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Final Assessment Report of Ecological/Social/Economic Sustainability Conditions and Trends

Gila National Forest, New Mexico

Forest Service

Gila National Forest

March 2017

Cover Photo: Whitewater Baldy Fire in the Mogollon Mountains by Micah Kiesow

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Final Assessment Report
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Abstract:

The Assessment Report presents and evaluates existing information about relevant ecological, economic, and social conditions, trends, and risks to sustainability and their relationship to the 1986 Gila National Forest Land and Resource Management Plan (forest plan), within the context of the broader landscape.

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List of Commonly Used Acronyms

AAW	Arizona Alder-Willow (ecological response unit)
ACHP	Advisory Council on Historic Preservation
AML	appropriate management level
AOI	annual operation instructions
AP	Apache (local zone)
ARPA	Archaeological Resource Protection Act
ATV	all-terrain vehicles
BASI	best available scientific information
BBER	Bureau of Business and Economic Research
BISON	Biota Information System of New Mexico
BLM	Bureau of Land Management
BMP	best management practice
BR	Black Range (local zone)
CAA	Clean Air Act
CCC	Civilian Conservation Corps
CCF	hundred cubic feet
CCVA	Climate Change Vulnerability Assessment
CDNST	Continental Divide National Scenic Trail
CDT	Continental Divide Trail
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CEQ	Council on Environmental Quality
CFF	cubic Feet
CFR	Code of Federal Regulations
CFRP	Collaborative Forest Restoration Program
CO	carbon monoxide
CPCC	Comprehensive Plan for Colfax County
CPGB	Colorado Plateau-Great Basin Grassland (ecological response unit)
CPM	coarse particulate matter
CS	context scale
CSP	concentrating solar power
CWCS	Comprehensive Wildlife Conservation Strategy
CWD	coarse woody debris
CWPP	County Wildfire Protection Plan
DEIS	draft environmental impact statement
DI	distribution index
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DW	Desert Willow (ecological response unit)
EA	environmental assessment
EIS	environmental impact statement
EO	Executive Order
EPA	Environmental Protection Agency
ERU	ecological response unit
ESA	Endangered Species Act
FAR	Functioning at Risk
FCI	facility condition index
FCO	Fremont Cottonwood-Oak (ecological response unit)

FCS	Fremont Cottonwood-Shrub (ecological response unit)
FEIS	final environmental impact statement
FIA	Forest Inventory and Analysis
FIDO	Forest Inventory Data Online
FOIA	Freedom of Information Act
FP	Functioning Properly
FPM	fine particulate matter
FRCC	fire regime condition class
FRI	fire rotation interval
FSH	Forest Service Handbook
FSM	Forest Service Manual
FVS	Forest Vegetation Simulator
FWS	Fish Wildlife Service
FY	fiscal year
GCM	Global Circulation Model
GIS	geographical information system
GMU	game management unit
GNF	Gila National Forest
HBI	Hilsenhoff Biotic Index
HM	head month
HUC	Hydrologic Unit Code
IBA	Important Bird Area
IF	Impaired Function
ILAP	Integrated Lands Assessment Project
IMPROVE	Interagency Monitoring of Protected Visual Environments
IRA	inventoried roadless area
JUG	Juniper-Grass (ecological response unit)
Kg/ha	kilograms per hectare
LAR	Land Area of the National Forest System Report
LCSAF	Little Colorado-San Agustin Fringe (local zone)
LG	Lower Gila (local zone)
LS	local scale
LSRS	Land Status Records System
MBGR	motorized big game retrieval
MCD	Mixed Conifer-Frequent Fire (ecological response unit)
MDC	motorized dispersed camping
MCW	Mixed Conifer with Aspen (ecological response unit)
MDN	Mercury Deposition Network
MF	Mogollon Front (local zone)
MIS	management indicator species
ML	maintenance level
MMCF	million cubic feet
MMS	Mountain Mahogany Mixed Shrubland (ecological response unit)
MOU	memorandum of understanding
MPO	Madrean Piñon-Oak (ecological response unit)
MSG	Montane Subalpine Grassland (ecological response unit)
MTBS	monitoring trends in burn severity records
MVUM	motor vehicle use map
NAAQS	national ambient air quality standards

NADP	National Atmospheric Deposition Program
NAGPRA	Native American Graves Protection Act
NCS	Narrowleaf Cottonwood-Shrub (ecological response unit)
n.d.	no date
NEI	National Emission Inventory
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NFS	National Forest System
NFSR	National Forest System road
NFST	National Forest System trail
NHD	National Hydrography Dataset
NHPA	National Historic Preservation Act
NM	New Mexico
NMAAQS	New Mexico ambient air quality standards
NMBCC	New Mexico Biodiversity Collection Consortium
NMCHAT	New Mexico Crucial Habitat Assessment Tool
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMED-AQB	New Mexico Environment Department, Air Quality Bureau
NMOCD	New Mexico Oil Conservation Division
NMOSE	New Mexico Office of the State Engineer
NMRPTC	New Mexico Rare Plants Technical Council
NO	nitrogen dioxide
NOA	notice of availability
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRHP	National Register of Historic Places
NRV	natural range of variation
NTN	National Trends Network
NVUM	national visitor use monitoring
NWI	National Wetland Inventory
O	ozone
OHV	off-highway vehicle
OML	operational maintenance level
ONRW	outstanding natural resource water
ORV	off-road vehicle
Pb	lead
PFC	proper functioning condition
PHA	priority heritage asset
PILT	payment in lieu of taxes
P.L.	Public Law
PJC	Piñon-Juniper-Evergreen Shrub (ecological response unit)
PJG	Piñon-Juniper Grass (ecological response unit)
PJO	Piñon-Juniper Woodland (ecological response unit)
PM	particulate matter
PNC	potential natural community
PPE	Ponderosa Pine-Evergreen (ecological response unit)
PPF	Ponderosa Pine Forest (ecological response unit)

PPW	Ponderosa Pine-Willow (ecological response unit)
PS	plan scale
PSD	Prevention of Significant Deterioration
PV	photovoltaic
RAD	Risk Assessment Database
RASES	Riparian Area Survey and Evaluation System
RD	Ranger District
RGCT	Rio Grande cutthroat trout
RHR	Regional Haze Rule
RMAP	Riparian Map
RMP	Resource Management Plan (Bureau of Land Management document)
RNA	research natural area
ROD	record of decision
ROS	Recreation Opportunity Spectrum
SCC	species of conservation concern
SCS	Soil Conservation Service
SDG	Semi-desert Grassland (ecological response unit)
SEINet	Southwest Environmental Information Network
SFC	Sycamore-Fremont Cottonwood (ecological response unit)
SFF	Spruce-Fir Forest (ecological response unit)
SHPO	State Historic Preservation Office
SIP	state implementation plan
SMS	Scenic Management System
SO2	sulfur dioxide
SRS	Secure Rural Schools
SYFMA	Sustained Yield Forest Management Act
TAP	travel analysis process
TCP	traditional cultural properties
TES	Terrestrial Ecosystem Survey
TEU	terrestrial ecosystem unit
TMR	Travel Management Rule
UG	Upper Gila (local zone)
UMCW	Upper Montane Conifer-Willow (riparian ecological response unit)
U.S.C.	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	US Geological Survey
UTV	utility terrain vehicle
VDDT	Vegetation Dynamics Development Tool
VOC	volatile organic compounds
VQO	visual quality objective
WPA	Works Program Administration
WQCC	Water Quality Control Commission
WRAP	Western Regional Air Partnership
WRAPTSS	Western Regional Air Partnership Technical Support System
WSA	wilderness study area
WTA	Willow-Thinleaf Alder (riparian ecological response unit)
WUI	wildland-urban interface
YCC	Youth Conservation Corps

Introduction to the Assessment

Purpose

The Gila National Forest is in the process of revising a land and resource management plan that has been in place since 1986. The 2012 Planning Rule (36 CFR 219) provides the framework to create local land management plans for national forests and grasslands across the nation. The rule establishes an ongoing, three-phase process: 1) assessment; 2) plan development or revision; and 3) implementation and monitoring.

The 2012 Planning Rule is intended to create a plan that guides resource management on the Gila National Forest within the context of the broader landscape. It takes an integrated and holistic approach that recognizes the interdependence of ecological, social, cultural and economic systems. Collaboration with stakeholders and process transparency are key components of this approach.

This document represents the assessment phase of the process. It is designed to rapidly evaluate information about ecological, economic and social conditions, trends, and sustainability relative to the 15 assessment topics listed in 36 CFR 219.6(b), and their relationships to the current land management plan. The approach uses the best available scientific information and local knowledge to inform the process. This assessment report is not a decision making document, but provides current information on assessment topics. The conditions and trends found in the assessment report will help to identify the current Forest Plan’s need for change, and aid in the development of the revised plan. The revised Gila National Forest’s Land and Resource Management Plan, also known as the Forest Plan, will consider a full range of multiple uses.

Throughout this document, the Gila National Forest is referred to as “Gila NF”, the “Forest”, or the “plan area”. The Gila National Forest Land and Resource Management Plan (USDA FS Gila NF 1986) is referred to as the “Gila NF Plan” or “Forest Plan”.

This introductory chapter includes an Ecosystem Services Framework section that describes how the ecological, social, cultural and economic assessments are interrelated and dependent on one another to provide for multiple use and sustained yield. An explanation of what is considered to be the best available scientific information follows. The Public Participation and Tribal Engagement sections describe the variety of ways the Gila NF has interacted with tribes and stakeholders in the early stages of the forest plan revision process. The Consideration of Existing Plans section identifies governmental or non-governmental land and resource management plans containing information relevant to the Gila NF Plan assessment and revision.

The Setting and Distinctive Features describes the physical characteristics and setting of the Forest, and its place within the broader landscape.

Section I. Ecological Integrity and Sustainability examines the conditions, trends and risks to integrity and sustainability for the five ecological resource areas identified in the 2012 Planning Rule (36 CFR 219.6(b)). Within this section, an ecological assessment of upland vegetation, soils, carbon, air, water, riparian, aquatic and at-risk species is conducted to understand current conditions and trends. These assessments conclude with an evaluation of risk for loss of integrity and sustainability which forms the basis for determining whether or not there is a need for change in the current Forest Plan to change management direction.

Section II. Social, Economic and Cultural Sustainability assesses conditions, trends and risks to sustainability for the ten social, cultural and economic based topic areas identified in the 2012 Planning Rule (36 CFR 219.6(b)). It assesses the goods and services obtained from the Gila NF which provide social, economic and cultural benefits to people and communities. It considers the current condition of the goods and/or services, drivers or stressors affecting demand or availability, the current ecological condition and trend of the resource(s) providing the goods and/or services, and the relationship between on and off Forest conditions. Each chapter concludes by identifying issues of concern, or risks that may prevent the sustainability of the goods and/or service, which forms the basis for determining whether or not there is a need for change in the current Forest Plan to change management direction.

Ecological integrity and sustainability on the Gila NF, and the Forest's ability to contribute to social, cultural and economic conditions are intricately connected and interdependent. Because of this connection and interdependence, there is considerable cross-referencing between chapters. References can be found toward the end of the report.

Forest Setting and Distinctive Features

The Gila NF lies in southern Catron, northern Grant, western Sierra and extreme northeastern Hidalgo counties in southwestern New Mexico. It was established in 1899 and covers approximately 3.3 million acres of public land, making it the sixth largest National Forest in the continental United State. Twenty four percent of the Forest area is composed of the Gila, Aldo Leopold and Blue Range Wildernesses. The Gila Wilderness was administratively established in 1924 by the U.S. federal government as the first designated wilderness. The Aldo and Blue Range Wildernesses were later established in 1980. The Forest Supervisor's office is located in Silver City, New Mexico with six ranger district offices in Glenwood, Mimbres, Quemado, Reserve, Silver City and Truth or Consequences. Figure 1 provides a vicinity map.

The Forest has 12 mountain ranges and an elevational range of 4,160 to 10,770 feet. Annual precipitation ranges from approximately 11 inches on the northern end of the Forest near Quemado and on the very southern end of the Black Range to over 35 inches in the higher elevations of the Black Range and Mogollon Mountains. The Forest includes semi-desert grasslands and shrublands, woodlands, ponderosa pine, mixed conifer and spruce-fir life zones. Major streams include the Mimbres River, the Gila River and its tributary the San Francisco River.

The Forest provides habitat for elk, deer, pronghorn, bighorn sheep, javelina, coatimundi, turkey, bear and mountain lion and many other wildlife species. Habitats across the Forest also support many endangered, threatened or candidate species such as Gila trout, spikedace, loach minnow, Chiricahua leopard frog, southwestern willow flycatcher, Mexican gray wolf, Mexican spotted owl and others.

The Forest has a rich cultural history with archaeological resources reflecting a 13,000 year occupational time period. At present, the Catron, Grant, Hidalgo and Sierra Counties are home to just over 50,000 people, who rely on the Forest to varying degrees as a source of sustenance. This has manifested through various means ranging from utilizing the natural resources on the Forest for livelihood; creating community synergy around issues and events; offering a place for groups to commune, work, and recreate together; to providing solitude, peace, and relaxation for individuals who want to get away from the social pressures and pace of their everyday world. While ways and means may have changed over time, people enjoy all manner of activities on the Forest. Firewood gathering is an important traditional activity as many local residents still rely on wood to heat their homes during the cold winter months. Permitted livestock grazing, hunting and outfitting and guiding are also long-standing traditions. The Forest also provides outdoor recreational activities for both area residents and tourists. Forest management continues to bring communities together over issues that affect them or to foster involvement through volunteer work on their favorite part of the Forest. All of these uses help maintain social cultures and longstanding traditions.

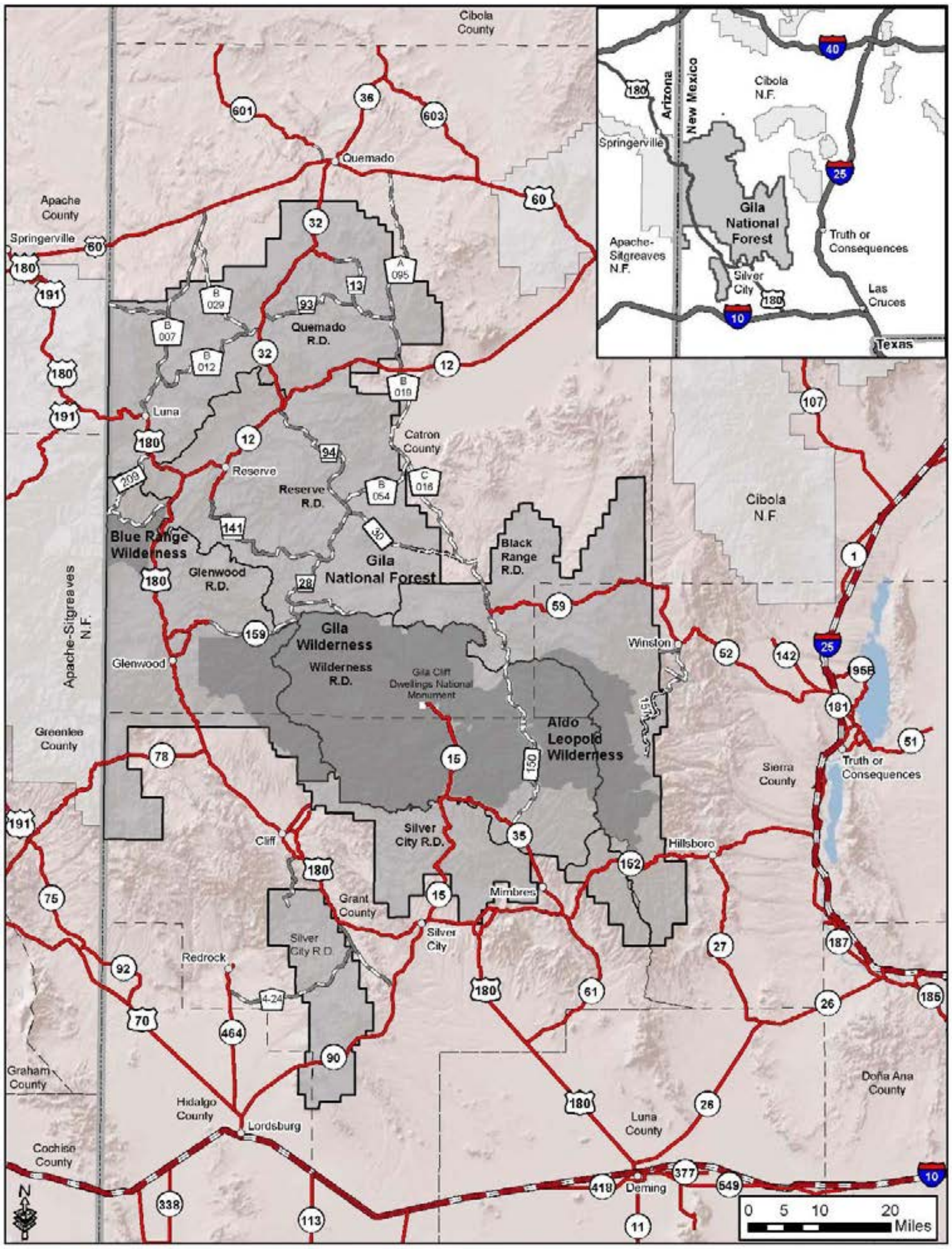

Figure 1. Location of the Gila National Forest.

Ecosystem Services Framework

Ecosystem services are a product of functioning ecosystems that affect social, cultural and economic conditions. They are the goods and services that people enjoy or benefit from, including but not limited to scenic views, fish and wildlife, recreation opportunities, food, forage, fiber, fuel, energy, clean water, timber, carbon storage, flood control, and disease regulation. The Millennium Ecosystem Assessment (MEA 2005) has served as the motivation for applying the ecosystem services concept to national forest and grassland management. Ecosystem services are grouped into four broad categories:

- Supporting ecosystem services are those that are necessary for the production of other ecosystem services, such as pollination, seed dispersal, soil formation and nutrient cycling.
- Regulating ecosystem services are the benefits people obtain from the regulation of ecosystem processes. Climate regulation, water filtration and purification, soil stabilization, flood control, and disease regulation are a few examples.
- Provisioning ecosystem services are the products people obtain from ecosystems, such as clean air, fresh water, energy, food, fuel, forage, wood products and minerals.
- Cultural ecosystem services are the nonmaterial benefits people obtain from ecosystems such as educational, aesthetic, spiritual and cultural heritage values, and recreational experiences.

Management of the ecological systems on the Gila NF will influence its ability to support some ecosystem services. For example, a regulating service such as flood control, can have important consequences both within and beyond the plan area. Ecosystem services that are important within the broader landscape and are likely to be influenced by the land management plan are the focus of the assessment and ultimately, plan revision (FSH 1909.12, Chap. 10, Sec. 13.12). Use of the ecosystem services concept and analysis of ecosystem services are integrated throughout the assessment.

Best Available Scientific Information

The assessment is based on the best available scientific information (BASI) that has been determined to be accurate, reliable, and relevant to the issues being considered (FSH 1909.12, Chap. 0, Sec. 07). Throughout the assessment process, relevant ecological, social, and economic scientific information was identified, documented, and evaluated to form a basis for the development of plan components and other plan information. The Gila NF has provided opportunities for public and governmental participation, inviting submission of information, including scientific information that may be relevant to the planning process.

The scientific information determined to be the BASI is identified throughout this assessment. How the BASI was used to inform the assessment is discussed as each issue is considered. A list of references is provided at the end of the report. Among the scientific information that may be considered the BASI are:

- Peer reviewed articles
- Scientific assessments
- Other scientific information, including, expert opinion, panel consensus, inventories, and observational data
- Data prepared and managed by the Forest Service or other federal agencies. This information may include monitoring results, information in spatially referenced databases, data about the lands and resources of the plan area, and various types of statistical or observational data.
- Scientific information prepared by universities, national networks, and other reputable scientific organizations

- Data or information from public and governmental participation (FSH 1909.12, Chap. 0, Sec. 07.13)

Not all scientific information is the BASI (FSH 1909.12, Chap. 0, Sec. 07.12). The BASI was determined according to the following three criteria:

1. **Accurate.** To be accurate, the scientific information must estimate, identify, or describe the true condition of its subject matter. This description of the true conditions may be a measurement of specific conditions, a description of operating behaviors (physical, biological, social, or economic), or an estimation of trends. Statistically accurate information is near to the true value of its subject, quantitatively unbiased, and free of error in its methods. The extent to which scientific information is accurate depends on the relationship of the scientific findings to supportable evidence that identifies the relative accuracy or uncertainty of those findings. The accuracy of scientific information can be more easily evaluated if reliable statistical or other scientific methods have been used to establish the accuracy or uncertainty of any findings relevant to the planning process.

2. **Reliable.** Reliability reflects how appropriately the scientific methods have been applied and how consistent the resulting information is with established scientific principles. The scientific information is more reliable if it results from an appropriate study design and well-developed scientific methods that are clearly described. The assumptions, analytical techniques, and conclusions are well referenced with citations to relevant, credible literature, and other pertinent existing information. Conclusions are based on reasonable assumptions that are supported by other studies and are consistent with the general theory underlying those assumptions or are logically and reasonably derived from the data presented. Any gaps in information and inconsistencies with other pertinent scientific information are adequately explained.

