in many overly stocked ponderosa pine and mixed conifer forests treatments will supply numerous cords of fuelwood, available to anyone with a collection permit provided there is sufficient access to the materials. ***Treatments in piñon-juniper and juniper grass systems would also create increased fuelwood availability and may ease access into these areas for the collection of special forest products like piñon nuts*** [FP20].

The predicted amount of timber available for sale (PTSQ) at 43.7 MMCF, is well within the sustained yield limit of the forest, allowing for the flexibility to harvest more timber under certain conditions or in certain areas as needed. The predicted wood sale quantities (PWSQ) at 52.8 MMCF, shows a large improvement over alternative 1. At this level of extraction and use, the forest can sustainably produce these amounts for years to come, providing a stable source of forest products that local communities may benefit from (***FP2-3***). ***Having a sustainable and increased product base may be grounds to create more outlets for forest product utilization, increasing jobs and boosting the economy of nearby and regional communities*** [FP21].

Alternative 3 – Natural Processes Emphasis

Plan objectives for vegetation in alternative 3 prioritize the use of prescribed burning and naturally ignited wildfires to meet resource objectives, instead of mechanical methods. As a result, alternative 3 would reduce the quantity and availability of forest products more than any other alternative and would provide negligible levels of beneficial effects tied to mechanical treatments (***FP1-5***). Though the estimated quantities of PTSQ and PWSQ are slightly higher than estimates for alternative 1, due to reclassifying forested lands into lands suited and lands not-suited for timber production (all of alt. 3); lands not-suited for timber production simply show estimated timber amounts present on the landscape to quantify the resource. ***The prevalence of fire without the pre-treatment of thinning has the potential to lead to increased fire intensity, tree mortality, and damage to residual trees, degrading the quality of timber sources into the future*** [FP22]**.** Further, the addition of 270,130 acres recommended for designated wilderness, combined with other plan direction eliminates the suitable timber base from the forest, which would reduce timber outputs and reduce availability of forest products acquired through mechanized means ***(FP7-8).*** As the bulk of these recommended areas are pre-existing as IRAs, where access for forest products is already challenging, nearby communities and forest users have already adapted to these conditions and regulations.

Alternative 4 – Human Uses Emphasis

Alternative 4 maximizes the use and availability of forest products and would be the most effective alternative to support existing forest product industries in the region, as well as have the potential to spur the creation of new business opportunities (***FP2, 21***). Also, this alternative increases Forest access and creates opportunities for the acquisition of forest products to a greater degree than all other alternatives by allowing for opening existing roads that are in highly used, but rather inaccessible areas to accommodate multiple uses. ***Improving motorized access to forest products could be especially advantageous for citizens that have mobility challenges or are elderly, alleviating the challenges associated with non-motorized transportation and accommodating a wider range of forest users [FP23].*** Further, with Plan objectives for a high number of forest acres to be treated with mechanical methods, the projected availability of forest products is the highest of all alternatives. However, the extensive use and frequency of mechanical treatments would likely have short-term negative impacts to the treated land ***(FP16)*** and lands within close proximity (***FP17-18***). However, these treatments may also have benefits to the ecosystem and could boost economic revenue for the forest and surrounding communities (***FP2, 4-5, 9-14***).

Economic gains from the increased production or availability of forest products may be limited to the short-term, as the quantities of anticipated timber and wood products are in excess of the sustained yield limit of the forest. Different from all other alternatives, the PTSQ for both decades 1 and 2 (138.2 MMCF and 82.4 MMCF, respectively; table 82) lie in excess of the sustained yield limit of the forest (70.6 MMCF). Since stand conditions over much of the forest are currently overstocked, an excess of harvesting over the sustained yield limit may be permissible if necessary, to meet restoration goals and reach desired conditions. The resulting forest products from increased treatment levels could boost short-term revenue for the forest and for local and regional communities surrounding it (***FP2, 4, 10-11, 23***).

3.10.3.3 Other Factors Potentially Impacting Forest Products

Management Areas (common to all alternatives)

Upon Plan revision, existing and proposed research natural areas, as well as designated and eligible wild and scenic rivers would have negligible effects on the availability of all forest products in the forest at large. These areas do not differ by alternative. Each of these management areas has Plan standards and guidelines to protect or improve the resources they contain in their natural or existing states. As such, practices such as cutting trees are largely restricted unless under extreme or specific circumstances. As a result, they slightly lessen the availability of forest products evenly across all alternatives (***FP2, 4, 9***).

Management Areas- Alternative 4 – Human Uses Emphasis

Under this alternative, two motorized recreation areas are suggested for inclusion in the management plan. This may increase Forest access for collection of forest products because off-road vehicle travel would be permissible within these designated motorized recreation areas. ***Off-road access may also facilitate the collection of forest products by local citizens for traditional uses***. ***The increased availability of forest products for collection under this alternative would decrease the quantity of woody fuels that contribute to uncharacteristic wildfire and support the multiple-use objective of the forest*** [FP24].

3.10.3.4 Cumulative Effects

The cumulative effects analysis timeframe for the forest products analysis is the next 10 to 15 years (expected lifespan of the forest plan), for all lands within the forest boundary and on any adjacent lands regardless of ownership.

Forest products are available on nearby Tribal lands, state lands, government lands (e.g., BLM) and adjacent national forests (Cibola and Carson National Forests) to varying extents. The Carson and Cibola NFs have desired conditions similar to the Santa Fe NF written in their forest plans for forested and woodland ERUs and have plan objectives to incorporate uneven-aged silviculture and fire treatments to return natural conditions and function to ecosystems. Like the timber lands in the Santa Fe NF, these neighboring national forest timber lands would also generate jobs and income associated with their PTSQ and PWSQ outputs.

Nearby Tribes and Pueblos also contribute to the forest product industry and help conduct fuel reduction treatments in the forest and on their adjoining lands. For instance, the Pueblo of Jemez established the Walatowa Timber Industries in 2012. Walatowa Timber Industries has partnered with the Santa Fe NF, Valles Caldera National Preserve, and private landowners to harvest timber, and sell lumber, latillas and firewood, connecting indigenous livelihoods to landscape-scale forest management efforts. Additionally, multiple partners have joined forces to conduct work in the Santa Fe NF in areas adjacent to Tribal lands under the Reserve Treaty Rights Land project. These combined efforts of generating forest products while maintaining or moving these ecosystems toward desired conditions, result in positive contributions to the social, economic, and ecological conditions across the cumulative effects area. Creating market for variably sized forest products would not only create additional job opportunities within the region but would also help to support more landscape-scale restoration efforts. As much of the cost associated with restoration (e.g., thinning treatments) lies in the removal and transport of the woody products from the forest and surrounding areas, existing markets near the land being treated greatly enhances the ability to conduct these treatments in departed systems over a wider area, providing greater ecosystem benefit and in turn, a sustainable supply of wood products to support the local and regional industries.

At least in the short term, the availability of forest products and opportunities for collection are likely to remain similar to current conditions, and cumulative effects from surrounding areas are likely to be minor. Though, as populations increase, more stress may be placed in the Santa Fe NF to meet the demands of people and industry ***(FP2-5, 13)***. ***By having forest products available on adjacent lands, the impact and dependence in the Santa Fe NF for these products would be lessened*** [FP25]***.***

3.11 Rangelands and Grazing

Rangelands are grasslands, shrublands, woodlands, wetlands, and deserts that are grazed by domestic livestock or wild animals. On the Santa Fe NF, most of the land is grazed by cattle unless it is too steep, designated for special use such as the Santa Fe Watershed, or is critical habitat for federally listed threatened and endangered species (e.g., New Mexico meadow jumping mouse).

Livestock grazing has a long history in the Santa Fe area. The Spanish first settled the area and began grazing the land for domestic production around 1600. The Forest was initially grazed by sheep, swine, cattle and goats. Today, it is grazed by cows, calves, and yearlings, with incidental use by permittees' working horses.

3.11.1 Affected Environment

At present, 244 grazing permits are authorized in the Santa Fe NF on 75 grazing allotments. Since 2005, livestock management on the Forest has been shifting to an adaptive management approach that allows stocking levels to change in response to variability in forage production, water availability, and precipitation patterns.

The primary management tool used in rangeland management in the Santa Fe NF is adaptive management. The adaptive management approach recognizes that our knowledge about natural systems can be uncertain (e.g., weather, fires, flood), and that future management will need to have the flexibility to adjust to meet the management objectives. When used appropriately, this flexibility better mimics natural processes and decreases the potential for undesired impacts on other resources. This adaptive management strategy is codified as policy in the Forest Service Handbook on Grazing Permit Administration and Rangeland Decision Making. The Region 3 Supplement to the handbook describes adaptive management as the following:

> " a system of management practices based on clearly identified intended outcomes and monitoring to determine if management actions are meeting those outcomes; and, if not, to facilitate management changes that will best ensure that those outcomes are met or re-evaluated. Adaptive management stems from the recognition that knowledge about natural resource systems is sometimes uncertain." (36 CFR 220.3)

As part of adaptive management, monitoring is essential to range management. For the Santa Fe NF, monitoring should answer the question "Is acceptable progress being made toward attainment of resource management objectives and thus desired conditions?" If the answer to this question is "yes," current management may continue. If the answer to this question is "no," various adaptive management adjustments may be initiated as long as they remain within the range analyzed as part of the allotment's NEPA analysis. When monitoring indicates the need for adaptive management adjustments, those adjustments can be implemented without NEPA review.

Rangeland management when performed appropriately provides for socio-economic and cultural services such as cattle production, while minimizing impacts to ecosystems such as retaining plant diversity, ground cover, water, and proper infiltration, wildlife habitat and forage. While the economic impact of grazing may seem small (the Santa Fe NF grazing program contributes approximately 154 jobs and $2 million in labor income to the analysis area (McSweeney and Raish 2012), to the local communities it is very important. McSweeney and Raish state that ranchers value ranching so much that even when it is not economically viable to rely on their grazing operation, they work other jobs as a means of supplementing their income (2012). A working ranch lifestyle, even in limited scale, carries tangible family and cultural benefits. Santa Fe NF grazing permits typically support small-scale operations, with herd size ranging from 1 to 374 head of cattle, and an average herd size per permit of only 39 head. Some families have made conscious employment choices in order to remain in the local community. In spite of the difficulties, they expressed hope for the future of the ranch, the land, and the family.

Ecologically, grazing, fire, and climate are major components in the balance between woody and herbaceous plant communities (Fuhlendorf et al. 2008). Unfortunately, most environmental resource units (ERUs) in the forest have an altered fire regime, due to prolonged fire suppression, changes in land uses or management, and fuel profiles. The absence of fire within fire-adapted systems has resulted in woody species encroachment into formerly open systems. As woody encroachment increases canopy closure also increases; once prolific understory grasses and forbs become scattered and sparse, increasing the proportion of bare ground susceptible to erosion. Declines in herbaceous ground cover as a result of woody encroachment, departed fire regimes, soil compaction, and erosion may affect the long-term ability of national forests to sustain the productivity of rangelands. On the Santa Fe NF, vegetation analyses show that the woodland and grassland ERUs commonly used for livestock grazing are trending toward unsustainable productivity (Ecological Assessment Vol. 1, 2016). The potential for unsustained grassland productivity is further compounded by the approximately 21,000 acres of invasive species currently found in the Santa Fe NF (White et al. 2015), creating concerns for rangeland management into the future.

3.11.2 Methodology and Analysis

Rangeland analysis was conducted by resource specialists for the planning area of the Santa Fe NF. The following analysis describes the current rangeland condition, projected trends in rangeland condition, and suitability for livestock grazing by alternative over the next 10 to 15 years. It also describes the potential effects associated with management activities that could affect rangeland condition and livestock grazing in the forest.

3.11.2.1 Assumptions

The following assumptions apply to the Rangeland Management portion of the Forest Plan.

- Since this analysis is done at the program level, site-specific determinations will be made in allotment-scaled NEPA analysis.
- Livestock grazing will be balanced with available forage using adaptive management as analyzed in allotment-level NEPA analysis.
- Livestock will be managed so that range conditions move toward desired conditions as outlined in this Plan.
- Unauthorized use of rangeland will be minimal to non-existent.
- Allotment-level NEPA sufficiency analysis (Section 18 Reviews) will be completed and reassessed before the grazing permit is reissued. Tools to monitor and manage areas where grazing is impacting other resources (e.g., riparian areas, habitat for at-risk species) will be assessed at the allotment level.
- Range infrastructure is built across the forest to more uniformly distribute cattle and their utilization of forage.
- We are aware of most populations of invasive species in the forest and they have been mapped.
- Site-specific invasive species management decisions will be made during allotment-level NEPA analysis.

3.11.2.2 Indicators

The following indicators can be used to measure the degree to which the Forest is managing the range resource and moving it toward the desired conditions of sustainability of the grazing program, grazing contributions to local communities, resilient rangelands, compatibility with ecological function and processes, diverse native plant communities, and functional range infrastructure. In the Environmental Consequences section below, each indicator is assessed according to alternative to determine the direct or indirect effects of management objectives, standards, and guidelines outlined in the Forest Plan.

Range Condition

Range condition is the state of health of the rangeland. Range condition is determined by comparing the existing hydrologic, soil, and vegetative condition to the potential or the site. The trend can be estimated using the interagency Indicators of Range Health protocol (Pelland et al. 2005). When a site is healthy, or in good condition, it is more resilient (relates to ***DC 3***) and can better recover from disturbances such as drought and fire. The apparent trend of the range can be assessed using "Attributes of Range Health," which include soil and site stability, hydrologic function, and biotic integrity (Pellant et al. 2005). Indicators associated with these attributes (e.g., bare ground, erosion, compaction, water infiltration rates, runoff, ground cover) can give us an indication as to whether or not the range condition is moving toward the desired conditions and are supporting diverse native plant communities, resilient rangelands, and ecological function.

Forage Production

Forage production is defined as the number of pounds of herbaceous above-ground vegetation produced in a given growing season. Forage production is a major factor in determining how many head of cattle can be stocked in the forest. It determines the amount of forage available to grazing animals. When vegetative communities are in good condition, forage production is generally higher. Forage production is generally determined at the allotment level using ground-truthed TEUI data. Forage production should also be verified from year to year through clipping studies.

Animal Unit Months (AUM)

An animal unit month (or one AUM) is the amount of forage needed by an "animal unit" (AU) grazing (in this case, cow-calf pair) for one month. The quantity of forage needed is based on the cow's metabolic weight; the animal unit is defined as one mature 1,000-pound cow and her nursing calf. AUM is a good metric to determine how many cattle the Santa Fe NF can sustainably support, and how our range program is contributing to local communities. Currently, the forest stocks a 10-year average of about 11,400 AUMs.

Range Infrastructure Condition

Range infrastructure in the forest includes fences, cattle guards, water tanks and troughs, and corrals. Infrastructure helps keep cattle evenly distributed across the forest. When range infrastructure is in poor condition, cattle can go where they wish. Under this scenario, cattle tend to congregate in and over-utilize riparian areas (Marlow and Pogacnik 1986). Keeping track of the infrastructure condition across the forest can help to determine the potential to manage cattle movement and keep them evenly distributed (relates to ***DC 7***), contributing to more resilient, diverse, and functional rangelands.

Invasive Species (Presence, Absence, or Acres Affected)

The presence, absence, or number of acres of invasive species across the forest is a measure of the known invasive species populations. This knowledge is important because invasive plants have the potential to create changes in fire return intervals, fire severity, and nutrient cycling (impacting the sites ecological function). Most importantly for the range resource, invasive species decrease the quality and quantity of available forage by replacing desirable and more palatable native species. The decline in forage impacts the forest's ability to sustain grazing and the Forest Service's ability to contribute quality grazing land for the benefit of local communities. Due to ease of establishment, spread, and persistence, controlling invasive species will continue to be an uphill battle into the future.

3.11.3 Drivers and Stressors

Environmental processes, or stressors push rangeland toward or away from its potential, or desired condition. This in turn impacts range health or condition, vegetation composition, vegetative community function, and structure, and the forage production produced on the range.

Rangelands can be impacted by stressors inside and outside the forest's control. The primary stressors that have an impact on rangeland management that are outside the forest's control are drought, unplanned fire, pathogens, invasive species, and wildlife. In the past 30 years, an average 11 percent decline in precipitation has necessitated adjusting numbers and timing of livestock grazing to compensate for reduced forage. Long-term climate change models show that reduced annual precipitation is likely to continue. Less precipitation, and subsequently less forage production is a concern for many communities adjacent to the forest for whom grazing is a way of life.

Other influences beyond the control of forest management that are compounding and increasing the risk to rangelands include; fractured ownership of private lands, legal uncertainties about land titles, and endangered species listings by the U.S. Fish and Wildlife Service. One such listing is the 2015 listing of the New Mexico meadow jumping mouse. This listing, and subsequent management plan requires strict protections for the New Mexico meadow jumping mouse within its riparian habitat. Which, in turn, has altered grazing management of the affected allotments.

Stressors can be managed through adaptive management and appropriate planning at the allotment level. Restoration, through the application of mechanical vegetation treatments and prescribed fire in acreages defined by Plan objectives can mitigate stressors (e.g., fire, woody encroachment, and invasive species) to some degree. Restoration practices can also be used to increase forage production, plant species diversity, and alter the structural and functional group composition of vegetation comprising Santa Fe NF rangelands. This would, in turn, increase the site's resilience to future stressors and disturbance, and forage production.

3.11.4 Environmental Consequences

3.11.4.1 Indicator: Range Condition

Effects common to all alternatives

All alternatives direct managers to maintain rangelands and manage for quality forage. Given this, grazing management in all alternatives would balance grazing with protection of the rangeland resource using an adaptive management approach to deal with fluctuations in available forage due to weather and other resource drivers and stressors. ***Declines in range condition would have negative effects on the ecosystem, by degrading biotic conditions through the reduction of herbaceous ground cover and increased bare soil, soil conditions through compaction or reduced stability, and water quality through sedimentation and erosion*** [RG1]***.*** Conversely, ***improved range condition would increase ecological resiliency and function by restoring proper structure and function through rangeland restoration, thereby improving soil stability and condition, hydrologic function, and biotic communities*** [RG2]***.***

Alternative 1 – 1987 Forest Plan

Under alternative 1, the no-action alternative, there are no specific plan components for vegetation management forestwide. Due to this, there would most likely be no change in livestock management from current management practices. Because alternative 1 lacks emphasis on restoration, the range condition would be expected to continue to decline gradually through increasing tree encroachment of grasslands and increasing woody species canopy cover (***RG1***). Rangelands under alternative 1 would also continue to have altered fire return intervals and uncharacteristic fire intensities when fire does occur.

Alternative 2 – Forest Plan

Alternative 2, the mix of natural processes and human uses alternative, would place a greater emphasis on restoration than alternative 1. Mechanical and fire treatments conducted for rangeland restoration (according to Plan objectives for this alternative) would improve the range condition in departed areas and move rangelands toward desired conditions. New research shows that ***low-intensity fire following mechanical treatments releases soil nutrients*** (Boerner et al. 2008)***, which may increase herbaceous species richness and cover*** (Willms et. al 2017; Abella and Springer 2015) **RG3*. Improvement in soil condition, species richness, and herbaceous cover would lead to improved range condition and would boost the productivity of the land for quality forage*** **RG4**. ***Increased growth and diversity of understory grasses in rangelands would also encourage a return to more natural cycles of fire, which would help maintain the improved rangeland condition over time*** **RG5*.*** Overall, alternative 2 is the strongest alternative to restore range condition across many areas of the forest.

Alternative 3 – Natural Processes Emphasis

In alternative 3, the natural processes alternative, the plan directs managers to utilize fire treatments (minimizes mechanical treatments) as well as allow for managed natural fires under the right conditions. The increased presence of fire on areas of the landscape that have been long unburned, have been left untreated, and are characterized by high fuel loads would increase the likelihood of experiencing a high-severity fire. High-severity fires are difficult to suppress and would result in negative effects (Bond et al. 2012) to soils and subsequently range condition. ***High-severity fires negatively impact soils*** (Bond et al. 2012), ***causing increased erosion and soil hydrophobicity*** (Neary et al. 2005) **RG6**. Also, ***high-severity fires promote the return of woody species over time and decrease herbaceous species richness*** (Abella and Springer 2015; Willms et al. 2017), ***which in turn decreases the range condition by changing the plant community structure and soil dynamics*** **RG7*.***

Increased probability of experiencing high-severity fire, reduces the effectiveness of this alternative to improve range condition over alternative 1. However, in the absence of high-severity fire, Plan directives for alternative 3 place emphasis on restoration to improve grass and forb abundance. This, in turn, causes this alternative to have a higher potential for reducing departure in rangeland conditions than alternative 1. Thus, the overall probability of alternative 3 to improve range condition is directly tied to the occurrence of high-severity fire in rangelands within the next 10 to 15 years.

Alternative 4 – Human Uses Emphasis

Under alternative 4, the human uses alternative, range condition would continue to decline (***RG1***) overall. Nonetheless, alternative 4 would reduce departure of rangelands from desired conditions more than alternative 1. This is due to the plan objectives for mechanical vegetation treatments, which would directly remove encroaching trees from some areas and increase canopy openness. However, the increase in forage production after mechanical treatments is short-lived without the follow-up treatment of (low severity) fire (***RG3***). ***If slash is not removed, it may temper the understory response to thinning*** (Abella and Springer 2015) **RG8** ***and may also increase susceptibility of the treated area to fires of higher severity*** **RG9** (see also ***RG6-7***). ***Mechanical treatments can also compact or disrupt soils, resulting in reduced soil productivity and poorer range conditions*** **RG10**.

3.11.4.2 Indicator: Forage Production

Effects common to all alternatives

All alternatives direct managers to maintain rangelands and manage for quality forage production. Given this, grazing management in all alternatives should balance grazing with protection of the rangeland resource using an adaptive management approach to deal with fluctuations in available forage. ***Declines in forage production would decrease the livestock grazing capacity that the forest can support over time, leading to decreased economic revenue for ranchers and departure from family ranching traditions*** [RG11]**.** Conversely, ***improved forage production would increase the capacity of the forest to provide high-quality forage for use by local ranchers, boosting local economies and upholding traditional land uses into the future*** [RG12]***.***

Alternative 1 – 1987 Forest Plan

Under alternative 1, there are no specific forestwide plan components for vegetation management. Under this alternative, it is expected that forage production should remain relatively stable and fluctuate with stochastic range site drivers such as weather. Thus, this alternative likely sustains the second highest level of forage production on rangelands over the next 10 to 15 years. ***Stable forage production would likely maintain the level of livestock grazing currently in the forest and continue to contribute to the livelihoods of local ranchers and their families*** [RG13].

Effects Common to alternatives 2, 3, and 4

Under alternatives 2, 3, and 4, desired conditions in the plan for forested ERUs call for less than 30 percent canopy cover. ***When forested canopy covers are thinned to less than 50 percent canopy cover, herbaceous cover and production increases*** (Abella and Springer 2015; Salmon et al. 2012; Mitchell and Bartling 1991) ***and results in an increase in the forage available for grazing in the forest*** [RG14].

Alternative 2 – Forest Plan

Under alternative 2, there would be more emphasis placed on restoration and sustainable livestock grazing than in alternative 1. ***Restoration treatments, which involve thinning with mechanical treatments and fire would improve vegetative production*** (Salmon et al. 2012***) leading to increased forage available to grazers in the forest*** [RG15]. However, this effect will likely not be immediate. Studies show that improvements in herbaceous understory vegetation occur after the first one to two years following treatment (Abella and Springer 2015). Therefore, alternative 2 would result in an increase in forage production after a few years (***RG12***) and is expected to result in the greatest increase in quality forage production in the forest over the lifetime of the Forest Plan. Increased forage production will lead to increased forage availability.

Alternative 3 – Natural Processes Emphasis

Under alternative 3, where natural disturbances such as fire are dominant across the landscape, over time woody species would increase, leading to decreased forage production (***RG11***). Plan objectives for vegetation treatments that rely predominantly on fire, combined with the densely stocked stands that currently characterize the forest, are likely to increase the potential for high-severity fire (***RG6-7***), leading to an increase in woody production, a decrease in forage production, and a decrease in forage available to grazers. Ultimately, alternative 3 would decrease forage in the forest over the lifetime of the Forest Plan in comparison to alternative 1, making it the least desirable of all alternatives for rangeland producers.

Alternative 4 – Human Uses Emphasis

Initially, with the mechanical treatments slated within Plan objectives, the quantity of herbaceous forage and forage for grazers would increase (***RG6-8***). ***Generally, mechanical treatments cause a decline in forage production over time*** (Willms et al. 2017, Abella and Springer 2015) **RG16*. In the short term, however, mechanical treatments can damage or denude areas of vegetation, exposing bare mineral soil to the effects of wind and water*** **RG17** leading to other detrimental effects (***RG10***). This affects forage availability by causing a long-term and short-term decrease in forage for grazing. As Plan objectives for alternative 4 prescribe a substantial increase in thinning and the removal of forest products, the impacts of mechanical treatments on herbaceous ground cover would be detrimental. Overall, alternative 4 would result in a decline in forage production (***RG11***), but not to the extent of alternative 3, making it roughly equal to or slightly less desirable than alternative 1.

3.11.4.3 Indicator: Animal Unit Months (AUM)

Alternative 1 – 1987 Forest Plan

The current forest plan does not include specific plan components that address vacant or understocked allotments but would retain the second highest average number of AUMs out of all other alternatives for the expected lifespan of the Forest Plan (10 to 15 years). Under the direction of alternative 1, grazing will continue to be managed to retain a balance with forage availability. Overall, ***the number of AUMs in the forest should remain relatively stable and fluctuate with changes to forage production (which is predicted to decline slightly), sustaining the socio-economic benefits of grazing at or near the current level*** **RG18**.

Alternative 2 – Forest Plan

Alternative 2 is written so that desired conditions are written to help managers balance restoration treatments with grazing resource needs. Plan guidelines are written to guide management so that vacant or understocked allotments would be made available to permittees when their allotment needs rest due to natural disturbances (such as fire), or Forest management activities including vegetation restoration or invasive species treatments. Stocking vacant and understocked allotments may result in a slight increase in the number of AUMs grazed in the forest. ***Increasing the number of AUMs grazing in the forest would have a positive socio-economic impact on our permittees and the local rural communities*** **RG19*.***

The restoration treatments that will be put in place to meet plan objectives for vegetation would have positive effects to plant communities and forage production (***RG3-5, 12-15***) that contribute to an increase in the amount of grazable forage available and subsequently AUMs that will be available under this alternative. These gains will not be immediate, as notable improvements in understory vegetation typically take a few years following mechanical and fire treatments (Abella and Springer 2015). The initial decline in forage production during restoration (***RG16-17***), and the (temporary) subsequent decline in stocking would be partially offset by stocking vacant and understocked allotments. ***Short-term reductions in AUMs would allow grasses and other forage plants time to recover and increase herbaceous establishment over larger areas in the absence of grazing pressure. This would lead to higher quality and more abundant forage to sustain grazing animals once reintroduced and contribute to increased ecosystem health and function*** **RG20*.***

Alternative 3 – Natural Processes Emphasis

Under alternative 3, Plan objectives direct the forest to remove fences (or other range infrastructure) that are deemed no longer necessary, and plan guidelines state that vacant or understocked allotments will not be restocked. With Plan objectives for vegetation using fire and very few mechanical treatments to move ERUs toward desired conditions, the likelihood of higher intensity fire increases. The associated effects of high-severity fire ***(RG6-7)*** would lead to decreased livestock numbers as a result of reduced available forage ***(RG11), and shrubby encroachment***. Ultimately, alternative 3 supports the fewest AUMs (***RG20***). ***Decreasing the number of AUMs grazing in the forest would have a negative socio-economic impact on our permittees and the local rural communities***[RG21]***.***

Alternative 4 – Human Uses Emphasis

Under alternative 4, Plan guidelines direct that vacant or understocked allotments should be made available for grazing. In the short-term, this may allow for a very slight increase (currently, most allotments are fully stocked) in the number of AUMs authorized across the forest. Plan objectives for thinning treatments may initially release the herbaceous understory from competition (Willms et al. 2017; Abella and Springer 2015) (***RG12***). However, these mechanical treatments may have negative impacts (***RG8-10, 16-17***), which would promote declines in range condition, soil condition, and forage production over time (Willms et al. 2017; Abella and Springer 2015). To balance the livestock numbers with the available forage, AUMs grazed across the forest would have to be decreased over time.

3.11.4.4 Indicator: Range Infrastructure Condition

Alternative 1 – 1987 Forest Plan

Under the current forest plan (alternative 1) there are no plan directives to fix degraded range infrastructure, and currently there is a backlog of infrastructure maintenance needs in the forest. The current plan calls for the removal of fences and loose wire as it is abandoned. Under alternative 1, we will continue to have a range infrastructure maintenance backlog. This will have a negative impact of the forest's resources as ***leaving range infrastructure in damaged conditions results in an unfettered distribution of livestock, and permits livestock access to sensitive areas (such as riparian habitats) which degrades habitat quality and water resources***[RG22].

Alternative 2 – Forest Plan

Under alternative 2, Plan objectives direct the removal, improvement, or reconstruction of 5 percent of the forest's poor and non-functional infrastructure annually. This level of improvement would allow for an increase in the amount of functional fencing across the forest, and potentially for a better distribution of livestock and a more uniform utilization of available forage. ***Regulating the distribution of cattle across the forest through the maintenance of proper infrastructure reduces the impact of grazing and helps to maintain resilient rangelands with balanced ecological function and diverse native plant communities***[RG23]***.*** Additionally, ***the removal of unnecessary fencing restores landscapes to a more natural condition (increasing visual quality), removes a potentially hazardous material (e.g., barbed wire) from the forest, and eases wildlife passage***[RG24]. Overall, alternative 2 would result in greater improvements to range infrastructure than alternative 1, would also be more effective at maintaining infrastructure than alternative 3; and is roughly equal to alternative 4.

Alternative 3 – Natural Processes Emphasis

Under alternative 3, Plan objectives direct that unnecessary fencing should be removed. This and the increase in fire utilized across the forest would result in a decrease in the amount of fencing across the forest over time, and would cause a corresponding decline in the ability of managers to evenly distribute cattle across the forest (***RG22***). This alternative would result in the least improvement to range infrastructure in the forest.

Alternative 4 – Human Uses Emphasis

Under alternative 4, to improve livestock distribution and utilization of available forage, Plan objectives direct the forest to annually improve or reconstruct 5 percent of the poor or non-functional infrastructure in the forest. This would lead to improved infrastructure and increase the even distribution of cattle across the forest (***RG23***). This alternative would be more effective than alternative 1 at restoring range infrastructure. The restoration of range infrastructure in alternative 4 is roughly similar to alternative 2, though alternative 2 would remove a greater quantity of unnecessary fencing, generating greater benefits to the forest (***RG24***).

3.11.4.5 Indicator: Invasive species (presence, absence, or acres affected)

Alternative 1 – 1987 Forest Plan

The current forest plan has not addressed invasive species management in its plan components, as invasive species management has not been a priority in past years. Under alternative 1, invasive species would continue to be managed as funds are available. It is expected that invasive species populations will continue to increase over the next 10 to 15 years. ***Invasive plants can negatively impact the ecological function of the site by changing fire return intervals, fire severity, plant community composition, hydrology, and nutrient cycling*** [RG25]**.** Moreover, ***invasive species decrease the quality and quantity of available forage by replacing desirable and more palatable native species, leading to a reduction forage that supports lucrative grazing opportunities*** [RG26]***.*** Overall, alternative 1 is the least effective alternative for the control or treatment of invasive species populations in the forest, as invasive plants will continue to not be managed.

Effects common to alternatives 2, 3, and 4

All alternatives aside from alternative 1, call for some form of invasive species management in the forest. However, a possible unintended consequence of the vegetation manipulations could be the spread of invasive plant species (Willms et al. 2017). ***None of the treatment goals for any of the alternatives presented in this analysis are sufficient to eradicate all the invasive species in the forest*** (White et al. 2015), ***but they start systems moving in the direction of desired species compositions and improved ecosystem health*** [RG27]. It is estimated that 1,500 acres of invasive plants would need to be treated annually to control invasive populations (White et al. 2015).

Alternative 2 – Forest Plan

Under alternative 2, there are Plan objectives to treat 600 acres of invasive species annually. This level of treatment would not be sufficient to control the forest's current invasive species population (White et al. 2015) but would be an improvement over current treatment levels (***RG27***). Plan objectives for vegetation treatments utilize mechanical and fire treatments to move ERUs toward desired conditions. However, ***both burning and thinning have the potential to increase the number of nonnative species in an area*** (Willms et al. 2017) [RG28], especially if these species are already present in the treated area. Many invasive plants increase as a response to disturbance, or easily establish as new populations through vehicles, livestock, or wildlife acting as vectors for transporting seed or vegetative material. Vehicle tires and equipment tracks typically result in more new invasive plant populations than grazing (Tyser and Worley 1992; Gelbard and Harrison 2003). Again, increases in invasive species have a negative impact on ecosystems by altering species composition, nutrient cycling, hydrology, and fire return intervals (see above). This alternative is expected to be more effective than alternative 1 at treating invasive species in the forest. However, this alternative would continue to move current conditions away from desired conditions to have fewer invasive species in the forest unless more acres of treatment can be implemented, as there is also the potential in this alternative to increase the spread and growth of, or introduce more invasive species from restoration treatments.

Alternative 3 – Natural Processes Emphasis

Under alternative 3, there are Plan objectives to treat 300 acres of invasive species annually (***RG27***). However, as this alternative prioritizes fire, there may be potential for invasive species spread (***RG28***). Invasive species present in the forest that may respond positively to fire include bull thistle, cheatgrass, and Dalmatian toadflax (Jacobs and Sheley 2003). Under this alternative, there would continue to be a gradual increase in the invasive species across the forest, moving conditions away from desired conditions.

Alternative 4 – Human Uses Emphasis

Under alternative 4, there are Plan objectives to treat 1,500 acres of invasive species annually. This level of treatment would be sufficient to reduce the current invasive species population in the forest (White et al. 2015), at least in localized areas over the short term (***RG27***). However, with increased human use and mechanical treatments, there would be an increase in weed infestations ***(RG28)***. Treating 1,500 acres per year would not be sufficient to control weeds, given the potential vectors for increasing the spread of weeds. Mechanical treatments have been consistently found to increase invasive species (Willms et al. 2017) such as bull thistle, which is found across the forest. Bull thistle has been found to establish after timber harvest without the additional disturbance of burning (Marcum 1971; Antos and Sharer 1980). Alternative 4 is likely to result in the highest spread of invasive species due to the prevalence of mechanical treatments and human uses (***RG10, 16-17, 27***).

3.11.4.6 Cumulative Effects

The previous analysis looked at rangeland-related impacts of the proposed alternatives for the Forest Plan in the Santa Fe NF over 10 to 15 years. The proposals in this plan would likely impact other lands adjacent to the forest to some degree, necessitating a separate, smaller analysis of cumulative effects. The following paragraphs analyze of the probable extended impacts including changes in fire regimes, forest vegetation, livestock production, and introductions and increases in invasive species populations throughout the area.

The area for this analysis includes BLM and National Park Service lands, state and tribal lands, private lands, and adjacent national forests in north-central New Mexico. For the foreseeable future, it is likely that grazing will continue throughout the area. It is reasonable to assume that there will be vegetative manipulations such as burning, mechanical treatments, and brush removal that would likely increase available livestock forage and grazing opportunities for the local communities surrounding the Santa Fe NF. It is also reasonable to assume that some amount of woody encroachment will also continue throughout the analysis area, and that this amount of this encroachment will be inversely proportional to the amount of prescribed burning and thinning treatments that will be performed throughout the landscape.

Because of its negative impacts to herbaceous plant production, woody plant encroachment can be considered a threat to livestock production (Scholes and Archer 1997). Mechanical treatments and prescribed fires can be used to mitigate this, but grazing pressure must be relaxed to allow for fine fuels to accumulate (Fuhlendorf et al. 2008). If we work with our partners across boundaries to design and perform restoration treatments, that could have a landscape-level effect, bringing more of the forest and adjacent lands into a more open-canopy condition, returning fire to a more natural regime, as a byproduct, we could increase the quality and quantity of forage at the landscape scale (***RG4-5, 12-14***). Partnership and working across boundaries would be the only way to accomplish this.

If we do not manage for woody encroachment across the forest and surrounding landscapes, and allow natural processes to dominate across the forest as is proposed, wildfire in the forest and on adjacent lands would increase. Fire may have varying impacts depending on the intensity of the fire when it occurs (***RG3, 5-7***). Given that the fire regimes across the forest and neighboring lands are departed, fires of high intensity are likely to result from unplanned fires. Under dry conditions, unplanned fires in areas of high fuel loadings can quickly get out of control, causing indiscriminate destruction of forest lands and adjacent lands and resources. Damage inflicted on forest lands by high-severity fires have a negative effect on range condition, increase shrubby species, decrease forage production, decrease the AUMs that can be stocked in the forest, damage range infrastructure, and promote the spread of common invasive plants that are currently found in the area and in the forest.

On the other hand, if we try to manage for woody encroachment through thinning, without using fire, there would likely be an increase in the amount of invasive species, a decrease in forage production, and subsequently, a decline the number of AUMs available to the local grazing community. The reduction in AUMs and spread of invasive species would also impact lands outside of the forest boundary. For further analysis, please refer to the analysis by indicator above.

Overall, direct forest management is needed to sustain the forage productivity of the Santa Fe NF, which contributes positively socio-economically to local communities. The current forest plan is not making sufficient progress toward managing woody encroachment to improve range condition or forage production. Furthermore, the number of AUMs stocked across the forest and neighboring lands is slowly declining (***RG21***). We need to work with our neighbors and partners at the landscape level to restore our lands, decrease shrub encroachment, and return fire to the landscape at a more natural level. This would help improve range condition and forage production. This would help support neighboring communities culturally and economically now and for years to come.

3.12 Recreation

Recreation opportunities provided by the Santa Fe NF are divided into two main groups: developed recreation and dispersed recreation. Developed recreation refers to activities that occur at discrete locations that have facilities constructed to concentrate certain types of uses. Examples of developed recreation sites in the Santa Fe NF include campgrounds, picnic areas, fishing sites, trailheads, downhill ski area, and boating ramps. These facilities generally provide a continuum of recreation opportunities with varying degrees of comfort, security, convenience, and social interaction. In contrast, dispersed recreation refers to activities that take place in less developed or undeveloped areas. Visitors participating in dispersed recreation activities are, by definition, more broadly distributed across Santa Fe NF lands. Dispersed recreation activities in the Santa Fe NF can include motorized and non-motorized uses, such as backpacking, rock climbing, day hiking, fishing, hunting, cross-country skiing, snowshoeing, wildlife viewing, driving for pleasure, and riding ATVs and snowmobiles. These activities often take place in areas characterized by more difficult access, thereby emphasizing solitude, challenge, and self-reliance.

3.12.1 Affected Environment

3.12.1.1 Recreation Opportunity Spectrum

The intent of recreation management in the Santa Fe NF is to provide a range of opportunities that allow visitors to have a diversity of experiences depending on their preferences and interests. Recreation opportunities are key indicators of how each alternative would affect management of the recreation program. The desired recreation opportunity spectrum (ROS) has been used to map the Santa Fe NF by the most applicable types of recreation opportunities desired for an area. The ROS is a continuum used for managing recreation opportunities based on a combination of physical, biological, social, and managerial settings, ranging from primeval to paved (Clark and Stankey, 1979). The ROS represents management objectives and not actual user experience. The physical setting is defined by the absence or presence of human sights and sounds, size of area, and the amount of environmental modification caused by human activity. The social setting reflects the amount and type of contact between individuals or groups. The managerial setting is distinguished by the amount and kind of restrictions placed on people's actions by the respective administering agency or private landowner (USDA Forest Service 1986).

The Forest Service uses six ROS classes as defined by in the USDA Forest Service 1986 publication "ROS Users Guide" that encompass recreation opportunities ranging from less to more developed settings. The ROS uses the following descriptors for recreation settings ranging from least to more developed settings, based on six factors: (1) access; (2) other non-recreational uses; (3) onsite management; (4) social interaction; (5) acceptability of visitor impacts; and (6) acceptable level of regimentation (USDA Forest Service 1986).

> **Primitive** areas are characterized by essentially unmodified natural environments of fairly large size. Interaction between users is very low and evidence of other users is minimal. The area is managed to be essentially free from evidence of human-induced restrictions and controls. Motorized use and mechanized equipment within primitive areas is not permitted. Primitive areas in the Santa Fe NF are found within the Pecos, San Pedro Parks, Dome, and Chama River Canyon Wilderness Areas.

> **Semi-Primitive Non-Motorized (SPNM)** areas are characterized by a predominantly natural or natural-appearing environment of moderate-to-large size. Interaction between users is low, but there is often evidence of other users. The area is managed in such a way that minimum on-site controls and restrictions may be present but are subtle. An example of a Semi-Primitive Non-Motorized area would be White Rock Canyon just west of the Caja del Rio Plateau near the City of Santa Fe.

> **Semi-Primitive Motorized (SPM)** areas are characterized by a predominantly natural or natural-appearing environment of moderate-to-large size. Concentration of users is low, but there is often evidence of other users. The area is managed in such a way that minimum on-site controls and restrictions may be present but are subtle. Most of Rowe Mesa and the Anton Chico area are examples of this classification.

> **Roaded Natural (RN)** areas are characterized by predominantly natural-appearing environments with moderate evidences of the sights and sounds of people. Such evidence usually harmonizes 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. Examples of Roaded Natural areas include parts of the Caja del Rio Plateau and mesas in the Jemez and Cuba areas.

> **Rural (R)** areas are characterized by a substantially modified natural environment. Resource modification and utilization practices are to enhance specific recreation activities and to maintain vegetative cover and soil. Sights and sounds of people are readily evident, and the interaction between users is often moderate to high. Many facilities are designed for use by large numbers of

people. Facilities are often provided for special activities, such as amphitheaters, group pavilions, group fire rings and cooking units, and so forth. Facilities for intensified motorized use and parking are available. Some facilities may be designed primarily for user comfort and convenience. Some synthetic but harmonious materials may be incorporated. Design may be more complex and refined. Examples of Rural areas in the Santa Fe NF are along NM Highway 475 to the Santa Fe Ski Basin, NM Highway 4 through the Jemez Mountains, and NM Highway 63 through the Pecos River Canyon.

Urban (U) areas are characterized by a substantially urbanized environment, although the background may have natural-appearing elements. Renewable resource modification and utilization practices are to enhance specific recreation activities. Vegetative cover 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 forms of mass transit often available to carry people throughout the site. Urban areas in the Santa Fe NF are primarily restricted to administrative facilities, but also include Ski Santa Fe facilities.

The Santa Fe NF offers visitors a multitude of opportunities for motorized and non-motorized recreation activities in ROS settings from Primitive to Rural (table 83).

3.12.1.2 Developed Recreation

There are more than 100 developed recreation sites within the Santa Fe NF. Recreation facilities in the forest include 25 developed campgrounds (table 84) with various amenities, such as campsites with tables, fire rings, and camping pads, trash pickup, drinking water, and horse corrals. These campgrounds include about 500 camp sites. Another five campgrounds are for groups and can accommodate up to 40 persons per campground. Developed recreation sites in the Santa Fe NF also include a dozen picnic areas encompassing about 100 picnic sites, 11 fishing access sites, 3 boat launches, and several scenic overlooks and interpretive sites (table 84). The Santa Fe NF has one developed downhill ski area, Ski Santa Fe, which is operated through a recreation special use permit (refer to Special Uses section).

Table 83. Number of acres of Santa Fe NF by ROS setting. Source: Santa Fe NF Geographical Information System, 2018

ROS Setting	Number of Acres	Percentage of Total Acres
Primitive	297,197	19.2%
Semi-Primitive Non-Motorized	592,876	38.4%
Semi-Primitive Motorized	435,186	28.2%
Roaded Natural	217,627	14.1%
Rural	1,801	0.1%
Urban	617	less than 0.1%
Total	**1,545,305**	

3.12.1.3 Dispersed Recreation

The Santa Fe NF manages approximately 1,113 miles of system trails (table 85), accessed by about 40 trailheads (table 84). About 87 miles of this total are motorized trails. There are an uncounted number and many miles of user-created trails, which are not managed as part of the Forest Service trail system. Forest system trails include about 40 miles of the Continental Divide National Scenic Trail (CDNST), which crosses the U.S. from Mexico to Canada, two national recreation trails (NRT), and three National Historic Trails (NHT; table 85). The forest includes four wilderness areas totaling just over 286,000 acres, approximately 53 miles of wild and scenic rivers, and a national recreation area. These congressionally designated areas are discussed in detail in the Designated Areas section of this chapter.

Recreational use of roads for motorized dispersed camping is authorized by the Travel Management Rule published in 2005 (USDA Forest Service 2005). This rule and the subsequent Santa Fe NF Travel Management Plan (USDA Forest Service 2013c) identified where dispersed camping is allowed along motorized travel routes in the forest. In these areas, motorized use for camping is permitted only within 150 feet of either side of the road. The travel management map is updated and published annually as the forest's MVUM.

Table 84. Number of developed recreation sites within the Santa Fe NF
Source: Santa Fe NF Natural Resources Manager Database and Forest geospatial data, 2017.

Site Type	Coyote Ranger District	Cuba Ranger District	Jemez Ranger District	Pecos/ Las Vegas Ranger District	Española Ranger District	Forest Total
Campgrounds	4	2	5	10	4	25
Camp sites	38	29	189	174	52	482
Group campgrounds	1	1	1	2	0	5
Picnic areas	0	1	4	5	2	12
Picnic sites	0	4	55	24	19	103
Other sites	2	2	2	0	2	8
Boating sites	2	0	0	0	1	3
Fishing access	0	0	8	3	0	11
Trailheads	2	3	5	15	15	40
Nordic ski areas	0	0	0	0	2	2
Downhill ski areas	0	0	0	0	1	1

Table 85. Estimated trail mileage by district, Santa Fe NF, including Continental Divide National Scenic Trail (CDNST), National Historic Trails (NHTs), and National Recreation Trails (NRTs)

Trail Type	Coyote Ranger District	Cuba Ranger District	Jemez Ranger District	Pecos/ Las Vegas Ranger District	Española Ranger District	Forest Total
All	149	62.2	77.9	415	08.5	1,112.8
CDNST	30.0	10.4	0	0	0	40.4
NRTs	10.9	0	0	0	9.0	19.9
NHTs	7.9	0	0	0.14	15.1	23.1

3.12.1.4 Recreation Activities

National Visitor Use Monitoring (NVUM) is a Forest Service recreation survey process that is conducted on each national forest approximately every five years since it was initiated in 2001. For the Santa Fe NF, NVUM was undertaken in fiscal years (FY) 2003, FY2009, and FY2014.

The FY2014 NVUM identified some of the more popular recreation activities in the Santa Fe NF as hiking or walking, viewing natural features, viewing wildlife, relaxing, downhill skiing, driving for pleasure, picnicking, and camping (USDA Forest Service 2016b). These results are fairly consistent with the prior two surveys (table 86). The NVUM data show that between 2003 and 2014 the six most frequently reported recreation activities in the Santa Fe NF were consistent and included: hiking or walking, viewing natural features, relaxing, viewing wildlife, driving for pleasure, and downhill skiing. Each of these activities was undertaken by at least 10 percent and as much as 66 percent of sampled Santa Fe NF visitors. Hiking or walking consistently ranked as the highest recreational use, engaging at 63 to 66 percent of sampled visitors, for all three survey periods.

3.12.1.5 Recreation Trends

The NVUM estimated total recreation visitation to the Santa Fe NF for FY 2003 at 1.36 million persons (Kocis et al. 2004). Subsequent NVUM surveys estimated total Santa Fe NF visits as 955,000 for FY2009 and 728,000 for FY2014 (USDA Forest Service 2016a; USDA Forest Service 2016b). However, alterations in methodology (including how the methodology is implemented, e.g., who is implementing the survey each year) and variability in sampling data preclude identification of any real trends in visitor use.

In 2014, the NVUM identified that approximately 83 percent of Santa Fe NF visitors traveled less than 100 miles to visit the Santa Fe NF, indicating they were New Mexico residents (USDA Forest Service 2016b). At the time of that survey, the population growth in the state was slowing from its former rigorous growth (Krasnow 2017), which may influence recreational use in the Santa Fe NF to also grow slowly or not at all.

Nationally, participation in outdoor recreation is growing, and there are more available choices as outdoor recreation activities have been evolving over the past few decades (Cordell 2012:1). Locally, Santa Fe NF staff have observed similar trends. These national trends are expected to continue over the next several decades (Cordell 2012:4). Cordell's research also pointed toward an increasing participation in "nature-based" outdoor recreation—that is, viewing and photographing nature. Contrary to what some Santa Fe NF managers might assume based on personal observations, yet consistent with the Santa Fe NF NVUM data, Cordell found that visitation to national forests declined in the decade from 2000 through 2009 (Cordell 2012:2-3).

Table 86. National visitor use monitoring comparison for FY 2003, FY 2009, and FY 2014 (percent participation by activity) (Kocis el al. 2004, USDA Forest Service 2016a and b)

Activity	2003	2009	2014
HIking/walking	62.9	65.4	66.0
Viewing natural features	63.2	31.9	50.9
Relaxing	53.4	21.7	29.1
Viewing wildlife	51.3	22.0	31.7
Driving for pleasure	20.8	11.2	10.8
Downhill skiing	15.6	10.0	17.7
Picnicking	14.5	8.0	6.0
Nature study	11.4	9.8	4.6
Visiting historic sites	10.5	2.8	2.7
Fishing	9.4	9.3	3.5
Developed camping	7.5	5.7	5.4
Primitive camping	5.7	1.9	3.9
Gathering forest products	5.6	3.2	4.8
Nature center activities	5.5	4.2	2.1
Backpacking	3.1	1.8	0.0

Activity	2003	2009	2014
Off-highway vehicle use	3.5	0.4	0.5
Other non-motorized	3.0	2.3	3.6
Bicycling	2.5	2.8	2.7
Cross-country skiing	2.0	9.1	2.0
Hunting	1.3	2.2	2.2
Horseback riding	1.2	0.6	0.4
Resort use	0.5	0.7	0.6
Motorized water activities	0.2	0.1	0.3
Non-motorized water activities	0.2	0.9	2.6
Snowmobiling	0.1	0.0	0.0
Other motorized	0.1	0.0	0.3

Cordell predicted that, nationwide, the five activities projected to grow the most in terms of number of participants over the next 50 years are:

- developed skiing;
- undeveloped skiing;
- challenge activities;
- equestrian activities; and
- motorized water activities

In contrast, the activities with the lowest projected growth in participant numbers nationwide over this same period are:

- visiting primitive areas;
- motorized off-road activities;
- motorized snow activities;
- hunting;
- fishing; and
- water floating activities.

For the Santa Fe NF, motorized water activities are non-existent and motorized snow activities are only available irregularly when snow conditions are sufficient. In addition, these predictions don't account for climate change, which could negatively impact growth for skiing and other snow-related activities. Floating activities are generally limited to the Rio Chama and Rio Grande.

As Cordell pointed out, while activities that currently have high participation levels may not show large percentage increases in participant numbers, even small percentage increases in already highly popular activities can mean quite large increases in participants (Cordell 2012:4).

3.12.1.6 Sustainable Recreation Strategy Action Plan

Since 2012, the Forest Service recreation program has focused on sustainable recreation, which is a Forest Service strategy for managing forest recreation programs to reflect current and future visitor needs, desires, and expectations. The Southwestern Region Sustainable Recreation Strategy (Furr et al. 2014) goal is: "To achieve a sustainable recreation program, essential to advancing the mission of the Forest

Service, with a diverse and engaged public that enjoys and actively cares for the national forests and grasslands of the Southwest."

In 2016, the Santa Fe NF, in accordance with Regional Office direction developed and adopted a Sustainable Recreation Strategy Action Plan (USDA Forest Service 2016c). The purpose of the Action Plan is to provide direction for making the Santa Fe NF's recreation program more sustainable. This Action Plan includes 11 actions which include implementing a public engagement plan and a Santa Fe NF volunteer plan, keeping the Santa Fe NF website recreation pages up-to-date, developing responsibilities for managing the Santa Fe NF dispersed recreation program using partners and volunteers, and reducing services or amenities, when needed, in order to keep develop recreation sites open for public use (USDA Forest Service 2016c). The Action Plan is not incorporated by amendment into the 1987 Forest Plan and, therefore, does not have the force of the forest plan behind it.

3.12.2 Methodology and Analysis Process

3.12.2.1 Assumptions

- The analysis assumes that visitors want varying experiences, from primitive to highly developed, to be available but that the Forest Service cannot accommodate all preferences in all parts of the forest.
- Recreation opportunity spectrum (ROS) settings are based on the physical, social, and managerial setting characteristics (FSM 2310). Desired ROS settings result from interdisciplinary discussions, public engagement, and the NEPA process. The amount of vegetation manipulation can have a large impact on ROS settings and is an objective way to look at whether management is meeting desired ROS.
- ROS classifications "Urban" (617 acres) and "Rural" (1,801 acres) were not included in the analysis of potential effects to ROS changes. These classifications comprise a very small part of the forest. In addition, vegetation treatments would not be expected to change whether areas are meeting the desired "Roaded Natural" ROS class.
- Primitive ROS classes were not considered as possibly being changed to another ROS class as a result of the alternatives. Most Primitive areas are within designated wilderness where policy is to permit ecological processes to operate naturally and manipulation of stand structure (e.g., thinning) should only be considered as a last resort. Other Primitive areas are located within inventoried roadless areas, which are much more expensive to treat with limited transportation infrastructure and hand crews, and therefore, would be very low priority.

3.12.2.2 Indicators

Recreation opportunities

Recreation opportunities represent the diversity of recreation activities that occur in the Santa Fe NF. The level of user satisfaction when participating in recreation activities is also a component of recreation opportunity. Management activities can impact recreation opportunity diversity and user satisfaction. In particular, vegetation treatments, which affect the overall natural setting of the Santa Fe NF, and the road system, which affects the way the forest is accessed and used for recreation, were considered in the analysis of alternatives. The ROS is a tool that can also be used to evaluate the diversity and extent of availability of various recreation opportunities in the forest.

Sustainable recreation

Sustainable recreation refers to management of forest recreation resources to provide opportunities that respond to visitor needs and expectations while sustaining these benefits for present and future generations. The recreation program must address a sustainable balance among the three spheres of environmental, social, and economic conditions (2012 Planning Rule). Sustainable recreation is composed of two concepts. One of these concepts is the flexibility to provide recreation opportunities of a type and in locations that people want, in the face of changing recreation trends. This includes appropriate recreation infrastructure and facilities. Another is the impact of recreation on other resources particularly ecological resources. If recreation activities damage ecological resources, they could degrade recreational experiences for some users as well as affect the ability of managers to protect other resources (e.g., wildlife habitat). For the first concept, recreation opportunities are discussed in the first indicator. The sustainable recreation indicator is concerned with recreation infrastructure and facilities from the first concept as well as the second concept.

User conflicts

With respect to recreation, user conflicts can be defined as an issue of goal interference. Conflict happens when a recreationist's goal is impeded by other users in the forest, whether by other recreationists or other resource uses. There are three general categories of conflict: (1) compromised safety, (2) degradation of valued resources; and (3) diminished quality of the recreation experience.

Recreationists can interfere with each other by the activity they choose and the method they choose to pursue that activity. For example, wheeled vehicles (e.g., bicycles, motorcycles, ATVs) can threaten the safety of equestrians and hikers by the former moving too quickly past the latter or without sufficient notification of their presence. Large, social (i.e., talkative) groups of hikers with loose, barking dogs can interfere with hikers who have a goal of achieving solitude.

Extractive uses such as timber harvesting and cattle grazing can also result in forest user conflicts. Recreationists may perceive extractive uses as degrading, valued forest resources and diminishing the quality of their experience, thereby thwarting their recreation goals.

3.12.3 Drivers and Stressors

Drivers and stressors may alter the supply of and demand for recreation opportunities, resulting in changes in the amount and pattern of recreation in the future.