   Scientific information that describes statistical or other scientific methods used to determine both its accuracy and uncertainty can be considered more reliable. The use of quantitative analysis that has known (and quantifiable) rates of errors and results improves this reliability. An accuracy assessment of the data supports the reliability of the quantitative analysis.

   The application of quality control to the scientific information also improves the reliability of the information. One form of quality control is peer review when scientific information has been critically reviewed by qualified scientific experts in that discipline and the criticism provided by the experts has been addressed by the proponents of the information. Publication in a refereed scientific journal usually indicates that the information has been appropriately peer reviewed.

3. **Relevant.** The information must pertain to the issues under consideration at spatial and temporal scales appropriate to the plan area and to a land management plan. Relevance in the assessment phase is scientific information that is relevant to providing information, including conditions and trends, about the 15 topics in 36 CFR 219(b) or to the sustainability of social, economic, or ecological systems (36 CFR 36 219.5(a)(1)). Relevance in the planning phase is scientific information pertinent to the plan area or issues being considered for the development of plan components or other plan content. (FSH 1909.12, Chap. 0, Sec. 07.12)

The BASI is not always a single source of scientific information that is “best” for a specific subject. When scientific consensus does not exist, the BASI may be from multiple sources and may recognize conflicting scientific information (FSH 1909.12, Chap. 0, Sec. 07.12).

Public Participation

Public participation in the planning process began prior to the May 2015 publication of a Public Notice in the Federal Register that marked the official start of the assessment. Briefings were provided to Catron, Grant, Hidalgo and Sierra County Commissions in 2015. A series of community conversations were held in March 2015 at Quemado, Reserve, Glenwood, Silver City, Mimbres and Truth or Consequences. The desired outcomes of these conversations were to introduce forest plan revision, identify expectations, opportunities and methods for communication and engagement, and build or enhance relationships between the Gila NF and its stakeholders. A Gila NF representative also attended a public meeting hosted by the Lincoln National Forest in Las Cruces in March 2015.

These initial conversations were facilitated by the National Collaboration Cadre. The Cadre is a network of people from around the United States who provide coaching and training assistance to national forests and their communities who are interested in understanding, developing and improving collaborative processes. Cadre members' experience range from Forest Service staff in all types of positions; local municipal and county government, both elected and staff; non-profit regional associations; to academics and project consultants. All members have worked for and/or with the Forest Service at varying points in their careers and from different perspectives.

Participants shared ideas, concerns, facts and dates related to the Gila NF that were significant to their communities and important for the Gila NF staff to be aware of through an exercise known as the Generations Wall. This exercise helped create an open dialog and provided the Gila NF staff a better understanding of local perspectives on national, regional and local Forest Service management history, values, current conditions, trends, threats and future desired conditions as they relate to the Gila NF and its communities. Expectations related to communication and engagement in the revision process were discussed in small groups including the expectations participants have of the Gila NF, expectations the Gila NF has of stakeholders, and the expectations stakeholders have of each other. Participants were asked to identify the best ways to engage them and their communities in the plan revision process and the preferred methods of sharing information and keeping people informed. They were also asked to identify any individuals or groups that were not in attendance or not represented and how those connections might be made. The information shared during these meetings were used to develop the Forest's Pubic Participation Strategy. The Public Participation Strategy and summaries of these conversations are available on the Gila NF's Plan Revision webpage at http://go.usa.gov/h88k.

After March 2015, the Gila NF presented on plan revision at 35 governmental and organizational meetings at the request of those self-convening groups. Informational booths at over 15 special events such as county fairs have been an ongoing way to share materials summarizing the plan revision process. On-line and interactive classroom sessions to engage Grant County youth and educators were conducted by Dr. Kathy Whiteman of Western New Mexico University. Input gathered from youth and educators revealed that existing designated areas, at-risk species, air, soil, water, ecosystems and ecosystem processes were considered the most important assessment topics. Fire damage, poor trail maintenance, human impact, and off-road vehicle use were areas of concern. Education, public involvement and partnerships were identified as opportunities to promote the best possible future outcomes of plan revision. Whiteman's report is included as Appendix F to the Assessment Input document on the Gila NF's Plan Revision webpage.

Another round of public meetings at the same locations was held in August 2015 to gather input for the assessment phase of plan revision. These meetings were facilitated by Karen Yori from Blue Earth Ecological Consultants, Inc. based in Santa Fe, NM. Participants were provided an overview of the assessment process, including the 15 topics identified in the 2012 Planning Rule and were asked two questions:

1) For the assessment topics that are most important to you, what current conditions and trends have you seen on the Gila?
2) What are your concerns associated with the conditions and trends you mentioned, and what may be some of the opportunities in those areas?

Opportunities were also provided for stakeholders to share knowledge, plans, and data for the assessment. These meeting materials and questions also went out in emails or written letters to stakeholders on the Gila NF's plan revision contact list that were not able to attend any of the meetings. The input gathered at these meetings and received via email or written response is available on the Gila NF's Plan Revision webpage in the document titled "Assessment Input" (USDA FS Gila NF 2015a). It is also used in the development of parts of the ecological, and social, cultural and economic sections of the assessment including a section devoted to stakeholder input in most chapters. These summaries build on the March 2015 conversations, describing how stakeholders value and use the Forest, how they understand Forest Service management and how they see the Gila NF of the future. Where there is broad agreement between stakeholder perspectives and assessment findings, there is confidence in moving forward. Whereas disagreement between stakeholder perspectives and assessment findings indicate potential opportunities for additional dialogue.

In February 2016, the Gila NF and the Southwestern Regional Office participated in the 6th Natural History of the Gila Symposium hosted by Western New Mexico University. A notice and invitation were sent out to the entire Forest plan revision contact list. Ecological assessment data and analysis approaches were presented, including: an overview of forest plan revision, the analysis framework, state and transition modeling, vegetation, soil, water, at-risk species and a history of insects and disease.

The Forest released the draft assessment report in September 2016 and draft need-for-change document in October 2016 to the public and other stakeholders for feedback. A need-for-change paints a picture of the strategic changes in current management direction necessary to address issues identified by the assessment report. Community meetings were held in communities surrounding the Forest (including Las Cruces) in late October to early November 2016 to discuss assessment key findings, collaborate to determine needs-for-change to the current plan, and continue the dialogue between the Forest and nearby residents, users, and interested individuals. Meeting materials were posted online to provide an opportunity for people that couldn't attend the meetings to be able to view the posters capturing some of the highlights from the assessment, and to contribute by providing feedback on draft assessment findings and needs-for-change to the existing 1986 Forest Plan. The Forest received 78 emails, letters, and forms providing feedback on the draft assessment report and need-for-change document, which were all considered as the Gila NF revised and finalized the documents.

The final needs-for-change will be summarized in the Federal Register in early 2017 along with a notice of intent to develop a revised forest plan. These needs-for-change statements provide focus for the second phase of planning – the development of the revised plan – where plan components are created to help ensure management meets desired conditions for each resource.

Tribal Engagement

The Gila National Forest maintains a governmental relationship with ten federally recognized Indian tribes, also directly contacting specific bands within those tribes that live nearby. All of these groups have been contacted by mail and by phone in regards to Forest Plan Revision. Face-to-face consultation has occurred with four tribes so far during the assessment phase. We hope that as the Forest Plan Revision process progresses that we will have substantive conversations with all ten tribes, developing a growing understanding of their vision of how we can best partner with them and how this landscape should best be managed into the future.

Topics of conversation with tribes during this phase covered a range of topics. Tribes discussed concerns about climate change, the importance of forest restoration, and an appreciation of recent travel management efforts, which hopefully reduce resource degradation and habitat fragmentation. There was some discussion of hunting and gathering on-Forest. Cultural resource management issues discussed included: research interests and concerns, and opportunities for tribal involvement in interpretation of cultural sites for Forest visitors. Another major topic was opportunities for tribal youth to be exposed to the traditional lands that are now part of the Gila National Forest, either through educational activities (on the ground or virtual), through working with other researchers, or as employees. Other Forests have solicited the tribes regarding their concerns and interests in forest management; comments they have received have reflected similar concerns and interests. Specific comments have been received by other Forests about concerns over increased development, impacts to resources from off-road travel, the environmental and cultural impacts of mining, chemical treatments of native plants, and protection of agave. We anticipate continued tribal involvement throughout the plan revision process and anticipate that the revised plan will emphasize mutually beneficial relationships between the Forest and Tribes.

Consideration of Existing Plans

The Gila NF will consider relevant, existing plans when developing the revised plan to look for opportunities to increase compatibility and reduce conflict. Plans and plan assessments identified for consideration include, but are not limited to:

- Catron, Grant, Hidalgo and Sierra County Master Plans
- Cities of Lordsburg, Truth or Consequences, and Town of Silver City Comprehensive Plans
- New Mexico Department of Game and Fish Comprehensive Wildlife Conservation Strategy
- New Mexico Draft State Wildlife Action Plan
- New Mexico Statewide Fisheries Management Plan
- U.S. Fish and Wildlife Service Recovery Plans
- New Mexico State Implementation Plan (Air Quality)
- New Mexico Forest and Watershed Health Plan
- New Mexico Statewide Natural Resources Assessment & Strategy and Response Plan
- Socorro-Sierra and Southwest New Mexico Regional Water Plans
- New Mexico State Water Plan
- New Mexico Statewide Water Quality Management Plan and Nonpoint Source Management Plan
- Soil and Water Conservation District Plans
- Bureau of Land Management Resource Management Plans
- Community Wildfire Protection Plans
- New Mexico Statewide Outdoor Recreation Plan
- Silver City Greenways Trail Master Plan
- New Mexico Department of Transportation Long Range Transportation Plan
- Other National Forests’ Land and Resource Management Plans and Plan Revisions

Section I: Ecological Integrity and Sustainability

Cloud in San Francisco Box by Micah Kiesow

Chapter 1. Ecological Integrity and Sustainability

Introduction

An ecosystem is a spatially explicit, relatively homogeneous unit of the Earth that includes all inter-acting organisms and elements of the abiotic environment within its boundaries (36 CFR 219.19). Ecosystem or ecological integrity is the quality or condition of an ecosystem, when its dominant ecological characteristics (e.g., composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand or recover from disturbances imposed by natural environmental dynamics or human influence. Ecosystem sustainability is the capability of an ecosystem to maintain ecological integrity and meet the needs of the present generation, without compromising the ability to meet their needs of future generations (36 CFR 219.19).

Structure of the Ecological Section

This introductory chapter defines and describes the general concepts and approach to the ecological assessment outlined in the Forest Service directives that accompany the 2012 Planning Rule including: key ecosystem characteristics; reference conditions, departure and trend; risk to ecological integrity and sustainability; system drivers and stressors; and spatial scales of analysis. The Ecological Response Unit (ERU) framework developed and employed by the Forest Service Southwestern Region and stakeholder input relevant to the general approach to assessing ecological integrity and sustainability is also presented. After the introductory chapter, the section proceeds with the assessment of key ecosystem characteristics relative to upland vegetation, baseline carbon stocks, upland soils, air, water, riparian, aquatic and at-risk species (i.e. resource areas). Each resource area chapter describes: ecosystem services; the data and analysis approach, including disclosure of assumptions, limitations and uncertainty; reference and current conditions, and trends related to key ecosystem characteristics; pertinent system drivers and stressors; evaluation of risk related to each characteristic; and stakeholder input received during the assessment. The structure of each of these chapters varies to accommodate the data, analysis methods and requirements of the 2012 planning rule and directives. Following the resource area chapters is a chapter describing the reference, historic and current system drivers and stressors, and their ecological effects and influence on departure, trend and risk associated with key ecosystem characteristics.

Key Ecosystem Characteristics

Ecological integrity is a relatively simple concept to define, but more difficult in practice to assess. Ecosystem characteristics are specific components of ecological conditions that sustain ecological integrity (FSH 1909.12, Chap. 10). A key ecosystem characteristic describes the composition, structure, connectivity, and/or function of an ecosystem. Key ecosystem characteristics are identified and evaluated for each ecosystem, but not all possible characteristics of ecosystems are identified or evaluated. Only those characteristics needed to provide the conditions necessary to maintain or restore the ecological integrity of terrestrial, aquatic, and riparian ecosystems in the plan area are considered (36 CFR 219.8). A limited suite of characteristics are selected to assess ecological integrity based on whether or not the characteristic is relevant and/or needed to assess other characteristics (e.g. at-risk species and habitat), and if information is readily available.

Reference Conditions, Departure and Trend

In order to manage the ecosystems of today, it is helpful to know as much as possible about past ecosystem conditions (Moore et al. 1999; Friederici 2004) and the processes that supported those conditions. Such conditions were not unchanging, but were sustained across what has been called a “natural range of variability” (NRV) (Falk 1990; Landres et al. 1999), alternately referred to as the “historic range of variability" (HRV). The NRV is part of the definition of ecological integrity (FSH 1909.12, zero code, sec. 05).

According to Schussman and Smith (2006a; 2006b), NRV is a description of change over time and space in the ecological condition of an ecosystem type, and the ecological processes that shape those types. The final Forest Service directives that accompany the 2012 Planning Rule define NRV as those conditions that pre-date European settlement as it is sufficiently long enough to include the full range of variation produced by dominant natural disturbance regimes such as fire and flooding, as well as short-term variation and cycles in climate (FSH 1909.12, zero code, sec. 05). Furthermore, the directives specify NRV as the preferred ecological reference model upon which to assess current conditions and ecological integrity (FSH 1909.12, Chap. 10, sec. 12.14). . The NRV concept is supported in the scientific literature (Dillon et al. 2005; Winthers et al. 2005, Weins et al. 2012, among others).

Where the characteristic or the data describing it do not lend themselves to the NRV approach to reference conditions, alternative approaches to defining the reference condition may be used based on the current understanding of conditions that would sustain ecological integrity (FSH 1909.12, Chap. 10, Sec. 12.14b). Those alternative reference conditions are described in the chapter in which they are used.

The comparison between reference and current conditions is used to determine the degree of departure and whether the trend is away or toward reference. Departure measures the degree to which the current condition of a key ecosystem characteristic is similar or dissimilar to the reference condition. When departure can be quantified, it is rated in this assessment on a scale from 0 to 100 percent, where 0 to 33 percent is considered "low" and within NRV, 34 to 66 percent is considered "moderate" departure from NRV, and 67-100 percent is considered "high" departure from NRV. Trends are a projection of future conditions under current disturbance and management activities, and may be described as "toward reference", "away from reference", or "static". In many cases, trends cannot be identified given the nature of the data.

The NRV or alternate approach to reference conditions are tools for assessing ecological integrity but do not necessarily constitute a management target or desired condition (FSH 1909.12, Chap. 10, sec. 12.14a,) although they may potentially help identify ecological characteristics for the maintenance, restoration and monitoring of ecosystems. In some ecosystems and/or for some key characteristics, it may not be either possible, feasible, sustainable, or desirable to return to NRV given the ecological changes that have occurred due to past management or are expected to occur with climate change. Desired conditions and management targets will be developed during the next phase of plan revision when the revised plan is developed and National Environmental Policy Act (NEPA) analysis is conducted. Development of desired conditions will be a collaborative effort involving the Gila NF staff, other federal agencies, state and local governments, non-governmental organizations and other interested and/or affected communities and individuals.

System Drivers and Stressors

System drivers are factors or processes that act on ecosystem characteristics and contribute to the natural or historic range of variability in conditions. Examples include natural vegetation succession, predominant climatic regime, and broad-scale disturbance regimes such as wildfire, flooding and insects and disease. Stressors are natural or human caused alterations in system drivers that may directly or indirectly threaten ecological integrity and sustainability. Examples include invasive species, altered fire regimes, and climate change. Examining system drivers and stressors across the reference and current time periods provides the "why" to the departure and trend analysis and informs the preliminary ecological need for change.

Management actions may act as system drivers or stressors, or both, depending on the ecosystem characteristic(s), site conditions, and the timing, frequency, duration, intensity, and extent of those actions. These actions may include but are not limited to: timber harvest, prescribed fire, permitted livestock grazing, water developments, seeding, and road construction. In some cases, past management policies and practices that are no longer in place (i.e. historic fire suppression and overgrazing) remain stressors to the present day because of the alterations to ecological processes that resulted. These alterations are referred to as legacies of past management.

The System Drivers and Stressors Chapter 9 is dedicated to this topic and is referred to throughout this section. Drivers and stressors that may exist but are not included in that chapter are identified and discussed relative to the specific characteristic(s) to which they apply.

Assessing Risk to Ecological Integrity and Sustainability

Risk is defined by the likelihood and severity of a negative ecological outcome. Ecological risk is the product of departure, trends and stressors (threats). The purpose of this assessment is to document whether or not the ecological resource characteristics analyzed are at ecological risk or not, and explore contributing factors. Risk is assessed on NFS lands, as it relates to systems and processes that are under agency control and/or authority. However, to understand risk to those lands, systems, and processes, they are assessed in the context of the larger landscape to the extent possible.

Risk is assessed for each ecosystem characteristic by weighing current departure from reference conditions against trend for that resource using a decision matrix. The matrix used to determine risk varies by characteristic, available data and the method of analysis. Table 1 provides an example of a decision matrix.

Table 1. Example of a decision matrix to assess Ecological Response Unit (ERU) risk

Current ERU Departure from Reference Condition	ERU Trend after 100 Years (departure from Reference Condition)		
	toward Reference Condition (> 5% change)	static, neither toward nor away (± 5% change)	away from Reference Condition (> 5% change)
significant departure (34 - 100%)	risk addressed; continue current management	potential risk due to legacy of past management or deviation due to ongoing activities	potential for high risk
non-significant departure (0 - 33%)	no risk; continue current management	no risk; continue current management	potential risk

Individual ecosystem characteristic risk assessments are conducted at multiple spatial scales. The “moderate” (34 to 66%) and “high” (67 to 100%) departure classes are outside of NRV, are uncharacteristic for the system and considered significant in terms of risk. Where there is significant risk, there is an ecological need for change. Risk can be mitigated if the characteristic is within agency authority and control or influence, and the trend and condition can be improved or reversed.

Spatial Scales of Analysis

Spatial scales to be considered in the analysis by topic should: 1) be sufficiently large to adequately address the interrelationships between conditions in the Gila NF and the broader landscape, but not so large that these interrelationships lose relevance in guiding land management planning; and 2) consider the extent to which ecological attributes of the broader landscape support, or are supported by, conditions in the Gila NF. The area of analysis for the assessment should also be large enough to capture: 1) characteristics (composition, structure, function, and connectivity) and geographic scale of relevant ecosystems; 2) fire and other forms or patterns of disturbance; 3) landform patterns or landtype associations; and 4) plant, animal, species, or community distribution and abundance (FSH 1909.12, Chap. 10). In addition, the area of analysis should also be large enough to capture broad-scale trends and encompass the natural range of variation in disturbance intensity, frequency, and areal extent. For most characteristics, it is possible and valuable to consider multiple scales for the assessment.

This assessment utilizes three spatial scales: context, plan and local. Context scale is needed to put the Forest's conditions in perspective with the surrounding landscape, including lands beyond the Forest boundary, and is necessary for determining the opportunities or limitation of the Gila NF to contribute to the sustainability of broader ecological systems. In some instances, a unique role or "spatial niche" of the Gila NF may become apparent at this scale. Context scale analysis can also identify impacts of the broader landscape on the sustainability of resources within the plan area (FSH 1909.12, Chap. 10).

Plan scale displays general current conditions and trends across the Gila NF. This scale drives the ecological need for change. Local scale subdivides the plan scale to identify any patterns that could inform priority setting.

The upland vegetation portion of the ecological assessment uses the ecoregion sections and subsections of the National Hierarchical Framework of Ecological Units (ECOMAP, 1993; Cleland et al., 1997)[1] for the context scale, the Gila NF for the plan scale and local units within the Forest delineated based on a rule set guiding the aggregation of watersheds. This rule set is included as Appendix A.

Water and air resource data and analysis do not lend themselves well to the ECOMAP delineations and instead, use watersheds and airsheds. The water analysis uses subbasins (4th level watersheds) for context scale analysis and watersheds and subwatersheds (5th and 6th level watersheds) for plan scale analysis. The local scale analysis uses the same units described above. The air analysis identifies a single relevant airshed. These spatial scales are described in more detail in those chapters.

Ecological Response Unit Framework

The assessment of terrestrial and riparian ecosystems and at-risk species, including key habitat, vegetation and soil characteristics, is stratified using the Ecological Response Unit (ERU) classification system. This system was developed and is employed by the USFS Southwestern Region (R3) to facilitate landscape scale analysis and planning. The ERU framework represents all major ecological types of R3 and represent a stratification of biophysical themes, similar to LANDFIRE biophysical settings. ERUs are map unit constructs that combine themes of site potential, historic disturbance regimes, and natural succession (USDA FS 2015a). Site potential is a term used to describe the characteristic ecological conditions at the latest successional state, resulting from interactions among climate, soil, and vegetation.

While the ERU map is ultimately a remote sensing product, on Forest Service lands the Terrestrial Ecological Unit Inventory (TEUI), formerly known as the Terrestrial Ecosystem Survey (TES), is the foundational dataset for ERU mapping. This includes data from the Gila NF's draft TEUI. The TEUI maps relationships between climate, soil and vegetation and is described in more detail in the Chapter 4: Soil.

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[1] Ecoregions are ecosystems of regional extent. Using the National Hierarchical Framework of Ecological Units (ECOMAP, 1993; Cleland et al., 1997) an analysis of the landscapes surrounding the Gila NF was completed using the ecological section and subsection units. This broad-scale analysis was done to set the context for the contributions the Gila NF makes to ecological sustainability. As described by Bailey (1980, 1983, 1985, 1998), ecoregions distinguish areas that share common climatic and vegetation characteristics (Cleland et al., 1997). Ecoregions are subdivided into provinces, which are controlled primarily by continental weather patterns such as length of dry season and duration of cold temperatures. Provinces are also characterized by similar soils. Sections are a subdivision of provinces, described by broad areas of similar subregional climate, geomorphic process, geology, geologic origin, topography, and drainage networks. Such areas are often inferred by relating geologic maps to potential natural vegetation "series" groupings such as those mapped by Küchler (1964). Ecological subsections are a further division of sections, and described by areas with similar surface geology, geomorphic process, soil groups, subregional climate, and potential natural vegetation communities (McNab and Avers, 1994). Because subsections are smaller in size they are more useful in planning at a smaller scale.

Data from the Southwest Biotic Communities, Integrated Landscape Assessment Project (ILAP), Regional Riparian Mapping Project (RMAP), climate gradient analysis and neighbor analysis corrections, as well as collaboration with the Universities of Arizona and New Mexico were also important in developing the ERU map (USDA FS 2015a).

Each ERU concept is supported by the best available science describing its distribution, dominant plant species, natural disturbances, seral state proportions, coarse woody debris and snags per acres, fire regime, and patch size under reference conditions (USDA FS 2015a). The Gila NF contains 14 upland ERUs that make up approximately 98 percent of the Forest and 12 riparian ERUs that make approximately two percent of the Forest. These ERUs and the percentage of the Forest they represent are displayed in the following table.

Table 2. Ecological Response Units of the Gila National Forest

Ecological Response Unit	Percentage of Gila NF
Forests	
Ponderosa Pine Forest (PPF)	19
Mixed Conifer-Frequent Fire Forest (MCD)	12
Ponderosa Pine-Evergreen Oak Forest (PPE)	12
Mixed Conifer w/ Aspen Forest (MCW)	2
Spruce-Fir Forest (SFF)	1
Woodlands	
Piñon-Juniper Woodland (PJO)	26
Piñon-Juniper Grass Woodland (PJG)	9
Juniper-Grass Woodland (JUG)	4
Madrean Piñon-Oak Woodland (MPO)	1
Piñon-Juniper/Evergreen Shrub Woodland (PJC)	1
Shrublands	
Mountain Mahogany Mixed Shrubland	5
Grasslands	
Montane/Subalpine Grasslands (MSG)	4
Colorado Plateau/Great Basin Grasslands (CPGB)	3
Semi-desert Grassland (SDG)	2
Riparian	
Fremont Cottonwood/Oak (FCO)	0.003
Fremont Cottonwood/Shrub (FCS)	0.06
Narrowleaf Cottonwood/Shrub (NCS)	0.7
Sycamore-Fremont Cottonwood (SFC)	0.2
Desert Willow (DW)	0.3
Arizona Alder-Willow (AAW)	0.1
Upper Montane/Conifer-Willow (UMCW)	0.02
Willow-Thinleaf Alder (WTA)	0.03
Ponderosa Pine/Willow (PPW)	0.03
Herbaceous/Wetland Riparian (HWR)	0.001
Arizona Walnut (AW)	0.0004

Stakeholder Input Received

Stakeholder input was received with respect to the assessment of ecological integrity and sustainability after the release of the draft assessment report. A few comments received were related to the use of pre-European settlement conditions as a point of reference and differentiating management activities as system drivers or stressors, or both. The perception is that this approach creates a false separation between humans, the environment and ecological processes, and fosters the impression of a negative relationship between humans and ecological integrity. Furthermore, the assertion is that ecological change is a constant and using a pre-European baseline is a “faulty foundation” on which to base future land management planning and does not foster integrated resource management.

Chapter 2. Upland Vegetation

Introduction

This chapter describes and assesses the vegetation component of terrestrial ecosystems within the Ecological Response Unit (ERU) framework described in Chapter 1: Ecological Integrity and Sustainability. Riparian ERUs are assessed in Chapter 7. Upland ERUs are grouped into forest, woodland, shrubland and grassland types as follows:

- Forest ERUs
    - Spruce-Fir Forest (SFF)
    - Mixed Conifer with Aspen (MCW)
    - Mixed Conifer-Frequent Fire (MCD)
    - Ponderosa Pine Forest (PPF)
    - Ponderosa Pine-Evergreen Oak (PPO)
- Woodland ERUs
    - Madrean Piñon-Oak Woodland (MPO)
    - Piñon-Juniper/Evergreen Shrub (PJC)
    - Piñon-Juniper Woodland (PJO)
    - Piñon-Juniper Grass (PJG)
    - Juniper Grass (JUG)
- Shrubland ERU
    - Mountain Mahogany Mixed Shrubland (MMS)
- Grassland ERUs
    - Montane/Subapline Grasslands (MSG)
    - Colorado Plateau/Great Basin Grassland (CPGB)
    - Semi-desert Grassland (SDG)

First, the ecosystem services of upland vegetation are described, followed by a review of the spatial analysis scales and a discussion of how they are used in the analyses presented in this chapter. Subsequently, key ecosystem characteristics are defined and described in terms of their importance, data and methods used to analyze them. These characteristics are:

- Seral state proportion
- Patch Size
- Coarse woody debris
- Snag density
- Fire regime
- Insects and disease

After the key characteristics, data and analysis methods section, system drivers and stressors are identified and discussed before a general description of each ERU and its respective analysis results and interpretations are presented. The chapter concludes with an assessment of risk, a chapter summary, and a summary of stakeholder input received during the assessment.

Ecosystem Services of Upland Vegetation

The diverse upland vegetation across the Gila NF provides many supporting, regulating, provisioning and cultural ecosystem services. Vegetative biodiversity supports and reflects the biodiversity in animal life that has co-evolved with various plant forms over time. Habitat for wildlife is an important supporting role of vegetation communities. The genetic variation inherent in vegetative biodiversity provides a regulatory service of system resilience through adaptive vegetation responses to an ever-changing environment, including climate changes. Soil formation and nutrient cycling are supported by vegetation. Vegetation is the most influential biotic driver of soil formation and the unique ability of plants to create food from the energy of the sun through the process of photosynthesis is the foundational support for nutrient cycling services. Regulatory services provided by vegetation include water cycling and filtration, erosion control and climate regulation. Vegetation moderates the passage of water across landscapes to mitigate floods and assists in holding soils in place so they can provide water filtration. Without soil, which is retained in part by the interlocking roots of many plants, clean water would be unattainable in the natural environment. Through evapo-transpiration, plants contribute to water cycling by pulling water up from the ground and releasing it into the air; this moisture contributes significantly to the Southwest’s summer monsoon storms. Vegetation provides shade that can mitigate increases in ambient temperature. Climate regulation is significant in the maintenance of many organisms, especially those that are immobile.

Since plants take in carbon dioxide and release oxygen as a byproduct of their respiratory process, they provide breathable air as a provisioning service. Forage, traditional foods and medicines, fuel and wood products are also provisioning services provided by the vegetation of the Gila NF. Cultural ecosystem services are provided by vegetation types and plant species across the forest as they contribute to aesthetics, support cultural values and provide opportunities for education, research, recreation, and tourism.

Scales of Analysis

Recall from Chapter 1: Ecological Integrity and Sustainability that the assessment generally utilizes three scales: context, plan and local. This chapter utilizes the cluster of ecoregional subsections (Cleland et al. 1997)[2] that surround the Forest as the context scale. The plan scale of analysis is defined by the Gila NF administrative boundary. The local scale of analysis breaks the plan scale into six local units delineated based on a rule set guiding the aggregation of watersheds (Appendix A). These local units are named Apache, Black Range, Little Colorado-San Agustin Fringe, Lower Gila River, Mogollon Front, and Upper Gila River. All scales of analysis, and their relationship with one another is displayed below in Figure 2.

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[2] As described by Baile (1980, 1983, 1985, 1998), ecoregions distingues areas that share common climatic and vegetation characteristics (Cleland et al. 1997). Ecogregions are subdivided into provinces based on continental weather patterns and similarly scaled soil characteristics. Sections are a subdivision of provinces, described by broad areas of similar subregional climate, geomorphic process, geology, geologic origin, topography, and drainage networks. Such areas are often inferred by relating geologic maps to potential natural vegetation such as those mapped by Küchler (1964). Ecological subsections are a further division of sections and described by areas with similar surface geology, geomorphic process, soil groups, subreagional climate and potential natural vegetation communities (McNab and Avers 1994). Because subsections are smaller in size, they are more useful for the purposes of this assessment.

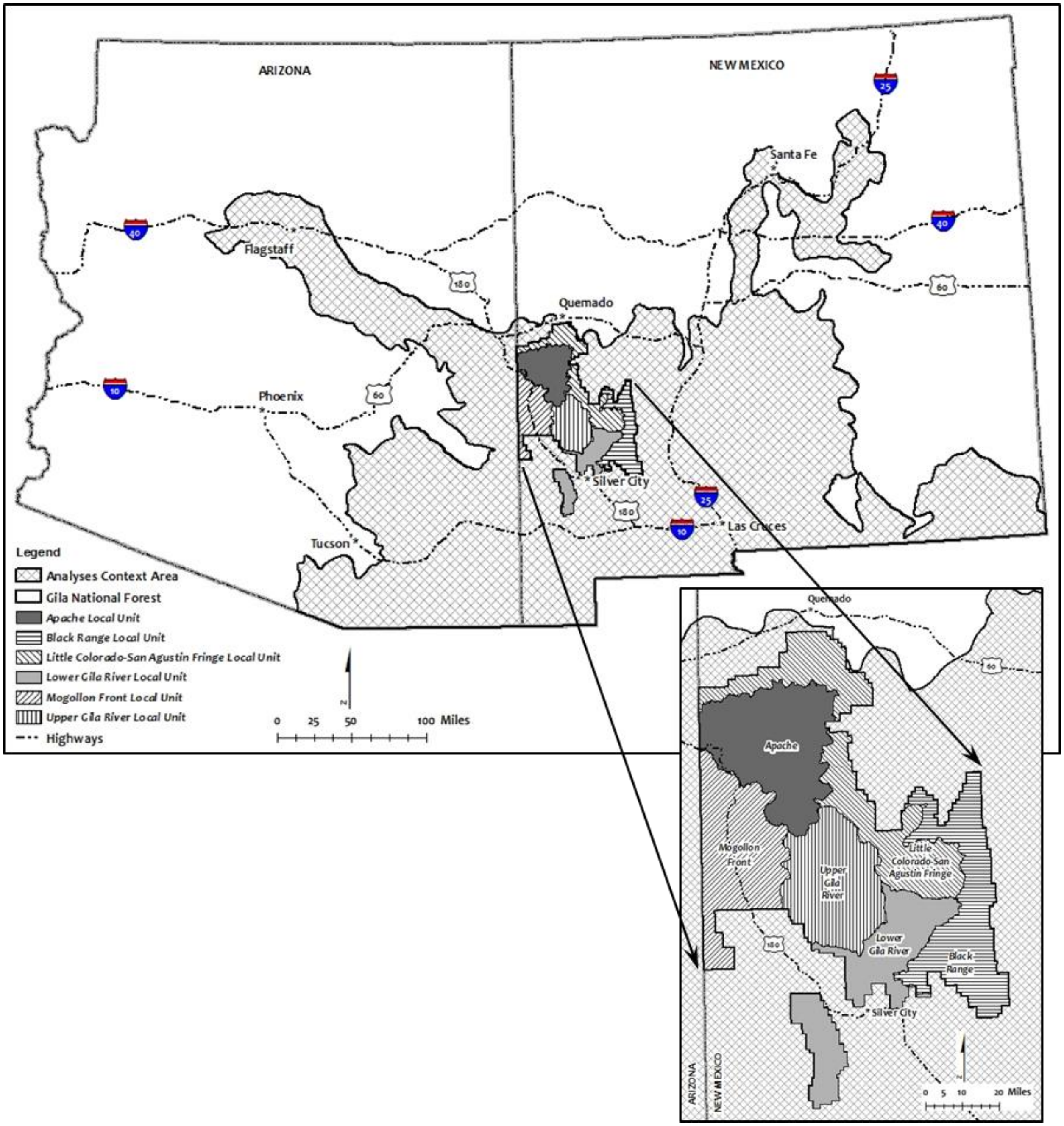

Figure 2. Relationship of the six local scale units within the Gila NF (plan scale); the Forest's relationship to the context scale area; and the context area's location within in Arizona and New Mexico

The plan scale is used to describe departure and risk to ecological integrity and sustainability potentially arising from management under the current (1986) Forest Plan. Local units are used to identify any patterns within the Forest that could inform priority setting. With respect to the local units, Table 3 displays the size of each and the distribution (number and amount) of each upland ERU contained within.

Table 3. Gila NF's upland ERU acreage distribution at the local unit scale

Gila NF Upland ERUs	Gila NF Local Units												Gila NF
	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	
Forests													
PPF	219,333	34.8	62,032	9.8	197,615	31.4	28,408	4.5	32,647	5.2	90,245	14.3	630,280
MCD	48,327	12.2	100,020	25.2	70,947	17.9	30,165	7.6	60,984	15.4	85,801	21.7	396,244
PPE	87,665	23.2	54,123	14.3	56,971	15.1	70,161	18.6	36,037	9.5	73,199	19.4	378,156
MCW	5,098	6.9	17,936	24.3	2,719	3.7	3,089	4.2	19,073	25.8	26,019	35.2	73,934
SFF	22	0.1	630	2.6	0	0.0	0	0.0	8,710	36.6	14,417	60.6	23,779
Woodlands													
PJO	97,007	11.4	260,351	30.7	111,055	13.1	191,213	22.5	146,107	17.2	42,707	5.0	848,440
PJG	65,676	22.5	13,225	4.5	93,597	32.1	33,158	11.4	54,838	18.8	31,155	10.7	291,649
JUG	422	0.4	0	0.0	0	0.0	39,759	34.8	65,898	57.6	8,317	7.3	114,396
MPO	855	4.9	252	1.5	869	5.0	0	0.0	13,794	79.5	1,591	9.2	17,361
PJC	909	8.5	2,100	19.7	1,449	13.6	17	0.2	6,203	58.1	0	0.0	10,678
Shrubland													
MMS	1,946	1.2	20,577	12.4	151	0.1	45,624	27.4	32,225	19.4	65,965	39.6	166,488
Grasslands													
MSG	20,028	17.6	6,835	6.0	37,045	32.6	0	0.0	137	0.1	49,740	43.7	113,785
CPGB	31,992	35.9	214	0.2	38,759	43.5	3,505	3.9	12815	14.4	1,901	2.1	89,186
SDG	6,424	11.5	1,747	3.1	2,896	5.2	14,982	26.8	28,231	50.4	1,708	3.1	55,988
Total	585,704	18.2	540,042	16.8	614,073	19.1	460,081	14.3	517,699	16.1	492,765	15.3	3,210,364

The Little Colorado-San Agustin Fringe local unit is the largest at 625,221 acres, while the Lower Gila River local unit is the smallest at 487,382 acres. Both the Apache and Mogollon Front local units contain all 14 upland ERUs, while the LGR local unit contains the least at 11 ERUs. Nine upland ERUs (PPF, MCD, PPE, MCW, PJO, PJG, MMS, CPGB and SDG) are represented in all local units; while SFF and JUG only occur in four of the six local units. The remaining upland ERUs (MPO, PJC and MSG) occur somewhere in between.

With regard to the context area, the Gila NF is located within the Arizona-New Mexico Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow Ecoregion Province (M313) (McNab and Avers 1994; McNab et al. 2005, 2007); the analysis context area for the Gila NF is defined as the combined area of the White Mountains-San Francisco Peaks-Mogollon Rim (M313A), Sacramento-Manzano Mountains (M313B) Ecoregion Sections, and the Chihuahuan Semi-Desert Ecoregion Province's Basin and Range (321A) Ecoregion Section. These ecoregion sections are displayed below in Figure 3. Detailed descriptions of each ecoregion section are provided by McNab and Avers (1994) and McNab and other (2005, 2007).

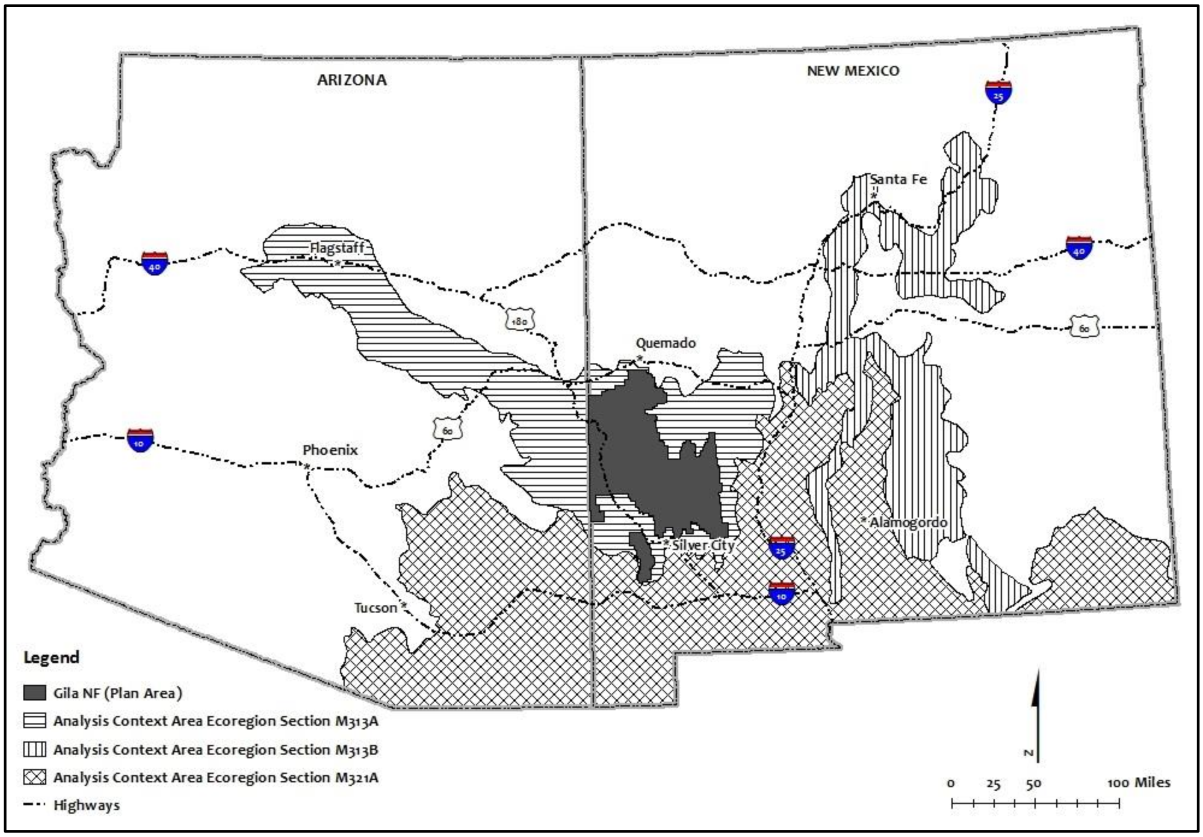

Figure 3. Gila NF in relation to the analysis context area, of the White Mountains-San Francisco Peaks-Mogollon Rim (M313A), Sacramento-Manzano Mountains (M313B), and Basin and Range (321A) Ecoregion Sections within Arizona and New Mexico

Table 4 presents the relationship, in acres, of the Gila NF to the total analysis context area. Overall, the three ecoregion sections total nearly 47 million acres. The Gila NF occupies seven percent of these total acres. The remaining 93 percent of the lands within the ecoregion sections are owned or managed by a diversity of entities; including the Apache-Sitgreaves, Coconino, Coronado, Kaibab, Lincoln, Prescott and Tonto National Forests, the states of Arizona and New Mexico, Bureau of Land Management, Bureau of Reclamation, Department of Defense, National Park Service, Fish and Wildlife Service, White Mountain, San Carlos and Mescalero Apache Nations, and numerous private organizations and citizens.