For the Santa Fe NF, changing climate conditions are most likely to be characterized by warmer and drier weather which may lead to increased fire frequency and severity. Increased fire frequency and severity would result in changes to forest vegetation conditions that could be viewed negatively by recreationists, particularly before landscapes have the chance to recover to their pre-fire conditions. Longer term changes that may be less desirable for some recreationists include a decrease in shade and increase in understory vegetation, such as locust, shrub oak, and grasses. Lower elevation areas of the Santa Fe NF, such as Anton Chico in the Pecos/Las Vegas Ranger District and the Caja del Rio Plateau and the area of El Invierno in the Española Ranger District are the most susceptible areas for vegetation changes (Hand et al. 2018). Even if the same recreation activities are still available post-wildfire, changes in forest structure (e.g., loss of forest canopy) or scenery would affect the recreation setting and, therefore, affect the recreation opportunity. In most cases, the changes in opportunities would likely be viewed negatively by recreationists desiring to camp in developed or dispersed areas, use developed trails, or simply to drive for pleasure and picnic (Venn and Calkin 2011:330), particularly in warm summer months when many visitors come to the Santa Fe NF to escape the heat of lower elevations and urban areas. Dead or blackened trees and shrubs, barren ground littered with charred remains of woody vegetation and ash, loss of shade, and gully erosion would negatively affect the recreation experience for most visitors, leading visitors to avoid these areas. For example, post-fire decrease in visitation by hikers and mountains bikers was observed in a study of several national forests in New Mexico, including the Santa Fe NF (Hesseln et al. 2003).

Depending on the location and severity of uncharacteristic wildfires, post-wildfire damage to developed sites, trails, or other dispersed recreation areas from the fire or post-fire flooding are likely unavoidable and would result in long-term changes to recreation opportunities in the Santa Fe NF. Long-term closures (i.e., 5- to 7-year duration following fires) of portions of the Santa Fe NF affected by uncharacteristic wildfires would be instituted for public safety. Any type of closure would result in a restriction of recreation opportunities available to Santa Fe NF visitors within the closure area. Additionally, drifting smoke during wildfires may negatively affect recreationists' experiences outside of restricted access areas and cause them to relocate to another area or abandon their activities altogether while smoke persists (Taylor 1988). Loss of infrastructure would result, at minimum, in lost recreation opportunities in the short term. These losses may endure for years at particularly high-investment recreation sites. Some lost facilities may never be replaced if sufficient funding is not available or if replacement of the site doesn't comply with the latest guidance for locating such facilities. For example, a developed campground currently located in a floodplain would be prohibited from being rebuilt in the same location for safety reasons.

Changes in climate could also exacerbate natural forest disturbances such as drought, insect infestations, and disease outbreaks. For example, extended drought would lead to insect infestations such as has occurred with mountain pine beetle (*Dendroctonus ponderosae*) in lodgepole pine (*Pinus contorta*) forests in the northern Rocky Mountains. At higher elevations, such as in the Pecos Wilderness, the National Insect and Disease Forest Risk Assessment anticipates substantial areas in the Santa Fe NF with greater than 25 percent loss of tree basal area from insects and disease through the life of the plan (Hand et al. 2018). Large outbreaks affecting tens of thousands of acres of forests could lead to increases in the potential for falling trees and affect recreationist's safety and forest access. This could reduce recreation opportunities, visitation numbers, and the quality of the recreation experience (Rosenberger et al. 2013).

Decreases in snowpack are likely to have negative impacts on winter recreation and streamflows (e.g., surface water for irrigation). Climate effects on winter recreation tend to be negative. Among the national forests in the Southwest, the Santa Fe has higher sensitivity for winter recreation (Hand et al. 2018), which is predominantly downhill skiing. Recreationists may cease winter recreation activities, shift to non-winter activities, or move to other national forests or sites where winter recreation activities can occur. Interestingly, climate change is projected to increase outdoor recreation participation overall, although variation in participation by specific activities is possible. The largest type of climate-sensitive recreation visits are warm-weather activities by local visitors. Benefits provided by recreation are expected to increase under climate change scenarios because increases in warm-weather activities are expected to outweigh losses in winter activities.

The ability of the Santa Fe NF to provide the same recreation opportunities to which forest users are accustomed may be constrained with a changing climate. For example, current visitor expectations of winter sports opportunities could be difficult to meet if there is less snow or insufficient water to create artificial snow in the future. Similarly, drought conditions could create increasingly extreme fire danger conditions that may lead to the forest choosing to implement fire restrictions more frequently, including possible forestwide closures. Both reduced snowpack and increased fire danger could alter or reduce recreation opportunities in the Santa Fe NF during what are currently the some of the most popular recreation periods. This would be contrary to one of the concepts of sustainable recreation: managing for visitor needs, desires, and expectations. Finally, reduced stream flows and warmer water temperatures would negatively affect fish populations and thereby fishing opportunities for Santa Fe NF visitors. New recreation opportunities may emerge as the forest changes and visitors adapt their expectations, a process that will be facilitated by sustainable recreation goals to create recreation opportunities that are ecologically, socially, and economically viable over the long term.

Within the planning period (the next 10 to 15 years), population growth and shifting demand for various recreation opportunities is expected to increase, particularly in the metropolitan areas around Albuquerque and Santa Fe. The population of Sandoval County—which overlaps with much of the western side of the forest—has been growing relative to state averages. This is likely to continue throughout the life of this Plan and impact recreation demand. Demographic changes (e.g., aging populations, people moving in from other parts of the country, increasingly urban populations, etc.) could also alter the types of recreation demanded most**.**

A growing and changing population places new demands on recreation that could result in ***more human concentration and use at existing recreation areas, increased conflicts, increased number of recreational and off-highway vehicles, and may reduce the quality of recreation settings***[RE36]. If use increases, ***compliance with regulations could become a greater challenge as recreational participants increase and often compete for space and resources***[RE38]***.*** This is likely to result in the ***greatest impact on the areas close to communities that offer semi-primitive and primitive recreation settings***[RE39] that emphasize solitude, challenge, risk, unmodified natural environments, and minimal encounters and/or signs of other users.

3.12.4 Environmental Consequences

3.12.4.1 Indicator: Recreation Opportunities

Effects Common to All Alternatives

The 1987 Forest Plan and Forest Plan (the proposed action) include plan guidance that direct management activities be consistent with ROS, particularly for dispersed recreation such as trail development and maintenance. Implementing ROS establishes ***recreation opportunities in a variety of settings and at various accessibility levels, which ensures a broad spectrum of recreationists are able to interact with the forest at their own pace and target their visit to specific interests or needs*** [RE1.]

Standards and guidelines in all alternatives allow for thinning and burning activities to be used to accomplish project or plan level desired conditions. In forested ERUs thinning and burning would reduce tree density and ***would change recreation opportunities available to Santa Fe NF visitors*** [RE3]***. The provision of less-densely vegetated forest lands would provide more opportunities for certain recreation activities***[RE4]***.*** Dispersed camping, picnicking, wildflower and wildlife viewing, travel by foot, horseback, skis, bicycles, or motorized vehicles, and some types of hunting (e.g., for elk) would all benefit from more open forest areas (Englin et al. 2001, Venn and Calkin 2011). Vegetative desired conditions for more open forests ***would be less appealing to some campers who may avoid dispersed sites with less vegetative screening*** [RE5]***.*** On the other hand, ***more open park-like areas would be more visually appealing and aid in accessing dispersed camping sites for some visitors (e.g., visitors pulling large trailers or driving RVs)*** [RE6]***. User-created trails for bicycling, horseback riding, and hiking may be a result in areas opened by fuel treatments or uncharacteristic large disturbances***[RE7]***. Such trails may disturb wildlife and fish and their habitats, result in soil compaction and erosion, and deteriorate water quality***[RE7a]***.*** Frequent and extensive vegetation treatments that ***elicit formal closures or cause***

recreationists to avoid these sites would be frustrating to users and negatively impact their recreation experiences in the Santa Fe NF[RE8]. Displaced recreationists may impact previously-undisturbed areas with effects similar to user-created trails or result in more people recreating in currently used areas, further frustrating all users.

Thinning and burning activities that change scenery in forested ERUs would also affect recreationists' experiences. Over the life of the plan, ***some recreationists would avoid treated areas with views of stumps, vegetation piles, and blacked and burned vegetation and be displaced to other areas***[RE9]***. Loss of screening vegetation and forest canopy that provide shading along trails or at dispersed camping sites would also negatively impact recreation use through decreased cooling in warm months as well as loss of privacy***[RE10]***.***

Vegetation treatments (i.e., thinning and burning) have the potential to alter ROS classes from those that are predominantly natural-appearing (i.e., P, SPNM, SPM, RN) to those with more modified environments (i.e., R or U). Mechanical treatments and prescribed burning actions would be ***consistent with managing for predominantly natural-appearing environments of P, SPNM, SPM, and RN ROS classes***[RE11], even though they would be visually evident (***RE9***). However, these treatments could result in more open environments and changes in recreation opportunities (***RE4, RE9, RE10***) by ***increasing the evidence of other users which may not be consistent with SPNM and SPM ROS classes***[RE12]***.*** In contrast, primitive ROS classes would not have similar effects (***RE12***) ***because most of the primitive areas in the forest are in Wilderness where mechanical treatments could not occur or are in less popular parts of the forest where the chance of encountering other users is always low***[RE13]***.*** In addition, fires that are uncharacteristically large and burn with more severe intensity could have effects (***RE9, RE10, RE4, RE8***) that occur over larger areas and last longer, and are thereby ***inconsistent with managing for predominantly natural-appearing ROS classes***[RE14]. Any minor inconsistencies in managing for ROS settings (***RE11, RE12, RE14***) would persist until the evidence of modification practices (e.g., stumps) are not prevalent and the vegetative desired conditions are restored. Effects (***RE14, RE8***) from uncharacteristic wildfires can be long lasting and ***would take longer periods to revert back to the desired ROS setting***[RE15]***.***

Roads provide recreationists with access to the forest and can affect the ROS settings and opportunities in the Santa Fe NF. All alternatives include road objectives for decommissioning, maintaining, or constructing roads. ***More and better-maintained roads would increase access throughout the forest and expand dispersed recreation opportunities***[RE16]. ***Fewer roads, achieved via decommissioning, would improve fish and wildlife habitat, increasing the quality and quantity of opportunities for wildlife watchers, fishers, and hunters to participate in their activities of choice***[RE17]***.*** Recreationists striving for solitude ***would also be likely to benefit from some areas being located at greater distances from roads or having a reduced road density***[RE18]***, which would discourage vehicle-based recreationists and the associated noise.*** However, despite educational efforts by the Forest Service, ***some of these increased opportunities could also encourage actions that are currently prohibited or discouraged, such as motorized use off designated roads or camping further than allowed from those roads, leading to damage or disturbance to other forest resources (e.g., water, soil, wildlife, sensitive plants)***[RE19] (Laverty and Williams 2000)**.**

Designated areas and eligible wild and scenic rivers are consistent across all alternatives. Management direction is often dictated by law, regulation, and policy. Some designated areas have a recreation focus and some emphasize specific types of recreation opportunities. For instance, the Jemez National

Recreation Area is a renowned area that offers a diversity of recreation opportunities. Scenic byways offer opportunities to view and appreciate the beauty of the Santa Fe NF. National recreation, scenic, and historic trails offer opportunities to explore exceptional trail experiences. Wilderness areas provide areas for many to connect with nature and experience solitude and primitive and unconfined recreation. Designated and eligible Wild and Scenic Rivers, especially those with recreation classifications, provide opportunities for recreation on or near free-flowing rivers with outstandingly remarkable values. Together and in concert with the rest of the forest where recreation can be less restricted and more open, these designated areas improve recreation opportunities and their effects (***RE1***).

Alternative 1 – 1987 Forest Plan

The absence of objectives for vegetation treatments (i.e., thinning and burning) would result in uncertainty as to the relative level of any of the specific effects on recreation opportunities in this alternative (***RE11, RE3, RE5, RE6, RE9, RE10, RE4, RE14, RE13, RE8, RE1***). If these activities continue at the average rate of fuels treatments that were undertaken in the forest from 2003 through 2013, the treated areas within the forested and non-forest ERUs would average about 5,397 acres of thinning and 9,720 acres of fire annually (see vegetation section, table 22). This level of vegetation treatments and their associated effects on recreation opportunities (***RE11, RE3, RE5, RE6, RE9, RE10, RE4, RE14, RE13, RE8, RE1***) would be the lowest of all alternatives.

The 1987 Forest Plan includes annual road objectives for constructing 9.5 miles, reconstructing 71.5 miles, and decommissioning 66 miles for a net decrease in forest roads for the first two decades under the 1987 Forest Plan. Such a decrease would represent the greatest number of miles of road construction, maintenance, and decommissioning and their associated effects on recreation opportunities (***RE18, RE19, RE16***) of all alternatives.

There are 1,853 acres of recommended wilderness in this alterative. Similar to designated wilderness, establishing recommended wilderness areas result in ***expanded opportunities for primitive and unconfined type of recreation and opportunities for solitude***[RE21]. Alternative 1 has the second lowest amount of recommended wilderness of all alternatives and therefore the effects on recreation opportunities (***RE1, RE21)*** would only be slightly better than alternative 4.

Effects Common to Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 include many more specific recreation plan components that focus on maintaining or achieving the desired ROS setting including new plan components regarding considering new and maintain existing recreation facilities and managing new recreation uses (e.g., drones, satellite dishes). These additional plan components better ensures ROS is used to manage recreation and greater effects related to using ROS (***RE1***) than in alternative 1.

Geographic areas include desired conditions that focus on continuing to provide the unique recreation opportunities within them as well as generally ensuring that recreation is well distributed and diverse. The addition of geographic areas further promotes recreation opportunities and their effects (***RE1***) for these areas in these alternatives.

Alternative 2 – Forest Plan

In alternative 2, recreation plan objectives direct completion every three years of (1) 75 percent of the deferred maintenance at two developed recreation sites; (2) trail maintenance and improved signage on at least 25 percent of system trails; and (3) improvements on at least one mile of poorly designed trail. There is also a guideline that directs closing, rehabilitating, or mitigating dispersed campsites that are not meeting scenic integrity objectives, having persistent user conflicts, or causing ecological damage. This plan guidance offers more specific direction to maintaining developed and dispersed recreation infrastructure in the Santa Fe NF and it provides the second highest amount of recreation site improvements of all alternatives. All of this direction combined allows for ***better maintained recreation infrastructure and facilities that can improve recreation experiences by increasing visitor comfort, feelings of safety, and accessibility*** [RE22]**.**

Under this alternative there are objectives for an average of 12,815 acres of thinning annually. This is the objective with the second largest amount of thinning of all alternatives, almost double the 6,744 average annual acres in alternative 1. In addition, prescribed burning and wildfire would be implemented on an average 35,140 acres annually. This is the second highest amount of burning proposed for any of the alternatives, a more than 10-fold increase in the average number of acres burned under the 1987 Forest Plan. The level of thinning and burning proposed with Alterative 2 and its associated effects on recreation opportunities (***RE11, RE3, RE5, RE6, RE9, RE10, RE4, RE14, RE13, RE1***) would be the second highest among of all alternatives. The likelihood of uncharacteristic fire and its effects on recreation opportunities (***RE15***) would be diminished in areas mechanically thinned and overall, as a guideline directs suppression when lighting strikes start fire outside the range of natural variability or when necessary to protect life, investments, and valuable resources.

Alternative 2 includes road objectives for decommissioning or maintaining 10 miles of road annually. This represents the second lowest number of road miles proposed for decommissioning or maintenance and their associated effects on recreation opportunities (***RE18, RE19, RE16***) of any alternative.

There are 25,868 acres of recommended wilderness in this alterative. This alternative has the second highest amount of recommended wilderness of all alternatives, and therefore, the effects on recreation opportunities (***RE1, RE21***) would be second only to alternative 3.

Alternative 2 includes two interpretive management areas: the Caja del Rio Wildlife and Cultural Interpretive Management Area and four separate cultural interpretive management areas. These management areas offer interpretive materials that provide relevant information about the areas. The addition of these specific recreation opportunities further increases the recreation opportunities and its effects (***RE1***) in this alternative.

Alternative 3 – Natural Processes Emphasis

A recreation plan objective in alternative 3 direct mitigating ecological damages at two developed recreation sites every three years. While these plan components offer more direction than alternative 1, it covers fewer areas than alternative 2 or 4. Therefore, alternative 3 would result in the second least amount of change to recreation opportunities (***RE22***) of all alternatives. Implementation of this objective could include activities such as (1) revegetating riparian areas close to or within developed recreation sites; (2) relocating sites, or (3) closing sites temporarily. There is also a guideline in this alternative that directs closing dispersed campsites not meeting scenic integrity objectives, having persistent user conflicts, or causing ecological damage. With this direction, alternative 3 has the greatest potential of any alternative to eliminate dispersed campsites. Potential closures of dispersed campsites with this alternative would limit use, desirability, and diversity of recreation sites (***RE8***) more than other alternatives.

For alternative 3, there are objectives for annual thinning of an average of 4,327 acres, which is about two-thirds of the average annual acres in alternative 1. This level of thinning and its associated effects on recreation opportunities (***RE11, RE12, RE3, RE6, RE9, RE10, RE41, RE13, RE8, RE1, RE16***) is the least of all alternatives. On the other hand, prescribed burning would be implemented on an average of 114,700 acres annually, which is about 35 times above the average number of acres that are burned under the current plan. This level of burning and its associated effects on recreation opportunities (***RE11, RE12, RE2, RE6, RE9, RE10, RE41, RE14, RE8, RE1, RE16***) is the most of all alternatives. In particular, the likelihood of uncharacteristic fire and its effect on recreation opportunities (***RE15***) would be exponentially higher in this alternative since areas with high fuel loads would not be thinned prior to the introduction of fire.

Alternative 3 includes objectives for decommissioning 25 miles of roads annually. This alternative also has the Wetland Jewels and Calaveras Management Areas, which includes a standard for no new infrastructure, including roads. This represents the greatest number of decommissioned miles and associated effects on recreation opportunities (***RE17, RE18, RE19***) of any alternative.

There are 270,130 acres of recommended wilderness in alterative 3. This alternative has the largest number of acres of recommended wilderness of all alternatives, which in turn would result in the greatest increase in available non-motorized and non-mechanized recreation opportunities (***RE1, RE21***) among all alternatives.

Alternative 4 – Human Uses Emphasis

Recreation plan objectives in alternative 4 include completion every three years of (1) 75 percent of the deferred maintenance at four developed recreation sites; (2) trail maintenance and improved signage on at least 40 percent of system trails; and (3) improvements on at least 2 miles of poorly designed trail. An additional guideline directs conducting all deferred maintenance at recreation sites. Guidelines for alternative 4 also direct expanding both the trail system and developed recreation sites, which would increase the amount and type of recreation opportunities offered across the Santa Fe NF. This alternative addresses deferred facility and trail maintenance and improvements to the greatest extent of all alternatives, with associated effects (***RE22***) on visitor experiences.

Alternative 4 proposes objectives for thinning an average of 40,200 acres annually, which is about six times the average annual acres in alternative 1. This level of thinning and the associated effects of thinning on recreation opportunities (***RE11, RE12, RE3, RE6, RE9, RE10, RE41, RE13, RE8, RE1, RE16***) is the most of all alternatives. In this alternative, prescribed burning would be implemented on an average of 5,600 acres annually. Burning this acreage, with its associated effects on recreation opportunities (***RE11, RE12, RE2, RE6, RE9, RE10, RE41, RE14, RE8, RE1, RE16***), is the least of all alternatives. The likelihood of uncharacteristic fire and its effects on recreation opportunities (***RE15***), which is the same for alternative 2, would be diminished in areas mechanically thinned.

Alternative 4 does not include objectives for road decommissioning but does include an objective to maintain 10 miles of road a year. This alternative also includes a guideline that would allow for the expansion of the road system through the inclusion of temporary roads. These plan components represent the second largest potential road system (i.e., road miles) and second greatest number of road miles maintained with their associated effects on recreation opportunities (***R16***) after alternative 1. More roads, as provided in this alternative, would also move away from the beneficial effects on recreation opportunities (***R17-19***) achieved by decommissioning roads.

There are no acres of recommended wilderness in this alterative. This alternative has the fewest number of acres of recommended wilderness of all alternatives and, therefore, the effects on recreation opportunities (***RE1, RE21***) would be the least of all alternatives.

Alternative 4 includes four types of management areas that focus on increased recreation opportunities: the cultural interpretive management areas and wildlife and cultural interpretive management areas that are also in alternative 2, two recreation management areas, and three motorized recreation management areas. The interpretive management areas offer educational materials that provide relevant information about the locations. The motorized recreation management areas include a desired condition that emphasizes a wide range of motorized recreation opportunities for recreationists of all riding abilities and a guideline that would increase motorized recreation through the conversion of unmaintained roads in poor condition to motorized trails. The recreation management areas focus on high-quality recreation opportunities and has guidelines which, while limiting the expansion of motorized routes (i.e., permanent and temporary roads), encourage construction of new trails. Combined, all these management areas would increase the availability of interpretive, motorized, and non-motorized recreation opportunities and their related effects (***RE1; RE1 and RE16; RE1 and RE17-19,*** respectively) more than in other alternatives.

3.12.4.2 Indicator 2 – Sustainable Recreation

Effects Common to All Alternatives

Recreation management under the 1987 Forest Plan and Forest Plan includes consideration of potential impacts to other resources, such as protection of soil and water quality, wildlife habitat, and cultural resources (e.g., the impacts of over-use of authorized areas such as intensively used "dispersed" camping areas). Although not specifically phrased as "sustainable recreation" in the 1987 Forest Plan, this direction would ensure that ***the natural resources that make recreating in the Santa Fe NF desirable and enjoyable do not suffer from long-term damage as a result of recreation uses***[RE25]and that ***recreation infrastructure can be maintained in a condition to allow it to continue to serve the use for which it was designed***[RE26]. In addition, protection of Santa Fe NF resources from unauthorized recreation uses, such as off-road vehicle travel, has been more tightly managed since the 2005 adoption of the Santa Fe NF Travel Management Plan (USDA Forest Service 2005), which has been incorporated into the 1987 Forest Plan. Similarly, the Forest Plan also includes a standard in the Roads section that directs motor vehicle use be consistent with the latest MVUM. Unauthorized uses off of designated routes can have negative effects on forest resources (***R19***), especially because they are not designed in a sustainable way.

The 1987 Forest Plan identifies the need to maintain and expand opportunities for volunteers and other human resource programs such as youth engagement. The 1987 Forest Plan includes a standard that directs managers to use volunteers and partners to meet Santa Fe NF objectives, such as recreation site and trail maintenance, wilderness patrol and education. Similarly, the Forest Plan includes a partnership section that specifically points out the need for partners and volunteers to increase capacity in managing forest resources and points out sustainable recreation. As recreation opportunities increase and diversify and national forest management resources dwindle, it is crucial that plan guidance recognize that ***partners and volunteers are one way to bridge the gap and achieve sustainable recreation and ecological desired conditions***[RE28] ***by supplementing Forest Service capacity***.

Locations of, and plan components for, designated areas and eligible wild and scenic rivers don't change across the alternatives. Management direction is often dictated by law, regulation, and policy. Regulations and plan direction limit the types of recreation opportunities in some of these designated areas in an effort to maintain high-quality environmental characteristics. Wilderness areas are characterized by natural-appearing landscapes and don't allow motorized or mechanized uses. Inventoried roadless areas have limited access via roads. Designated and eligible wild and scenic rivers, especially those with wild classifications, have limited access to protect water resources such as water quality. These areas, therefore, support beneficial effects of sustainable recreation management (***RE25***).

Alternative 1 – 1987 Forest Plan

The 1987 Forest Plan was written at a time when there was emphasis on expanding recreation. This is best demonstrated by an objective that directs significant improvement in the trail system through construction and reconstruction of 16 miles of trail annually as well as an increase in maintenance. In recent years this plan direction has not always been feasible due to lack of capacity and funding.

Currently, the Santa Fe NF has a trail system of over 1,000 miles, including six nationally designated trails and about 40 trailheads. Trails that are not maintained to standard may have unsafe conditions, cause resource or trail damage, deviate from planned design standards, and in short, are far from sustainable. In addition, poorly maintained trails encourage recreationists to create their own unauthorized routes, whether they be small reroute around a fallen tree or a fully designed and constructed trail.

The 1987 Forest Plan also does not specify objectives for addressing deferred maintenance at sites or on trails, although it does include a standard that trails be maintained to standard. This absence of direction is in all practicality equal to a lack of direction for sustainable recreation infrastructure. This alternative has the least capacity for managing for sustainable recreation and its associated effects (***RE36, RE28, RE26***) in terms of infrastructure and facility maintenance.

There are 1,853 acres of recommended wilderness in this alterative. Similar to designated wilderness, recommended wilderness areas have limitations on the types of recreation opportunities available within their boundaries, such as no motorized or mechanized recreation. These limitations help preserve the untrammeled and natural characteristics of recommended wilderness areas. Alternative 1 is second only to alternative 4 in having the fewest acres of recommended wilderness. The effects (***RE1, RE21***, ***RE25***) on recreation of managing areas of the forest as recommended wilderness would, therefore, be greater than the effects of alternative 4, but less than alternatives 2 and 3.

Effects Common to Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 include recreation components that focus on developing and implementing a sustainable recreation program. The use of the term “sustainable recreation” is also found throughout the recreation section of the plan. These components include a desired condition to make sustainable recreation opportunities variable, adaptable to changing uses and trends, and available commensurate with public interest—which is covered in the recreation opportunity portion of the analysis—and to make sustainable recreation opportunities commensurate with resource capacity and other natural and cultural values—which is covered in Effects Common To All Alternatives. Additional desired conditions point toward sustainable recreation sites and trail system. Guidelines also direct sustainably designed and implemented recreation developments and trails that minimize long-term resource damage. With this plan direction renovations and rehabilitation of sites and trails would include practices that result in fewer maintenance needs going unchecked. Another guideline directs action (i.e., a mix of closing, rehabilitating, mitigating by alternative) at dispersed campsites to remedy unacceptable ecological damage. These desired conditions and guidelines ensures concepts of sustainable recreation are integrated into recreation site and trails and their related effects on sustainable recreation (***RE25, RE26***) more than alternative 1. In addition, a desired condition in recreation specifically focuses on engagement with local communities, stakeholders, and volunteers to foster partnerships and facilitate managing sustainable recreation, leading to better addressing this aspect and greater effects on sustainable recreation (***RE28***) than alternative 1.

Jemez Mesas and Canyons Geographic Area includes a desired condition to protect vulnerable features from recreation. The West Sangres and Caja Geographic Area includes a desired condition that emphasizes that trails and facilities are well maintained and balanced with ecological resources. The West

Sangres and Pecos River Canyon Geographic Areas promote partnerships to increase sustainable recreation. (***E28***). The addition of these geographic areas further promotes sustainable recreation and its effects (***RE25, RE28, RE26***) for these areas in these alternatives.

Alternative 2 – Forest Plan

In alternative 2, recreation plan objectives direct completion every three years of (1) 75 percent of the deferred maintenance at two developed recreation sites; (2) trail maintenance and improved signage on at least 25 percent of system trails; and (3) at least 1 mile of poorly designed trail should be corrected with a sustainable design. A guideline also directs closing, rehabilitating, or mitigating dispersed camping sites that are causing environmental damage. This plan guidance offers better and more regular maintenance of developed and dispersed recreation infrastructure in the Santa Fe NF ensuring the second most progress toward sustainable recreation and its effects (***RE25, RE26***).

Alternative 2 includes 25,868 acres of recommended wilderness, the Caja Del Rio Wildlife and Cultural Interpretive Management Area, and four separate cultural interpretive management areas. Standards and guidelines limit motorized and mechanized recreational uses in recommended wilderness to preserve its natural characteristics. The Caja Del Rio Wildlife and Cultural Management Area includes guidelines that limit cross-country travel and the construction of roads. The cultural interpretive management areas include a guideline that directs that trails and viewing areas should not impact archeological integrity. Therefore, recreation opportunities offered in these management areas are designed and implemented to protect natural, wildlife, and cultural resources. This alternative, as compared to all other alternatives, would provide the second most progress toward sustainable recreation and its effects (***RE25***) in these areas.

Alternative 3 – Natural Processes Emphasis

Alternative 3 does not specify addressing deferred maintenance or recreation sites and trails. Rather, recreation objectives for this alternative include mitigation of ecological damage at two developed sites every three years and closing and rehabilitating dispersed camping sites that are causing environmental damage. Recreation sites in this alternative would make the most progress toward sustainable recreation and its effects (***RE25, RE26***).