Table 4. Land area, in acres, of the Gila NF (GNF) in relation to the analysis context area (CA) of the three ecoregion sections

Context Area Ecoregion Sections	Context Area Section Acres	Context Area on-GNF			Context Area off-GNF	
		acres	% of GNF	% of CA	acres	% of CA
M313A-White Mountains-San Francisco Peaks-Mogollon Rim Ecoregion Section	13,475,094	3,210,302	> 99	24.3	10,264,792	75.7
M313B-Sacramento-Monzano Mountains Ecoregion Section	8,614,390	0	0.0	0.0	8,614,390	100
321A-Basin and Range Ecoregion Section	24,843,240	62	< 1	< 1	24,843,178	> 99
Total	46,932,724	3,210,364	100	7.0	43,722,360	93.0

Table 5 presents the relationship, in acres and percentages of the upland ERUs occurring on the Gila NF and within the context area.

Table 5. Area of Gila NF upland ERUs both on and off-Forest within the context area

Gila NF Upland ERUs	Total ERU Area on Gila NF		Total ERU Area within Context Area	
	acres	% of Gila NF	acres	% of Context Area
Forests				
PPF	630,280	19.3	3,805,078	8.1
MCD	396,244	12.1	1,174,058	2.5
PPE	378,156	11.6	622,820	1.3
MCW	73,934	2.3	399,406	0.9
SFF	23,779	0.7	177,491	0.4
Woodlands				
PJO	848,440	25.9	2,585,904	5.5
PJG	291,649	8.9	1,411,018	3.0
JUG	114,396	3.5	3,703,181	7.9
MPO	17,361	0.5	902,219	1.9
PJC	10,678	0.3	401,552	0.9
Shrubland				
MMS	166,488	5.1	356,451	0.8
Grasslands				
MSG	113,785	3.5	379,720	0.8
CPGB	89,186	2.7	2,804,141	6.0
SDG	55,988	1.7	16,091,824	34.3

While the focus of this chapter is on the analysis of key upland vegetation characteristics at the plan scale and local scales, an attempt is made to identify the Forest's opportunities and limitations to contribute to the sustainability of those upland Ecological Response Units (ERUs) managed by the Gila NF. This is done, in part, by comparing the quantity and spatial extent of those ERUs within the Forest's administrative boundary to the quantity and spatial extent of those ERUs with the context area. This comparison is hereafter referred to as the "spatial niche" analysis.

Spatial Niche

The spatial niche analysis relates the Gila NF to its surroundings, in this case, the context area landscape. As mentioned above, the spatial niche of a given ERU is dependent on the relative spatial distribution of an ERU, but also considers the relative spatial distribution of seral state proportion departure from reference conditions within that ERU. The purpose of the spatial niche analysis is to develop an understanding of the extent to which the ecological attributes of the broader landscape support, or are supported by, conditions in the plan area (FHS 1909.12, Chap 10, sec. 11.1); in other words, the purpose of the spatial niche analysis is to aid in the description of the opportunities and limitations of the Gila NF to contribute to ecological sustainability within the context area landscape. It does not, however, drive the ecological need for change to the current Forest Plan. Those needs are driven by the plan scale analysis.

With respect to spatial distribution, there must be enough of the ERU on the Forest that it may serve an important ecological role, and enough that its condition can be accurately assessed. The Gila NF's contribution to ecological integrity also depends on the percent of the context landscape occupied by the ERU and the relative proportional representation of the ERU on-Forest to off-Forest. Abundance on the landscape and proportional representation at the plan scale can be combined into a single variable that defines the opportunity for the Forest (plan scale) to influence context scale conditions. Relative Proportional Representation (RPR) is calculated using the following formula: *RPR = ((% of GNF - % of context area)/(% of GNF + % of context area))*. A value of 0 indicates the percent of the forest covered by an ERU is the same as the percent of the context area covered by that ERU; positive values indicate the ERU proportion of the forest is greater than the ERU proportion of the context area, (ERU is greater on forest); and negative values indicate the ERU proportion of the context area is greater than the ERU proportion of the forest (ERU is greater in context area)

Opportunity for influence is represented in Figure 4. Along the diagonal axis, increasing toward the upper right corner, where ERUs are more common in the plan area than in the context landscape, but are rare overall. Higher opportunity for influence means that the sustainability of the system at the context scale is more sensitive to conditions at the plan scale, and the Gila NF has a unique role in restoring or maintaining integrity when possible.

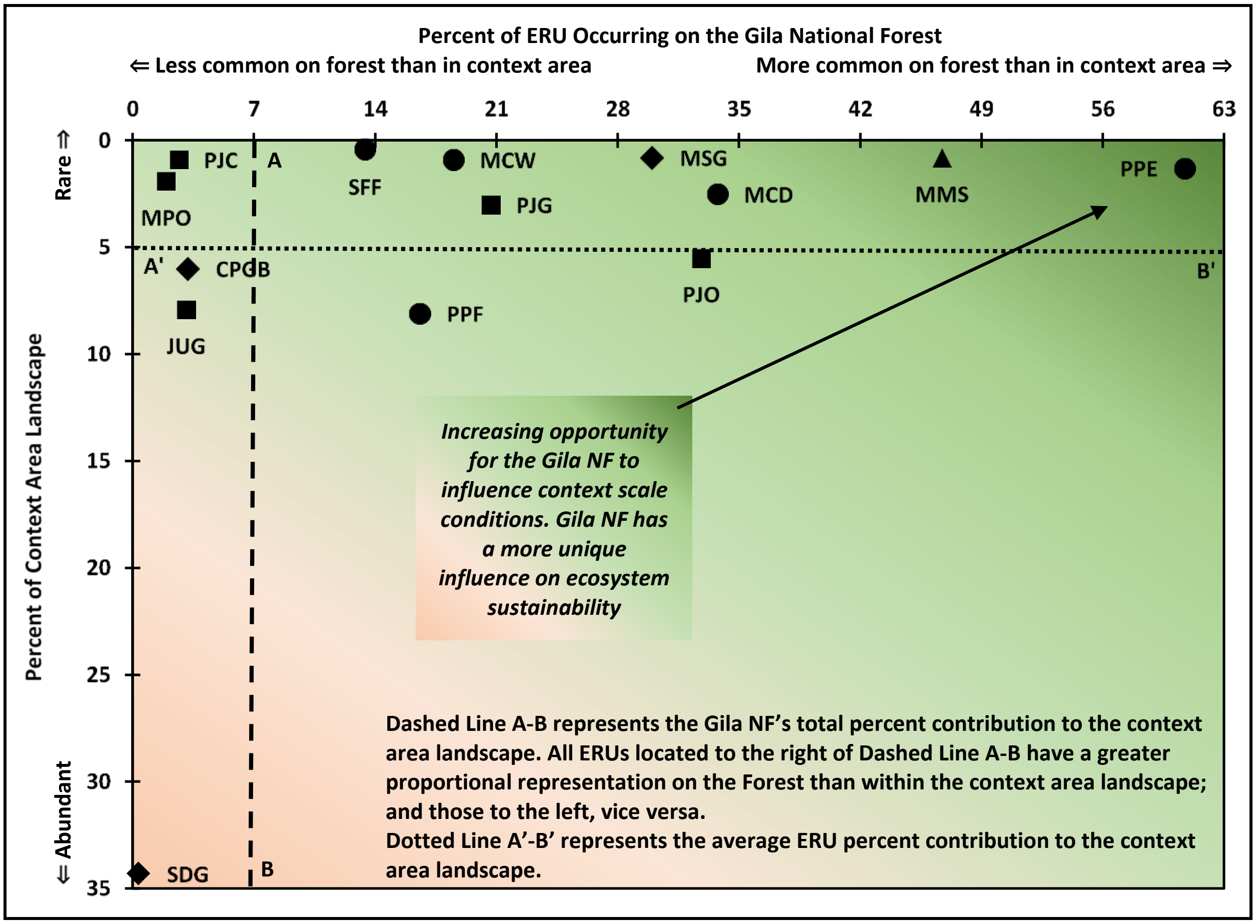

Figure 4. Gila NF's opportunity to influence ecosystem sustainability and integrity within the context area landscape.

For example, the Gila NF has a unique role in the sustainability of the ponderosa pine/evergreen oak (PPE) and spruce-fir forest (SFF) ERUs. PPE is slightly more common at the context scale than SFF, but a majority of the PPE ERU occurs on the Gila NF. SFF is more proportionally distributed on- and off-Forest, but is very rare overall. Thus, the small amount of SFF that occurs on the Gila NF may significantly influence the context area scale. The role of the plan area on the sustainability of ERUs like juniper grass (JUG) and semi-desert grassland (SDG) is not unique, since these ERUs are more common outside the Gila NF. While the Gila NF may influence conditions of these ERUs, the opportunity for influence is not unique, but can be many places in the context landscape. The Gila NF may have less opportunity to influence context scale conditions in any of the ERUs to the left of Dashed Line A-B.

Finally, moderate or high seral state departure suggests the loss of ecological integrity and risk in a system. The distribution of that departure defines the Gila NF's role in addressing risk. This results in three potential spatial niche interpretations that can occur alone, or in combination:

1. The Gila NF can have a greater influence on the integrity and sustainability of ERUs that are more common on the Forest, either because they are generally rare or simply because they are more common on the Forest.

2. ERUs with greater seral state departure are of greater concern because ecological integrity may already be low.

3. Where ERUs have less seral state departure on the Forest than in the context scale, the Forest may provide an important refuge supporting system sustainability regardless of the quantity of the ERU located on Forest.

The results of the seral state proportion and spatial niche analyses are presented and discussed relative to each ERU later in this chapter.

Key Ecosystem Characteristics, Data and Analysis Methods

Seral State Proportion

This characteristic describes the proportion of a given ERU in each seral state. Seral states are relatively transitory plant communities that develop during natural vegetation succession. Seral states may vary in species composition and structure. Seral state proportion is assessed at the context, plan and local scales using the Vegetation Dynamics Development Tool (VDDT) (ESSA 2006, 2007) state-and-transition model and models developed by LANDFIRE (various dates), the Nature Conservancy (Schussman and Gori 2006) and the Integrated Landscape Assessment Project (ILAP) dataset (Hemstrom et al. 2012), refined by the Southwestern Regional Office with input from Forest specialists. Comparison between the context and plan scale analyses of this characteristic also informs spatial niche analyses.

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 (overstory composition, structure and cover), models can be developed that define transitions among phases. These "state-and-transition" models can be built and adapted so that the dynamics of the system reflect NRV, and the resulting distribution among state classes represents the ERU reference condition (Weisz et al. 2009)[3]. Reference conditions describing this characteristic are based on a review of the best available scientific information by the USFS Southwestern Regional Office (USDA FS 2015a). ERU summary tables are footnoted with specific reference condition sources, where applicable.

The VDDT state and transition models both define seral states for each ERU and allow comparison among management scenarios. Most state transition destinations and probabilities are derived from Forest Vegetation Simulator (FVS) modeling (Dixon 2002). Burn severity information is compiled from Monitoring Trends in Burn Severity (MTBS 2014) records (Eidenshink et al. 2007; Bhattarai et al. 2012; WFLC 2014), and Rapid Assessment of Vegetation Condition after Wildfire (RAVG) data (USDA FS 2015b). Other inputs came directly from Forest management actions, insect and disease surveys, and wildfire data from the past 18 years (1996-2014).

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[3] Also see example in Ryan et al. (2006) and Smith (2006a; 2006b).

While the reference conditions are based on the best available scientific information and multiple lines of corroborating evidence, the information describing these conditions are not without limitations. The importance and influence of physical ecosystem characteristics such as slope, aspect, geology and physical and chemical soil characteristics, are not well described in the literature. However, these ecosystem characteristics can strongly influence vegetation structure in a given ERU and seral state. Additionally, the Gila NF occupies a geographic area that is influenced by the dynamics of several different physiographic provinces and two different desert systems. As a result, it is an ecological transition zone; it may not be reasonable to expect that all the ERUs on the Forest have the potential to express the central tendency of the NRV described by the available data. In some cases, these limitations likely lead to inflated departure values. The assignment of current state class proportions uses regional satellite imagery based classifications of vegetation size class, canopy cover, dominance type, and storiedness (number of tree canopy levels) at a 1:100,000 scale, with extensive photo interpretation and field data collection (Midscale Vegetation Mapping Project (Mellin et al. 2004)). The Midscale Vegetation Mapping Project provides coverage for National Forest System Lands only. The ILAP dataset is used to describe conditions for other lands. Existing vegetation is assigned to an ERU and then to the appropriate state class within that ERU according to state class descriptions that were developed by the Southwestern Regional Office (USDA FS 2015a). The Midscale Vegetation Map has been updated to reflect the large stand replacement wildfires that have occurred since the map was originally developed. However, due to the update protocol that averaged fire severity across map unit polygons, the update underestimates stand replacement fire in some cases. This tends to express itself strongest in the Spruce-Fir Forest and Mixed Conifer with Aspen ERUs where fewer acres are shown as being in early seral states than is actually the case on the ground. In these two ERUs, seral state departure is likely higher than depicted by this analysis.

Departure in seral state proportion is quantified at the context, plan and local scales by conducting a similarity analysis (Czeknowski 1913 as cited in Kent and Coker 1992) between the current distributions of seral state classes in a given ERU to that distribution described by the reference condition. Departure is simply the inverse of similarity. Departure from reference condition is broken into thirds for descriptive purposes (0 to 33% = low departure, 34 to 66% = moderate departure, 67 to 100% = high departure), but is best viewed as varying continuously from low to high. Departure ratings above 33 percent are considered significant in terms of the risk to ecological integrity and sustainability.

Projected trends under current management are described by future predicted distributions depicted by VDDT modeling. Model results are not precise predictions, but indicate relative trends and are sensitive to changes in management or disturbance. For this analysis, future trend assumes the continuation of current levels of management indefinitely. Even though, the Forest can affect sustainability at scales greater than the plan area, the Gila NF only affects management at the plan scale and only collects management information on the Forest; so VDDT models can only be reliably parameterized at the plan scale. Therefore, future trend is modeled only at the plan scale, though trends at the context scale or local scale may be discussed where information suggests they differ.

All VDDT modeling assumes current climatic conditions persist into the future. Consideration of climate change is provided by the Gila's Climate Change Vulnerability Assessment (CCVA) (Triepke 2015) which is discussed under the System Drivers and Stressors subheading in this chapter, and in more detail in Chapter 9: System Drivers and Stressors.

These datasets and analysis approach do not allow for direct analysis of old growth, as was done in previous planning efforts. The approach taken in this assessment provides information about landscape scale populations and the key factors and processes that influence them. The limited inferences that can be made about old growth from the seral state proportion analysis are presented in those discussions. Aside from the fact that data sufficient to directly analyze old growth does not currently exist, this issue is discussed in the white paper produced by the Forest Service Southwestern Region entitled ‘Desired conditions for use in forest plan revision in the southwestern region: development and science basis” (2014).

Some define old growth as the climax or late-successional state of forest development (Helms 2004). These definitions, however, ignore the old stages in early successional forests such as with quaking aspen stands that are successional to climax spruce-fir forests. An ecological understanding of old growth requires a perspective that includes multiple spatial and temporal scales, ranging from individual trees, to stands, to regions, and across forest types. While the structural and ecological definitions of old growth were first developed in the coastal Pacific Northwest (Franklin et al. 1981, Er and Ines 2003), those particular definitions do not work for most forests in other ecological settings. This is because there are substantial differences in the species compositions, tree longevities, sizes, densities, and variations in the types, intensities, and frequencies of natural disturbances across forest types (Harmon et al. 1986). These biological and ecological factors result in different tree structures, densities, distributions and landscape patterns when a forest type is in its old stage. Because of the complex and dynamic nature of forests, efforts to conserve biodiversity by providing old growth in landscapes must take into account all developmental stages, not just old growth (Spies 2004).

Patch Size

A “patch” is a contiguous area of the same system type (ERU) with similar overstory conditions and canopy cover. For this analysis, patch size is defined as the average patch size in acres by ERU at the plan scale. Figure 5 illustrates patch size in a woodland system.

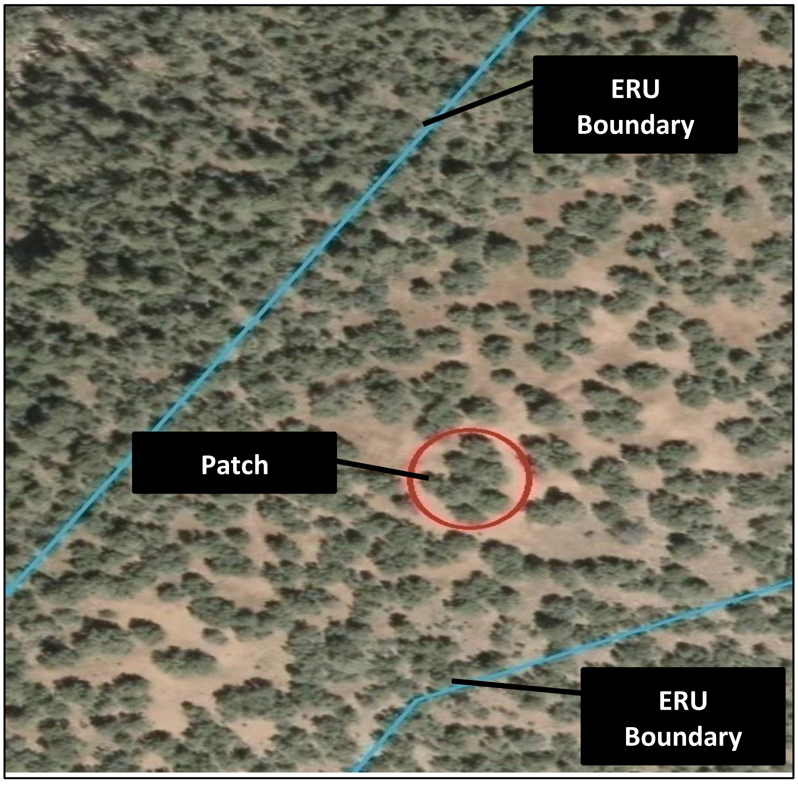

Figure 5. Patch size illustration in area mapped as PJ Grass Woodland

All patches of a given ERU that intersect the Forest boundary are included in the analysis which means in some cases, the analysis area may extend significantly into the context area landscape. Patch size is only analyzed for forest and woodland systems for which there is scientific literature to rely on. Patch size plays a significant role in fire behavior and fire effects. Patch size and associated heterogeneity also influences insect and disease spread and persistence, and wildlife habitat. Patch size is an important element of wildlife habitat because each wildlife species is adapted to a particular range of patch sizes and distribution.

Larger, more homogeneous patches than occurred historically typically means diversity has decreased (Turner et al. 2011) which can lower adaptive capacity and sustainability. Homogeneity is often driven by lack of fire disturbance, selective ungulate grazing/browsing, post-harvest single-age regeneration, and woody species expansion. This may mean disturbances can spread more continuously, species composition is more uniform, and there is less edge habitat. Edge habitat tends to support relatively higher levels of biodiversity. Where larger patch sizes are combined with increases in closed canopy conditions and increased fuel loading, the stage is set for uncharacteristically large, severe wildfires. For these reasons, current landscape distribution of patches that resemble the distribution under reference conditions best accommodate the varying preferences of all wildlife species and simultaneously contribute to fire behavior and fire effects that are closer to the natural range of variation.

Departure was calculated by comparing current patch size described by the Midscale Existing Vegetation dataset, to the reference range of patch sizes (Eddleman 1987; Huffman et al. 2006; Moore et al. 2004; Margolis 2007 and 2011; O'Conner et al. 2014; Pearson 1950; Vankat 2013; Wahlberg et al. 2014) using the calculations displayed in Table 6. Because this characteristic also uses the updated Midscale Existing Vegetation dataset, departure is likely underestimated in the SFF and MCW ERUs as previously described. Departure is calculated at the plan scale only. No trends are projected for this characteristic.

Table 6. Definition of patch size departure based on current patch size in relation to a reference range of patch sizes.

Current Patch Size Range	**Reference Patch Size Range**		
	smaller than reference patch size	within reference patch size	larger than reference patch size
Departure	$= 1 - \left(\frac{\textit{current patch size}}{\textit{low end of reference range}} \right)$	0	$= 1 - \left(\frac{\textit{high end of reference range}}{\textit{current patch size}} \right)$

Coarse Woody Debris and Snag Density

Ecologically, a dead tree is as important to the forest ecosystem as a live one (Franklin et al. 1989), and according to Marcot (2002), provide several 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. The importance of coarse woody debris in forests has been partially documented, although much remains to be discovered (Stevens 1997). What is known of these roles is divided into four, inter-related categories: 1) the role in productivity of forest trees (nutrient cycling); 2) the role in providing habitat and structure to maintain biological diversity; 3) the role in geomorphology of streams and slopes; and 4) the role in long-term carbon storage. The importance of each of these roles to an ecosystem varies throughout the forests by natural disturbance type, biogeoclimatic zone and moisture regime (Stevens 1997). Scarce coarse woody debris and snags can indicate a lack of appropriate habitat and inadequate nutrient cycling. An overabundance may indicate underlying stress on an ecosystem, such as drought or insect outbreaks, and potentially increases wildfire severity.