This alternative includes 270,130 acres of recommended wilderness, the Wetland Jewels Management Areas, and the Holy Ghost Management Area. Standards and guidelines limit motorized and mechanized recreational uses in recommended wilderness to preserve its natural characteristics. The Wetland Jewels Management Area includes a standard for no new infrastructure and a guideline that infrastructure should minimize impacts to wildlife. The Holy Ghost Management Area includes a standard directing that management activities must avoid or minimize impacts to the habitat of Holy Ghost ipomopsis and an objective to develop interpretive material or display educating visitors and recreationists about the Holy Ghost ipomopsis plant. Plan direction in these management areas minimizes the impacts that recreation (***RE25***) and recreation infrastructure (***RE26)*** have on these areas and improves the ability to manage for sustainable recreation the most of all alternatives. However, the quantity of areas with more limited use recreation in this alternative might increase unauthorized uses and their effects (***RE27***) both inside and outside of recommended wilderness.

Alternative 4 – Human Uses Emphasis

Alternative 4 recreation plan objectives direct completion, every three years of (1) 75 percent of the deferred maintenance at four developed recreation sites; (2) trail maintenance and improved signage on at least 40 percent of system trails; and (3) at least 2 miles of poorly designed trail be improved. A guideline also directs not closing dispersed camping sites that are causing environmental damage but mitigating or rehabilitating instead. This alternative also includes management areas with objectives to improve trails and roads. An objective in the motorized recreation management areas adds maintaining 10 miles of motorized trail. The recreation management areas includes an objective to maintain and sign 25 percent of system trails every three years. This direction would ensure that existing recreation sites have the second least progress toward sustainable recreation and its effects (***RE25, RE26***).

There are no acres of recommended wilderness in this alterative. Since this alternative has the least amount of recommended wilderness of all alternatives, it would have the most acres subject to potential long-term damage as a result of recreation use.

Alternative 4 includes several management areas that include direction for sustainable recreation. As in alternative 2, the Caja Del Rio Wildlife and Cultural Interpretive Management Area and four cultural interpretive management areas limit recreation infrastructure and use to protect wildlife and cultural resources (***RE25, RE26***) are included with alternative 4. Alternative 4 also adds two recreation management areas and three motorized recreation management areas. The motorized recreation management areas include a desired condition that roads and trails are clearly marked to improve user compliance and a guideline that motorized trails that cross riparian areas should be constructed to reduce impacts to those riparian areas. The recreation management areas have a desired condition that promotes partnerships to improve sustainable recreation and a guideline that directs avoiding construction of roads and decommissioning unneeded roads. These management areas would therefore make progress toward sustainable recreation and its effects (***RE25, RE26, RE25/27, RE28***).

3.12.4.3 Indicator 3 – User Conflicts

Effects common to all Alternatives

Designated areas and eligible wild and scenic rivers are consistent across all alternatives. Management direction is often dictated by law, regulation, and policy. Some designated areas have a recreation focus, and some emphasize specific types of recreation opportunities as explained in the Sustainable Recreation indicator. Limiting the types of recreation activities in a management or designated area can not only serve to promote sustainable recreation, but can also reduce the potential for user conflict as fewer activities come in contact with each other. Reduced user conflict would ***improve the quality of the recreation user experiences*** [RE29]***.***

Alternative 1 – 1987 Forest Plan

The 1987 Forest Plan addresses user conflicts with two standards that direct separating or otherwise resolving recreation uses that may adversely affect or cause conflicts with one another. This plan direction addresses user conflicts, thereby benefitting recreation experiences (***RE29***). Potential solutions for separating recreation uses could involve single-use trails or trails managed for single use on certain days. Creating more trails would require building and maintaining more recreation infrastructure~~,~~ such as trailheads and signage. If not sustainably constructed or maintained over time, both the new trails and their associated infrastructure could ***cause ecological damage to soil, wildlife, water, and cultural resources***[RE31]. Managing trails for single uses that vary by day of the week would also require ***increased public education*** [RE32] to make trail users aware of new trail-use rules, which could increase the burden of trail policing on Forest Service personnel. If recreationists did not follow the rules (i.e., if a mountain biker used a trail on a hiking day), single-use days could result in ***more user conflicts and lower the quality of the recreation experience for conflicting user groups***[RE33]***.*** Mitigating user conflicts can be particularly challenging as ***conflicts can be ubiquitous and solutions to the satisfaction of all users are rare, resulting in the need for extensive management resources***[RE34]***.***

There are 1,853 acres of recommended wilderness in this alterative. Similar to designated wilderness, recommended wilderness areas have a lower diversity of recreation uses, and therefore, less potential for user conflict (e.g., hikers will not encounter mountain bikers or off-highway vehicle users). This alternative has the second lowest amount of recommended wilderness of all alternatives and, therefore, the effects on user conflict (***RE29***) would only be slightly better than alternative 4.

Effects Common to Alternatives 2, 3, and 4

The proposed Plan addresses user conflicts with two desired conditions: (1) indicate where potential user conflicts are avoided or infrequent and are resolved quickly; and (2) the trail system is designed to minimize them. It also includes a standard about designing recreation facilities to prevent human and wildlife conflicts and a guideline about closing or altering dispersed camping sites when there are persistent user conflicts. This direction is less specific about resolving user conflicts than in alternative 1, but it has more flexibility to successfully address user conflicts and, therefore, fewer effects related to user conflicts (***RE29, RE30, RE31, RE32, RE33***). Partnerships, as discussed in the sustainable recreation indicator, would ***increase the capacity for education about user conflicts and solutions***[RE35], including awareness of impacts on other uses. Ultimately, partnerships can be one way to overcome the challenges of addressing user conflicts (***RE34***) that exist in alternative 1.

The addition of geographic areas encourages management for user conflict resulting in increased beneficial effects (***RE29, RE35***) for these areas in these alternatives. For example, the West Sangres and Caja Geographic Area includes a desired condition that focuses on minimizing user conflict. The Pecos River Canyon and East Sangres Geographic Areas promote partnerships to reduce user conflict.

Alternative 2 – Forest Plan

Certain types of recreation are more limited in several of the management areas in alternative 2. There are 25,868 acres of recommended wilderness in this alterative where desired conditions and standards prohibit motorized and mechanized recreation. In the Caja del Rio Wildlife and Cultural Interpretive Management Area, motorized recreation is more limited because guidelines limit construction of cross-country travel areas and permanent or temporary roads. Recreation in the Canada Bonita Proposed Research Natural Area would be non-motorized day use as directed by a standard. Other standards prohibit new trail construction, new roads, and campfires. The cultural interpretive management areas focus on interpretive excursions to cultural sites; user conflicts and their effects (***RE29)*** may be reduced in these management areas due to limited choices in types of recreation that can occur. As this alternative has the most cultural interpretive management areas, it would reduce user conflict and its effects (***RE29***) the second most of all alternatives.

Alternative 3 – Natural Processes Emphasis

Certain types of recreation are more limited in several of the management areas in alternative 3. There are 270,130 acres of recommended wilderness in this alterative where desired conditions and standards prohibit motorized and mechanized recreation. Recommended wilderness in this alternative contributes to the most acres of land where certain recreational uses are prohibited or restricted of all alternatives. The Holy Ghost Management Area includes plan guidance designed to educate users about the endangered Holy Ghost ipomopsis and minimize their impacts on the plant. This guidance would restrict all types of recreation use. The addition of these management areas would have the greatest beneficial effects on user conflict (***RE29***).

Alternatives 4 – Human Uses Emphasis

Alternative 4 includes two additional guidelines, one for trails and another for recreation sites, both of which are aimed at expanding recreation infrastructure to reduce user conflicts. This direction would result in this alternative having the greatest beneficial effect related to user conflicts (***RE29***). It would also have the greatest effect of all alternatives related to consequences of expanded recreation infrastructure as a solution to user conflicts (***RE30-33***).

Alternative 4 includes several management areas where management direction is included to address user conflict. As in alternative 2, recreation in the two types of interpretive management areas is focused on interpretive excursions to cultural sites. This alternative also adds the two recreation management areas and three motorized recreation management areas. The recreation management areas have a desired condition that further emphasizes the forestwide desired condition that recreation opportunities are organized in a way to reduce user conflict. In addition, a guideline promotes new trail construction in locations that will separate uses in congested areas. The Motorized Recreation Management Areas include an objective to clearly sign motorized routes and trails to reduce user conflict. These management areas address user conflict by focusing on motorized recreation. This is different than in alternative 2 and 3 where there are no specific areas managed specifically for motorized recreation. The effect (***RE29***) would likely be comparable to alternative 2, but still less than alternative 3.

3.12.4.4 Cumulative Effects

The analysis area for cumulative effects includes the Santa Fe NF and adjacent public lands including the Carson and Cibola NFs, Valles Caldera National Preserve, Bandelier National Monument, Pecos National Historic Park, Bureau of Land Management lands, New Mexico State lands, tribal lands and the numerous counties and municipalities that overlap or are located in the immediate vicinity of the forest. These public lands provide a wide range of recreation opportunities in addition to the Santa Fe NF. However, differences in agency missions and lands managed often result in different types of recreation experiences and visitation trends.

The National Park Service (NPS) tends to manage visitor activities more stringently than the Forest Service. They provide highly developed and managed visitor facilities, as well as offer permitted back-country opportunities. Visitation to NPS sites in New Mexico has been relatively steady, and was around 1.6 million people in 2014 (NMSP 2015). The density of visitors to NPS sites is considerably higher than those of other federally managed lands at over 4 visits per acre in 2014 (NMSP 2015). Due in part to the sheer amount of land managed by the BLM in the state (more than 13 million acres), those lands tend to get the most visitation overall, although visitor density is only slightly more than that of the National Forest System. New Mexico state lands typically emphasize particular land features such as a lake (e.g., Fenton Lake), and offer related recreation opportunities such as boating, fishing, swimming, and camping. Local park facilities are typically oriented toward day users and more urban recreation opportunities such as soccer fields, picnic shelters, and playgrounds. The other national forests in New Mexico provide opportunities similar to the Santa Fe NF (particularly the Carson, which is geographically close) and the National Forest System in New Mexico hosts more than 3 million visitors annually, with the Cibola typically seeing the most visitors annually (NMSP 2015). Visits per acre to national forests are the lowest of all federally managed lands, though, providing more opportunities for solitude. Given the different recreation emphases of other managed lands, the Santa Fe NF fulfills a specific and important niche in providing a diversity of recreation opportunities in the region (***RE1-RE7***). It also adds to the already diverse National Forest System lands by providing opportunities to view ecosystems, species, and landscapes unique to the Santa Fe.

Management of the Santa Fe NF balances dispersed recreation with developed recreation. The forest provides opportunities for a wide variety of recreational activities from primitive backcountry backpacking to downhill skiing. As stated above, adjacent public lands also provide a variety of recreation opportunities. However, while these lands receive plenty of recreation visitors, the forest is a major destination for locals in the Santa Fe and Albuquerque metropolitan areas, as well as for residents of the many smaller towns located within 50 miles of the forest. Recreation management in the forest compliments those of other agencies and adjacent county and municipal recreation objectives and management. Many county management plans outline goals around increasing or improving open space amenities, including connecting trails that are managed by different entities. Cross-boundary recreation management will increase recreation opportunities and improve user experiences throughout the planning area. Improved off-forest recreation opportunities will also help mitigate stress on Forest recreation infrastructure from growing and changing populations, particularly around metropolitan regions where population growth is most likely to occur.

One example of regional recreation management initiatives is the Greater Santa Fe Recreation Partnership, which started in 2018, and includes local, State, and Federal land management agencies. The partnership is collaboratively working to improve cross-boundary and interagency trail management in the area around Santa Fe metropolitan area (Santa Fe, Los Alamos, Glorieta, etc.). Developing a more comprehensive trail management strategy will complement the Santa Fe NF's objective to promote increased trail management and maintenance. This will increase the impact of the Santa Fe NF recreation management objectives and has the potential to improve trail-based recreation overall in the region. The plan components outlined in the Santa Fe Forest Plan will cumulatively add to those being put forward by the Greater Santa Fe Recreation Partnership over time.

Additionally, in areas where population is predicted to increase (e.g., metropolitan areas of the state), the demand for recreational opportunities and open space will likely grow. Land management agencies would continue to provide a variety of recreation opportunities, but are not likely to be able to meet all the demand for every activity desired. In order to address the impacts associated with increased visitations, all public land agencies have employed additional recreation management actions or have installed additional facilities to implement sustainable recreation and ensure its beneficial effects (***RE25, RE26***). These actions support the Santa Fe NF's sustainable recreation direction and move the region as whole toward a recreation environment that is viable in the long term, continuing to support recreation jobs and spending while protecting the well-being of residents and the ecological systems that provide for such spectacular recreation opportunities.

3.13 Roads and Infrastructure

3.13.1 Affected Environment

3.13.1.1 Roads

The forest road system within the planning area provides access to NFS lands and private inholdings. The majority of the access is provided for administration of the forest, public recreation, and forest product extraction. National Forest System roads (hence forward referred to as "forest roads") are those roads within the Santa Fe NF under the jurisdiction of the Forest Service and determined necessary for the protection, administration, use, and development of the resources found in the Santa Fe NF. Roads managed by public road agencies such as states, counties and municipalities that help provide access to NFS lands, but do not fall under the jurisdiction or direction of the national forest, will not be included in this evaluation.

Approximately 6,900 miles of roads serve the Santa Fe NF. This includes approximately 180 miles of roads that travel through private property and are maintained by the Forest Service. Pursuant to the Travel Management Rule (36 CFR 212.51), a motor vehicle use map (MVUM) identifies designated National Forest System roads, trails and areas available for public use. In addition to these National Forest System roads, there are numerous unauthorized roads and motorized trails, many of which were created prior to the implementation of the Travel Management Rule when cross-country travel was allowed on the majority of the forest. The Forest Service does not have an inventory of all unauthorized routes, so those roads and trails are not included in this analysis.

The intended purposes and standards for roads are documented in the road management objectives, which contain design, operation, and maintenance criteria. The Forest Service uses the term *maintenance level* to describe the service provided by, and maintenance required for, a road. We assign a maintenance level to a road based on the vehicle type that we expect to use the road, and the intended use of the road. A road designed for passenger cars would be different than a road for logging trucks. The maintenance level also gives users an indication of the level of comfort to expect while driving on the road.

The Forest Service uses five maintenance levels to define the general design standards, use, and associated type of maintenance required: 1 through 5. Maintenance level 1 roads are not open for public or administrative motorized use and instead are for the purpose of maintaining drainage facilities and runoff patterns. Maintenance level 2 roads require the least amount of maintenance and gives the user the lowest comfort level; these are managed as open only for administrative purposes, typically fire management or vegetation improvement projects. Maintenance level 5 roads provide the greatest user comfort, but also require the most maintenance. Level 3 and 4 roads are suitable for passenger cars and level 2 roads are suitable only for high-clearance vehicles. Road miles by maintenance level differ across the forest by district, and the Santa Fe NF has no maintenance level 5 roads. Table 87 shows the number of road miles by maintenance level for each district.

Table 88 shows how road maintenance costs vary by the maintenance level of the road, and maintenance activities such as reconditioning ditches, shoulders, roadbeds, gravel surfaces, culvert cleaning, roadside brushing, etc. Road maintenance costs for maintenance level 3 and 4 roads may include the need for gravel or asphalt replacement and repair.

Table 87. Road maintenance level miles

Ranger District	Level 1	Level 2	Level 3	Level 4	Total Miles
Coyote	370	940	130	2	1,442
Cuba	170	1,140	100	4	1,414
Jemez	650	540	70	9	1,269
Pecos-Las Vegas	117	1,670	30	10	1,827
Española	370	515	55	3	943
Forestwide	1,677	4,805	385	28	6,895

Table 88. Average road maintenance costs by maintenance level

Maintenance Level*	Approximate Miles	Estimated Maintenance Cost per Mile*	Estimated Total Annual Maintenance Cost
1	1,700	$788	$1,340,000
2	4,800	$873	$4,190,000
3	390	$897	$350,000
4	28	$786**	$22,000
Total	**6,918**		**$5,902,000**

*Costs based on current Northern New Mexico Road Maintenance contract

**Because level 4 roads are a hardened surface (typically asphalt), maintenance needs are less frequent.

Maintenance is not performed on all miles of forest roads annually due to adequate road conditions and lack of funding. Road maintenance budgets have declined by 58 percent over the last decade. The declining road maintenance budgets have caused a large backlog of *deferred maintenance* needs across the forest. Deferred maintenance is maintenance that was not performed when it was needed or when it was scheduled, and it was delayed.

Road maintenance schedules are developed for and approved by each district in the forest. These schedules are developed and based on road maintenance program priorities such as legal requirements (e.g., land grant agreements or cooperative agreements with other agencies), safety, and resource needs and are limited by the amount of resources in any year.

Roads considered to be in good condition have drainage that has been adequately maintained, road surface condition that allows for use by high-clearance vehicles on level 2 roads or passenger cars on level 3and 4 roads, and has had roadside brushing.

Emphasis is placed on roads maintained for passenger car use. These motorists have a greater expectation that hazards will be identified or mitigated on these roads. Damaged sections of road, including deficient bridges where continued use is determined to be unsafe, are closed until the hazard can be corrected or mitigated. Forest roads that are not maintained regularly can adversely affect the surrounding environment through degradation of wildlife habitat, vegetation or soil productivity, water quality, and disturbance to archeological sites. These effects are explained in other chapters.

The Forest Service decommissions roads by ensuring that motor vehicles can no longer use the road. Some roads that were not correctly decommissioned are likely causing resource damage and should be treated to mitigate the damage. Other roads have decommissioned themselves as trees and other vegetation have grown over the road.

3.13.1.2 Infrastructure and Facilities (Bridges, Dams, Buildings, and Water Systems)

Infrastructure and facilities impact land and water systems across the Santa Fe NF, both positively and negatively. There are 53 bridges, approximately 3,700 culverts, and about 3,000 additional road drainage or stream crossings in the Santa Fe NF. There are several dams in the forest, but the Forest Service owns only one of them—Truchas Lake Dam in the Pecos Wilderness. Fenton Lake dam is on State property, but part of the lake is on Forest land. Nichols and McClure reservoirs are mostly on private property, but parts of the lakes and dams are on Forest land. Each dam is given a "hazard rating" as an indication of the amount of damage that could happen if the dam failed. The only Forest-owned dam—Truchas Lake Dam—has a current hazard rating of 'Low.' It is unlikely that the number of dams will either increase or decrease any time soon. Dams require substantial time and resources to build and maintain.

The Santa Fe NF also manages 40 water systems and 53 wastewater systems, most of which are associated with campgrounds, picnic areas, and administrative sites. These systems have wells, some type of water treatment system, and a distribution system. Like a municipal water system, the Forest Service systems must meet Federal and State drinking water standards. Similarly, the wastewater must be treated to a certain set of standards as well. Because we must meet drinking and wastewater standards, we regularly test the systems. This will continue. Because the current system is adequate, we are not likely to build new campgrounds and new systems. We will, however, need to maintain and update the systems as necessary to keep them operational.

Of the 258 buildings that are used as part of administration of the Santa Fe NF, the Forest Service owns all but 4. The Forest Service leases a portion of the Walatowa Visitor Center and a number of administrative buildings (e.g., district offices). The condition of the buildings in the forest varies depending on things like age, original construction, maintenance, and location. To standardize the method throughout the agency, we use a measure called facility condition index. We calculate the index from deferred maintenance costs and replacement value, and we use the index to rate the building, either good, fair, or poor. Table 89 shows a summary of the building conditions in the forest.

Table 89. Buildings and ratings in the forest. Data based on 2018 NRM database.

Category	Number of Buildings	Rating	Deferred Maintenance
Administrative	34	Good	$7.70 million
Administrative	4	Fair	
Administrative	94	Poor	
Recreation	23	Good	$0.07 million
Recreation	0	Fair	
Recreation	5	Poor	

Not all buildings are maintained to highest standard on an annual basis; maintenance is based on resource availability and maintenance priorities. The first maintenance priority is emergency repair, then there are critical maintenance needs including public safety, employee health and safety, and our ability to carry out the Forest Service's mission. Once critical needs have been addressed, non-critical maintenance needs are performed. For example, updating facilities to current codes and standards. As budgets shrink, it is apparent that only higher priority maintenance work will be completed. Deferred building maintenance is calculated to be about $8 million (table 89).

3.13.2 Indicators and Assumptions

Changes to the forest road system were evaluated based on management guidance (e.g., desired conditions, guidelines, standards, objectives and management approaches) and geographic delineations (e.g., recommended wilderness, semi-primitive non-motorized designation and management areas) in each alternative that would influence future motorized access in the forest. Impacts from roads vary according to use, location, road maintenance level and other factors. This analysis looks at management designations and direction that would affect the forest road system and makes the assumption that across the forest reduced miles of NFS roads would generally equate to decreased motorized access and ecological impacts from roads and increased opportunity for more primitive recreation.

Because the primary goal of the NFS road network is to facilitate access to the forest, the extent to which the alternatives increase or decrease motorized access is a useful indicator of effects—including both public access and administrative access. The other indicator used is ecological effects—an umbrella term for how the natural environment is impacted. Because no road affects just a single resource, the impacts to the natural environment are best analyzed holistically. In addition, the following assumptions were made when conducting the analysis:

- None of the alternatives has specific objectives, during the life of the plan, to construct new motorized routes. Proposals for new development and the associated environmental effects will be considered through project-level planning.
- New motorized routes will not be constructed in designated wilderness areas, inventoried roadless areas, and other areas with restrictions or prohibitions on new motorized route construction.
- Generally, the current road maintenance levels and available resources are not expected to change over the life of the plan.
- NFS roads no longer needed for current or future use will be decommissioned by re-contouring, ripping, and seeding as appropriate and will be analyzed on a project-level basis.

3.13.3 Drivers and Stressors affecting Roads, Infrastructure, and Facilities

The Santa Fe NF's ability to maintain its current forest road infrastructure is threatened. Although there are about 6,900 miles of roads on the landscape (per infrastructure database, INFRA), only about 2,200 miles of roads are open to the public and forest users for motorized use. These are the roads on the MVUM, which provide access to both recreationists and other forest users. The remaining 4,700 miles of roads may be administrative use roads or non-system roads within the forest's administrative boundaries. Although non-system roads are not maintained by the forest, most of these roads intersect with NFS roads and still contribute to erosion and sedimentation. Off-forest improvements to highways that connect to these roads and growing local populations have contributed to an increase in use. The forest is engaging its stakeholders through road maintenance agreements, but a critical and growing gap in resources for maintenance of facilities and roads still exists. For example, at a public meeting in Cuba, a participant expressed, "Road closures, and not being able to access (the forest) are my biggest concern."

Ownership changes on adjacent lands, unresolved legal issues, new off-forest right-of-way regulations, and on-forest dams not managed by the Forest Service all complicate management and increase costs. Continued population growth in the Santa Fe and Albuquerque metropolitan areas is expected, and would add to the demand for additional lands for development purposes, especially infrastructure. The focus on this growth in urban areas may also shift which NFS system roads get the most use, and communities that have not planned for additional infrastructure needs may request acquisition of NFS lands for infrastructure. If private properties, especially inholdings, change from rural or undeveloped land to subdivisions or higher density uses, encroachment into NFS land could occur, resulting in resource impacts and land survey needs. As communities grow and infill occurs, undeveloped lands and their open space values are converted to residential or commercial uses. This growth would likely result in continued pressures to maintain NFS lands for their open space values and may trigger the need to acquire right-of-way in places where informal public access is lost to development.

Use of off-highway vehicles and changing motorized technologies (e.g., larger vehicles) may also complicate management. The largest ecosystem drivers impacting forest access are extreme wildfires and floods, which impact the integrity of these systems, thereby continually adding to the already-massive deferred maintenance backlog on roads and administrative facilities.

In a severely burned area of the forest, fire eliminates all live vegetation, downed woody material, litter, and needles that would normally absorb or slow the movement of water. The soil is scorched to the point that it repels water and increases erosion potential. The combination of these conditions increases runoff in these areas, focusing water and sediment in large amounts in existing drainages. These post-fire flows result in plugged culverts, road damage, gully erosion of cut and fill slopes, erosion and deposition along road surfaces and relief ditches, and threaten human safety. Bridges trap large woody debris, forcing the water channels to spill over and blow out bridge approaches while also damaging the bridge superstructure itself. In September 2013, both Gallinas and Holy Ghost Canyons were flooded in one major event.

Damage to the forest transportation system caused by fires and ensuing floods results in expenses above the annual road maintenance budget, thereby reducing the amount of money available for standard road maintenance. Many damaged areas require annual repair for several years until the drainages have revegetated and stabilized. Some damage qualifies for funding from the Federal Highway Administration, but only on level 3 and 4 roads.

Similarly, budget shortfalls have severely hampered the forest's ability to manage its infrastructure and facilities to standard. Although the funding for administrative building maintenance has been fairly consistent since 2008, around $464,000 per year, it has not kept up with the accumulating deferred maintenance estimated at $3.9 million. The Forest Service recognizes this and has established directives to ensure and enhance the sustainability of new and existing buildings. Many of these directives are standard engineering principles; the directives are in place to ensure that the principles are followed.

When the Forest Service follows these engineering principles, facilities costs over the life of the facility will be lower. For example, installing solar panels and solar water heating on a building will likely cost more at construction, but over the life of the building will save money. This is money that the taxpayer does not have to pay, and it can allow money to be moved to other forest programs.

3.13.4 Environmental Consequences

3.13.4.1 Indicator: Motorized Access

Effects common to all alternatives

In all alternatives, the public access roads identified on the motor vehicle use map (MVUM) do not change, specific roads are not identified for closure or decommissioning, and new roads are not identified. However, each alternative does have plan components that would allow for varying opportunities to add to the MVUM, or close or decommission permanent and temporary roads not on the MVUM, depending on the alternative theme. Locations of these actions would be identified in site-specific project planning.

In all alternatives, road maintenance is determined based on the maintenance level assigned to all national forest roads and would be evaluated and prioritized accordingly. Road decommissioning would be determined on a case-by-case basis considering long-term need for current system roads and the need to obliterate illegal travelways within the forest.

In general, the presence of roads in the forest increases access for users, supporting multiple uses like recreation (e.g., hiking, camping, biking, skiing), hunting, fishing, wildlife viewing, and sightseeing). Proper maintenance of these roads benefit the surrounding environment by reducing sedimentation and erosion into the waterways, limiting user off-tracking, which protects archeological resources, and repair fencing and culverts to improve habitat connectivity.

Forest system roads make participating in multiple-use activities easier, increasing user satisfaction and bringing economic revenue to surrounding communities from increased visitation [RD1]. ***Forest roads also increase ease of access for ranchers to care for and manage their livestock, facilitating grazing operations that contribute to the local economy and sustain traditional uses in the forest*** [RD2]. ***Forest system roads provide the necessary access to complete vegetation management treatments to increase ecosystem diversity and resiliency*** [RD3] ***and ease access for firefighters, increasing their safety and ability to successfully mitigate fire risks to values of interest*** [RD4]. ***The acquisition of forest products such as fuelwood, piñon nuts, Christmas trees, mushrooms, wildlings, greenery, and medicinal plants is eased by motorized access, sustaining the continued cultural and traditional uses of these products*** [RD5]***.***

In all alternatives, ***climate change and drought will likely reduce access and require additional maintenance because of the increased likelihood of catastrophic wildfire, flood events, and other uncharacteristic natural disasters, which can then lead to erosion, fallen trees, damaged culverts, and blow-outs*** [RD6].

Effects common to alternatives 2, 3, and 4

Motorized access would not be affected by the addition of geographic areas in alternative 2, 3, or 4 because there are no plan components in geographic areas pertaining to roads.

Alternative 1 – 1987 Forest Plan

Alternative 1 would provide the second greatest potential for increased motorized access to the forest due to minimal additions for designated and management areas that restrict the potential for new roads to be added to the MVUM. This alternative has minimal proposed wilderness and no travel-restricted management areas (excluding restrictions within designated wilderness). In alternative 1, plan components specify that access (via the road system) balances the need for public access, land management, resource protection, user safety, and cost effectiveness. Resources benefited by road construction, maintenance, and closing varies across the forest (determined by management areas). In addition, 4 existing designated wilderness areas and 56 inventoried roadless areas would be maintained. No road closures would be needed to implement this alternative. Maintaining current levels of road access sustains multiple forest uses ***(RD1-5)***.