Coarse woody debris is defined as tons per acre of downed dead woody material greater than three inches in diameter. Snag density is defined as the number of standing dead trees, or stems, per acre by diameter classes (i.e., > 8", > 18"). Reference conditions for both coarse woody debris and snags are based on limited available data or calculations for maximizing ecological sustainability (Ernest et al. 1993; Graham et al. 1994; Harrod et al. 1998; Sánchez-Meador et al. 2008; USDA Forest Service 2011; Weisz et al. 2011). Current conditions are based on stand exam survey information collected by the Gila NF at the plan scale only. The stand exam data varies in the date it was collected both between and within individual ERUs. Some of the data is older, and some has been collected or updated as part of recent projects. No analogous information is available at the context scale, and plan scale data are not necessarily numerous or well distributed enough to allow local scale analysis. Departure from reference condition is using the same methodology as described for patch size and broken into thirds for descriptive purposes (0 to 33% = low departure, 34 to 66% = moderate departure, 67 to 100% = high departure). Departure values are best viewed as varying continuously from low to high. Projected trends are assumed based on the relationship between snags and coarse woody debris, and seral state proportion.

Fire Regime

Fire is an integral component in the function and biodiversity of many natural habitats and organisms, and these communities have adapted to withstand and even to exploit natural wildfire. More generally, fire is regarded as a "natural disturbance", similar to flooding, wind-storms, and landslides, that has driven the evolution of species and controls the characteristics of ecosystems. Each ERU has a characteristic fire regime that is integral to its ecological integrity. If fires are too frequent, plants may be killed before they have matured, or before they have set sufficient seed to ensure population recovery. If fires are too infrequent, plants may mature, senesce, and die, without ever releasing their seeds; or species composition may shift to favor uncharacteristic combinations; or live and dead biomass may simply accumulate to uncharacteristic levels.

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; Mutch 1992; Johnson and Van Wagner 1985; Sugihara et al. 2006). A fire regime is a generalization based on the characteristics of fires that have occurred over a long period. Fire regimes are often described as "cycles" or "rotations" because some parts of the histories usually get repeated, and the repetitions can be counted and measured. FRCC is an important tool for measuring the effectiveness of efforts to maintain sustainable landscapes (NIFTT 2010). FRCC ratings describe a level of departure from native ecosystems as they existed prior to Euro-American settlement:

- **FRCC I** – Fire regimes are within the natural or NRV and risk of losing key ecosystem components is low. Vegetation attributes (composition and structure) are intact and functioning (departure ≤ 33%)
- **FRCC II** – Fire regimes have been moderately altered. Risk of losing key ecosystem components is moderate. Fire frequencies may have departed by one or more return intervals (either increased or decreased), potentially resulting in moderate changes in fire and vegetation attributes (34 - 66% departed)
- **FRCC III** – Fire regimes have been substantially altered. Risk of losing key ecosystem components is high. Fire frequencies may have departed by multiple return intervals, potentially resulting in dramatic changes in fire size, fire intensity, and fire severity as well as landscape patterns. Vegetation attributes have been substantially altered (≥ 67% departed) (WFM 2012).

FRCC was calculated at the plan and local scales by averaging seral state proportion departure and fire regime departure. Characteristic fire regime was defined as the average of NRV reported for each ERU. Local scale ratings were area weighted for each ERU to determine a percentage by class at the plan scale.

Trends are assumed to follow those of seral state proportion. Fire severity and fire frequency[4] are important components of fire regimes. While included in the FRCC calculations, they are also assessed independently from FRCC. This is important because departure in FRCC does not necessarily mean all components that contribute to FRCC are departed; one or more of these individual characteristics may contribute to moderate or high departure in FRCC, while others may be in low departure. For example, the season in which fire typically burns may be the same as under reference conditions, but severity may be departed from the reference. Projected trends are assumed based on the VDDT modeling inputs and outputs for seral state proportion.

Fire Frequency

Fire frequency is assessed at the context, plan, and local scales. Fire frequency at the plan scale is based on Gila NF wildfire history data from the 30 year period between 1984 and 2013. Point data was buffered by acreage and replaced by polygons of known perimeters where available[5]. Fire rotation (FR-average area burned per year) was calculated for each ERU and the total ERU acreage was divided by that average. Fire rotation at the context scale is based on nationally compiled federal agency wildfire occurrences point information[6], which was buffered by acreage and replaced by actual fire perimeters, when available. Fire perimeters were obtained from Gila NF data at the plan scale and a combination of Apache-Sitgreaves, Coconino, Coronado, Kaibab, Lincoln, and Tonto NFs, and MTBS perimeters elsewhere within the context area. MTBS only maps fires over 1,000 acres as far back as 1984. For large parts of the context scale the only source of fire perimeter information is MTBS (2014), data, so the analysis was bounded using its earliest available information (1984-2014). Any discrepancies at the plan scale were resolved in favor of Gila NF data. Departure was calculated by comparing fire rotation (FR) calculations to the reference mean fire return interval (MFRI) as shown in Table 7. No trends are projected for fire frequency.

Table 7. Definitions of fire frequency departure based on current fire return interval in relation to a range of reference mean fire return intervals (MFRI)

Current Fire Interval	Reference Mean Fire Return Interval Range		
	less frequent than reference MFRI	within reference MFRI	more frequent than reference MFRI
Departure	$= 1 - \left(\frac{\textit{current fire return}}{\textit{low end of reference range}}\right)$	0	$= 1 - \left(\frac{\textit{high end of reference range}}{\textit{current fire return}}\right)$

Fire Severity

Fire severity is described by the percent of burns that are non-lethal, mixed severity, and stand replacement fire[7]. Fire severity is only assessed at the plan and local scales, since burn severity data is

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[4] Reference fire frequency is measured in mean fire return interval (MFRI), or the average number of years between two successive fire events in a given area. Current fire frequency is measured slightly differently, using fire rotation (FR). Fire rotation is the number of years it would take for an area equal to the entire ERU to burn. Both a shorter MFRI or FR indicate more frequent fire in the system; however, they are calculated from different measurements and are not equivalent, but can still be compared to infer trends.

[5] The Gila NF collects actual perimeters (polygon data) for all fires over 10 acres, smaller fires are recorded only as a point and acreage.

[6] The Federal Fire Occurrence Website (FFOW 2016) is maintained by USDI U.S. Geological Survey. Available at: http://wildfire.cr.usgs.gov/firehistory/index.html.

[7] Vegetation Burn Severity: The effect of a fire on vegetative ecosystem properties, often defined by the degree of scorch, consumption, and mortality of vegetation and the projected or ultimate vegetative recovery (Lentile et al. 2006; Morgan et al. 2001). The vegetation burn severity of a fire depends on the fire intensity and the degree to which ecosystem properties are (or are not) fire resistant. For example, a fire of exactly the same fireline intensity might kill thin-barked trees but have little effect on thick-barked trees, or it may root-kill rather than canopy-kill trees, which would result in greater mortality than initially observed (Parsons et al. 2010). Burn severity indicators are classified and defined as follows (Parsons et al. 2010): 1) Low Soil Burn Severity - Surface organic layers are not completely consumed and are still recognizable. Structural aggregate stability is not

limited or unavailable in some areas within the context area. In some cases, data is also unavailable for some local units and/or some fires. Information describing fire severity was obtained from monitoring trends in burn severity (MTBS) data (all available records collected for Arizona and New Mexico going back to 1984), supplemented by Burned Area Emergency Response (BAER) data, where MTBS was missing or incomplete. An important limitation of the MTBS dataset is associated with the timing of the satellite imagery. MTBS uses post-fire imagery and estimates severity based on the spectrum of light reflected by the vegetation and/or ground. The post-fire environment can change rapidly, especially in the Southwest, where the summer monsoons typically end monsoons; in areas where the monsoon rains lead to a robust herbaceous response, MTBS can interpret lower severity levels than what actually occurred. With regard to MTBS data and the 2013 Silver Fire, the Forest is continuing to work with the Geospatial Technology and Applications Center (GTAC) (formerly the Remote Sensing Applications Center (RSAC)) to correct severities that were misidentified as low due to the success of the post-fire seeding treatments and were actually higher severity, stand replacement type fires. This is also an issue in grassland fires as fire only removes top-growth and new growth begins quickly.

Burn severity was summarized by ERU, at the context and plan scales. An average ERU severity was calculated and compared to the reference average severity (Krausmann and Triepke 2014) using the equation *FS=1-(current average severity/reference average severity)* with values stratified into low, moderate and high as described for other characteristics. No trends are projected for fire severity.

Insects and Disease

Insects and disease are the severity and frequency of outbreaks of damage agents at the plan and local scales. Determinations for insect and disease departures from reference condition come from *Forest insect and disease history of the Gila National Forest: input for the Gila NF plan revision* (Ryerson 2015) provided by the Southwestern Regional Office. Insects and diseases are important components of forest ecosystems and greatly influence forest structure and species composition over time. They are characteristic to some degree and at some frequency in all ERUs, not only as disturbance agents, but also as significant contributors to ecosystem function. While insect and disease impacts often conflict with human objectives and forest management goals, their effects on the forest may be detrimental or beneficial from an ecological perspective (Ryerson 2015). According to Ryerson (2015), with the exception of nonnative agents such as white pine blister rust, the primary forest insects and diseases in the Southwestern Region and on the Gila NF are native organisms that have long been part of the ecosystem and have evolved with their plant hosts.

The USDA FS Southwestern Region has evaluated the most common forest insects and diseases on the Gila NF using information from historical reports, published documents, aerial survey information, and USFS specialists' knowledge (Ryerson 2015). Data from Aerial Detection Surveys, conducted by the USFS, are

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changed from its unburned condition, and roots are generally unchanged because the heat pulse below the soil surface was not great enough to consume or char any underlying organics. The ground surface, including any exposed mineral soil, may appear brown or black (lightly charred), and the canopy and herbaceous understory vegetation will likely appear "green." 2) Moderate Soil Burn Severity - Up to 80 percent of the pre-fire ground cover (litter and ground fuels) may be consumed but generally not all of it. Fine roots (≅ 3/32 in. diameter) may be scorched but are rarely completely consumed over much of the area. The color of the ash on the surface is generally blackened with possible gray patches. There may be potential for recruitment of effective ground cover from scorched needles or leaves remaining in the canopy that will soon fall to the ground. The prevailing color of the site is often "brown" due to canopy needle and other vegetation scorch. Soil structure is generally unchanged. 3) High Soil Burn Severity - All or nearly all of the pre-fire ground cover and surface organic matter (litter, duff, and fine roots) is generally consumed and charring may be visible on larger roots. The prevailing color of the site is often "black" due to extensive charring. Bare soil or ash is exposed and susceptible to erosion, and aggregate structure may be less stable. White or gray ash (up to several centimeters in depth) indicates that considerable ground cover or fuels were consumed. Sometimes very large tree roots (> 3 in. diameter) are entirely burned extending from a charred stump hole. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

summarized for the Gila NF by ERU for the period 1998-2013. Similar survey data is not available for non-NFS lands, therefore insect and disease outbreaks are discussed qualitatively at the context scale, when information is available. Otherwise, insects and diseases are only assessed at the plan scale. Information concerning departure from reference conditions for insects and disease is not available; therefore no departure ratings are assigned.

System Drivers and Stressors for Upland Vegetation

Recall from Chapter 1: Ecological Integrity and Sustainability that system drivers are factors or processes that act on ecosystem characteristics that contribute to the natural or historic range of variability in conditions. Stressors are natural or human caused alterations in system drivers that have the potential to threaten ecological integrity and sustainability. The primary system drivers and stressors for upland vegetation are:

- Natural vegetation succession
- Fire
- Insects and diseases
- Herbivory
- Invasive and noxious plant species
- Non-fire vegetation treatments
- Climate
- Climate change

Because these factors and processes impact or involve many other ecosystem components of both upland and riparian systems and ecosystem components are interconnected, Chapter 9: System Drivers and Stressors is dedicated to their discussion in an attempt to reduce repetition and redundancy. With respect to climate change, the Gila NF Climate Change Vulnerability Assessment (Triepke 2015) described in Chapter 9 is of particular importance to the risk assessment of upland vegetation characteristics and is referred to many times throughout this chapter.

Additionally, in the context of system drivers and stressors, recall that the NRV approach to reference conditions is defined by the period prior to European settlement; this means that the NRV includes the influence of Native American populations. Ecological conditions during the reference time period were by no means pristine. As described in Chapter 17: Cultural and Historic Resources, some aspects of ecological change during this time period responded directly to the influence of human populations. On the Gila NF, archeological researchers have compiled evidence that human dynamics influenced changes in the distribution of plant and animal species (Creel et al. 2010; Creel and Speakman 2012; Minnis 1985; Schoolmeyer 2009).

Recall from the previous subsection that a few system drivers and/or stressors are analyzed as key ecosystem characteristics as well. Those that are not analyzed as ecosystem characteristics are not of lesser importance, rather it is due to the lack of data or limitations of the available data that their analysis is limited to the discussions in the System Drivers and Stressors.

Forested Ecological Response Units

The following subsections focus on individual ERUs identified as forest types in the introduction. A general description of each ERU is provided, followed by the analysis of departure and trend related to the characteristics identified in the introduction. The spatial niche analysis concludes each individual ERU discussion.

SPRUCE-FIR FOREST (SFF) ERU

General Description


Figure 6. SFF ERU (photo by L.J. WhiteTrifaro 2009)

Also known as sub-alpine conifer forests, the SFF ERU (Figure 6) ranges in elevation from 9,000 to 10,500 ft. along a variety of gradients including gentle to very steep mountain slopes. Generally, annual precipitation ranges from 27 to 36 inches, with 50% coming between October 1st and March 31st. Although rare, the Spruce-fir forest occurs throughout the Southwestern region, occurring on the Apache-Sitgreaves, Carson, Cibola, Coconino, Gila, Kaibab, Lincoln, and Santa Fe National Forests. This ERU is comprised almost entirely of Engelmann spruce (*Picea engelmannii* Parry ex Engelm.) and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) and/or corkbark fir (*A. lasiocarpa* (Hook.) Nutt. var. *arizonica* (Merriam) Lemmon) associations. Common understory species may include but are not limited to red baneberry (*Actaea rubra* Aiton) Willd.), sprucefir fleabane (*Erigeron eximius* Greene), strawberryleaf raspberry (*Rubus pedatus* Sm.), whortleberry (*Vaccinium myrtillus* L.), and twinflower (*Linnaea borealis* L.). Natural system drivers and stressors in this ERU include climate, vegetation succession, blow-down, insect and/or disease outbreaks, and fire.

Figure 7 and Figure 8 show that the majority of this ERU occurs in the central portion of the context area and south central portion of the Forest.

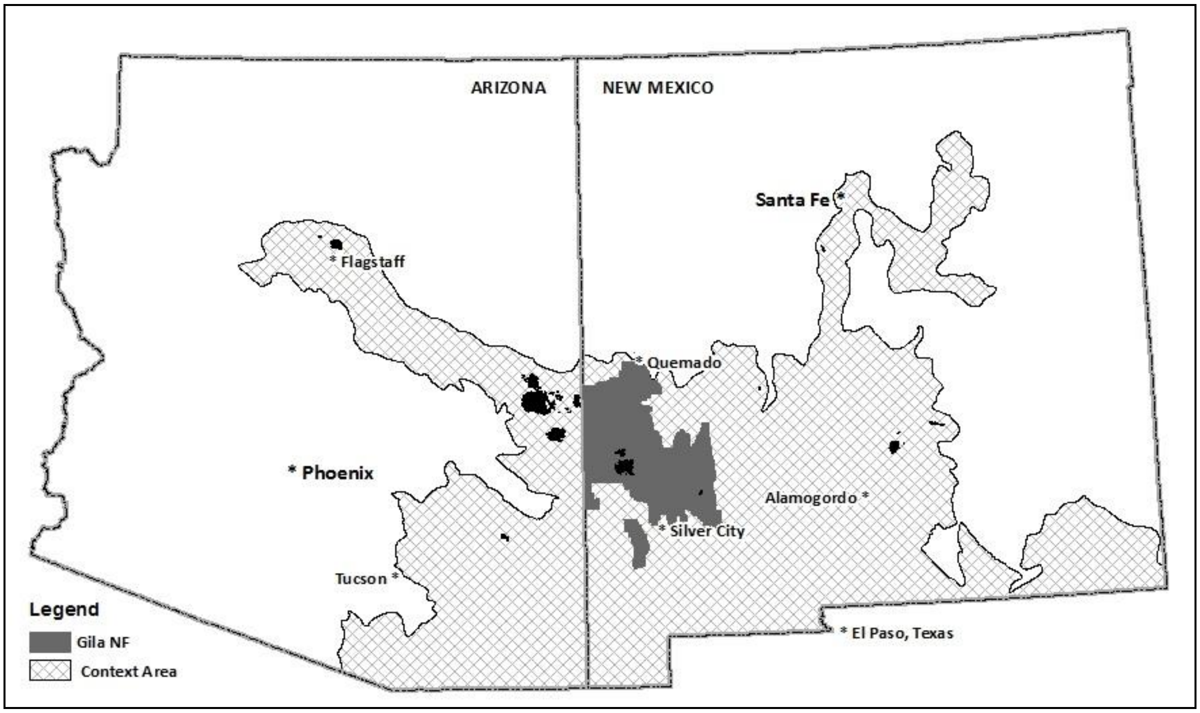

Figure 7. General location (in black) of the SFF ERU within the context area

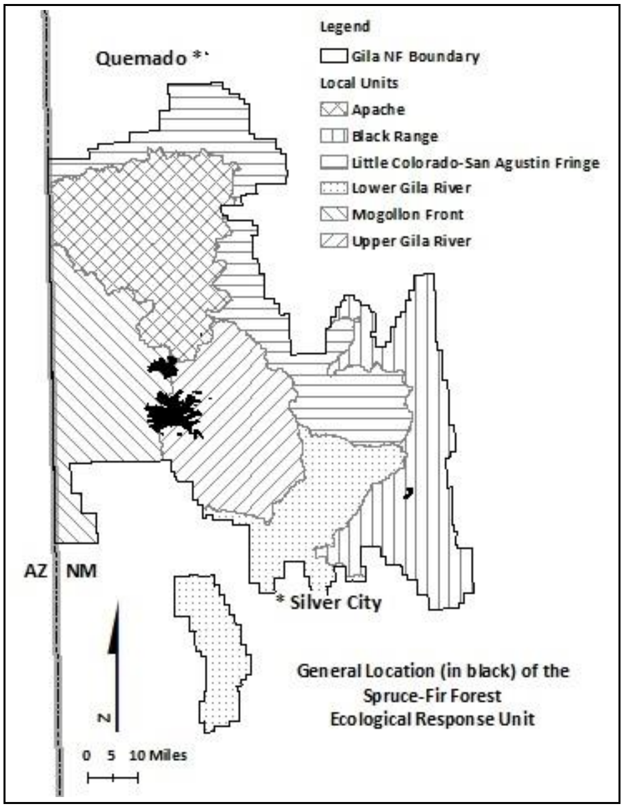

Figure 8. General location (in black) of the SFF ERU within the Gila NF and the six local units

The SFF ERU contains two Subclasses:

> *Spruce-Fir Lower (AKA "Spruce-Fir Mix")*: This subclass typically occurs between 9,500 and 10,900 feet and includes a suite of mixed conifer species, especially Rocky Mountain Douglas-fir and white fir. Quaking aspen, occurs as a component that may be codominant or dominant (Muldavin et al. 1996), depending on seral state. This subclass often occurs in the transitional ecotone between the Mixed Conifer with Aspen ERU and the upper elevation subclass of the Spruce Fir Forest ERU. It generally has similar process dynamics to the Mixed Conifer with Aspen but supports different tree species.
>
> *Spruce-Fir Upper (AKA "Spruce-Fir Pure)*: Spruce and subalpine fir dominate the "Upper" subclass of this ERU which is typically found between 10,500 and 11,500 feet. It occurs adjacent to and below the Bristlecone Pine and Alpine and Tundra ERUs, above its "Lower" counterpart.

Seral State Proportion

Under reference conditions the majority of the SFF ERU was comprised of single or multi-storied small to very large size-trees with typically closed canopy trees and a contingent of aspen (Table 8). Historically, these forests were dominated by even age stands of shade tolerant shrubs and trees that were adapted to closed canopy characteristics (Smith et al. 2006d).

Table 8. Seral state make-up of the SFF ERU under reference (RC) and current conditions for both the Gila NF and context area (CA).

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A, B, C, G	EARLY-SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover, and seedling/sapling (< 5" dbh/drc), small (≥ 5" & < 10" dbh/drc) tree sizes with open (≥ 10% & < 30%) or closed woody canopy cover, all storiedness	21	68	60	21	21
D, H	MID-SERAL: Medium to large size (≥ 10" & < 30" dbh/drc) trees, all storiedness with open or closed woody canopy cover	33	32	39	32	33
E, F	LATE SERAL: Very large size (≥ 30" dbh/drc) trees, single or multi-storied with closed woody canopy cover	46	0	0	0	0
I, J	LATE SERAL: Very large size trees, single or multi-storied with open woody canopy cover *(occurs on contemporary landscapes only…)*	0	0	0	0	0
Total		100	100	100	53	54

Departure Index Rating╫ = 100 – ∑ similarity values: Gila NF = (100 – 53) = 47 or MODERATE; and Context Area = (100 – 54) = 46 or MODERATE

‡ USDA FS 2015d; Smith 2006d

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

╫ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

Departure is moderate at all scales, with the exception of the two local units within the Forest where SFF does not occur: Lower Gila River and Little Colorado-San Agustin Fringe. Currently there is a sizeable over representation the grass, forb, sparsely vegetated or recently burned and seedling/sapling, small, medium and large size-trees, single or multi-storied with open or closed woody canopy cover characteristics (seral states A, B, C, G); a significant under representation of very large size trees, trees, single or multi-storied with closed woody canopy cover (seral states E, F).

There is almost no (<1%) representation of very large size trees (20 in. +); which might be the indicative of mature to old forest spruce-fir conditions (Vandendriesche 2013). On the other hand, "large" does not always mean "old", nor does "small" necessarily equate to "young" as the maximum achievable size of any particular species is also a reflection of site conditions (Kaufmann et al. 1990). While this analysis does not directly address old growth, the percentage of very large size trees (diameters 20 inches or more at breast height) may provide useful inferences related to the status of old growth forests (Boyden et al. 2005; Vandendriesche 2013). On the other hand, the thematic resolution of the dataset used to assess seral state proportion must be considered. The Midscale Existing Vegetation Mapping Project stratifies tree size classes into four categories: 0”-4.9”, 5”-9.9”, 10”-19.9” and 20”+. Size class categories are assigned based on the dominant diameter class of the dominant tree species. Therefore, representation of the larger size classes may be present within areas in the smaller size class categories. Old growth, as defined by the current Forest Plan is not defined solely by the diameter of trees, but by the age of the stand as a whole, stand density and the general absence of disturbance (USDA FS 1986). This discussion applies to all ERUs.

Departure in seral state proportion is primarily the result of recent extents of stand replacement fire on the Forest and throughout the context area. As disclosed in the Key Ecosystem Characterisitics, Data and Analysis Methods section, this departure is most likely underestimated due the protocol used to update the Midscale Existing Vegetation map after these large fires occurred. These fires occurred primarily as a result of extended drought rather than past fire suppression. While fire suppression has influenced conditions in and adjacent to the SFF ERU (and MCW), the period of fire suppression policy likely had less effect on infrequent fire systems such as these. Recent impacts associated with insects and disease (see subsequent subheading), and the increased vulnerability of drought stressed trees to those insects and diseases are certainly another contributing factor. As previously mentioned in the general description of this ERU, aspen can be vegetation component on suitable sites in the early to mid-seral states. Where aspen is present, herbivory by elk can be significant. Based on qualitative field observations, there are areas within this ERU on the Forest currently experiencing heavy elk pressure, and others that are not.

Herbivory by domestic livestock has been and remains incidental on the Gila NF as most of this ERU has been limited in its ability to produce sufficient quantities of palatable herbaceous species to attract or hold livestock, either due to characteristics of the soil or long periods of canopy closure characteristic of this ERU. Additionally, most of the SFF occurs in unallotted areas of wilderness areas and/or frequently occurs on steep slopes (≥40%) which are not typically used by domestic livestock. These steep slopes and the large percentage of this ERU occurring within designated wilderness areas (~82%), also limits the influence past timber harvest has had in this ERU on the Forest, and the potential for timber harvest in the future.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 9. Recall that the trend analysis is conducted at the plan scale only.

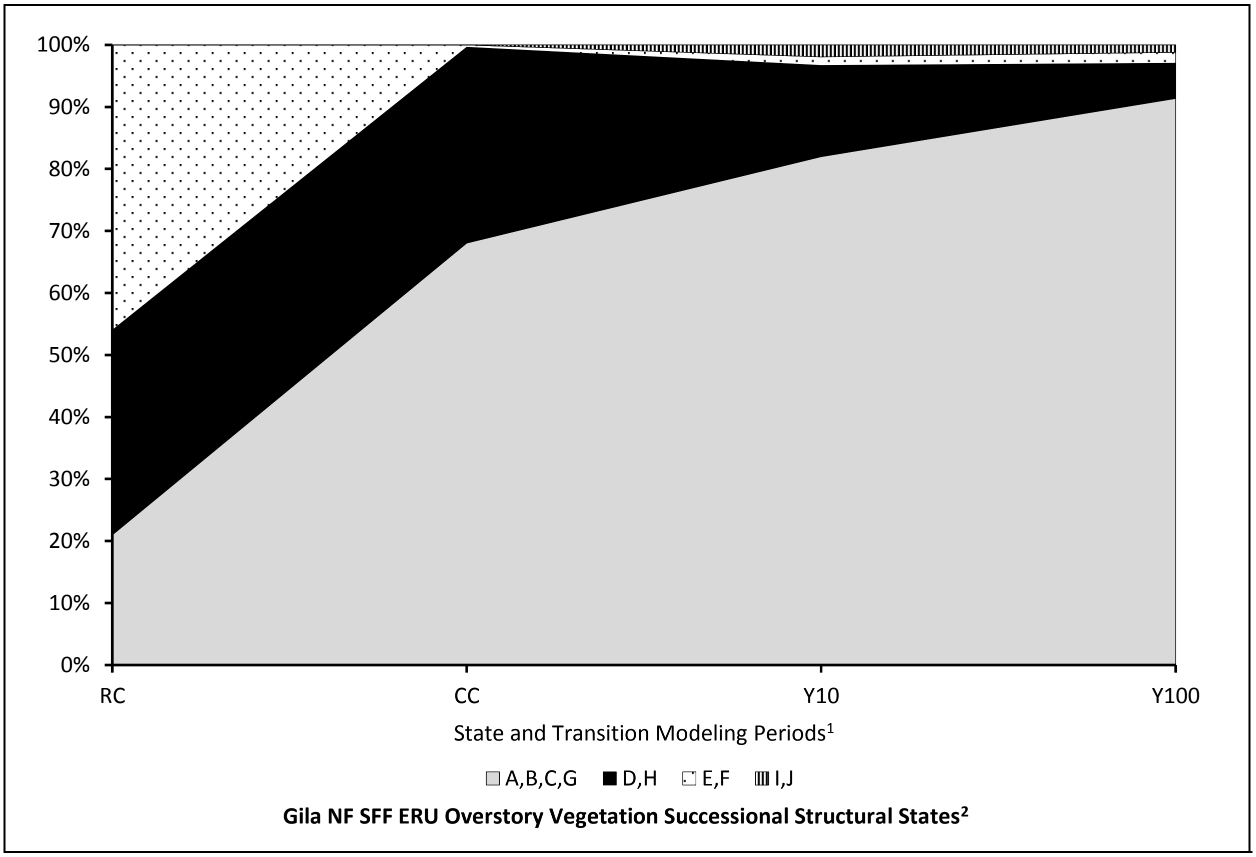

Figure 9. Gila NF overstory vegetation successional structural states for SFF ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 47% or moderate departure from RC
Y10 = State and transition modeling results at 10 years = 63% or moderate departure form RC
Y100 = State and transition modeling results at 100 years = 72% or high departure from RC
[2] See Table 8 for a description of the overstory vegetation successional structural states

The VDDT modeling indicates that under current management (and the current climatic regime) existing departure in seral state proportion continues to trend away from reference conditions into the future by approximately 25 percentage points (Figure 9).

Patch Size

Table 9. Gila NF current departure of patch size in Spruce-Fir Forest

Reference Range:	200 to 1,000 ac.
Current Mean:	79 ac.
Departure:	Moderate

As shown in Table 9, current mean patch size is smaller than reference conditions due to recent large, stand replacement fires across contiguous areas of this ERU. Again, because this characteristic uses the same dataset used to assess seral state proportion, departure is likely underestimated.

Coarse Woody Debris and Snag Density

Table 10. Gila NF current and projected departure of coarse woody debris in Spruce-Fir Forest

	Coarse Woody Debris	Departure/Trend
Reference:	42.5 T/ac.	
Current:	87.2 T/ac.	Moderate
100-years:	81.7 T/ac.	Moderate/Trend Away from Reference

The analysis in Table 10 indicates there is nearly 2 times the amount of coarse woody debris per acre than the data suggests was present historically. Past fire suppression may have contributed to the accumulation of coarse woody debris in this ERU, however, it likely had less influence in infrequent fire systems such as SFF and MCW ERUS than in frequent fire systems such as the MCD and PPF ERUs. Additionally, the data used to assess this characteristic was collected prior to recent stand replacement fire, drought, and insect and disease outbreaks. Coarse woody debris removed and/or added to the SFF ERU by these more recent processes are not reflected in the analysis. There may actually be more or less tons per acre than depicted here.

Table 11. Gila NF current and projected departure of snags in Spruce-Fir Forest

	Snag Density (8" dbh)	Departure/Trend	Snag Density (18" dbh)	Departure/Trend
Reference:	25.0/ac.		9.0/ac.	
Current:	19.0/ac.	Low	11.2/ac.	Low
100-years:	19.0/ac.	Low/Away from Reference	11.2/ac.	Low/Away from Reference

The analysis in Table 11 indicates there are fewer smaller snags per acre than the data suggests was present historically, which may be a reflection of the predominantly late-seral closed canopy conditions prevalent across this ERU on the Forest when the data used to conduct this analysis was collected, prior to recent stand replacement fires. In contrast, larger snag densities were lower than under reference conditions. Again, recent events such as stand replacement fire, drought, and insect and disease outbreaks have altered these conditions. More current data would likely describe a different situation.

Fire Regime

Fire is an infrequent but important stand initiating disturbance in these cool, mesic forests (Peet 1988). Mean fire-return intervals vary between 150 and 400 years but are probably not cyclical (Arno 1980; Romme and Knight 1981; Crane and Fischer 1986; Peet 1988; Turner and Romme 1994; Farris et al. 1998). Although small fires may occur more frequently than large fires; infrequent fires are considered to be most important in shaping the overall structure and composition of the landscape (Romme 1982; Johnson and Wowchuk 1992; Agee 1993; Turner and Romme 1994; Bessie and Johnson 1995; Farris et al. 1998).

Fire Frequency

Table 12. Reference and current Gila NF fire frequency for Spruce-Fir Forest

Reference:	**MFRI*100-200 yrs. mixed severity fire and 200-400 years stand replacement fire** (FF‡ = average 156 yrs., mixed severity rotation 100 yrs., and stand replacement rotation 350 yrs.ǂ)
Current:	FF = 17 yrs.
Departure:	High

*Wahlberg et al. 2014; Krausmann and Triepke 2014

‡ Romme and Knight 1981; Grissino-Mayer et al. 1995; Schussman et al. 2006; Smith 2006d; Romme et al. 2009a; WDNR 2011; Krausmann and Triepke 2014

ǂ Margolis et al. (2011) and Swetnam and Falk (2015).

As shown in Table 12, in the last 19 years (1996-2015), fire has occurred with strikingly greater frequency in this system than it did historically as reflected by the high ERU departure rating. All local units containing SFF are also in the high departure category. These departures are primarily the result of drought. Departure in fire frequency is also high within the context area, however, fire occurs with less frequency, on average, than during the reference time period (current FF = 1,568 years). While the entire Southwest has been affected by drought conditions, those conditions have varied from place to place.

Fire Severity

Between 1996-2015 average annual acres burned by wildfire within the SFF ERU at the plan scale is 1,395 acres; roughly 25% at low severity, 20% at moderate severity and 56% at high severity. While the current average severity at the plan scale is approximately 62%, as opposed to the reference condition's 58% (Krausmann and Triepke 2014), fire severity departure is low. Departure is low in all local units containing SFF except the Apache which is highly departed, and in the Black Range local unit for which there is no data. Severity is lower in the Apache local unit than under reference conditions (~15%). Just 22 acres of SFF is mapped in the Apache local unit adjacent to frequent fire PPF, MSG and MCD ERUs at between 7,800 and 7,900 feet just upslope from a drainage. There are no TEUI sample points documenting the presence or potential for SFF in this area. This indicates the ERU map has likely classified this as SFF in error. On the other hand, if SFF or the potential for it was actually present in this location, lower fire severity may actually be within the natural range of variability given the small patch size and immediate adjacency of frequent fire, low severity systems. In general, fire severity is consistent with what is known about the reference time period.

Both moderate and high severity are typically stand replacement type fires within the SFF on the Gila NF. Conifer species in this ERU are fire sensitive, and even if mortality is not an immediate result of the fire, it frequently occurs shortly thereafter. While aspen is considered fire adapted due to its re-sprouting ability, mature trees are also easily killed with very little heat.

Fire Regime Condition Class (FRCC)

Table 13. Gila NF Reference FRCC and departure for Spruce-Fir Forest

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 97.3%	FRCC III = 0.0%	No data = 2.7%
Departure:	Moderate, Trend Away from Reference			

ǂ Romme and Knight 1981; Grissino-Mayer et al. 1995; Schussman et al. 2006; Romme et al. 2009a; WDNR 2011; Krausmann and Triepke 2014

As shown in Table 13, the vast majority of this ERU is within FRCC II, indicating a moderate departure. This is also the case for the two local units for which all the data elements are available (Mogollon Front and Upper Gila River), as well as the context area. At the Forest and local scales departure is driven by increased fire frequency and recent large, contiguous extents of stand replacement fire, rather than the stand replacement nature of these fires. At the context scale, an FRCC II rating reflects lower fire frequency than would be expected under the reference condition.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 1,970 acres. The highest level occurred in 2014 at 18,837 acres. Overall, nearly 100% of this ERU has been affected to some degree by insect and disease activities since 1997.

There is a lack of documented observations and evaluation of historical insect and disease activity in the spruce-fir type on the Gila NF because of the limited distribution on the Forest (0.7% of the Gila NF based on ERU analysis) and its relative remoteness. Many of the common agents would be expected to be present, but have not necessarily been specifically documented. Common agents include bark beetles, defoliating agents, broom rust, and root diseases (Ryerson 2015).

Spatial Niche

The SFF ERU is concentrated in isolated pockets at the very highest elevations within the context area. At 177,491 acres within the context area it contributes roughly 0.4% to the context landscape. At 23,779 acres the SFF ERU contributes roughly 0.7% to the Gila NF's land base (Table 14). The SFF represents the 12th largest ERU within both the context area and Forest. However, it has a great proportional representation on the Forest (0.32%) than in the context area (Table 14). This ERU has a moderate seral state proportion departure rating at scales in which it occurs (Table 8). In general, this ERU has gone from a normally very large (20 in. +) size tree-closed canopy nature to a more open herbaceous, smaller (< 20 in.) size-trees condition throughout its range within the context area.

Table 14. SFF ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
SFF	23,779	0.7	177,491	0.4	13.4	0.32

Table 15. SFF ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%		
	22	0.1	630	2.6	0	0.0	0	0.0	8,710	36.6	14,417	60.6	23,779	0.7	177,491	0.4
Percent seral state departure	67 Moderate		48 Moderate		No SFF		No SFF		46 Moderate		54 Moderate		47 Moderate		46 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

As shown in Table 15, the Gila NF's spatial niche, or influence on this particular ERU has to do with higher proportional representation on the Forest, its seral state proportion departure, and its rarity. The Forest has a greater influence on the ecological integrity and sustainability of the Spruce-Fir Forest because there is more of it located on the Forest than within the context area. Both its departure and rarity heighten the Forest's responsibility to restore and/or maintain this ERU. Given the same degree of departure on the Forest and across the context area, the Forest is not currently well positioned to act as a refugia for SFF.

MIXED CONIFER W/ ASPEN FOREST (MCW) ERU

General Description


Figure 10. MCW ERU (Wahlberg et al. 2014)

The MCW ERU (Figure 10) hosts a variety of dominant and co-dominant species spanning mesic environments in the Rocky Mountain and Madrean Provinces. Wet mixed conifer forests range in elevation from approximately 9,000 to 10,500 feet along a variety of gradients including gentle to very steep mountain slopes, situated between ponderosa pine and dry mixed conifer forests below and Spruce-Fir Forest ERU above. Generally, annual precipitation ranges from 23 to 32 inches, with 50% coming between October 1st and March 31st. Dominant and co-dominant vegetation varies in elevation and moisture availability. Ponderosa pine occurs incidentally or is absent, while Douglas-fir, southwestern white pine, white fir, and Colorado blue spruce occur as dominant and or codominant conifer species. Understory vegetation is comprised of a wide variety of shrubs, graminoids, and forbs depending on soil type, aspect, elevation, disturbance history, and other factors. Historically this ERU had over 10% tree canopy cover, with the exception of early, post-fire plant communities.

Originally aspen (*Populus tremuloides* Michx.) was conceptualized as having been a unique system, however it now understood as a component of the mixed conifer w/ aspen forest ERU that varies in its dominance with successional status. The understory structure may have shrubs and an herbaceous layer, or just an herbaceous layer. Common shrubs include mountain spray, or rock-spiraea (*Holodiscus dumosus* (Nutt. ex Hook.) A. Heller), thimbleberry (*Rubus parviflorus* Nutt.), fivepetal cliffbush (*Jamesia americana* Torr. & A. Gray), and mountain ninebark (*Physocarpus monogynus* (Torr.) J.M. Coult.). The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Some of the species typically found associated with aspen include Nevada peavine (*Lathyrus lanszwertii* Kellogg var. *leucanthus* (Rydb.) Dorn), Fendler's meadow-rue (*Thalictrum fendleri* Engelm. ex A. Gray), elkweed (*Frasera speciose* Douglas ex Griseb.), common yarrow (*Achillea millefolium* L.), Canadian white violet (*Viola canadensis* L.), Indian paintbrush (*Castilleja* spp. Mutis ex L. f.), and several grasses and sedges. Distribution of aspen within this ERU is limited by several factors including adequate soil moisture required to meet its high evapotranspiration demand, the length of the growing season or low temperatures, and major disturbances that clear areas of vegetation and stimulate root sprouting and colonization.

Figure 11 and Figure 12 show that the majority of this ERU occurs in the northern portion of the context area and south central portion of the Forest.

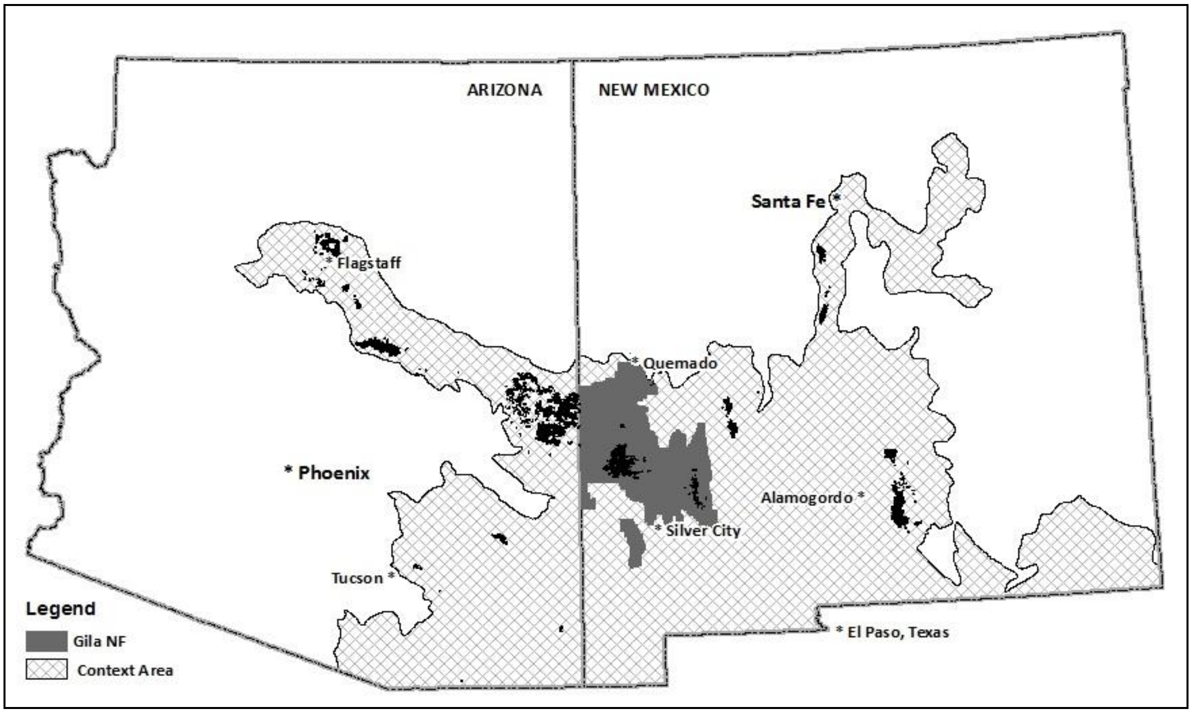

Figure 11. General location (in black) of the MCW ERU within the context area

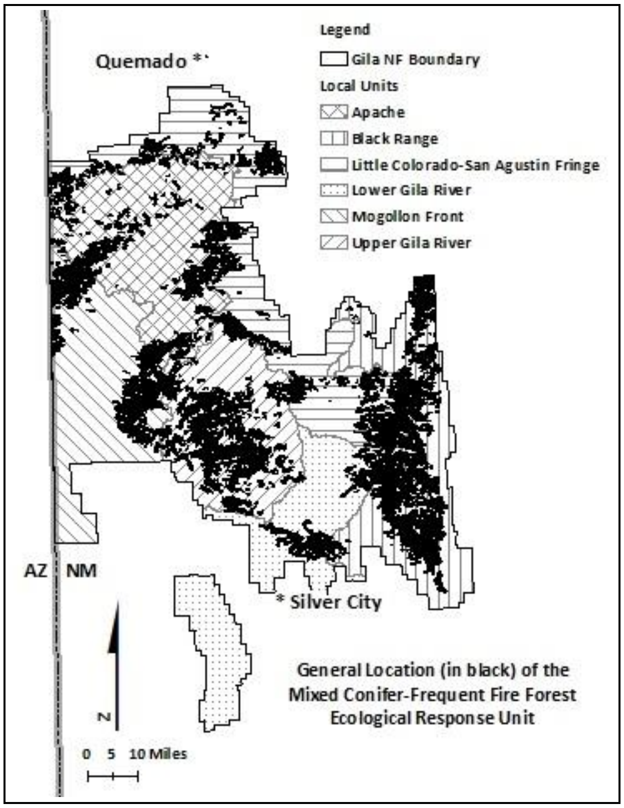

Figure 12. General location (in black) of the MCW ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the MCW ERU was comprised of single or multi-storied small to very large size-trees, typically closed canopy conditions, and a significant contingent of aspen. Historically, these forests were dominated by even age stands of shade tolerant shrubs and trees that were adapted to closed canopy characteristics (Smith et al. 2008).