Alternative 2 – Forest Plan

Alternative 2 would provide less potential for increased motorized forest access than alternative 1, but more than alternative 3. The reduction in motorized Forest access is predominantly due to motorized travel restrictions in the following proposed management areas: recommended wilderness, the Caja Del Rio Wildlife and Cultural Interpretive Area, Cañada Bonita Research Natural Area, and eligible wild and scenic rivers. The motorized travel restrictions ensure no expansion of current motorized access into these areas would occur. Under this alternative, objectives for road decommissioning and maintenance are tied to restoration, leaving a manageable system for public and administrative access (***RD1-5***). Temporary roads, created to accomplish vegetation treatments or restoration activities, would be restored to natural vegetative conditions following the cessation of work.

Alternative 2 would provide a mix between public access and recommended semi-primitive motorized closures, which would decrease motorized travel in the forest, but not to the extent of alternative 3. ***This additional emphasis on semi-primitive conditions would increase the difficulty in accessing more remote parts of the forest, potentially lessening recreational visits or creating difficulties for traditional and cultural use practices within some areas*** [RD7]***.*** It is also likely that additional road miles would be closed based on biological needs (e.g., reducing habitat fragmentation or to achieve restoration objectives) and to protect human health and safety (i.e., in hazardous areas following fire or insect outbreaks) and to protect resources (e.g., habitat for threatened and endangered species; improve water quality in riparian areas).

Alternative 3 – Natural Processes Emphasis

Alternative 3 would provide the least potential for increased motorized access to the forest because it focuses more on decommissioning roads and less on maintaining them. This alternative also has motorized travel restrictions that would prevent current and potential future motorized access in the following proposed management areas: recommended wilderness, the Caja Del Rio Wildlife and Cultural Interpretive Area, Cañada Bonita Research Natural Area, and eligible wild and scenic rivers. Alternative 3 recommends 42 new parcels of land (+270,000 acres) for wilderness designation in addition to the 4 existing designated wildernesses areas. ***Over time, road closures within wilderness areas would improve wilderness character and lower overall road density, improving landscape connectivity and wildlife habitat*** **[RD8]*****.*** Within the recommended wilderness areas, motorized vehicle use would be eliminated, and foot travel would be encouraged to reach areas within the wilderness boundaries. ***Decreased motorized access would increase values related to natural landscapes such as solitude, absence of noise pollution, and presence of wildlife species*** **[RD9]**.

Under this alternative, decommissioning roads will be prioritized over road maintenance and no new roads would be built. However, temporary roads would be allowed to undertake landscape restoration and similar projects. These temporary roads would be restored to natural vegetative conditions following the cessation of restoration work. Roads that would be closed and obliterated would require a site-specific NEPA decision.

Alternative 4 – Human Uses Emphasis

Alternative 4 would provide for the greatest potential for motorized access because it places more emphasis on road maintenance and less on road decommissioning, while also proposing no additional areas for wilderness designation that would restrict current and future expansion of motorized access. Plan components would emphasize road maintenance to increase access for traditional and cultural uses, for removal of forest products including fuelwood, and for recreation activities. Objectives for road decommissioning are diminished under this alternative, and new permanent and temporary roads may be built, especially to implement mechanical treatments or to provide for traditional and cultural uses. With plan objectives for vegetation treatments that predominantly utilize mechanical treatments over large treatment acreages, the effects of motorized access would be amplified under this alternative (***RD1-5***).

Alternative 4 would provide a similar number of motorized road miles as alternative 1, but also proposes to create a management area encouraging access to and use of existing motorized trails. The proposed motorized recreation area in this alternative would increase user participation and satisfaction, alleviate pressure from other Forest trail systems, and minimize user conflicts. ***The addition of a motorized recreation area may lead to a higher frequency of use, which could amplify negative environmental effects such as increasing erosion or compaction of soil, reducing water infiltration and increasing runoff, and decreasing water quality downstream from the recreation area*** **[RD10]*****.***

3.13.4.2 Indicator: Ecological Effects

Effects common to all alternatives

Roads can have detrimental effects to the environment in which they occur. Ecological impacts of roads include ***habitat fragmentation, avenues for undesired species dispersal (e.g., nonnative or invasive species, transporting insects or diseases—on firewood for example—that degrade the environment on local or larger scales), and altered water runoff and drainage patterns*** [RD11]. Roads also greatly ***restrict travel and dispersal for small animals, particularly for aquatic and riparian species (e.g., salamanders, turtles, frogs), potentially increasing mortality rates or restricting gene flow between populations*** [RD12]***.*** Road maintenance can help mitigate these detrimental effects by reducing erosion impacts to streams, watersheds, and the landscape. Well-maintained roads may also discourage Forest users from creating their own roads, which can have negative environmental impacts (***RD11, RD12***).

Alternative 1 – 1987 Forest Plan

Alternative 1 would not provide for any change in ecological function because the NFS road system would be managed the same as it currently is, as described above in the Affected Environment. Ecological impacts (***RD11-12***) would be expected to be greater under this alternative than in alternatives 2 or 3, but less than alternative 4.

Alternatives 2 and 3

Alternatives 2 and 3 would provide for improved ecological function because of their emphasis on rehabilitating roads (including closing, decommissioning, and naturalizing roads) for public and administrative use. ***The ecological consequences of closing, decommissioning and naturalizing roads generally result in increased wildlife habitat connectivity, reduced public waste dumping, reduced sedimentation and impacts to plants and archaeological sites, decreased vandalism and theft of archaeological sites, and less noise disturbance to wildlife*** [RD13]. The exact magnitude and location of these effects, however, is difficult to assess at the plan scale because the effectiveness of achieving these effects is largely dependent on site-specific situations and design features. In general though, fewer roads equates to an overall trend of a decrease in negative ecological effects (***RD11-12***), therefore, alternative 3 would be expected to have the lowest magnitude of negative ecological effects of all alternatives. It is also assumed that roads for administrative use only would have lower use and correspondingly fewer impacts to ecological resources than roads that are open to the public. These effects would be more pronounced in alternative 3 (lower impacts), because it proposes a stronger emphasis on rehabilitation than alternative 2, which seeks to advance both road rehabilitation and public access goals.

Alternative 4 – Human Uses Emphasis

Alternative 4 would provide for decreased ecological function because of its emphasis on maintaining roads for public and administrative use rather than rehabilitating the roads back to their natural state. ***The ecological consequences of having more roads available for the public to use generally result in decreased wildlife habitat connectivity, increased public waste dumping and sedimentation, greater impacts to plants and archaeological sites, increased vandalism and theft of archaeological sites, and more noise disturbance to wildlife*** [RD14]. The exact magnitude and location of these effects is difficult to assess at the plan scale because they are largely dependent on site-specific situations and features. Generally, more roads equate to an overall trend of an increase in these effects (***RD11-12, 14***).

Cumulative Effects

The plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carry out any project or activity. Because the plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions), there can be no direct effects. However, there may be implications, or long-term environmental consequences, of managing the forests under this programmatic framework.

The cumulative effects timeframe for the roads, infrastructure, and facilities analysis is the next 10 to 15 years, and the spatial boundary includes the national forests adjacent to Santa Fe NF; State and county highways that access and traverse the national forest; cities encompassed by the national forest; easements to access inholdings; Santa Fe, Sandoval, Rio Arriba, San Miguel, Los Alamos and Mora Counties encompassing the national forest; and designated NFS highways in the Santa Fe NF.

State and local government agencies with road management authority can be expected to continue to maintain their existing road network across the forest. Some changes such as widening, resurfacing, and bridge replacements are probable but are dependent on budgets and funding allocations. The likelihood of jurisdiction of NFS roads being passed to other public road agencies is low.

Areas proposed for treatment as part of the Southwest Jemez Mountains Collaborative Landscape Restoration are located on Santa Fe NF lands. Use of NFS roads for access to treatment areas would result in increased traffic and greater variety of vehicles to include heavy equipment. This would result in a need for more frequent road maintenance and possibly road improvements to accommodate this increased activity safely.

Change in ownership of private lands can result in continued requests for road access across NFS lands. Depending on the circumstances, these may be requests for Forest or private road special use authorization. Depending on the terms and conditions written into any new authorizations, opportunities for access to NFS lands may be created.

3.13.4.3 Indicator: Infrastructure and Facilities

Effects common to all alternatives

The majority of management direction affecting administrative facilities, bridges, dams, culverts, and water systems in the Santa Fe NF would not change under any alternative from direction in the current forest plan (alternative 1). The facility master plan would be reviewed and updated annually as necessary to reflect management needs. The proposed revised plan provides guidance to balance management recommendations found within the facilities master plan and the desired conditions of the proposed revised plan to determine how facilities would be managed over the life of the plan.

Effects common to alternatives 2, 3, and 4

Alternatives 2, 3 and 4 include plan components that require adherence to scenic integrity objectives, discourage construction in hazardous or environmentally sensitive areas, and encourage incorporation of native vegetation and low-intensity lighting in building and landscaping plans. These measures would improve the aesthetics of the landscape surrounding administrative and recreation facilities, which would enable visitors to better view the forest in its natural state, improving visitor experience. These measures would also have the effect of creating more natural habitats and refugia for species.

Cumulative Effects

Infrastructure within the planning area may be impacted if an uncharacteristic fire ignites in and spreads from the forest, as severe fires clear the land of vegetation, resulting in unstable soils that erode in rains following fires. The increased runoff from these burned areas results in plugged culverts and road damage, and also causes extensive damage to buildings or other infrastructure through flooding. In this way, large and severe fires can impact areas well outside of the burn scar, with environmental consequences that may persist for many years (see Vegetation and Fire FEIS).

Unplanned closure of administrative facilities as a result of unsafe structures could result in a loss of services to local communities. Community members would have to travel farther to a district office for permits or to address issues with local staff. Residents in communities may feel less appreciated or receive less support from the Forest Service. Unplanned closure of recreation infrastructure could affect recreation experience of users or impact business that rely upon a facility to draw tourists.

Damage or the failure of key recreation infrastructure could also pollute water sources, which could affect the drinking water of downstream communities. It could also impact water used for agricultural purposes.

Growing populations in the areas around the Santa Fe NF may also increase the use of facilities in the forest. This could result in faster paced wear, more detrimental effects on infrastructure life-span and its environmental impacts. This could adversely affect user experiences in the forest, potentially leading to visitors choosing non-Forest Service lands over the Santa Fe NF. Higher use could also drive up maintenance costs, which could result in deteriorating facility quality. As a result, facilities may be closed or decommissioned in the future, impacting the ability of the Forest Service to complete their work effectively, provide quality experiences and services to the public, and collaborate effectively with other land management agencies.

3.14 Lands and Realty: Cross-Boundary Management, Land Status, and Special Uses

3.14.1 Affected Environment

The lands and lands special uses program in the Santa Fe NF includes several different activities. “Cross-Boundary Management” or the “All-Lands Approach” is a collaborative approach to resource management that emphasizes harmonious land uses across boundaries with adjacent landowners and relevant governmental entities. “Realty and Access” refers to land exchanges, purchases, boundary management, and other activities that primarily concern real property rights and transactions. “Special uses” refer to authorizations to use National Forest System (NFS) lands for non-Federal uses that are primarily commercial or private in nature. These uses can be things such as utility corridors, private and public roadways, communications sites, and commercial filming. For recreation special uses, which includes outfitter and guide permits, recreation events, and ski area permits, refer to the Recreation section of this document.

3.14.1.1 Cross-Boundary Management (‘All-Lands Approach’)

“Cross-Boundary Management” or the “All-Lands Approach” is a holistic way of looking at forest management that considers how pressures and management of surrounding lands may impact resources or activity on NFS lands. This includes collaboration with adjacent landowners—both public and private—to advance mutual management goals like increasing habitat connectivity or decreasing wildland fire risk. It is important to note that this approach does not mean that Forest Service managers would seek to direct or control management of non-NFS lands. Nor does it mean that Forest Service managers would conform management to meet non-NFS goals. It does mean that Forest Service managers would seek to ground planning and management of each unit in an understanding of the roles, values, and contributions of NFS lands within a broader, all lands context.

3.14.1.2 Realty and Access

A large component of the Lands program is to consolidate management of the Federal estate within the proclaimed forest boundary to enhance public benefit. The establishment of access rights throughout the forest is needed to create accessibility to both public and private lands within the proclaimed boundary of the national forest. The Santa Fe NF is not a highly consolidated forest from the standpoint of land ownership. The area now known as the Santa Fe NF experienced a great deal of settlement pressure and many private inholdings were created during the Homestead patent eras. Inholdings are identified as those lands located within proclaimed national forest boundaries that are wholly surrounded and landlocked by NFS lands. There are about 350 private land inholdings within the Santa Fe NF administrative boundary, totaling nearly 136,000 acres. These inholdings are, in turn, often heavily subdivided into smaller parcels creating literally thousands of individual parcels of private land.

The Forest Service may provide access to private land within the national forest boundary in certain cases, though this depends upon a number of factors. Within forest boundaries, the Forest Service is legally obligated to allow physical access to private property when no other means of access is available, but the Forest Service is not required to physically construct infrastructure for access or to absorb the cost of construction. The manner in which access is provided to a private land inholding is a discretionary decision for the Forest Supervisor, and is based upon individual facts and circumstances. Federal laws do not require that the Forest Service authorize access in a manner that would degrade natural resources. For example, if a property has historically been accessed via a riparian area and that manner of access causes resource damage, an alternate means of access and location can be allowed instead. Balancing the access needs of private property owners with resource protection is a primary concern, creating a need for standards and guidelines that address how access to private lands is authorized so as to minimize natural resource damage, while also ensuring that the rights of access to private lands are respected. At the same time, many areas of the forest are inaccessible by the public because the only access to Federal land is across private property, creating a need for plan direction that encourages the protection of existing public access rights and the acquisition of new access opportunities to forest lands.

3.14.1.3 Special Uses

Forests also commonly allow communities, industry, and other entities to use public lands for infrastructure, utility corridors, private and public roadways, communications sites, and commercial filming, through issuance of special use authorizations. With the changes in technology and population growth, there has been a marked increase in need and demand for more of these types of developments and the services they provide.

The increased demand for energy has generated increased emphasis on the management of utility corridors to provide additional services and to expand or create new corridors. In the years since the existing forest plan was published (USDA Forest Service 2010), the forest has seen a marked increase in infrastructure demands, including roads, utility corridors, and communications facilities (e.g., cell towers). There is a need for standards and guidelines in the forest plan that minimize resource damage to NFS lands when evaluating placement of infrastructure for land development (i.e., authorization of use and occupancy), specifically as it relates to the expansion of the wildland-urban interface. In addition, there is a need for Plan direction for the authorization, location, maintenance, and inspection of current and future utility and communication site infrastructure as the demand for these services increase.

3.14.2 Methodology and Analysis

3.14.2.1 Indicators

Two primary indicators are used to analyze the environmental consequences of revising management direction for Cross-Boundary Management, Realty and Access, and Special Uses. First, the intertwined concepts of *access and management* are used because the lands and lands special uses programs emphasize streamlining management and ensuring access for the public and for Forest Service administrators. The two concepts are combined into one indicator because one often heavily influences the other. A Forest Service easement across private land, for example, could serve the dual purpose of allowing public travel into areas that were previously inaccessible and allowing Forest Service employees the ability to better manage the resources found in areas made accessible by that easement.

The second indicator used is *ecological* effects, an umbrella term for how the natural environment is impacted by cross-boundary management, realty and access, and special uses. Because no special use authorization, lands or realty instrument affects any single resource, the impacts to the natural environment are best analyzed holistically. For example, a special use permit to use a road could affect a myriad of individual resources—water quality, wildlife habitat, soil condition, vegetative cover, etc.—but for the sake of simplicity, these effects are best thought of as affecting an ecological system rather than an individual resource.

3.14.2.2 Assumptions

This analysis also includes a number of assumptions about the lands and lands special uses programs over the life of the plan:

- The Forest Service has the personnel and funding capacity to screen, process, and manage special uses and land ownership adjustments.
- Community and public needs for services will continue.
- The population of New Mexico will continue to grow and be dependent on electricity. Consumers will continue to demand reliable electricity. The economy will fluctuate over time and influence the rate of energy corridor development.
- The emphasis of the lands program will remain on consolidating the forest's land base for easier management—not shrinking or transferring the Federal estate to private parties or other jurisdictions.

3.14.3 Environmental Consequences

3.14.3.1 Indicator: Access and Management

Alternative 1 – 1987 Forest Plan

Alternative 1—the no-action alternative—provides criteria for acquisition or exchange that include public and administrative access as priorities, but also includes a list of proposed Land and Water Conservation Fund Recreation Acquisition Composites—lands identified as needed for construction of public recreation facilities, for dispersed recreation and open space, and for protection of public recreation resources. ***Strict adherence to this list could narrow opportunities to work with local communities in addressing their expansion needs and public access to Federal land***[LR1]. In addition, some areas identified for acquisition by the existing forest plan are no longer relevant.

Effects common to Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 would identify criteria for acquisitions or exchanges without listing specific areas in the Plan. This would allow the forest to be flexible and to make determinations based on the current needs of both the forest and of local communities. There would also be management emphasis to work with local communities to understand their community expansion needs, preserve open space and water, and retain access to NFS lands. ***Meeting the needs of local communities for increased Forest access would reduce user conflicts and enhance satisfaction in public ownership of NFS lands*** **[LR2]**.

The action alternatives also require "access reciprocity" when easements are granted, resulting in access through private lands for public and administrative purposes that would be lacking under the no action alternative. ***Increased access would help Forest Service personnel and the public to easily get to more of the forest, which would allow for the Forest Service to better maintain or restore sensitive areas, aid in fire management efforts, or conduct vegetation treatments in areas that were formerly difficult to access*** **[LR3]**.

Parcels identified for disposal and exchange are typically those that have become difficult to manage because surrounding ownership conditions have changed, or the lands no longer serve a useful function. These are often former administrative sites, isolated tracts, or scattered parcels, and rarely impact access for public use or administration. ***The disposal or exchange of these sites would help allocate resources to other areas of the forest that are more useful or productive, allowing for more project-level work like restoration, recreation, and interpretation*** **[LR4]**. Alternatives 2, 3, and 4 would also encourage cooperation with counties or local communities to identify lands to be included or excluded from consideration of future land exchanges.

Under alternatives 2, 3, and 4, there would be continued efforts to consolidate land ownership within the forest boundary and establish new rights-of-way, where needed, to benefit both private landowners and Federal land management. The purchase of small isolated inholdings within the forest would simplify management activities and streamline public access (***LR5)***. The need to acquire rights-of-way for road and trail access is reduced with a consolidated land pattern.

3.14.3.2 Indicator: Ecological Effects

Alternative 1 – 1987 Forest Plan

The existing forest plan allows for the most permits issued to construct new roads and utility corridors to serve private inholdings. ***The creation of new roads or utility corridors would benefit private individuals or corporations within the inholding by increasing infrastructure delivering services such as electricity to new areas*** ***[LR6]***. However, ***the development of new roads or utility corridors has negative ecological impacts including habitat fragmentation, which increases stress on wildlife and disrupts gene flow; altered vegetation, which can lead to soil and water cycle disruption, soil compaction and erosion, and degraded water quality; and noise pollution*** **[LR7]**. ***The addition of new utility corridors could also increase the risk of uncharacteristic fire, as many fires are ignited through trees falling against powerlines, leading to a host of negative ecological effects like increased erosion, flooding potential, and vegetation type conversions*** (see Vegetation and Fire) **[LR8]**.

Effects common to Alternatives 2, 3 and 4

Alternatives 2, 3 and 4 would result in fewer adverse effects to natural resources than under the current plan because fewer permits and rights-of-way would be issued for new roads and utilities to serve private inholdings (***LR7-8***). Standards and guidelines requiring maximization of existing rights-of-way and infrastructure would consolidate needed infrastructure in areas that already have such infrastructure present, or in areas located within a private inholding.

Alternatives 2, 3 and 4 also emphasize the need for land exchanges to result in a more contiguous land base, and to avoid creating isolated parcels. ***Having a continuous land base has ecological benefits such as providing quality wildlife habitat and connectivity of travel corridors, protections for at-risk species, and maintaining naturally appearing landscapes*** **LR9**. Working collaboratively with local governments and communities early on land exchange projects (per the associated management approach) would result in land exchanges being developed that meet community and national forest needs, and may see parties agreeing to potential tradeoffs of open space values for other resource benefits.

3.14.3.3 Cumulative Effects

The cumulative environmental consequences are spatially bounded by an area larger than the Santa Fe NF's proclaimed boundary, generally the area immediately adjacent to the forest. Continued development in the communities within and surrounding the forest, as well as the state of New Mexico, influence landownership adjustment cases, boundary issues, and the demand for use and occupancy of NFS lands. This analysis of cumulative effects considers foreseeable activities over the next 10 to 15 years.

Continued population growth in surrounding communities and in the Southwest is expected and would add to the demand for additional lands for development purposes, especially infrastructure. Communities that have not planned for additional infrastructure needs would likely request acquisition of NFS lands for infrastructure. ***As private properties, especially inholdings change from rural or undeveloped land to subdivisions or higher density uses, encroachment into NFS land becomes more frequent, resulting in resource impacts and land survey needs*** **LR10**. As communities grow and infill occurs, undeveloped lands and their open space values are converted to residential or commercial uses. ***This growth would likely result in continued pressures to maintain NFS lands for their open space values. This may also trigger the need to acquire formal rights of access in places where informal public access is lost to development*** **LR11*.***

Cumulatively, continued growth in communities as shown in the census numbers and the resulting demands for acquisition of NFS land tend to move the forest away from desired conditions of natural open space adjacent to communities. ***As further development occurs, residential encroachments onto the national forest are expected to occur more frequently and degrade wildland character, ecological integrity, recreation opportunities, and scenic values, among others.*** **LR12*.*** Working with other governmental partners on ordinances and plans could continue to reduce potential impacts to forest resources.

Property owners within areas considered wildland-urban interface often make requests for access and utility infrastructure across NFS lands. When wildfires threaten large-scale destruction of private property, millions of dollars are spent defending these private lands and property, and additional pressure is placed on forest management to accommodate the rebuilding process, including road and other infrastructure reconstruction, after damage occurs. In recent years, the real estate industry has enforced tighter standards for marketable and insurable titles, which has resulted in a larger workload for lands and boundary management in the forest. In addition, the subdivision (fragmentation) of private parcels increases demands for utilities and access to the forest.

All communities adjacent to the Santa Fe NF recognize the open space and recreational values the forest provides, and have developed goals and objectives in their plans to preserve these characteristics. Still, there will likely continue to be tradeoffs of resource values in the forest as a result of expanding communities and their needs. There will also likely continue to be tension between the desires to retain forest lands near communities and the need to provide land for infrastructure that serves the expansion of those communities. Local collaboration expectations with communities and their desire for open space may result in localized exchanges. However, all alternatives acknowledge community needs and the locations where land adjustments are appropriate and minimize impacts to other resources. As such, these cumulative effects would be consistent among all alternatives.

3.15 Energy and Minerals

The Forest Service recognizes the importance of NFS mineral resources and energy production to the well-being of the Nation, and encourages bona fide mineral and energy exploration and development. But, it also recognizes its responsibility to protect the surface resources of the lands under its care. Thus, the Forest Service is faced with a double task: to make minerals and other energy resources from NFS lands available to the national economy, and at the same time, minimize the adverse impacts of those activities on other resources.

There are four types of energy and mineral resources in Santa Fe NF:

- Leasable minerals include commodities such as oil, natural gas, geothermal heat, and coal. Currently, there are 209 oil and gas leases covering approximately 89,000 acres. These minerals are disposed of through leases issued by the Bureau of Land Management after the Santa Fe NF provides the appropriate stipulations. Development can only occur after site-specific NEPA analysis for each proposed development. Leasing decisions are not part of this forest plan revision.
- Salable minerals are common varieties of sand, gravel, stone, clay, cinders, and pumice. The Forest Service has the authority to dispose of, or allow for public use and sale, these materials on public lands through a variety of discretionary methods.
- Locatable minerals are commodities such as gold, silver, copper, and lead; along with some nonmetallic minerals such as gypsum and gemstones on lands open to mineral development. The Mining Law of 1872 grants U.S. citizens the right to prospect and explore for minerals on lands open to mineral entry. The right of reasonable access for exploration and development of locatable mineral is guaranteed. The Forest Service can require reasonable protection of surface resources and compliance with other Federal laws (e.g., Clean Water Act, Clean Air Act, Endangered Species Act, Archaeological Resources Protection Act, etc.), but cannot deny a request to explore and develop the minerals on NFS lands.
- Renewable energy includes wind energy, solar arrays, hydroelectric dams, and biomass utilization. The Forest Service has the authority to permit construction of renewable energy facilities and infrastructure under special use permits.

3.15.1 Affected Environment

3.15.1.1 Leasable Minerals (Oil and Natural Gas, Geothermal, and Coal)

Oil and natural gas have been extracted from the Santa Fe NF since the 1940s. In January 2018, there were 209 oil and gas leases covering approximately 89,000 acres in the Santa Fe NF, with 50 producing oil and natural gas wells on these leases. All of these leases and wells are within the San Juan Basin portion of the Santa Fe NF where an Oil and Gas Leasing Environmental Impact Statement (EIS), which included forest plan amendments that established stipulations on new oil and gas leases, was completed in 2008, and supplemented in 2012.

In 2004, the BLM's Farmington Field Office and the Santa Fe NF developed a reasonably foreseeable development scenario (RFDS) to serve as the basis for the Santa Fe NF 2008 Oil and Gas Leasing EIS analysis and Forest Plan Amendment. The RFDS projected there could be a total of 20 wells drilled between 2005 and 2024 (20 years) with 11 of the wells producing from the Pictured Cliffs formation and 9 producing from the Mancos shale formation in the Santa Fe NF.

Since 2010, there has been increased interest in developing the Gallup/Mancos Play in the San Juan Basin—an area north and west of the Santa Fe NF—utilizing horizontal drilling and hydraulically fracturing the horizontal leg. In 2014, the BLM's Farmington Field Office developed an RFDS to analyze this potential development. Although the northwestern part of the Santa Fe NF is included in the analysis area for this RFDS, the Gallup/Mancos Play does not underlie the Santa Fe NF, so the 2004 RFDS does not need to be changed. Projections indicate that formations under the Santa Fe NF would not be responsive to the technologies for hydraulic fracking, indicating that these technologies for oil and natural gas production are not seen as reasonably foreseeable at this time. Indeed, there has been no recent use or expression of interest in horizontal drilling technology in the Santa Fe NF.

The 2004 RFDS can be a useful projection of oil and gas development in the Santa Fe NF. The number of wells projected in the 2004 RFDS seems to be high, as only two wells were drilled between 2004 and 2017. However, the projection that wells would be drilled in the Pictured Cliffs and Mancos shale formations seems to be accurate, as both wells drilled since the RFDS was completed were in the Mancos shale formation.

This decrease in production is attributed to the depletion of the oil and gas fields, with no new fields or producing units being discovered. Therefore, production is expected to continue declining. As production declines, several existing wells are expected to become uneconomical to operate (the cost of operating and maintaining the well will exceed the value of its production). These wells will be plugged, and the well sites reclaimed. Although the RFDS projects that 20 new wells could be drilled by 2024, between 2000 and 2017, more wells have been plugged and reclaimed (16) than drilled (2).

Geothermal energy (naturally occurring heat within the Earth) is used in two ways. The first is direct use, which generally uses lower temperature water systems for such things as spas (hot springs), aquaculture (raising fish), facility heating, and greenhouses. The second is electrical generation that generally requires higher temperature and pressure systems, including enhanced systems in which water is injected into hot, dry rocks to extract the heat.

There are no leases for commercial direct use, although several hot springs are directly used for recreational purposes in the Santa Fe NF. There are no current electrical generation operations in the Santa Fe NF. The area within and southwest of the Valles Caldera was extensively explored during the 1970s and early 1980s, but no development occurred because a suitable power line corridor could not be found between the proposed generating plant and the end use during the development attempt.

Renewed interest in geothermal leasing was expressed in 2012, and the Santa Fe NF analyzed the impacts of geothermal leasing in a 2017 programmatic geothermal leasing EIS. The results of that EIS informed a decision to close the study area (figure 26) to geothermal leasing. The decision to prohibit geothermal development in the Santa Fe NF was made to prevent unacceptable impacts to other resources. Geothermal leasing may still be possible outside of the study area upon completion of a site-specific NEPA analysis and decision, but this is highly unlikely—nowhere outside of the study area has geothermal energy production potential. In January 2018, there were no geothermal leases in the Santa Fe NF, and none are expected.