Table 16. Seral state make-up of the MCW ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A, K	EARLY-SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	1	17	11	1	1
B, T	EARLY TO LATE SERAL: Aspen/mixed deciduous trees of all sizes with open or closed woody canopy cover	21	43	33	21	21
C, D, G, H, L, M, P, Q	EARLY TO MID-SERAL: Seedling/sapling (< 5” dbh/drc), small (≥ 5” & < 10” dbh/drc), medium (≥ 10” & < 20” dbh/drc) and large (≥ 20” & < 30” dbh/drc) tree sizes, all storiedness with open or closed woody canopy cover	29	40	55	29	29
E, F, N, O	LATE-SERAL: Very large size (≥ 30” dbh/drc) trees, all storiedness with closed woody canopy cover	49	0	0	0	0
I, J, R, S	LATE-SERAL: Very large size trees, all storiedness with open woody canopy cover *(occurs on contemporary landscapes only…)*	0	0	0	0	0
Total		100	100	99	51	51

Departure Index Ratingǂ = 100 – ∑ similarity values: Gila NF = (100 – 51) = 49 or MODERATE; and Context Area = (100 – 51) = 49 or MODERATE

‡ USDA FS 2015c; Smith 2006a, 2006c

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

ǂ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

As shown in Table 16, departure in seral state proportion is moderate at the context, plan and local unit scales. Currently there is a sizeable over representation of aspen (seral states B, T) and seedling/sapling, small, medium and large size-trees, single or multi-storied with open or closed woody canopy cover characteristics (seral states C, D, G, H, L, M, P, Q); a significant under representation of very large size trees, trees, single or multi-storied with closed woody canopy cover (seral states E, F, N, O). Similar to the SFF, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of SFF, also applies here.

This departure is primarily the result of recent extents of stand replacement fire on the Forest and throughout the context area and may be underestimated as discussed in the SFF. These fires occurred primarily as a result of extended drought rather than past fire suppression. While fire suppression has influenced conditions in and adjacent to the MCW ERU, the period of fire suppression policy likely had less effect on infrequent fire systems such as the MCW. Recent impacts associated with insects and disease (see subsequent subheading), and the increased vulnerability of drought stressed trees to those insects and diseases are another potentially contributing factor. Herbivory by elk can be significant where aspen is a co-dominant or dominant species.

The VDDT model has the ability to consider elk impacts. Elk impacts are considered because according to (Bailey and Whitham 2002; Rolf 2001 (as cited in Smith 2006b), if elk are present, they may browse aspen until it does not produce ramets (root sprouts) within 2-5 years. Furthermore, Bailey and Whitham (2002), also reported that after three growing seasons, elk had consumed 36 to 85 percent of aspen shoots in an unfenced burned area within a mixed conifer-ponderosa pine forest in northern Arizona. Five years after this burn, not one of seventy regeneration plots outside of elk fences showed any living aspen sprouts. Based on qualitative field observations, there are areas within this ERU on the Forest currently experiencing significant impacts due to elk, and others that are not. This was quantified by Gila NF staff and accounted for in the modeling.

Herbivory by domestic livestock has been and remains incidental in this ERU on the Gila NF as it frequently occurs on steep slopes (≥40%). Additionally, where closed canopy conditions were or are present, sufficient quantities of palatable herbaceous species to attract or hold livestock are generally absent. These steep slopes and the large percentage of this ERU occurring within designated wilderness areas (~65%), also limits the influence past timber harvest has had in this ERU on the Forest.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 13. Recall that the trend analysis is conducted at the plan scale only.

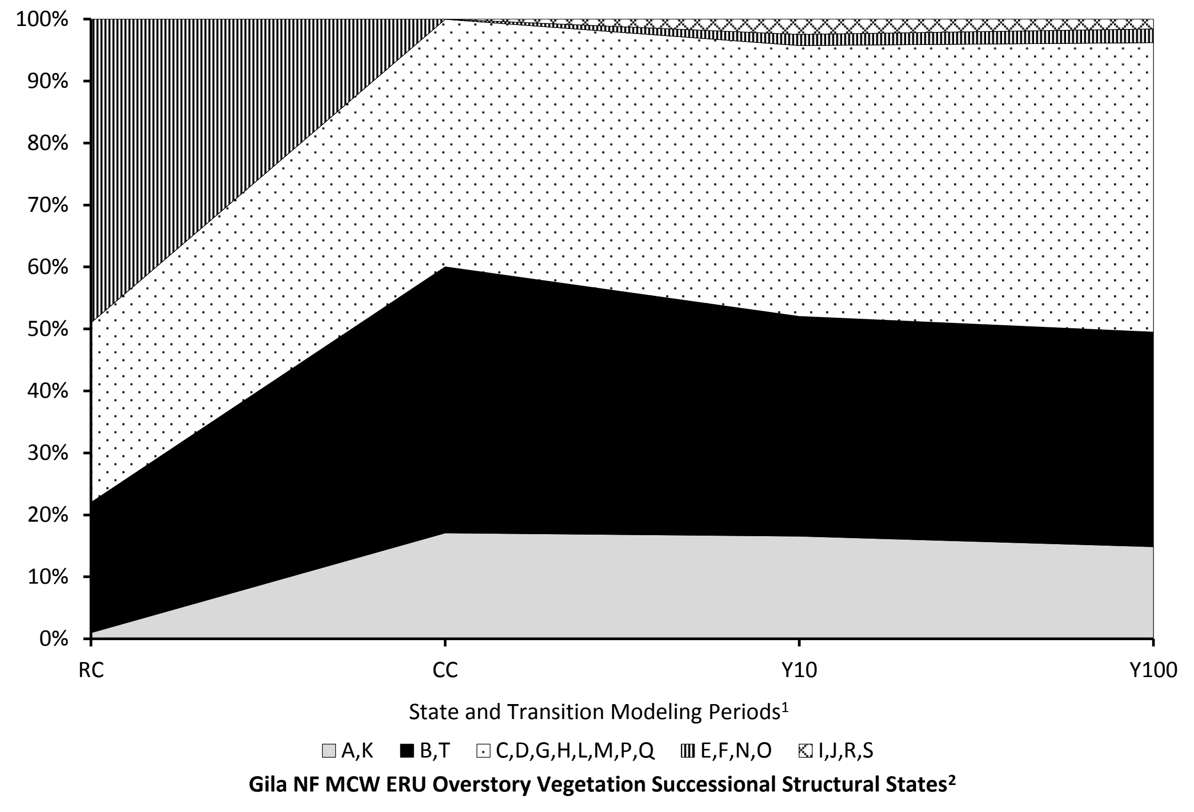

Figure 13. Gila NF overstory vegetation successional structural states for MCW ERU under reference conditions (RC), current conditions, and following state and transition modeling results at 10 and 100 years, based on current management activities

[1] RC = Reference conditions

CC = Current conditions = 49% or moderate departure from RC

Y10 = State and transition modeling results at 10 years = 47% or moderate departure form RC

Y100 = State and transition modeling results at 100 years = 47% or moderate departure from RC

[2] See Table 16 for a description of the overstory vegetation successional structural states

The VDDT modeling indicates that under current management (and the current climatic regime) existing departure in seral state proportion remains largely unchanged into the future (±5%). As reflected in the modeling inputs and briefly discussed in Chapter 11: Multiple Uses, a very small number of MCD acres are currently treated annually using fire and/or non-fire vegetation management activities in part because of limitations imposed by steep slopes (≥40%). Additionally, wilderness designations currently limit non-fire vegetation management activities.

Patch Size

Table 17. Gila NF current departure of patch size in Mixed Conifer w/Aspen

Reference Range:	100 to 400 ac.
Current Mean:	62 ac.
Departure:	Moderate

As shown in Table 17, mean patch size is currently smaller than during the reference time period due to the recent large, contiguous extents of stand replacement fire. Again, because this characteristic uses the same dataset used to assess seral state proportion, departure could be underestimated.

Coarse Woody Debris and Snag Density

Table 18. Gila NF current and projected departure of coarse woody debris in Mixed Conifer with Aspen

	Coarse Woody Debris	Departure/Trend
Reference:	30.0 T/ac.	
Current:	81.7 T/ac.	High
100-years:	81.7 T/ac.	High/Static

As shown in Table 18, there is currently nearly 3 times the amount of coarse woody debris per acre than historical evidence indicates. Past fire suppression may have contributed to the accumulation of coarse woody debris in this ERU, however, it likely had less influence in infrequent fire systems such as MCW, than in frequent fire systems such as the MCD and PPF ERUs. This is more readily explain by a combination of stand replacement fire, increased mortality due to drought as well as insects and disease, and relatively slow decomposition rates. Again, more recent drought, fire and insect and disease outbreak events that have occurred since the stand exam data was collected have altered the conditions depicted in this analysis. More current data would likely describe a different situation.

Table 19. Gila NF current and projected departure of snags in Mixed Conifer with Aspen

	Snag Density (8” dbh)	Departure/Trend	Snag Density (18” dbh)	Departure/Trend
Reference:	14.0/ac.		4.0/ac.	
Current:	27.1/ac.	High	10.2/ac.	High
100-years:	27.1/ac.	High/Static	10.2/ac.	High/Static

As shown in Table 19, there is currently nearly 2 to 2-½ times the number of snags per acre than historical evidence indicates. This is likely due to the same factors identified for increases in coarse woody debris.

Fire Regime

The Mixed Conifer w/ Aspen ecosystem is characterized by infrequent high and mixed severity fire (Romme et al. 2009a; Roccaforte 2013; Wahlberg et al. 2014). Small scale, stand replacing fire events play an important role in aspen regeneration, and upwards of 150 to 400 years for high intensity, stand replacing crown fires (Fulé et al. 2003; Swetnam et al. 2005; Vankat 2006; Vander Lee et al. 2006).

Fire Frequency

Table 20. Reference and current Gila NF fire frequency for Mixed Conifer with Aspen

Reference:	**MFRI* 150 to 400 yrs.** (FF‡ = average 120 yrs., mixed severity rotation 100 yrs., and stand replacement rotation 150 yrs.)
Current:	FF = 16 yrs.
Departure:	High

**Wahlberg et al. 2014

‡ Barrett 1988; Baisan and Swetnam 1990; Bradley et al. 1992a; Smith 2006a and 2006c; Romme et al. 2009a; Barrett et al. 2010; O'Connor et al. 2014; Wahlberg et al. 2014; Krausmann and Triepke 2014, Huffman et al. 2015; Swetnam and Falk 2015

As shown in Table 20, in the last 19 years (1996-2015), fire has occurred with much greater frequency in this system than it did historically as reflected by the high departure rating. Departure varies from high to low across the Forest's local units, with the Little Colorado-San Agustin Fringe in low departure (FF=96 yrs.), Lower Gila River in moderate departure (FF=37 yrs.), and the remaining local units in high departure with frequencies varying from 14 to 20 years. These departures are primarily the result of drought. Across the context area, departure is low (FF=257 yrs.). While the entire Southwest has been affected by drought conditions, those conditions have varied from place to place.

Fire Severity

The 19-year (1996-2015) average annual acres burned within the MCW on the Forest is 3,330 acres; roughly 47% at low severity, 22% at moderate severity and 31% at high severity. Current average fire severity lower than reference condition's 65% (Krausmann and Triepke 2014) by approximately 22 percentage points, giving it a low departure rating. Departure is moderate in the Little Colorado-San Agustin Fringe local unit where severity is 41 percentage points lower than the reference.

Both moderate and high severity are typically stand replacement type fires in the MCW on the Gila NF. Dominant conifer species in this ERU are fire sensitive, and even if mortality is not an immediate result of the fire, it frequently occurs shortly thereafter. While aspen is fire adapted, re-sprouting from its' root system, mature trees are also easily killed with very little heat.

Fire Regime Condition Class (FRCC)

Table 21. Gila NF reference FRCC and departure for Mixed Conifer with Aspen

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 85.2%	FRCC III = 0.0%	No data = 14.8%
Departure:	Moderate, Trend Static			

‡ Krausmann and Triepke 2014.

As shown in Table 21, all of this ERU for which there is data falls within the FRCC II category, indicating a moderate departure from the natural fire regime. This is also the case across all local units. Increased fire frequency and fire extent are the primary driver of FRCC departure. The context area is also moderately departed in term of FRCC, however, this is largely due to decreased fire frequency and presumably altered fuel characteristics as lower fire frequencies contribute to the accumulation of fuels.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 2,765 acres. The highest level occurred in 2013 at 28,278 acres. Overall, nearly 67% of this ERU has been affected by insect and disease activities since 1997.

The *Forest Insect and Disease History of the Gila National Forest* report (Ryerson 2015) does not differentiate between the MCD and MCW ERUs; see the MCD insect and disease section. Within the aspen component of the MCW ERU specific records of activity on the Gila NF extend only back to 1974 in available documents. However, primarily the western tent caterpillar (*Malacosoma californicum*) and the large aspen tortrix (*Choristoneura conflictana*) are the insects most often found defoliating aspen on the Gila NF. According to Ryerson (2015), this is probably due to the limited abundance of aspen on the Forest compared to other Forests in the Region and its presence in relatively remote and rugged locations such as on the Black Range. There was a widespread infection of aspen shoot blight (a fungal disease) in central and southern New Mexico in 1979. The soft bark of aspen is easily wounded by physical injury, various insects, and abiotic factors like abrupt declines winter temperatures. These wounds allow for the development of various canker diseases. Aspen is also subject to root rot. Recently, aerial surveys have detected aspen mortality throughout NM. Aspen on southerly aspects are more susceptible to drought, particularly at the lower elevational limit of its range, and entire clones may be affected on such sites. On the Gila NF, aspen mortality has been observed throughout the Forest. A total of nearly 3,800 acres has been mapped with aspen mortality over this period.

Spatial Niche

The MCW is limited at 399,406 acres (0.9%) within the context area and 73,934 (2.3%) of the Gila NF, represents the 10th largest (tied with the PJC ERU) within the context area, and 10th largest ERU on the Forest. However it has a greater proportional representation on the Forest (0.45) than in the context area (Table 22). This ERU has a moderate seral state proportion departure rating within the context area as a whole, on the Forest and in each local unit within the Forest (Table 16). In general, this ERU has gone from a normally very large (20 in. +) size tree, closed canopy nature to a more open herbaceous, smaller (< 20 in.) size-trees with a larger aspen component throughout its range within the context area.

Table 22. MCW ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	**Total ERU Area on Gila NF (column 2)**		**Total ERU Area within CA (column 3)**		**Gila NF's Contribution to Total ERU within CA (column 4)**	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
MCW	73,934	2.3	399,406	0.9	18.5	0.45

Table 23. MCW ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		**Black Range**		**Little Colorado-San Agustin Fringe**		**Lower Gila River**		**Mogollon Front**		**Upper Gila River**		**Gila NF**		**Context Area**	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	5,098	6.9	17,936	24.3	2,719	3.7	3,089	4.2	19,073	25.8	26,019	35.2	73,934	2.3	399,406	0.9
Percent seral state departure	49 Moderate		62 Moderate		50 Moderate		60 Moderate		49 Moderate		49 Moderate		49 Moderate		49 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with higher proportional representation on the Forest, its seral state proportion departure, and its rarity. The Forest has a greater influence on the ecological integrity and sustainability of the Mixed Conifer with Aspen ERU because there is more of it located on the Forest than within the context area. Both its departure and rarity heighten the

Forest's responsibility to restore and/or maintain this ERU (Table 23). Given the same degree of departure on the Forest and across the context area, the Forest is not currently well positioned to act as a refugia for MCW.

MIXED CONIFER-FREQUENT FIRE FOREST (MCD) ERU

General Description


Figure 14. MCD ERU (photo by L.J. WhiteTrifaro)

The MCD ERU (Figure 14) spans a variety of semi-mesic environments in the Rocky Mountain and Madrean Provinces. Generally, annual precipitation ranges from 16 to 32 inches, with 45-55% coming between October 1st and March 31st. In the southwestern US, mixed conifer forests may be found at elevations between 6,000 and 10,000 ft., situated between ponderosa pine, pine-oak, and/or or piñon-juniper woodlands below and wet mixed conifer and/or spruce-fir forests above. Typically these types were dominated by ponderosa pine in an open forest structure (< 30% tree canopy cover), with minor occurrence of aspen (*Populus tremuloides* Michx.), Rocky Mountain Douglas-fir, white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.), and southwestern white pine (*Pinus strobiformis* Engelm.). On contemporary landscapes, more shade tolerant conifers, such as Douglas-fir, white fir ((Gord. & Glend.) Lindl. ex Hildebr.), and blue spruce (*Picea pungens* Engelm.), tend to increase in cover in late succession, contrary to conditions under the characteristic fire regime. However, historically, these species could have achieved dominance in localized settings where aspect, soils, and other factors limited the spread of surface fire. Historic management practices including but not limited to logging, fire suppression and overgrazing have transformed many of these forests across the context area and region (Cooper 1960; Covington and Moore 1994; Lynch et al. 2000). Currently, much of this type is dominated by closed structure (> 30% tree canopy cover) and late seral species as a result of fire suppression.

Figure 15 and Figure 16 show that the majority of this ERU occurs in the northern and eastern portions of both the context area and Forest.