The Santa Fe NF has no history of or expectations for other leasable minerals such as coal, potassium, sodium phosphates, oil shale, sulfur, or solid leasable minerals.

3.15.1.2 Salable Minerals (Sand; Limestone, Basalt/Rhyolite, Granite, And Pumice)

Salable minerals (also known as mineral materials or common variety minerals) are the minerals used for construction and industrial uses. All salable mineral disposals require appropriate NEPA analysis before the miner may obtain a permit from the appropriate ranger district. The type of permit depends upon the circumstances of the disposal as described in 36 CFR 228.57.

Sand is plentiful in the Santa Fe NF, but Cuba Mesa is the only authorized common-use area (as defined in 36 CFR 228.42). Gravel sources containing quantities of quality gravel are scarce, and there are no developed sites in the Santa Fe NF. Decomposed granite has been used as aggregate on several roads, and several sites are developed for this material. Between 2006 and 2013, the annual sales of sand and gravel from the Santa Fe NF averaged 7 tons.

Extensive deposits of limestone, basalt/rhyolite, and granite in the Santa Fe NF yield good quality crushed rock and riprap. Between 2006 and 2013, the annual sales of crushed rock and riprap from the Santa Fe NF averaged 23 tons of crushed rock and 750 tons of riprap.

Pumice deposits, resulting from the Toledo and Valle Caldera eruptions, which blanket the Jemez Mountains have been extensively mined since the early 1940s. Cinders are mined from a volcanic cone southwest of the City of Santa Fe from a site jointly managed by the Santa Fe NF and the BLM. Between 2006 and 2013, the annual sales of pumice and cinders from the Santa Fe NF averaged 43,345 tons.

Decorative rock is found over the entire Santa Fe NF; however, resource concerns and mineral withdrawals limit the availability of stone. Between 2006 and 2013, the annual sales of decorative stone from the Santa Fe NF averaged 66 tons.

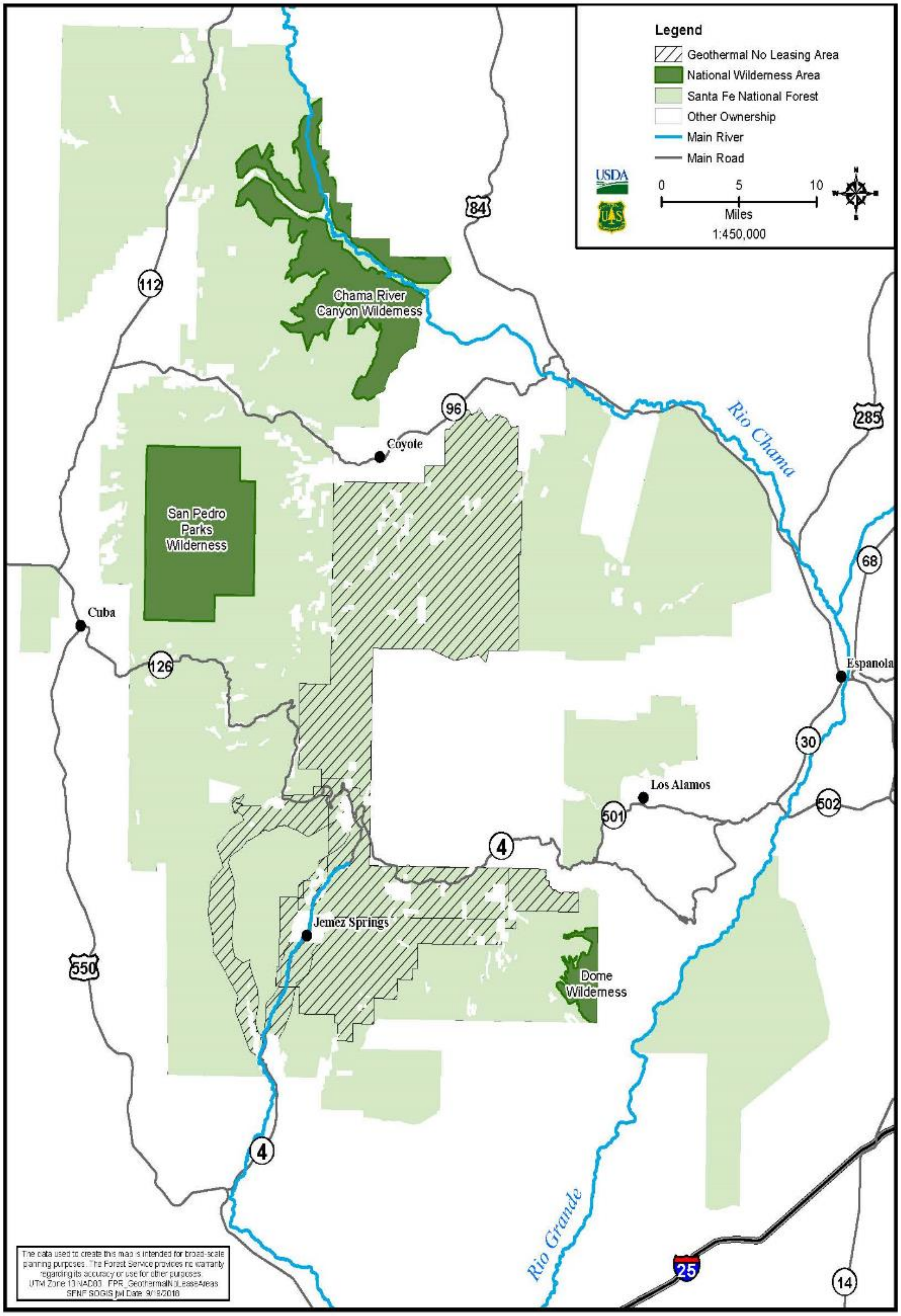

Figure 26. Santa Fe NF geothermal no leasing area

3.15.1.3 Locatable Minerals (Copper, Gold, Silver, Uranium, and Rare Earth Elements)

Mining claims, which establish the claimant's rights to the minerals, can be staked in the Santa Fe NF, except in areas that are withdrawn (such as wilderness areas, the Jemez National Recreation Area, wild and scenic rivers with wild classifications, and designated and proposed research natural areas). However, before conducting any surface-disturbing activities, the miner must describe the proposed operation to the Santa Fe NF, and the Forest Service must comply with the NEPA and authorize the proposed activity.

Historically, copper, gold, silver, uranium, and rare earth elements have been mined from various Santa Fe NF locations. There are a few mining claims for Santa Fe NF locations; however, currently, there are no active mines or exploration projects for these minerals. There are occasional hobby operations to prospect for gold and silver or collect copper minerals as specimens. The small size and low grade of the known locatable minerals deposits will continue to make them uneconomical to mine. The remoteness and lack of rail transportation to processing facilities is a significant factor in determining the economics of developing a mine.

In January 2018, there were 54 unpatented mining claims for locatable minerals in the Santa Fe NF. The only mineral production is from small, "recreational" operations, primarily for mineral specimens. No locatable mineral exploration or development projects with significant surface resource impacts are projected.

3.15.1.4 Renewable Energy (Wind Energy, Solar Power, Hydroelectric Power, and Biomass)

There are no active or pending proposals for commercial wind energy in the Santa Fe NF. Some interest was expressed for testing and development on Rowe Mesa (Pecos Ranger District) in 2009, but no formal application was made, and no work was done. The 2007 statewide survey for potential wind energy sites indicates a small portion of Rowe Mesa has the best potential for wind energy in the Santa Fe NF, but it only rates as moderate potential. On-site use of windmills for pumping water is expected to continue.

Small-scale photovoltaic installations are currently used at numerous Santa Fe NF sites. These installations are used to pump water for livestock, to power oil and gas monitoring and reporting facilities, to provide power for communication sites, and to power fire lookout towers and campground host sites. Small photovoltaic solar installations for on-site use are likely to be constructed at Santa Fe NF administrative sites, campgrounds, water wells, and other facilities operated by authorized Santa Fe NF users such as oil and gas operators, the ski resort, and private cabin owners. Additional Forest Service site photovoltaic installations can be expected to comply with policy (FSM 2170.3). On-site photovoltaic generation is expected to continue and increase by Santa Fe NF users. No commercial photovoltaic power production is occurring, and none has been proposed.

There are no Federal Energy Regulatory Commission (FERC)-licensed hydroelectric power generation sites within the Santa Fe NF. There are two FERC sites on the Chama River (El Vado and Abiquiu) outside of the Santa Fe NF, and two sites exempt from FERC on the Santa Fe River (Nichols Reservoir and McClure Reservoir) within the Santa Fe NF (FERC 2014).

Commercial and personal use (firewood) of biomass is discussed in the Forest Products (section 3.10 of this EIS) and Northern New Mexico Traditional Communities and Uses (section 3.8 of this EIS).It is the policy of the Forest Service to "optimize energy use from renewable resources" (FSM 2170.3) for its facilities, so expansion of renewable energy can be expected.

3.15.2 Methodology

3.15.2.1 Assumptions

For all alternatives, oil and natural gas leasing and development under the leasable minerals analysis is only expected to occur within the Oil and Gas Leasing Management Area because that is the only area of the Santa Fe NF with the potential for these products. Therefore, areas outside the oil and gas leasing area that are or have the potential to be withdrawn from leasing, such as the Cañada Bonita proposed research natural area or recommended wilderness areas, are not analyzed below.

3.15.2.2 Indicators

Leasable minerals: Opportunity for oil and gas and geothermal leasing across the leasing area including lands that could be withdrawn from leasing through management as wild and scenic river or recommended wilderness or the potential designation of new wild and scenic river or wilderness.

Salable minerals: The acres available for minerals, given limitations from different surface use restrictions in each alternative. Most salable minerals are sold off-forest, while contracts supply Santa Fe NF road and recreation site needs. Since Santa Fe NF salable mineral availability has little relationship to material availability for road maintenance and construction, ground cover for parking areas, and landscaping at administrative and developed recreation sites in the Santa Fe NF, this indicator will not include the presence of facilities that require in-service use of salable minerals.

Locatable minerals: Effects to locatable minerals in each alternative would be dependent on which lands were or could be withdrawn from mineral entry. Withdrawn lands would only affect future locatable mineral activities, not existing mineral claims.

Renewable energy: Opportunity for various types of renewable energy across the Santa Fe NF.

3.15.2.3 Drivers and Stressors

The primary driver for energy and minerals development is regional, national, and global economic factors including supply and demand, technical factors, and political decisions. These factors determine whether commercial renewable energy development is economically viable, and whether oil and natural gas (fossil fuels) remain the primary fuels for electrical generation.

In the long term, climate change may drive the energy market across the Nation to use fewer fossil fuels (oil and natural gas) and increase the use of renewable energy (photovoltaic solar energy and wind) to generate electricity. However, in the near term, if temperatures continue to increase and precipitation decreases, additional energy may be needed for residential and commercial cooling and to pump more water for both agricultural and human use. If renewable energy generating and storage battery facilities cannot keep pace with the increased electrical demand, then additional fossil fuel (probably natural gas) will be necessary for the new power plants.

Alternative energy and consumer electronics require minerals, notably the rare earth elements, which are not currently mined in the United States. The deposits of rare earth elements in the forest are considered to be uneconomic to mine under current conditions, but changing markets and/or regulatory environments could change the economic feasibility; so, an increase in mining might occur.

Catastrophic wildfires may temporarily impact mineral production by requiring shut-downs during and after the fire; and repair or replacement of equipment and infrastructure damaged by the fire. Road damage due to runoff events (flooding) following fires has occurred in the past, causing significant changes to the operations (haul routes changed until the damage could be repaired). In a longer term, the soil and vegetation damage caused by a wildfire might preclude the authorization of mineral material sales to prevent further soil loss and sedimentation; and require additional measures for leasable and locatable mineral operation authorizations.

Increased visitor use and the changing demographics of the visitors change the expectations for forest management. The expectation of fewer and less visible extractive uses may make authorizing future minerals operations more contentious (Lybecker et al. 2005).

3.15.3 Environmental Consequences

3.15.3.1 All Indicators

Effects common to all alternatives

Under all alternatives, decisions regarding mineral activities in the Santa Fe NF would align with law, regulation, and policy, and would be consistent with plan decisions for other resource areas to the extent possible.

Under all alternatives, mineral activities may have adverse environmental consequences on some resources in the short term and long term. Short-term environmental consequences could include increased human activity, such as motorized traffic, noise from drilling and mining equipment, temporary roads, ground disturbance during exploration activities, and construction of the authorized well pads, pipelines, or mines. Long-term environmental consequences could include operation and maintenance of the authorized facilities over the life of the facility. Operation and maintenance activities may include increased human activity and noise, motorized vehicle traffic, or additional ground disturbance. ***The effects of these short- and long-term consequences could include increased traffic conflicts with other users on Forest roads, changes to surface water flow paths and quantities, the loss of vegetation, soil disturbance and compaction, wildlife displacement and habitat fragmentation, decreased air quality due to dust and vehicle emissions, increased noise, increased risk of human-caused fires, and decrease in recreational opportunities[M3]. Extractive mineral activities that alter the landscape would most likely encumber other uses and ecological processes on NFS lands-for the foreseeable future[M6].*** Standards in the 1987 Forest Plan and Plan (the proposed action) lessen these environmental consequences by requiring mitigation measures to protect resources affected by mineral operations, including specific standards to ensure protection to wildlife and scenery.

Over the long term, the greater public and communities should benefit from services provided by mineral activities. ***The potential beneficial effects of mineral activities include meeting the requests of the public for the minerals, increasing national energy security, providing local employment, supporting Federal and State programs through royalties paid, and providing a tax base for the State and county [M4]***.

As the minerals are extracted, the deposits are depleted and would not be available for use in the future. Therefore, mineral extraction would result in an irreversible commitment of the resource[M5]. The scale of the impacts described above would vary based on the level of mineral activities that are described below for each indicator.

Effects common to alternatives 2, 3, and 4

The addition of geographic areas in the Forest Plan would have no change on the minerals program. None of the desired conditions for any of the geographic areas effect mineral activities.

3.15.3.2 Indicator: Leasable Minerals

Effects common to all alternatives

The amendment direction from the 2008 Oil and Gas Leasing EIS and 2012 supplement for the 1987 Forest Plan (alternative 1) is for the same area and includes the same plan direction as the Oil and Gas Leasing Management Area in alternatives 2, 3, and 4. This direction provides stipulations, in the form of standards and guidelines, which protect many resources from effects associated with oil and gas leasing activities. These stipulations include:

- No surface occupancy for certain unstable slopes, roadless areas, and specific heritage resource sites. ***This reduces erosion and mass wasting on steep slopes which would impair long-term soil productivity and watershed conditions***[M14]***. Eliminating surface disturbances within designated roadless areas would help maintain the area's roadless characteristics including natural appearance, opportunities for quiet and solitude, and manageability of the area's boundaries***[M7]***. Finally, protections against the irreversible loss of heritage resources would ensure that significant heritage resource sites on the National Register of Historic Places and that are important interpretive sites remain to preserve aspects of cultural history as well as provide educational opportunities for the public***[M8].
- Controlled surface use for certain riparian, inventoried roadless, and scenic areas. Avoidance of wetland and riparian areas would protect surface waters by reducing the probability for sedimentation along stream channels and spills near drainage ways which would ***maintain existing water quality***[M9]***.*** Beneficial effects for inventoried roadless areas is the same as listed above for "no surface occupancy" (see ***M7***). Controlling surface use would protect long-term scenic values by preventing oil and gas activities from being visually evident and contrasting with the natural character (form, line, color, texture) of the landscape so ***scenic values are maintained*** [M10].
- Timing limitations to protect spotted owl, northern goshawk, peregrine falcon, big game winter range, calving and fawning areas and habitats. Timing limitations limit disturbance from drilling and construction activities to ***minimize risks to reproduction during critical breeding, fledgling, and calving periods or during winter, a critical period for health of deer and elk. These timing limitations ensure the health and persistence of these species on the landscape will not be affected by development*** [M11]***.***

With these stipulations oil and gas development is more limited by location and physical feasibility. The application of stipulations may affect a company's ability to access the surface to drill a well. Minerals beneath an area with a no surface occupancy restriction may not be accessible unless the reserves can be accessed through directional drilling, which is generally more costly, and may make development uneconomical. However, since most of the area with production potential is already leased, these stipulations do not apply. Further, oil and gas production is already declining, likely as a result of depleted resource in the area, so the loss in production from new leases with the stipulations would be small.

In all alternatives, just under 1 mile of the Rio Puerco within the Oil and Gas Leasing Management Area would be managed as an eligible wild and scenic river with a preliminary classification of wild. In the Forest Plan, direction for riparian and wetland areas in all alternatives includes stipulations that would protect riparian values, steep and erodible soils, and prevent construction (e.g., roads, pipelines, well pads, etc.). These stipulations would prevent direct impacts to water resources such as increased sedimentation from development and soil erosion as well as contamination from accidental spills (***M14 and M9***). Additional plan guidance for eligible wild and scenic rivers would protect the river's outstandingly remarkable values, which for the Rio Puerco are scenery, botanical, and fish. Although the management area already includes stipulations for scenery (M10), it has no specific stipulations for botanical or fish resources. Therefore, surface occupancy for oil and gas leasing around the Rio Puerco would be very limited, based on the combination of plan guidance for riparian areas, eligible wild and scenic rivers, and the Oil and Gas Leasing Management Area. The area around the Rio Puerco is not currently leased and the measures required to protect riparian areas and eligible wild and scenic river values in the area might make mineral development uneconomical (***M12***).

If Congress designated the Rio Puerco as a wild and scenic river, the proposed plan includes a standard to protect the river's outstandingly remarkable values in the wild and scenic river section. The same section includes another standard that new mining activities must minimize surface disturbance, sedimentation, pollution, and visual impairment (***M14, M9, M10***), which would further protect the Rio Puerco's outstandingly remarkable values and continue to limit the likelihood of oil and gas leasing here.

In all alternatives, there is a standard that prohibits geothermal leasing in a study area (figure 26) on the Jemez, Cuba, Española, and Coyote Ranger Districts—the only area in the Santa Fe NF where there is geothermal development potential. The 2018 Geothermal leasing EIS amended the 1987 Forest Plan to include this standard (alternative 1), which has been carried forward in the minerals section of the proposed plan in alternatives 2, 3, and 4. The absence of any future geothermal leasing would eliminate resource impacts on soil, groundwater, surface water (***M14, M9, M10***); vegetation, fish and wildlife habitat (***M11***); and disturbance of religious and cultural uses of the landscapes (***M8***); dust and vehicle emissions (***M3***); disturbance to livestock, grazing operations, and livestock forage (***M6***); and ***risk of seismic activity***[M13]. Outside of the geothermal study area, there are also no environmental impacts because there has never been—nor would there likely ever be—any geothermal production potential.

Effects common to alternatives 1, 2 and 4

Alternatives 1, 2, and 4 have no acres of recommended wilderness areas within the Oil and Gas Leasing Management Area (Oil and Gas Leasing amendment for alternative 1), so the availability of lands for oil and gas leasing are only constrained by stipulations laid out in the amendment for the 1987 Forest Plan (alternative 1) and Oil and Gas Leasing Management Area in the Forest Plan. These stipulations limit the possibility of negative effects for many resources (e.g., wildlife, cultural, soil, etc.) (***M6-M11, M14***). Production of oil and gas is expected to continue to decline but would continue for the foreseeable future.

Alternative 3 - Natural Processes Emphasis

Alternative 3 would have about 7,038 acres of recommended wilderness within the Oil and Gas Management Area. The proposed plan includes a standard for recommended wilderness that prevents new energy developments and leases, so these areas would be withdrawn from future leasing. These leasing limitations would carry forward if Congress designated these areas as wilderness. The parts of the recommended wilderness areas that are leased at the time of recommendation or designation or both could see oil and gas development and the associated impacts (***M1-M3, M5-M6, M7-M11, and M14***). The parts of the recommended wilderness areas without leases would be managed to prohibit oil and gas development and the associated impacts (***M1-M3, M5-M6, M7-M11, and M14***). Alternative 3 protects more acres from oil and gas development than any of the other alternatives.

3.15.3.3 Indicator: Salable Minerals

Effects common to all alternatives

Under all alternatives, the Santa Fe NF would continue to have an active salable mineral materials program, and demand for these resources is expected to continue. There is no indication that the quantity of materials sold would significantly increase.

In the minerals section of all alternatives, there is a standard that ensures reclamation of mineral areas to restore resource impacts. Throughout the plan, standards and guidelines in resource sections for scenery, watershed, soils, cultural resources, vegetation, and wildlife resources require that these resources are protected or effects are mitigated during projects, which would include salable mineral projects. This plan direction would limit salable mineral activity across the forest, minimizing negative environmental effects (***M1-M3, M5-M6***), while promoting beneficial effects (***M4***).

In all alternatives, salable mineral extraction would be prohibited on 335,975 acres. Congressionally designated wildernesses and the Jemez National Recreation Area Management Area (Management Area X in the 1987 Forest Plan) are withdrawn from mineral entry as part of their governing laws. Designated and eligible wild and scenic rivers (Management Area F in the 1987 Forest Plan) with wild classifications are not available for mineral activities, because it is Forest Service policy to protect their eligible status pending a suitability determination. The designated and proposed research natural areas have a standard for no surface occupancy for minerals, thereby, preventing salable mineral extraction. These areas would protect ecological and socioeconomic resources from mining impacts (***M1-M3, M5-M6)***.

Alternative 1 – 1987 Forest Plan

In the 1987 Forest Plan, the extent of the Santa Fe NF is divided into management areas that each have their own standards that impact the availability of salable minerals. In addition to the withdrawn areas in all alternatives, there are an additional 332,405 acres of no salable mineral activity in the Santa Fe NF. These include:

- Management Area I incudes a standard that does not permit mineral extraction, including salable minerals. This protects and preserves in situ the high value cultural resources such as large multi-room pueblos surrounded by a high number of field houses, pit house village, lithic scatters, stone quarries, a Spanish Colonial hacienda, and historic logging and mining camps in these areas (see ***M8***).
- Recommended wilderness areas within Management Area H. This protects the wilderness characteristics of the area from mining impacts (***M1-M3, M5-M6***) so they remain eligible to be designated as wilderness by Congress.

An additional 84,034 acres of the Santa Fe NF (Management Areas C and D) have limited salable mineral activity where sand and gravel extraction is only allowed when visual quality can be returned within a year of project initiation. Salable mineral extraction is eliminated or reduced in these areas, thereby, limiting availability of these materials for use in the Santa Fe NF (***M4)***, but protecting the visual resources within these areas (see ***M10***). This alternative has the second most acres of withdrawn areas and associated effects (***M1-M6***).

Alternative 2 – Forest Plan

In addition to the withdrawn areas in all alternatives, alternative 2 would have an additional 25,868 acres of restrictions on salable mineral disposals within recommended wilderness management areas. The

Forest Plan includes a standard that does not permit mineral extraction in recommended wilderness, so these areas would not be available for salable mineral development except where such activities are allowed pursuant to valid existing rights. This protects the wilderness characteristics of the area, so they remain eligible for potential designation as wilderness by Congress. This alternative has the second least acres of withdrawn areas and associated effects (***M1-M6***).

Alternative 3 – Natural Processes Emphasis

Alternative 3 would have an additional 270,130 acres of restrictions on salable mineral disposals within recommended wilderness management areas, where the proposed forest plan restricts mineral extraction. This would protect the wilderness characteristics of the area the most of all alternatives, so they remain eligible for potential designation as wilderness by Congress. This alternative has the most acres of withdrawn areas and associated effects (***M1-M6***).

Alternative 4 – Human Uses Emphasis

Alternative 4 has no additional acres of restrictions on salable mineral disposals within any additional management areas. Therefore, this alternative has the most acres of land available for salable minerals disposal and the greatest associated effects (***M1-M6***).

3.15.3.4 Indicator: Locatable Minerals

Effects common to all alternatives

In all alternatives, 349,000 acres or 23 percent of the Santa Fe NF is withdrawn from mineral location and development. These lands include congressionally designated wilderness (4 areas totaling 287,116 acres), eligible and designated wild and scenic rivers with wild classifications (11 rivers totaling about 68 miles), the Jemez National Recreation Area designated area (48,859 acres), and designated and proposed research natural areas (2 designated, 1 proposed, totaling 1,549 acres). The known locatable mineral deposits in the Santa Fe NF are small and low grade, so active mines and exploration projects would continue to be occasional and in small areas of withdrawn lands, so the withdrawals would not limit the beneficial effects of mineral extraction (***M4***).

Alternative 1 – 1987 Forest Plan

The 1987 Forest Plan includes no additional direction on areas withdrawn from locatable minerals. Therefore, only the same 349,000 acres as are common for all alternatives are withdrawn from locatable mineral development. This alternative has the second lowest number of withdrawn acres and associated effects of mineral development (***M1-M6***).

Alternative 2 – Forest Plan

The Forest Plan does not limit development of locatable minerals in recommended wilderness; although if areas are designated wilderness, they would be withdrawn from minerals development. Alternative 2 has 25,868 acres of recommended wilderness. This possibility of withdrawn acres and associated effects of mineral development (***M1-M6***) is the second highest of all alternatives, but represents a negligible impact on locatable mineral development, because the potential for mineral occurrence within the proposed areas is low.

Alternative 3 – Natural Processes Emphasis

Alternative 3 has the most acres of recommended wilderness (270,130 acres) and represents the greatest possibility of withdrawn acres. This possibility of withdrawn acres and effects associated with mineral activities (***M1-M6***) is the highest of all alternatives, but represents a negligible impact on locatable mineral development, because the potential for mineral occurrence within the proposed areas is low.

Alternative 4 – Human Uses Emphasis

Alternative 4 not only has no acres of recommended wilderness, but also has 68 acres recommended to be removed from wilderness. Therefore, this alternative has the lowest potential of all alternatives for additional acres withdrawn from mineral material development and associated effects of mineral extraction (***M1-M6***), although the potential for this activity is already low in the Santa Fe NF.

3.15.3.5 Indicator: Renewable Energy

Effects common to all alternatives

The construction of commercial-scale solar, wind, or hydroelectric facilities would be unlikely under any of the alternatives. The likelihood of requests for construction of additional power lines to transmit renewable power generated off-forest across the Santa Fe NF would be equally likely under any of the alternatives. In all alternatives, plan direction for scenery, wildlife, riparian protection, archaeology, and traditional and cultural ways of life would make it difficult to determine a route for power transmission lines within the Santa Fe NF without causing unacceptable impacts to these resources, which may constrain the development of commercial alternative energy generation and reduce the associated effects, including beneficial effects (***M1-M6***).

In New Mexico's rural communities, fuelwood (firewood) obtained from NFS lands is often the only source of heat for homes and is a form of very small-scale renewable energy. Plan direction for forest product availability, including personal firewood permits, would continue to be made available as discussed in the forest products and rural historic communities sections. The level of this activity is expected to remain constant across all alternatives and for the life of the plan. Therefore, fuelwood supply from the forest would remain the same and would continue to support the cultural use, as well as provide the means for local and rural populations to heat their homes in winter. Fuelwood use, while culturally important, would not substantially diminish wood products forestwide, and is therefore unlikely to have any effect on the likelihood or scale of any commercial biomass activity.

3.15.4 Cumulative Environmental Consequences

The cumulative effects timeframe for the minerals and energy analysis is the next 10 to15 years. The spatial extent includes the Santa Fe NF and the local communities within and closely adjacent to the Santa Fe NF boundary. The demand for minerals and energy resources in the Santa Fe NF is influenced by external factors such as the economy and public demand for these resources, as well as nearby construction and development. These factors and past trends are considered in evaluating cumulative effects for energy and minerals.

While development of oil and gas resources in the San Juan basin has increased during the past 5 years, development of oil and gas resources in the Santa Fe NF has not. As mentioned in the affected environment section, oil and gas production has decreased during the past 15 years. This decrease in production is attributed to the depletion of the oil and gas fields, with no new fields or producing units being discovered, an effect that occurs over time with non-renewable resources (***M5***). As production declines, several existing wells are expected to become uneconomical to operate (the cost of operating and maintaining the well would exceed the value of its production). These wells would be plugged, and the well sites reclaimed. Similar to the Santa Fe, the Carson NF has established an oil and gas management area to guide management of these resources, and no activities there would affect management of oil and gas in the Santa Fe NF.

Deposits of most locatable minerals in and around the Santa Fe NF are small and low quality, making these materials uneconomical to mine. In addition, the remoteness of these deposits and lack of transportation infrastructure connecting potential extraction sites to processing facilities poses huge hurdles for economic viability. Therefore, these materials are unlikely to be mined in large quantities over the life of the plan, reducing associated effects (***M1-M3, M5-M6***), and in particular, beneficial effects (***M4***). The one possible exception is the copper and silver deposit in the Dalton and Macho Canyon area (Pecos Ranger District). This needs further exploration, however, to determine if it is large enough and rich enough to warrant development. Approval of any plans of development at that site would be difficult to obtain because of the rugged topography, lack of access, proximity to the Pecos Wilderness, and location within Santa Fe County (which has very restrictive mining regulations), making effects (***M1-M6***) less likely.

The Santa Fe NF has few salable minerals resources (gravel, stone, and clay) available or being developed, compared to the amount on private, State, tribal and other Federal lands within the cumulative effects area. Administrative use of mineral material sources may be reduced by changes to the Santa Fe NF transportation system, as there may be fewer roads to maintain. However, the external uses for salable resources are expected to increase in response to population growth and economic recovery that may spawn increased building and road construction. If salable mineral demand drives prices up, it may become more economical and necessary for the Santa Fe NF to develop more salable mineral sources for in-service use, which has not been done in several years because of cost. This would increase the effects to other resources (***M1-M6***). However, cumulatively, the effects of salable mineral materials activities would be minor in proportion to the effects of the activities that are ongoing outside the Santa Fe NF within the cumulative effects area.

Renewable energy sources and related effects (***M1-M6***) within the cumulative effects area are unlikely to change over the duration of the plan. There are four FERC-licensed hydroelectric power generation stations within the cumulative effects area, but none are likely to undergo major changes to their function or administration, and none are proposed. There is little potential for wind energy development in or around the Santa Fe NF because of relatively low wind speeds as evaluated by New Mexico Energy, Minerals, and Natural Resources Department. There is some potential for solar energy production, but this is unlikely because surrounding areas have higher solar energy potential and are located closer to necessary energy infrastructure. Demand for solar-generated electricity—a huge driver of solar development potential—is also closely linked to oil and gas prices that are currently too low to make solar development in the Santa Fe NF economically feasible. Finally, geothermal energy potential in the cumulative effects area is largely confined to the Valles Caldera—on which geothermal energy production is prohibited—and parts of the Santa Fe NF subject to a “No Leasing” decision from 2018. Geothermal energy development and associated environmental effects (***M1-M6, M8-M11, M13, M14***) within the cumulative effects area are, thus, highly unlikely, though direct use of geothermal energy does occur on a small scale for things like facility heating and recreational hot springs.

3.16 Scenic Resources

Vision is the primary sense for most people and influences how people experience the landscape, the ecological features, and the human elements, which combine to give an area identity and contribute to people’s connection to a place. People value scenery with natural-appearing landscapes. Scenery varies depending on existing natural features including vegetation, water features, landform, and geology, along with the cultural features and human alterations found in the landscape (e.g., buildings, structures, manipulations of the land or vegetation). Cultural features and human alterations may contribute to scenic character, when these elements have historical backgrounds, have nostalgic connotations, reflect the cultural legacy of an area, or create a visually pleasing complement to the natural character of the landscape.

Research shows there is a high degree of public agreement regarding scenic preferences and people tend to value most highly the more visually attractive and natural-appearing landscape. Scenic characteristics are important in creating people's connection to a place for local residents and visitors alike. They provide a sense of attachment and opportunities to connect with nature. Scenery is the backdrop and the setting for the entire Santa Fe NF and largely contributes to the experiences people have and seek in the forest. All activities forest visitors experience are performed in an environment influenced by the surrounding scenic character.

Although scenery was not identified as a focus area need for change in the assessment, most of the focus area topics indirectly relate to scenery. Restoration of vegetation structure and improvement of forest health improves scenery, especially in the long term. Restoration, conservation, and maintenance of grasslands, meadows, riparian ecosystems, and soils also improves scenery. Water features increase the scenic attractiveness of the forest and measures to improve water resources also improve and enhance scenery. Additionally, scenic character is a component of managing for sustainable recreation. Scenery was identified as a non-focus area with a need for plan direction to integrate scenery management into all resource management decisions with the intent of retaining and enhancing scenic resources while integrating with other resources (e.g., restoration, habitat diversity, and timber management).

3.16.1 Affected Environment

The landscapes of the Santa Fe NF have a wide variety of features providing for spectacular scenery in the Southwest. People are drawn to the Santa Fe NF for its diversity of scenic features including higher elevation spruce-fir forests, aspen adding vibrant gold during autumn, lush high mountain meadows filled with wildflowers, dramatic landforms with vibrant colors, brilliant red rock canyons and cliffs, sandstone bluffs, and mountain peaks. The inspiring mountain scenery and cool mountain air and waters provide an escape from the desert heat. The national forest offers dark night skies and provides the backdrop to many communities and homes. The Santa Fe NF area has a variety of scenic settings with mesas, canyons and peaks rising from deserts, meadows, and grasslands. Many prehistoric and historic sites add richness of character and culture. A summary of input received from public meetings regarding forest scenery follows:

> *The diversity of the scenery on the forest is highly valued – from the rock formations and the color of the earth to the gold of the aspens and the green spaces in summer. Forest users value the variety of landscapes, different terrains, elevation, and seasonal changes. The night sky is also a value of the scenery from the forest as people escape from bright city lights and enjoy the stars in the darkened sky. For many communities, the forest serves as the "backdrop of [people's] home[s]."* (USDA Forest Service 2016a, page 192).

3.16.1.1 Summary of existing conditions and trends

Managing for scenic quality benefits the local and regional economy of the Santa Fe NF area. The Santa Fe NF continues to be a popular recreation area for local communities, New Mexico, and surrounding states. The aesthetic and scenic values of the Santa Fe NF contribute to the attractiveness of both the recreation resource and the general quality of life for residents, both long-term and newly arrived. As a tourist destination, northern New Mexico's small businesses and jobs are supported by this high-quality aesthetic environment. Demand for properties along the forest boundary is increasing, and prices reflect the higher value given for these qualities (USDA Forest Service 2016a, page 191). Both residents and visitors experience connection to a place that is partially dependent on the natural environments of the forest.

Trends to enjoy the natural scenic beauty of a forest environment exist since viewing or photographing natural features or scenery is one of the nation's fastest-growing nature-based recreation activities (Cordell 2008, Cordell 2012). On the Santa Fe NF, viewing natural features or scenery was the recreation activity identified as having the highest or second-highest participation level during National Visitor Use Monitoring surveys conducted in 2003, 2009, and 2014 (Kocis et al. 2004, USDA Forest Service 2016b, USDA Forest Service 2016c). Demand and use are anticipated for hiking, walking, viewing natural features or scenery, viewing wildlife, driving for pleasure, and relaxing, with use likely concentrated near water sources (USDA Forest Service 2016a, page 190). It is important to manage the scenic resources to ensure quality sightseeing and recreation experiences for the public and sustain traditional cultural values. Scenery is an integral component of all forest settings and contributes to the quality of the users' experience. Providing a natural-appearing landscape for these visitors is important since Santa Fe NF visitors rank scenery and attractiveness of the forest landscape as important to very important (Kocis et al. 2004, USDA Forest Service 2016b, USDA Forest Service 2016c).

The public, including local stakeholders and community members, has identified the diversity of the Santa Fe NF scenery as a highly valued and important asset for adjacent communities and forest visitors (Russel and Adams-Russel 2005 and USDA Forest Service 2016a, page 190). The Forest has landscape features common to other forests in New Mexico with rolling hills and low mountains, ponderosa pine and pinyon-juniper forests, and sagebrush or grassland plains. However, distinctive landscape features are also found throughout the forest and include red rock canyons and cliffs, the fall color combinations of conifer and aspen forests, grasslands fringed by conifer forests, mountain peaks, and flowing streams. Although distinctive landscapes can be found throughout the forest, they often coincide with special designated areas due to the presence of high-quality scenery within these areas and scenery being an important part of the designation, such as a scenic byway. The special designations also have the highest concern for natural-appearing scenery because scenery is an important part of many designations.

Among the approximately 1.6 million acres of NFS lands in the Santa Fe NF, about 300,000 acres are designated wilderness including the Pecos, San Pedro Parks, Dome, and the Chama River Canyon, which provide for distinctive scenic landscape features and unaltered, naturally evolving scenic character. There are eight nationally or state designated scenic byways, one national recreation area, one national scenic trail, two national recreation trails, three national historic trails, and three designated wild and scenic rivers within the Santa Fe NF. Scenery is a key component of these designated areas.

Scenic byways offer unique scenic driving experiences for northern New Mexico. Viewing natural features was the second most popular activity in the Santa Fe NF, driving for pleasure the sixth most popular activity, and over 47 percent of forest visitors reported using a scenic byway (USDA Forest Service 2016c).

Jemez National Recreation Area (Jemez NRA) provides outstanding scenery and recreation opportunities. Jemez NRA is composed of dramatic landscapes with breathtaking views of sheer cliff faces, pock-marked tuff exposures, flat topped mesas, and lush canyon bottoms. The two primary river corridors in the Jemez NRA, Rio Guadalupe and Jemez River, receive the most recreation use in the Jemez NRA. The outstanding scenery is one of the main resources drawing visitors to the Jemez NRA each year (USDA Forest Service 2002).

The Continental Divide National Scenic Trail is intended to provide for scenic, high-quality, primitive hiking and horseback riding experiences, while preserving the significant natural, historic, and cultural resources along the Trail. Cañones Creek National Recreation Trail offers spectacular views of the Cañones Canyon cliffs. Winsor National Recreation Trail is a popular trail with opportunities to view high-elevation mountain scenery.

Scenery is an outstandingly remarkable value for two of the Santa Fe NF's designated wild and scenic rivers: East Fork of the Jemez River and Pecos River (USDA Forest Service 2002, 2003).

Management of multiple resources has, to varying degrees, altered the natural scenic character of the Santa Fe NF. The most obvious effects on scenic resources are from vegetation and landform alterations. Resource management activities that have altered scenic resources include vegetation management, mineral extraction, utility installation, road and trail construction and maintenance, developed recreation site construction, fire management (suppression and prescribed burning), overly dense vegetation resulting from fire suppression, and livestock grazing.

Most noticeable changes to scenic conditions across the landscape occur through natural processes such as wildfires or flooding. These natural disturbances shape the vegetation and landform features of the landscape and affect the overall sustainability of the scenic character. Fire can also benefit scenic character. Historically, fires in the Sangre de Cristo Mountains have resulted in large areas of aspen, which provide golden fall colors intermixed against green conifer covered mountains. Wildfires that burn with mixed severity have fewer impacts to scenic character than those that burn with uncharacteristically high severity, which result in greater tree mortality. Low- and mixed-severity fires are a characteristic part of the historic landscape and range of variability. Other factors that will continue to negatively affect the sustainability of the scenic character of the forest include: drought conditions affecting vegetation and water features, invasive species affecting native vegetation, tree encroachment on meadows and other forest openings, and conifer encroachment on aspen (USDA Forest Service 2016a, pages 183-188).

Existing Conditions through Components of the Scenery Management System Inventory

The Scenery Management System (SMS) provides a systematic approach to determine the relative value and importance of scenery in National Forest System lands through the completion of the SMS inventories listed below. Ecological settings and resiliency concepts provide the environmental context for the SMS. In 2013 and 2014, the Santa Fe NF completed the SMS inventories as part of the plan revision process to map existing condition of the scenic resources (USDA Forest Service 2015). The SMS inventory included mapping of:

- existing scenic integrity (the existing condition of scenic resources);
- scenic attractiveness (the intrinsic scenic beauty of a landscape based on land form, rock form, water form, and vegetation);
- concern levels (the relative concern for scenery along roads and trails);
- visibility (the foreground, middle ground, and background areas visible from concern level roads and trails);
- scenic classes (the relative importance of scenery overall); and
- scenic character descriptions (existing condition descriptions of valued scenic attributes and scenic character written at the ecological subsection scale). The scenic character description is a standalone document (USDA Forest Service 2015 (SCD doc)).

3.16.2 Methodology and Analysis Process

3.16.2.1 Forest Service Scenery Management

The U.S. Forest Service has been managing scenery as a resource since the 1970s, first using the visual management system (VMS) and later the SMS. Both systems provide a framework to inventory, assess, and manage scenic resources. However, the SMS represents the agency's latest science in fulfilling its legal requirements for managing scenic resources and achieving high-quality scenery. The SMS integrates increased understanding of ecological processes, disturbance patterns, and cultural landscapes in identifying the effects of various management practices on scenic resources.

In forest plans, both systems establish a spectrum of levels or objectives to determine the acceptable level of alteration in the landscape. The VMS uses visual quality objectives (VQOs), while the SMS uses scenic integrity objectives (SIO). SIOs and VQOs can be cross-walked to show how they relate to people's perceptions of scenery (table 90).

Table 90. Scenic integrity objective, visual quality objective, and perception crosswalk (USDA Forest Service 1995, 2-4)

Scenic Integrity Objective (Alternatives 2, 3, and 4)	Visual Quality Objective (Alternative 1)	Public Perceptions of Scenery
Very High	Preservation	Unaltered; scenic character is intact; naturally evolving
High	Retention	Appears Unaltered; alterations to scenic character may be present but are not evident; naturally appearing
Moderate	Partial Retention	Slightly altered; alterations are subordinate to scenic character being viewed (scenic character is dominant, not the alteration); relatively naturally appearing
Low	Modification	Moderately altered; alterations begin to dominate the valued scenic character being viewed.
Very Low	Maximum Modification	Heavily altered; alterations may strongly dominate the valued scenic character

3.16.2.2 Indicators

The environmental consequences analysis considered how each alternative would provide for scenery management using the following indicators:

- Acres of visual quality objective or scenic integrity objective allocations of each alternative. Existing or proposed plan direction provides for varying amounts of natural-appearing scenery for forest visitors.
- Whether the VMS or SMS is used to manage scenery.
- A qualitative discussion of the potential effects to scenic resources from management activities.

3.16.2.3 Methodology

Potential effects of management activities was determined through research and analysis of similar projects and review of the current 1987 Forest Plan and the proposed Forest Plan and alternatives. ArcMap and geographic information system (GIS) data layers were used to analyze 1987 Forest Plan direction for visual resources, direction for scenic resources management in the Forest Plan, review SMS inventories to determine the existing condition of scenic resources, develop scenic integrity objectives for the action alternatives, review proposed management areas and proposed plan components, and analyze the alternatives in regards to desired conditions for scenic resources (scenic integrity objectives).

3.16.2.4 Assumptions Specific to Scenery

- The principles of scenery management and environmental design will be applied in project-level planning in all NFS activities.
- Scenery management techniques and principles will be used to mitigate any future site-specific land altering activity or introduced elements on the land, to achieve and maintain desired scenic integrity objectives and desired scenic character.
- Changes in scenery and changes in public expectations related to landscape aesthetics and scenery will be monitored and documented (FSM 2382 – Scenery Management). Changes in public expectations related to landscape aesthetics and scenery would most likely be monitored at a regional or national level but may also be assessed during scoping for site-specific projects and review of current research when completing scenery analyses for site-specific projects.
- Managing for natural-appearing scenery is important to the public.

  "Research has shown that high-quality scenery, especially that related to natural-appearing forests, enhances people's lives and benefits society" (USDA Forest Service 1995, page 17).

  "Research shows that there is a high degree of public agreement regarding scenic preferences. This research indicates that people value most highly the more visually attractive and natural-appearing landscapes" (USDA Forest Service 1995, page 30).
- Desired scenic character often includes and is linked to preferred visual settings. Gobster (1994) summarizes visually preferred settings as having four common attributes: large trees; smooth, herbaceous ground cover; an open midstory canopy with high visual penetration; and vistas with distant views and high topographic relief.
- Scenery inventory GIS data layers will be reviewed during future project-level analysis and updated as ground-truthing occurs to keep the data layers accurate and relevant.
- For the no action alternative, the visual quality objectives identified in the current Plan and other current Plan direction would be used to manage scenery. To describe and compare consequences, this analysis will use SMS terminology (SIOs) for all alternatives.

3.16.3 Stressors and Drivers

Natural resources and settings would be vulnerable to adverse effects of atypical temperatures and rainfall patterns from climate change. Some associated effects include drought, increased number and intensity of wildfires, increased insect and disease outbreaks affecting vegetation, and decreased water yield and availability. Severe wildfires would remove forest vegetation and thereby diminish the scenic quality of the landscape especially when a wildfire burns at an uncharacteristic scale or severity. When fires burn at high intensities over large areas, as is more likely during severe drought and increased temperatures, heavy runoff from extreme storms may remove understory vegetation, which would reduce the quality of scenic vistas. When insect and disease outbreaks occur at epidemic levels, tree mortality with standing and fallen dead trees would reduce scenic quality especially when the mortality dominates scenic vistas. Defoliation of trees from insects and disease would also affect the scenic quality changing the scenic views while trees are defoliated.

The Forest Plan under the action alternatives includes desired conditions and management approaches to increase resiliency to natural disturbances such as drought or climate change. These strategies guide a forest management response to extreme weather events and wildfire, both of which destroy native vegetation and dominate views of the landscape in various vegetation communities at all elevations. Plan direction also guides managing the restoration of resources and ultimately, scenic quality, in the aftermath of such events. Direction in the Forest Plan under the action alternatives would, therefore, facilitate the adaptation and resiliency of forest vegetation to climate-induced events. Hence, the quality of vegetative landscapes as well as scenic quality in the Santa Fe NF would be maintained or improved under the action alternatives.

3.16.4 Environmental Consequences

3.16.4.1 Effects common to all alternatives

Desired conditions under Scenic Resources complement multiple-use activities and would maintain or improve scenic quality and scenic character resilience and ***provide opportunities for the public to connect with nature***[S1]***.*** They emphasize a variety of ecologically sound, resilient, and visually appealing landscapes ***that sustain scenic character, have long-term resilience to changing conditions***[S2]***, and contribute to visitor's sense of place***[S3]. They also emphasize cultural landscapes and areas the public values highly for scenery and that scenery ***reflects ecosystem diversity***[S4], ***enhances recreation settings***[S5], and ***contributes to the quality of life for local residents and communities as well as Santa Fe NF visitors***[S6].

3.16.4.2 Indicator: Scenic Integrity Objective (SIO) Allocations

Effects common to all alternatives

Under all alternatives, scenery would continue to be managed by direction given in U.S. Forest Service manuals and handbooks, which provide general guidance for scenery management. Each alternative provides for scenery management to varying degrees. Santa Fe NF lands would continue to be managed for natural-appearing landscapes and scenic quality (***S1-6***). For the no-action alternative, the VQOs identified in the current Plan would be used to manage scenery. However, to describe and compare consequences, this analysis will use SMS terminology (SIOs) for all alternatives. Table 90 provides a crosswalk between SIOs, VQOs, and how people perceive the different levels. SIOs would help protect and improve scenic quality across most of the Santa Fe NF, yet in some locations SIOs would be lower to allow for necessary and accepted land uses that have lower scenic quality, such as at electronic sites.

The amount, location, and emphasis of scenery management is determined by SIOs, which vary by alternative. SIOs for each alternative are in Appendix M. Designated wilderness and recommended wilderness areas are managed for an SIO of "very high." Here, ***landscapes are unaltered with a naturally evolving scenic character; few deviations from the natural character occur, such as non-motorized trails or trail signs***[S7]. Areas highly valued for scenery (foreground views of high concern travel routes and areas and areas with outstanding scenic quality), some designated areas (such as Jemez NRA and designated wild and scenic river corridors) are managed for an SIO of "high." Here, ***landscapes appear unaltered, even though some deviations to the scenic character are present. Deviations in the scenic character in "high" SIO borrow from elements in the landscape, such as form, line, color, texture and pattern***[S8]. Developed recreation sites (e.g., campgrounds, picnic areas, recreation residences, and lands viewed from moderate use areas or backdrops of less scenic quality) usually have an SIO of "moderate." Here, ***scenic character appears slightly altered but noticeable deviations remain visually subordinate***[S9]. Communication sites, transmission lines, active mines, and other areas seldom seen from common use areas have SIO of "low" or "very low." Here, ***scenic character appears moderately to-***

heavily altered and deviations begin to dominate the scenic character being viewed [S10]. Disruptive activities may occur with land managed for "low" or "very low." Although having lower scenic quality, these are necessary and accepted land uses. The composition of SIOs across the forest would influence how natural-appearing the landscape is and varies by alternative. ***The "very high," "high," and "moderate" SIOs result in a relatively natural-appearing landscape***[S11]. In particular, "***very high" and "high" SIO provide an intact and attractive scenic setting for forest visitors and residents*** [S12]. ***The "low" and "very low" SIOs result in more modified landscapes that are often considered less scenic and visually appealing***[S13]. ***Forest visitors would have lower quality experience and satisfaction if the proportion of "low" and "very low" SIOs are too high proportional to the "very high," "high," and "moderate" SIOs***[S14]. ***Forest visitors would also have lower quality experience if "low" or "very low" SIOs are allocated to areas with high use where visitors expect to see a natural-appearing scenic character***[S15].

Alternative 1 - 1987 Forest Plan

In alternative 1, Santa Fe NF acres are almost equally spread across the five SIOs (table 91). The majority of the forest (63 percent) is managed for a natural-appearing landscape under "high," "very high," and "moderate" SIOs (***S11***). Alternative 1 has one of the largest proportion of lands being managed for "very high" SIO, primarily due to non-Wilderness portions of the Santa Fe Watershed being managed for "very high" with associated effects of managing for "very high" (***S7, S11, S12***). A significant portion (38 percent) of the Santa Fe NF is managed for "low" or "very low" SIOs where scenic character appears moderately to heavily altered and deviations begin to dominate. This alternative has the greatest number of acres and associated effects associated with "low" and "very low" SIO (***S10, S13, S14***). Disruptive activities may occur in lands managed for these SIOs with few considerations for scenery. Structures may not have architectural styles, materials, or colors that blend with the landscape or vegetative treatments may have noticeable dominant patterns, edges, or shapes with associated effects (***S13, S14, S15*)**. Overall, scenic resources would be maintained at a lower SIO level than for alternatives 2, 3, or 4. Given the importance of viewing scenery in the Santa Fe NF, this may ***diminish visitor satisfaction***[S16], lower the quality of visitor experience (***S15***), or even decrease the sense of attachment and opportunities to connect with nature in the Santa Fe NF (***S1, S3***).

Table 91. Summary of SIO acreages by plan alternative for the Santa Fe NF (appendix M)

Scenic Integrity Objective	Alternative 1 Acres (percent)*	Alternative 2 Acres (percent)	Alternative 3 Acres (percent)	Alternative 4 Acres (percent)
Very High (Unaltered)	329,807 (21%)	317,911 (21%)	558,784 (36%)	292,841 (19%)
High (Appears Unaltered)	345,440 (22%)	807,954 (52%)	590,769 (38%)	831,853 (54%)
Moderate (Slightly Altered)	323,856 (20%)	375,944 (24%)	353,679 (23%)	377,116 (24%)
Low (Moderately Altered)	234,884 (15%)	43,811 (3%)	42,388 (3%)	43,811 (3%)
Very Low (Heavily Altered)	364,945 (23%)	0	0	0

* Acres estimated from 1987 Forest Plan and Management Area corporate GIS data if VQO acreage was not listed for a Management Area in the 1987 Forest Plan. These acres do not include any change in land ownership since the plan was adopted.

The communities, recreation areas, roads and waterbodies providing the basis for "high" SIO are based on VMS inventories completed in the 1980s. Areas identified in 2014, with a higher concern for scenery, may have SIOs such as "low" or "very low," which provide limited protection of scenic resources in these areas. ***Continuing to manage scenic resources based on the inventories completed almost 30 years ago does not reflect the increased concern for scenery evidenced in the recently completed SMS inventory, importance of scenery to forest visitors*** (Kocis et al. 2004, USDA Forest Service 2016b, USDA Forest Service 2016c), ***population growth, and expectations for scenic variety and natural-appearing scenery throughout the Santa Fe NF identified by the public in the forest planning process***[S17] (USDA Forest Service 2016a, page 192).

In alternative 1, plan guidance may make it more difficult for managers to integrate scenery into project planning and work toward an improved scenic resource condition. The SIOs do not reflect changes in visitor use patterns, do not incorporate views from trails, and do not reflect current public opinion, especially concerns about community backdrops and scenery (***S15, S16, S17***). Additionally, the SIOs do not recognize the cultural importance of some human modifications including historic sites, well-designed buildings such as visitor centers, and human-made features such as campgrounds. Since all of these inputs are important to accurately reflect scenery desires and perceptions, current Plan direction does not provide adequate guidance for protecting scenic quality or moving toward desired conditions over the life of the plan, and therefore, lacks the beneficial effects scenery provides (***S1-6***). The 1987 Forest Plan also contains direction for projects such as recommendations for viewshed corridor plans, which ***are no longer priority or in line with current practice for managing scenery or feasible with current funding***[S18].

The continued use of the visual management system and visual quality objectives in alternative 1 is not consistent with current Forest Service policy for scenery management. The Scenery Management System incorporates considerations for ecological settings and restoration of ecosystem resiliency better than the visual management system, resulting in the least beneficial effects (***S1-6***) in alternative 1.

Effects common to alternatives 2, 3, and 4

The conversion to the Scenery Management System in the action alternatives aligns with current Forest Service policy.

In alternatives 2, 3, and 4, a guideline under Scenic Resources directs that management activities are consistent with SIOs. The SIOs for these alternatives are based on integration with other resources and SMS inventories completed in 2014. Using SIOs developed through the interdisciplinary planning process would help protect and improve scenic quality across the Santa Fe NF with more beneficial effects (***S1-6***) than in alternative 1.

Alternatives 2, 3, and 4 have small proportions of the Santa Fe NF managed for "low" SIOs (3 percent) and no lands managed for "very low" SIO. Therefore, effects related with these SIO (***S13, S14, S15***) are less than in alternative 1. "Moderate" SIO levels are consistent across all alternatives (23 to 24 percent, table 91). This distribution of SIOs would result in more of the forest being managed for more natural-appearing scenic character than alternative 1 with associated effects (***S6-9, S11-12***). This would maintain or improve visitor satisfaction and contribute to a higher quality visitor experience than alternative 1 for those visitors expecting to recreate in natural-appearing scenic character (***S1, S3, S5, S14-S15***).

Alternatives 2 and 4

In addition to Effects Common to All Alternatives and common to alternatives 2, 3, and 4, there are some effects common to alternatives 2 and 4. In these alternatives, the majority of Santa Fe NF lands are managed for "high" SIO (54 and 55 percent, respectively) (table 91). The alternatives also have similar proportions of lands managed for "very high" SIO (19 and 18 percent respectively). These alternatives have the most of the Santa Fe NF managed for natural-appearing landscapes with intact scenic character, with the majority of that land outside of designated or recommended wilderness, and the greatest effects for "very high" and "high" SIOs (***S7, S8, S11, S12***). The amount of high scenic quality, but with ample modifications such as developed recreation sites that can improve the ease and quality of visitor experiences, may provide the best balance between scenic quality and visitor use of the forest (***S11, S12, S14, S15***).

Alternative 3 – Natural Processes Emphasis

In addition to Effects Common to All Alternatives and Common to Alternatives 2, 3, and 4, some effects are unique to alternative 3. In this alternative, the majority of lands are still managed for "high" SIO (46 percent), although there is a greater proportion of lands managed for "very high" SIO (28 percent) with associated effects (***S7***). The effects associated with "very high" SIO would be greatest in this alternative (***S7, S11, S12***). The increased acreage of lands managed for "very high" reflect the increased recommended wilderness management areas in this alternative. Fewer deviations from natural character would occur in alternative 3, resulting in ***more undisturbed scenic vistas***[S19] than other alternatives, but also in the fewest ***recreational amenities and developed areas***[S20].

3.16.4.3 Indicator: Consequences of Multiple Use on Scenic Resources

Effects Common to All Alternatives

Management activities associated with vegetation management (including mechanical treatments and fuels treatments), fire (prescribed and naturally ignited wildfire), energy development (including oil and gas or geothermal), range, recreation facilities, transportation infrastructure and facilities and special uses would impact the existing landscape and have the potential to thereby impact scenic resources. In all alternatives there are standards (1987 Forest Plan) and guidelines (Plan) that specify that management activities would blend in with the natural landscape according to the VMS and SMS systems and would help protect scenic quality with associated effects (***S1-6***).

Management activities affect scenic resources by ***altering the appearance of the natural landscape***[S21] over both the short and long term. In the short term, management activities are usually noticeable after project completion and defined for scenery as contrasts or deviations to the surrounding natural landscape. ***Some activities may have visually dominant effects in the short term, which may be out of step with adopted SIOs***[S22]. ***Activities such as large-scale vegetation management (including mechanical treatments and fire) to restore ecosystem resiliency provide short-term deviations to scenery in the form of stumps and burn scars***[S23]**.**

Although management activities would have some short-term impacts on scenery, they also would begin to move the landscape toward the desired conditions for Scenic Resources over the long term. ***Ultimately this would result in the lasting sustainability of valued scenery attributes, such as clear lakes and streams, vegetative ground cover, large trees, mosaic of conifer forests and aspen or meadows, open mid-story canopy with high visual penetration and vistas with distant views and high topographic relief to name a few*** (Gobster 1994)[S24]. Healthy, fire-resistant vegetation that allows fires to move through the landscape at the appropriate scale, frequency, and intensity allows the systems to recover relatively quickly from fire, which can benefit long-term scenic quality and scenic character with associated effects (***S1-6***). Short-term and long-term would be defined in project-level analyses based on the specific activities proposed. Project mitigation or design would consider scenic resources under any alternative to meet the SIOs. It is assumed that, through site-specific project design or mitigation, the landscape would move toward scenery desired conditions under all alternatives with associated beneficial effects (***S1-6***).

Alternatives 2, 3, and 4

A guideline under Scenic Resources directs mitigating project-level scenery impacts to scenic resources, including minimizing high-intensity wildfire, which would help protect natural settings valued by visitors (***S1-3, S5-6***) more than in alternative 1.

Vegetation Management

Effects common to all alternatives

Vegetation management activities (including mechanical treatments and fuels treatments) would be conducted to improve forest health and resilience to wildfire, disease, and insect infestation, and in time enhance and protect long-term scenic quality. However, these actions also would temporarily impact the existing landscape and scenic resources. Activities including tree removal, depending on the intensity of the treatment, can have varying consequences on scenery. Mechanical treatments could change the character of the landscape where activities occur in the short term. ***Vegetation treatments may have short-term effects of ground disturbance, stumps, and slash***[S25], but in the long term, if mitigated for scenery, may ***provide for some preferred scenic settings, such as visual access into the forest, greater vegetative diversity, larger trees, and an herbaceous ground cover***[S26] (Gobster 1994). In the long term, the removal of some trees, dependent on scale and intensity of treatment, may improve scenic character, as ***thinning makes stands more resilient, which in turn may protect the scenic character of an area and buffer it from detrimental impacts from large-scale disturbance like fire or large insect outbreaks***[S27]. Healthy, fire-resistant vegetation (such as vegetation conditions allowing fires to move through the landscape without doing major damage and that recover relatively quickly from fire) is important for long-term scenic quality and scenic character resilience. ***People often describe feelings of loss due to the noticeable changes in scenic character and sense of place from uncharacteristic large-scale disturbance***[S28]**.** "In general, natural forest disturbances that result in extensive areas of dead or dying trees such as the destruction of the forest by fire or flooding are perceived negatively" (Ryan 2005). Hence, healthy and resilient forest environments that recover relatively quickly would maintain or improve scenic character, which maintains sense of place attachment (***S3***) and opportunities to connect with nature (***S1***). In all alternatives, the effects of these vegetation management activities (***S25-28***) would be most evident in areas with suitable timber, firewood, wildland-urban interface or where ponderosa pine and mixed conifer-frequent fire ERUs are dominant. The following geographic areas also have forested vegetation restoration needs and would have effects to scenery from vegetation management activities: Canadas and Nacimiento, Jemez Mesas and Canyons, North Jemez Mountains, West Sangres, Pecos River Canyon, East Sangres, and Rowe Mesa and Anton Chico.

Alternative 1 – 1987 Forest Plan

The 1987 Forest Plan includes no objectives that direct specific amounts of vegetation treatment, either mechanically or with prescribed fire. Additionally, the 1987 Forest Plan includes no specific plan direction that differentiates between the short-term or long-term scenic effects listed in the effects for all alternatives. The visual resource direction in this alternative requires projects meet retention within one year, which is not always achievable. ***This would make it difficult to implement projects and may reduce the quantity of management activities described above that can be implemented***[S29] ***(S17).*** Fewer vegetation treatments would not help reduce the risk of uncharacteristic wildfire in overstocked stands or frequent fire ERUs and would affect the sustainability of scenic character (***S1-6, S26, S27***) as well as reducing effects to scenery from vegetation treatments (***S25-28***) the most of all alternatives.

Alternative 2 – Forest Plan

Objectives for vegetation treatments in the Forest Plan would improve forest health and resilience to wildfire, disease, and insect infestation, and in time enhance and protect long-term scenic quality (***S24***) and associated beneficial effects (***S1-6***) more than alternative 1.

Vegetation treatments implemented to achieve these objectives would create scenic quality changes in the short term (sometimes ranging from 3 to 5 years) to maintain or improve long-term scenic quality (***S21-27***). The Plan includes a guideline that says there can be short-term impacts inconsistent with SIOs when SIOs are achieved over the long term with associated effects (***S23, S24, S27***). Therefore, the short-term impacts described for each management activity in the Effects Common to All Alternatives section above would be allowed, simplifying the implementation of such projects. Ultimately, the more acres of vegetation treatments that occur, the greater the reduction in the adverse effects that uncharacteristic large-scale disturbance have on scenic quality (***S27, S28***).

Alternative 3 – Natural Processes Emphasis

Alternative 3 would have the least amount of mechanical treatment and the least amount of short-term impacts to scenery resources as described under Effects Common to All Alternatives (***S22, S23, S25***). Conversely, addressing areas of high potential for uncharacteristic large-scale disturbance would be limited to prescribed fire, which is not always practical or safe, therefore the probability of long-term effects from uncharacteristic disturbance may be greater (***S28***).

Alternative 4 – Human Uses Emphasis

Objectives for vegetation treatments in alternative 4 have the greatest acres treated mechanically and therefore would have the most short term effects to scenery resources as described under Effects Common to All Alternatives (***S22,S23,S25***), as well as the greatest potential for reduction of adverse effects related to uncharacteristic large-scale disturbance (***S27, 28***).

Fire (Prescribed and Naturally Ignited Wildfire)

Effects common to all alternatives

Prescribed and managed fire activities would occur under all alternatives. Treatments to restore fire-adapted ecosystems vary and include use of prescribed fire as well as naturally ignited wildfire. ***All fire activities would be evident in the short term with burned, blackened vegetation, and charred ground surfaces***[S30] (***S23***). Grasses and shrubs typically recover quickly, depending on when treatment occurs and moisture conditions during the growing season. ***In the long term, prescribed fire usually increases the diversity of texture, color, vegetative size classes, and distribution across the landscape. In the long term, prescribed fire at lower intensities creates preferred scenic settings and increases sustainability of scenic character***[S31]**.**

In all alternatives, the effects of these fire activities would be most evident in areas with frequent fire systems such as ponderosa pine and dry mixed conifer-frequent fire ERUs are dominant. The following geographic areas also have fire-related restoration needs and would have effects to scenery from fire activities: Canadas and Nacimiento, Jemez Mesas and Canyons, North Jemez Mountains, West Sangres, Pecos River Canyon, East Sangres, and Rowe Mesa and Anton Chico.

Alternative 1 – 1987 Forest Plan

Effects of fire management activities would be similar to those described for alternative 1 under Vegetation Management (***S23-27, S29***) with the least scenic character resilience among alternatives.

Alternative 2 – Forest Plan

Objectives for vegetation treatments in the Forest Plan would improve forest health and resilience to wildfire, disease, and insect infestation, and in time enhance and protect long-term scenic quality as described under Effects Common to All Alternatives (***S30-31***). Effects of fire management activities would be similar to those described for alternative 2 under Vegetation Management.

Alternative 3 – Natural Processes Emphasis

Objectives for alternative 3 would apply the most prescribed fire and naturally ignited wildfires for restoration. Therefore, alternative 3 would have the most short-term and long-term impacts to scenery resources as described under Effects Common to All Alternatives (***S30-S31***).

Alternative 4 – Human Uses Emphasis

Objectives for alternative 4 would apply the fewest acres of managed fire, and thus, the least short-term and long-term impacts to scenery resources as described under Effects Common to All Alternatives (***S30-S31***).

Energy Development

Effects common to all alternatives

There is potential to impact the existing landscape and scenic character from development associated with leasable energy minerals (including oil, natural gas, and geothermal heat sources) under all or some alternatives. Site-specific NEPA analysis precedes leasing, exploration, and development outside the current leasing management. ***Potential impacts of these developments are longer in duration and can include changes to scenic resources from road and pad construction and associated facilities***. ***When activities, such as those currently in the Cuba Ranger District, are scattered across the landscape, borrow colors from the landscape for facilities and sited to blend with the topography of the area, these activities have minimal impact on scenic resources***[S32].

All alternatives include an area in the northwestern part of the Santa Fe NF as mapped in the EIS oil and gas leasing project environmental impact statements. Exploration and development would continue within the area under the appropriate regulations and stipulations to protect resources.

All alternatives include a geothermal leasing management area, partially located within the following geographic areas: Canada and Naciemiento, North Jemez Mountains, and Jemez Mesas and Canyons. This management area includes a standard for no leasing so there would be no consequences for scenic resources.

Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 include the Oil and Gas Leasing Area Management Area, with guidelines minimizing the surface disturbance to protect high SIO areas (***S8, S11, S12***). Potential impacts from these types of activities described above would be evident in the proposed management area and Canada and Naciemiento and North Jemez Mountains Geographic Areas proposed in alternatives 2, 3, and 4 (***S32***).

Range Management

Effects common to all alternatives

Range management would continue under all alternatives. In places with the most range activities, views may include windmills, cattle, cattle trails and waste, stock tanks, fences, and other private ranchland features. Effects of range management can be negative or positive depending on an individual's preferred setting. ***Impacts perceived as negative may include noticeable changes to the landscape when looking at short grazed vegetation, the difference between grazed and ungrazed vegetation at allotment boundaries and fences, cattle waste dominating grasslands and meadows, and trailing around water developments***[S33]. Concentrated livestock trails often occur around water sources or spring developments and may begin to dominate the landscape in foreground views depending on the number of cattle in the allotment and ground vegetation in the area (***S21***). Most range facilities are small and localized, and with some mitigation for scenery, would have minimal effects on or help contribute to, scenic character of the landscape. Many local residents are accustomed to viewing these structures and features and ***consider them a highly-valued part of the traditional landscape. Some visitors may also have an appreciation of the rural or pastoral character of these landscapes***[S34]. For many residents and some visitors, the presence of this activity contributes to the "sense of place" or "cultural identity" of these areas (***S3, S6, S34***), while for others this activity is not viewed as positively (***S33***).

These activities would be most evident in management areas with range emphasis and the East Sangres and Mesa and Anton Chico Geographic Areas. Management direction for range management varies across the alternatives. All alternatives improve the scenic condition by either improving, removing, or reconstructing range infrastructure as needed.

Alternative 1 – 1987 Forest Plan

Alternative 1 focuses on maintaining rangelands and quality range forage, but does not emphasize this in ecosystems where this is sustainable. Scenic resources may be more impacted as described in the Effects Common to All Alternatives (***S33***) since the plan does not emphasize restoration of departed vegetation types.

Alternative 2 – Forest Plan

Restoration of departed vegetation types in alternative 2 would improve grass and forb abundance throughout the forest, providing increased forage for livestock grazing, and decreasing negative impacts described in the Effects Common to All Alternatives section (***S33***). Alternative 2 also emphasizes the improvement or reconstruction of infrastructure, and along with the other range plan components, may provide a balance between both the positive and negative impacts on scenic resources described in the Effects Common to All Alternatives section (***S33, S34***).

Alternative 3 – Natural Processes Emphasis

Potential consequences to scenic resources as described in the Effects Common to All Alternatives section may be less evident in alternative 3, reflecting the alternative's natural processes emphasis and the range plan components (***S33***). Range objectives in alternative 3 propose to remove a percentage of infrastructure that is no longer necessary and would improve the scenic condition for those would do not view range infrastructure positively (***S33***).

Alternative 4 – Human Uses Emphasis

Alternative 4 emphasizes the improvement or reconstruction of infrastructure. Potential consequences to scenic resources as described in the Effects Common to All Alternatives section may be more evident in alternative 4, reflecting the alternative's human uses emphasis (***S33, S34***).

Recreation

Effects common to all alternatives

Recreation activities, both developed and dispersed, would continue for all alternatives. Developments for recreation activities are evident, such as roads, trails, campgrounds, and day use areas (trailheads or picnic areas), and they are appropriate for the ROS setting, which is usually rural or roaded natural. ROS incorporates the naturalness of scenery as one of the variables of the setting characteristics. Facilities may be evident and noticeable, creating a built environment to an otherwise natural environmental setting. ***When facilities are designed to blend with the surrounding landscape, they have minimal effects to scenery***[S35] with other associated effects (***S8***). When best environmental and sustainable design practices are used, facilities can harmonize with the surrounding landscape or enhance and complement the surrounding scenic character. Additionally, recreation facilities that conform to the cultural landscape may have "high" SIO within rural or roaded natural ROS settings with associated effects (***S8, S11, S12)***. The location of facilities affects the surrounding setting because they raise the level of concern for viewing the surrounding scenery by becoming viewing platforms for visitors. ***Unmanaged recreation use or recreation use beyond the designed capacity can cause natural resource damage adjacent to and within recreation sites, roads, and trails, affecting the natural-appearing scenery adjacent to these areas with exposed soils, soil compaction, or erosion, which dominates landscape views***[S36].

These activities are most evident in management areas and geographic areas with recreation emphasis. Geographic areas with the most developed recreation emphasis include: North Jemez Mountains, Jemez Mesas and Canyons, West Sangres, and Pecos River.

Alternative 1 – 1987 Forest Plan

Plan components limit motorized recreation to routes specified on the MVUM and minimize impacts of new and existing trails to riparian zones and wet meadows while trail maintenance gives priority to safety, followed by resource damage and design standards. Although recreation plan components do not emphasize sustainable recreation, it is anticipated that scenery resource conditions described in the Effects Common to All Alternatives section would be maintained (***S35, 36***).

Alternative 2 – Forest Plan

Objectives for alternative 2 include decreasing deferred maintenance at developed recreation sites, conducting trail maintenance, and verifying proper signage. Well-maintained recreation infrastructure maintains or improves scenic resource conditions when facility materials and colors meet SIOs (***S11***). A recreation guideline to close, rehabilitate, or otherwise mitigate dispersed sites when site conditions are no longer consistent with the SIO would improve scenic conditions at dispersed campsites (***S36)***. Recreation plan components for alternative 2 emphasize sustainable recreation, which would maintain or improve scenic resource conditions described in the Effects Common to All Alternatives section (***S35, 36***).

Guidelines for the Cultural Interpretive Management Area and desired conditions for Caja Del Rio Wildlife and Cultural Interpretive Management Area consider recreation use with other resource needs. This reduces natural resource impacts, thereby, reducing potential consequences to scenic resources described above.

Alternative 3 – Natural Processes Emphasis

Consequences for alternative 3 would be similar to those described for alternative 2, with some differences. Alternative 3 has fewer objectives for recreation with a focus on mitigating ecological damages at developed recreation sites. This would improve scenic conditions in areas with ecological damage (***S36***). A recreation guideline for dispersed campsites is similar with the same effects to scenic resources as alternative 2. Although alternative 3 reflects the alternative's natural processes emphasis, potential consequences to scenic resources as described in the Effects Common to All Alternatives section may be more evident because deferred maintenance and trail maintenance are not emphasized (***S35, S36***). Less trail maintenance may impact scenery viewing opportunities from trails.

Guidelines for the Cultural Interpretive Management Area and desired conditions for Caja Del Rio Wildlife and Cultural Interpretive Management Area consider recreation use with other resource needs. Plan components for Holy Ghost Canyon Management Area balance the high recreation use with other resource needs. This reduces natural resource impacts, thereby reducing potential consequences to scenic resources described above.

Alternative 4 – Human Uses Emphasis

Alternative 4 reflects a human uses emphasis. Objectives for alternative 4 include the most deferred maintenance at developed recreation sites and conducting the most trail maintenance among alternatives. These objectives would maintain or improve scenic resource conditions with well-maintained recreation infrastructure that meets SIOs and maintain or improve scenery viewing opportunities from developed and dispersed recreation sites and trails (***S11***). A recreation guideline states that dispersed campsites should not be closed, but should be rehabilitated or otherwise mitigated when site conditions are no longer consistent with the SIO. This would improve scenic conditions at dispersed campsites and continue to provide scenery viewing opportunities from dispersed camping sites (***S35, S36***).

Guidelines for the Cultural Interpretive Management Area and desired conditions for Caja Del Rio Wildlife and Cultural Interpretive Management Area consider recreation use with other resource needs. Plan components for the Motorized Recreation Management Area emphasize a range of motorized recreation opportunities, which can have short-term consequences on scenic resources associated with trail maintenance or construction and long-term benefits for scenery viewing opportunities. Plan components for the West Pecos Management Area balance the natural setting with recreation values, which complements scenery management of this management area.

Transportation Management

Effects common to all alternatives

Road-related activities, such as maintenance or decommissioning, would continue under all alternatives. Road construction would impact scenic resources ***by creating evident contrasts in color and texture and changing landforms for cut and fill slopes***[S37]. Effects of road construction may be dominant in foreground, middleground, and even background distance zones depending on location and design. Roads also serve as the viewer platform, ***offering opportunities and access to view scenery***[S38]. The somewhat modified setting of a viewer platform (road or trail) is accepted as a necessary component allowing travelers to experience the greater landscape (USDA Forest Service 1995, page D-1). Decommissioning of roads ***would create noticeable soil color contrasts in foreground views of the concern level travel routes and use areas, by exposing fresh, often lighter colored, soils during decommissioning activities***[S39]. In the short term, these areas visually recover quickly as the area revegetates (***S21, 22***). In the long term, road decommissioning is typically ***beneficial to scenery resources by recontouring slopes to***

mimic natural landforms and rehabilitating and revegetating exposed soils typically noticeable on cut and fill slopes created during road construction[S40]. Decommissioning of roads may also change the scenery viewing opportunities if the road was open to motorized travel, changing the access for the opportunity from motorized to non-motorized (***S20, S38***). Road maintenance is beneficial for scenic resource viewing by providing access and a platform for viewing scenery from motorized vehicles (***S20, S38***).

Alternative 1 – 1987 Forest Plan

Plan components specify that access (via the road system) balances the need for public access, land management, resource protection, user safety, and cost effectiveness. Guidelines for alternative 1 emphasize reconstruction and rehabilitation of existing roads over new road construction (***S37***). Scenic resources would be maintained or improved as described in the Effects Common to All Alternatives section (***S37-40***).

Alternative 2 – Forest Plan

Objectives for road decommissioning and maintenance are tied to restoration, leaving a manageable system for public and administrative access. Other plan components limit road construction in semi-primitive areas, riparian areas, or where roads impair water quality or have excessive erosion. Scenic resources would be maintained or improved as described in the Effects Common to All Alternatives section (***S37-40***).

Alternative 3 – Natural Processes Emphasis

Plan components would further emphasize road decommissioning to improve ecological conditions including wildlife habitat connectivity, riparian areas, water quality, and soil erosion. Objectives for road maintenance would be diminished, no new roads would be built, although few temporary roads could be allowed. Scenic resources would have more effects described above for road decommissioning and less effects described above for road construction (***S37, S39, S40***). Alternative 3 would have more beneficial effects on scenic quality than other alternatives because of decommissioning more roads ***(S40***).

Alternative 4 – Human Uses Emphasis

Plan components would emphasize road maintenance rather than decommissioning and plan components to consider adding temporary roads to the road system rather than decommissioning. Alternative 4 may increase negative effects on scenic quality because of more road and trail construction as described in the Effects Common to All Alternatives section (***S37***). Alternative 4 may also increase motorized scenery viewing opportunities (***S20, S38***).

Wilderness

Effects common to all alternatives

Management of designated wilderness and maintenance of wilderness characteristics in the recommended wilderness management areas ***would result in landscapes that appear natural, are intact, and generally appear to be unmodified by management activities***[S41] because these lands are managed for “very high” SIO (***S7***). The amount of designated wilderness is the same across all alternatives. All alternatives have plan components for designated wilderness to protect wilderness character, which benefits scenic resources as described above. The amount of recommended wilderness varies by alternative. Vegetation and fuels management activities would be limited to the use of wildland fire and potential effects to scenic resources from wildland fire are discussed above (***S30, 31***).

Alternative 1 – 1987 Forest Plan

Alternative 1 has two areas of recommended wilderness with effects the same as those described for the Effects common to all alternatives section (***S41, S7, S30, S31***).

Alternative 2 – Forest Plan

Alternative 2 has five recommended wilderness management areas: Dark Canyon, White Rock Canyon, Thompson Peak, Enchanted Lakes, and Grace Tract. This would afford additional protection for about 25,793 acres of natural settings and scenic quality (***S7, S41***) in these areas because of restrictions on new development and facilities, which often negatively impact scenic quality

Managing these five areas as recommended wilderness would reduce the ability to implement forest health improvement projects with mechanical treatments in these areas. There would be fewer short-term effects from mechanical treatments (***S25***) and it may take longer to benefit long-term scenic quality and scenic character sustainability and associated effects (***S23, S24, S26, S27, 30, 31***).

Alternative 3 – Natural Processes Emphasis

Alternative 3 would have the most acres in recommended wilderness management area managed for "very high" SIO and would provide the greatest scenic resource protection and maintenance. This would afford additional protection for about 177,037 acres of natural settings and scenic quality (***S7, S41***) in these areas because of restrictions on new development and facilities, which often negatively impact scenic quality.

Managing these areas as recommended wilderness would reduce the ability to implement forest health improvement projects with mechanical treatments in these areas. There would be less short-term effects from mechanical treatments (***S25***) and it may take longer to benefit long-term scenic quality and scenic character sustainability (***S23, S24, S26, S27***). It would increase the use of wildland fire use with associated effects (***S30, S31***).

Alternative 4 – Human Uses Emphasis

Alternative 4 would have no recommended wilderness management areas, and therefore, the fewest acres with "very high" SIO (only in designated wilderness) (***S7***). Although alternative 4 would provide overall lower levels of scenic resource protection when compared to other action alternatives, most of the forest would be managed for "high" and "moderate" SIOs (***S8, S9, S11, S12***).

Special Uses and Facilities

Effects common to all alternatives

Lands special use activities, such as utility and energy corridors, communication sites, cell towers and alternative energy development would continue in all alternatives. Development associated with facilities and special uses would impact scenic resources. ***Structures may not have architectural styles, materials, or colors that blend with the landscape***[S42]. In the short term, ***active construction, vegetative clearing, and other ground-disturbing activities can dominate the landscape***[S43]. Utility and energy transmission corridors, along with communication sites, are generally long-term commitments of NFS lands having high potential to affect scenic resources for a long duration. In the long term, operations and maintenance of permanent structures are usually greatest when these developments occur in very high or high SIO areas, where operations or structures do not borrow from the form, line, color, or texture found in the surrounding landscape (***S7, S8, S42, S43***). Cleared rights-of-way and utility structures contrast highly with the surrounding landscape and often dominate the scenic character. ***Structures with strong vertical***

elements, unnatural colors, synthetic materials, or large scale may especially dominate the characteristic landscape being viewed [S44]. All alternatives would have similar effects from energy corridor rights-of-way and communications sites.

Forest Service administrative and permitted facilities would continue in all alternatives. Development associated with facilities would impact scenic resources (***S42-44***). When facilities including buildings are designed (materials, colors, architectural styles) to blend with the surrounding landscape, they have minimal effects (***S35, S8, S9***) to scenery or contribute to the scenic character and cultural landscape or both with beneficial effects (***S1-6***).

Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 have a desired condition under Special Uses that visual impacts of emerging technology, communication sites, utility corridors, and other authorized infrastructure are minimal as a result of coordination and co-location, and are in harmony with the surrounding landscape. A special uses guideline that would have new power or utility lines buried, would reduce impacts to scenic resources (***S42-44***).

Alternatives 2, 3, and 4 include a guideline under Scenic Resources that would result in facilities that complement and blend with natural landscapes using the concepts of form, line, color, texture and pattern during project planning and design, which would have beneficial effects (***S35, S8, S9, S1-6***). A management approach under Scenic Resources is to consider the Forest Service Built Environment Image Guide in construction or reconstruction of Forest Service facilities. This would reduce scenic impacts of facilities (***S42***) and ensure consistency with the scenic character of the Southwestern Region.

3.16.4.4 Cumulative Effects

The cumulative effects analysis timeframe for scenic resources is the next 10 to 15 years and the area is the Santa Fe NF, the lands adjacent to and lands within the Santa Fe NF under other ownership. Cumulative effects are those consequences of past, present, and foreseeable activities on lands of other ownership that, in conjunction with management activities likely to occur in the Santa Fe NF, may intensify, negate, improve or otherwise affect scenic resources. The Santa Fe shares borders with the Carson NF, the Valles Caldera National Preserve, National Park Service, Bureau of Land Management, State of New Mexico, tribal lands, other municipalities, and private land.

The Carson NF is in the process of revising its forest plan, and plan revision would implement the SMS. Consistent management of scenic resources with the SMS across forest boundaries would be beneficial to scenery in the long term (***S1-6)***.

Bandelier National Monument and Valles Caldera Land Trust (National Park Service) include outstanding scenic resources adjacent to the Santa Fe NF. Bandelier National Monument promotes, preserves, and protects the prehistoric and historic resources and ecosystem processes of the monument. Comprehensive management of the Valles Caldera National Preserve includes the protection and preservation of the scientific, scenic, geologic, watershed, fish, wildlife, historic, cultural and recreational values. With emphasis on preserving and protecting natural resources, including scenic values, it is anticipated that any cumulative consequences would promote natural or natural-appearing scenery (***S1-6, S11, S12***).

Management on some adjacent lands complements the scenery management of the Santa Fe NF including Valles Caldera Land Trust, and lands managed by Bureau of Land Management, which uses a visual resource management system. Counties with open space- or scenery-related language in guiding documents or plans also complements scenery management of the forest across ownership boundaries.

Agencies or municipalities that do not manage for scenery may have noticeable differences in levels of development across boundaries, which could impact the scenic quality in areas such as scenic byways and nationally designated trails.

State of New Mexico manages State Trust Lands to optimize economic benefit for the Trust beneficiaries (including schools, universities, hospitals, and public institutions). While these lands permit public access, they are not managed like other public lands such as national forests or national parks. As these lands are managed, leased, or auctioned, scenic resources may or may not be considered in that action.

Mechanical vegetation treatments may occur on much of the land within the cumulative effects analysis area. This, combined with the types of treatments that may occur in the Santa Fe NF in all alternatives, could result in cumulative effects to scenic resources that should be analyzed in detail during site-specific NEPA environmental analysis. More of the landscape, in the short term, may appear to be moderately to slightly altered until the longer term SIO is achieved (***S21-27***). Also, differing scenery guidance by the managing agencies may result in contrasting landscapes, especially near or along administrative boundaries. For example, one agency may prefer a forested landscape with regularly spaced trees, while another may favor trees in groups or clumps with openings between them.

Since most private lands and other ownerships do not have regulations for scenic resource management, the effects of ongoing developments next to National Forest System lands can sometimes have negative effects on scenic resources when viewing the continuous landscape (***S13, S21***). Forest visitors often view scenery as a continuous landscape with little discernment regarding the land ownership being viewed. Sometimes management activities occurring on ownership boundaries can be quite noticeable if the change in form, line, color, or texture of the activity follows ownership boundaries rather than a natural landscape feature. If activities on private lands are designed to lessen impacts to scenic resources, the difference between private lands and National Forest System lands is less apparent Including scenic or aesthetic resources or open space character in regional, county, and community plans helps promote the management and value of scenic resources across ownership boundaries in the cumulative consequences analysis area.

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