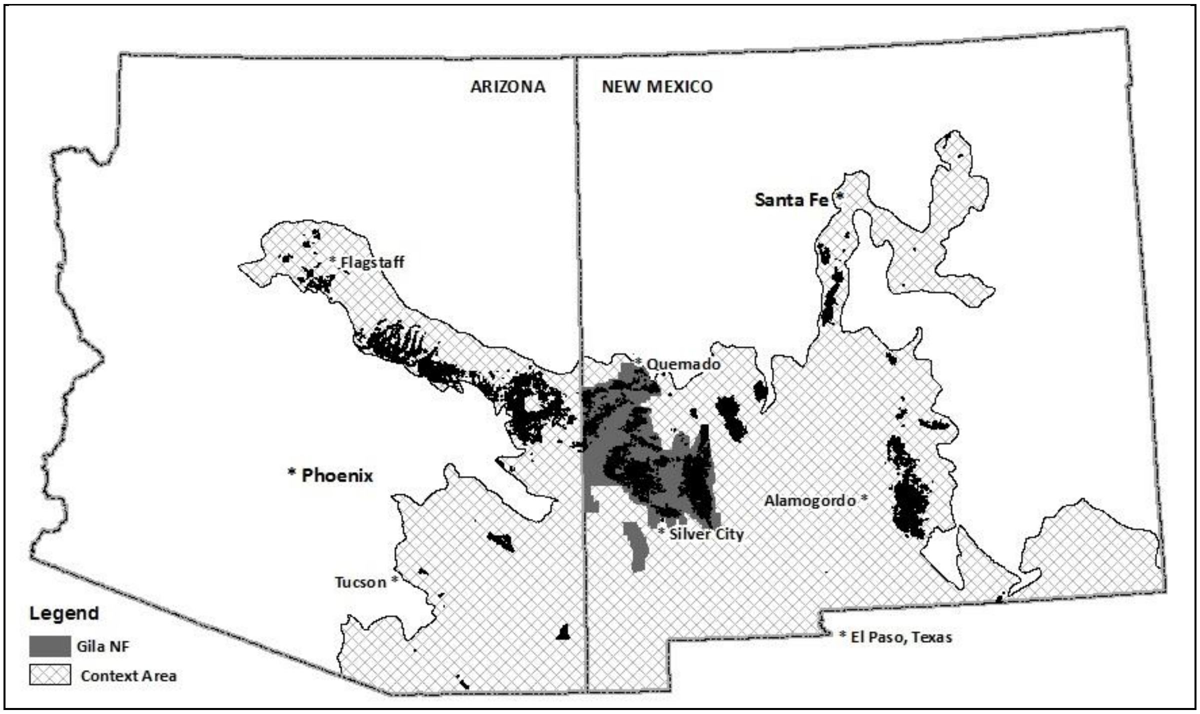

Figure 15. General location (in black) of the MCD ERU within the context area

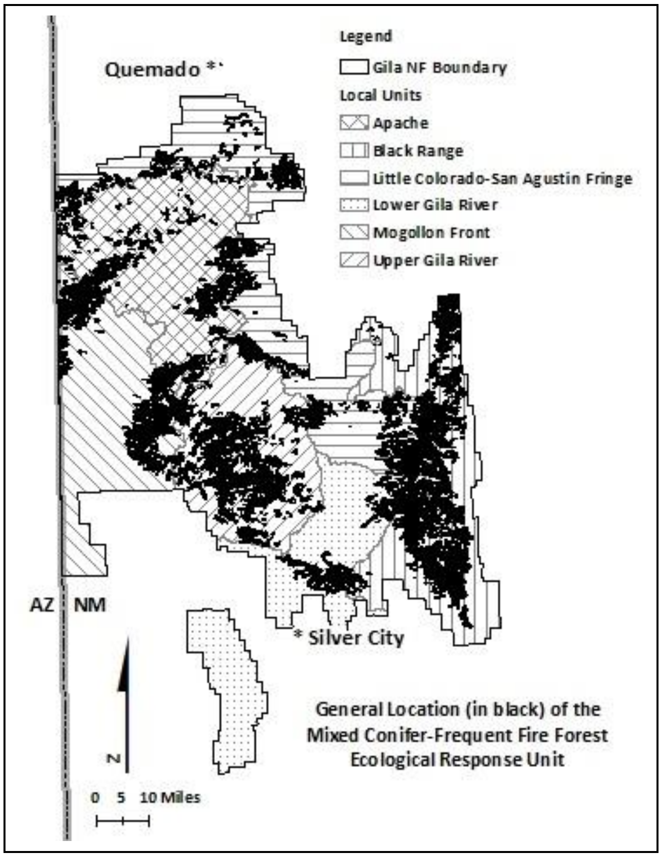

Figure 16. General location (in black) of the MCD ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the MCD ERU was comprised of multistoried, medium to very large size trees with typically an open canopy nature (Table 24). Historically these forests were dominated by shade intolerant shrub and tree species that were adapted to the open canopy characteristics.

Table 24. Seral state make-up of the MCD ERU under reference (RC) and current conditions for both the Gila NF and context area (CA).

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A, B, F, N	EARLY-SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs, seedling/sapling size (< 5” dbh/drc) trees with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	20	14	17	14	17
C	MID-SERAL: Small size (≥ 5” & < 10” dbh/drc) trees with open canopy cover	10	4	6	4	6
D, E	LATE-SERAL: Medium to very large size (≥ 10” dbh/drc) trees, single storied with open canopy cover *(occurs on contemporary landscapes, historically rare/localized)*	0	7	4	0	0
G	MID-SERAL: Small size trees with closed canopy cover	5	10	12	5	5
H, I, L, M	LATE-SERAL: Medium to very large size trees, single or uneven-aged (multi-storied) with closed canopy cover	5	57	57	5	5
J, K	LATE-SERAL: Medium to very large size trees, uneven-aged (multi-storied) with open canopy cover	60	7	5	7	5
Total		100	100	100	36	38

Departure Index Ratingǂǂ from RC = 100 - ∑ similarity values: Plan area = (100-36) = 64% = MODERATE; and Context Area = (100-38) = 62% = MODERATE

‡ Smith 2006a; LANDFIRE 2007c; USDA FS 2013b

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

ǂǂ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

At the plan and context scales, departure in seral state proportion is moderate. Most local units are also in the moderate departure category with the acception of the Apache and Little Colorado-San Agustin Fringe local units which are in high departure. However, percent departures are likely inflated to some extent due to the limitations of the available data as discussed previously. Regardless, there are currently more small to medium sized trees, and a higher degree of canopy closure in this ERU than under reference conditions. Similar to the SFF and MCW, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of SFF and MCW ERUs, also applies here.

While past timber harvest has certainly affected this ERU on the Forest, more of this ERU occurs on steep slopes (≥40%) than any other ERU, which has limited logging operations. In the early days of timber harvesting on the Gila NF, logging practices have been described by Theodore Rixon of the USGS. In his 1905 report, he described the best trees being cut in ways that endangered the remaining or adjacent stands and that some areas that have been harvested had been converted to shrublands (Rixon, 1905). Fire suppression (Covington and Moore 1992), legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock are larger contributing factors to departure than past timber harvest. Herbivory reduces fine fuels, and decreases competition between herbaceous plants in the understory and regenerating conifers, providing the competitive advantage to conifer species. Chapter 9: System Drivers and Stressors discusses these management factors and their interrelationships in greater detail.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 17. Recall that the trend analysis is conducted at the plan scale only.

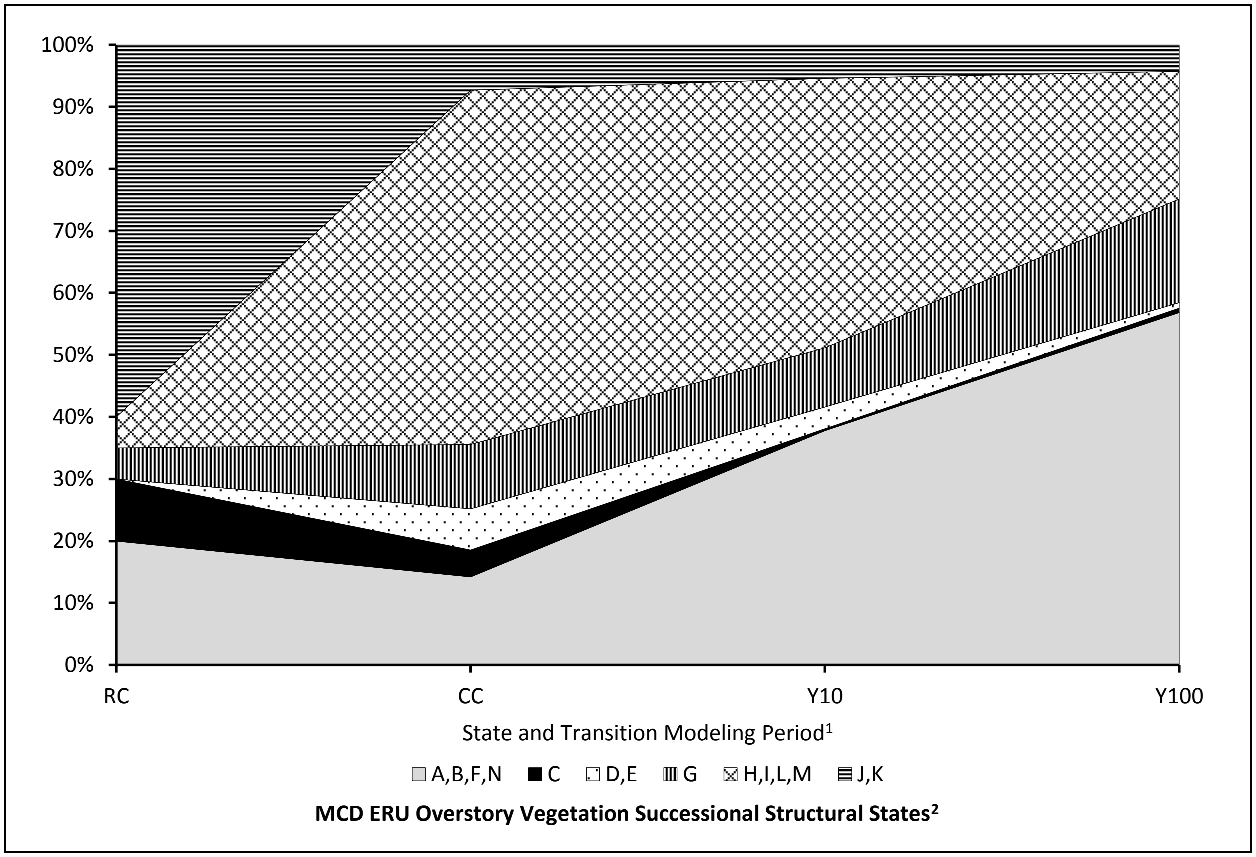

Figure 17. Gila NF overstory vegetation successional structural states for MCD ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities.

[1] RC = Reference conditions
CC = Current conditions = 64% or moderate departure from RC
Y10 = State and transition modeling results at 10 years = 64% or moderate departure from RC
Y100 = State and transition modeling results at 100 years = 65% or moderate departure from RC
[2] See Table 24 for a description of the overstory vegetation successional structural states

The VDDT modeling indicates that under current management (and the current climatic regime) existing departure in seral state proportion remains largely unchanged into the future (±5%). As reflected in the modeling inputs and briefly discussed in Chapter 11: Multiple Uses, a relatively small number of MCD acres are currently treated annually using either fire or non-fire vegetation management activities in part because of limitations imposed by steep slopes (≥40%).

Patch Size

Table 25. Gila NF current departure of patch size in Mixed Conifer-Frequent Fire

Reference Range:	0.02 to 50 ac.
Current Mean:	64 ac.
Departure:	Low

As shown in Table 25, while departure in seral state proportion reveals increases in tree densities, those increases have not been enough to create departure in mean patch size. This suggests the issue is not infill of openings, but rather understory crowding. These conditions indicate the development of ladder fuels as the primary concern. Potential shifts to the dominance of shade tolerant species, as opposed to ponderosa pine, are also likely given this analysis; but again, site specific physical environmental characteristics (e.g. slope, aspect and soils) also play a role in species composition. Species composition is discussed and analyzed as a key ecosystem characteristic in Chapter 4: Soils.

Coarse Woody Debris and Snag Density

Table 26. Gila NF current and projected departure of coarse woody debris in Mixed Conifer-Frequent Fire

	Coarse Woody Debris	Departure/Trend
Reference:	13.7 T/ac.	
Current:	59.1 T/ac.	High
100-years:	59.1 T/ac.	High/Static

As shown in Table 26, there is currently nearly 6 times the amount of coarse woody debris per acre than historically. This is likely due to the combination of past fire suppression, stand replacement fire, higher tree densities than under reference conditions and mortality due to increased competition, and drought. Slow decomposition rates also contribute.

While mortality due to insects and disease also adds coarse woody debris to the system, it is unlikely a significant contributor to departure at this time. Insects and disease, relative to this ERU are discussed under that subheading. Because some of the data used to assess this characteristic was collected prior to recent stand replacement fire, drought and insect and disease outbreaks and restoration projects (see Timber and Special Forest Products subheading in Chapter 11: Multiple Uses), values may be stronger reflection of past fire suppression and older stand replacement fires. There may actually be more or less tons per acre than this analysis depicts.

Table 27. Gila NF current and projected departure of snags in Mixed Conifer-Frequent Fire

	Snag Density (8” dbh)	Departure/Trend	Snag Density (18” dbh)	Departure/Trend
Reference:	9.0/ac.		4.0/ac.	
Current:	19.3/ac.	High	6.5/ac.	Moderate
100-years:	19.3/ac.	High/Static	6.5/ac.	Moderate/Static

As shown in Table 27, there is currently nearly 3 times the number of snags per acre than historically (Weisz et al. 2011), with the greatest increase being in the smaller size class. This is likely due to the increased densities of smaller trees (seral states G, and H, I, L, M). Additionally, the other factors contributing to departure in coarse woody debris also influence the departure in snag density.

Fire Regime

The natural fire regime of this ERU is typified by frequent, low severity non-lethal surface fire (Baisan and Swetnam 1990; Grissino-Mayer et al. 1995; Heinlein et al. 2005), though less frequent mixed severity fires also occurred (Wahlberg et al. 2014). Stand replacement fires were generally restricted to the closed canopy forest (LANDFIRE 2007c; Vander Lett et al. 2006) in relatively small patch sizes (Touchan et al. 1996). Additionally, there is evidence that high severity fire was primarily driven by topographic factors, particularly the steepness of slope (Margolis and Balmat 2009; Margolis et al. 2011).

Fire Frequency

Table 28. Reference and current Gila NF fire frequency for Mixed Conifer Frequent Fire

Reference:	**MFRI*9-22 yrs.** (FF‡ = average rotation 13 yrs. and mixed severity rotation 77 yrs.)
Current:	FF = 24.4 yrs.
Departure:	Low

*Wahlberg et al. 2014; Krausmann and Triepke 2014

‡ Baisan and Swetnam 1990; Ahlstrand 1980; Grissino-Mayer and Swetnam 1995; Heinlein et al. 2005; Smith 2006a; LANDFIRE 2007c; O'Connor et al. 2014; Huffman et al. 2015; Krausmann and Triepke 2014; Swetnam and Falk 2015

As shown in Table 28, in the last 19 years (1996-2015), fire has not occurred quite as frequently in this system as it did historically. Departure in fire frequency at the context scale is high (~257 yrs.). Departure in fire frequency is low at the plan scale and in the Upper Gila, Black Range and Mogollon Front local units. It is moderate in the Lower Gila River local unit and high in the Apache and Little Colorado-San Agustin Fringe local units with frequencies ranging from 34 to 40 years. Departure in fire frequency reflects factors that reduce the fine fuels necessary to carry fire, particularly livestock grazing as the herbaceous plants that provide forage are also the primary source of fine fuels. Fire suppression may also be a factor where Wildland Urban Interface, or other highly valued resources are at risk, when fire weather and fuel conditions do not support the achievement of the management objectives, or when resources needed to manage a particular fire are unavailable. Resources to manage fires may be unavailable when they are committed to managing or suppressing fires elsewhere.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfires within the MCD ERU on Forest is 15,051 acres; roughly 68% low severity, 20% moderate severity and 12% at high severity. Current average fire severity is higher than reference condition’s 18% (Krausmann and Triepke 2014), with a moderate departure rating. Within the Forest’s local units, departure ranges from low to high. The Upper Gila River and Little Colorado-San Agustin Fringe local units are in low departure, the Apache in moderate, and the Black Range, Lower Gila River and Mogollon Front in high departure. Possible reasons for higher severity include higher tree densities than under the reference period, coarse woody debris accumulations from past stand replacement fires and fire suppression, drought conditions and local topography.

Fire Regime Condition Class (FRCC)

Table 29. Gila NF reference FRCC and departure for Mixed Conifer-Frequent Fire

Reference:	FRCC I			
Current:	FRCC I = 25.2%	FRCC II = 67.1%	FRCC III = 0.0%	No data = 7.6%
Departure:	Moderate, Trend Static			

‡ Krausmann and Triepke 2014

As shown in Table 29, although a significant percentage of the MCD ERU has an FRCC of I, indicating the fire regime is within the natural range of variability, most of this ERU has a FRCC of II, indicating moderate departure. The context area and all local units within the Forest also have an FRCC of II. Departure in structural vegetation and fuels attributes, indicated by the seral state and coarse woody debris analyses, and higher fire severity contribute to FRCC departure. Fire frequency departure is also a factor in where they are moderate or high. Factors contributing to departure previously discussed in those analyses apply to FRCC as well.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 2,750 acres. The highest level occurred in 2001 at 13,435 acres. Overall, nearly 12% of this ERU has been affected by insect and disease activities since 1997.

The primary bark beetles in mixed conifer forests are the Douglas-fir beetle (*Dendroctonus pseudotsugae*) in Douglas-fir and the fir engraver (*Scolytus ventralis*) in white fir. Because the Douglas-fir beetle has often been considered the primary mortality agent in Douglas-fir, the role of many of the other bark beetles and woodborers has probably been underestimated (Ryerson 2015). The activity by Douglas-fir beetle specifically, increased Region-wide during the late 1950s to epidemic levels. The outbreak on the Gila NF peaked in 1958 affecting nearly 128,000 acres. Following the 1950s drought period, little bark beetle activity in Douglas-fir was recorded. As with the bark beetles in pines, attacks under endemic population levels are typically limited to injured or diseased trees. Stand density, species composition, and host tree diameter are all important factors in determining susceptibility of attack by these bark beetles (Ferrell et al. 1994; Schmitz and Gibson 1996). The limited length of records for bark beetle activity in the mixed conifer forests of the Gila NF exhibits no major changes in outbreak frequency or duration (Ryerson 2015). In southern New Mexico and on the Gila NF specifically, western spruce budworm defoliation has often been of less concern. However, an outbreak was reported in the mid-1960s with a peak in 1964 of over 40,000 acres on the Forest. Dwarf mistletoes, root diseases and broom rusts are common in the MCD ERU, but are not above endemic levels (Ryerson 2015). One interesting note: White pine blister rust, caused by the fungus *Cronartium ribicola*, is a recently introduced non-native invasive disease in the Southwestern Region and is one of the most damaging tree diseases in North America. The disease was introduced from Europe in the early 1900s. It was first detected on the Gila NF in 2005, in Johnson Canyon, south of Luna, NM. According to Ryerson (2015), eventually this disease is expected to impact white pine populations in many areas of the Southwest and may even eradicate white pine from the most susceptible sites. More information about white pine blister rust and potential management approaches is provided in Chapter 9: System Drivers and Stressors.

Spatial Niche

The MCD ERU is widespread and at roughly 1,174,058 acres (2.5%) of the context area and 396,244 acres (12.1%) of the Gila NF, represents the 3rd largest ERU on the Forest and 7th largest within the context area. It has a greater proportional representation on the Forest (0.66) than in the context area (Table 30). This ERU has a moderate seral state departure rating at the plan and context area scales (Table 24). However, the Little Colorado-San Agustin Fringe local unit within the Forest has a high departure rating. In general, this ERU has gone from a normally large (20 in. +) size tree-open canopy nature to a medium (< 20 in.) sized tree-closed canopy condition throughout its range within the context area.

Table 30. MCD ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	**Total ERU Area on Gila NF (column 2)**		**Total ERU Area within CA (column 3)**		**Gila NF's Contribution to Total ERU within CA (column 4)**	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
MCD	396,244	12.1	1,174,058	2.5	33.7	0.66

Table 31. Gila NF MCD ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		**Black Range**		**Little Colorado-San Agustin Fringe**		**Lower Gila River**		**Mogollon Front**		**Upper Gila River**		**Gila NF**		**Context Area**	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	48,327	12.2	100,020	25.2	70,947	17.9	30,165	7.6	60,984	15.4	85,801	21.7	396,244	12.1	1,174,058	2.5
Percent seral state departure	75 High		47 Moderate		74 High		62 Moderate		56 Moderate		52 Moderate		62 Moderate		62 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with higher proportional representation on the Forest. Although the MCD ERU is not particularly rare within the context area, it is relatively more common on the Forest than in the context areas as a whole; therefore the Forest has a greater influence on the integrity and sustainability of this system.

PONDEROSA PINE FOREST (PPF) ERU:

General Description

Figure 18. PPF ERU (photo by M.R. White 2002)

This ERU (Figure 18) generally occurs on loose, well-drained soils derived from igneous, metamorphic, and sedimentary parent material at elevation ranging from 6,000 to 10,000 feet. Ponderosa pine forest is typically bounded at the upper elevation by mixed conifer forest, and at the lower elevation by grasslands or piñon-juniper woodlands, although extensive intergrading of species may occur at ecotone boundaries along gradients of slope, elevation, aspect, and moisture (Moir 1993). Generally, annual precipitation ranges from 17 to 28 inches, with 45 to 55% coming between October 1st and March 31st. The dominant species in this system is ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson var. *scopulorum* Engelm. [8]). Other trees, such as Gambel oak (*Quercus gambelii* Nutt.), Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn.) Franco), twoneedle piñon pine (*Pinus edulis* Engelm.), and junipers (*Juniperus* spp. L.) may be present. There is typically a shrubby understory; such as currants/gooseberries (*Ribes* spp. L.), and buckbrush (*Ceanothus* spp. L.), mixed with a variety of grasses and forbs, such as Arizona fescue (*Festuca arizonica* Vasey), mountain muhly (*Muhlenbergia montana* (Nutt.) Hitchc.), pine dropseed (*Blepharoneuron tricholepis* (Torr.) Nash), blue grama (*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths), fleabanes (*Erigeron* spp. L.), pussytoes (*Antennaria* spp. Gaertn.), and others. This ERU sometimes occurs as savannah, depending on geomorphology, geology and soils, with extensive grasslands interspersed between widely spaced clumps or individual trees. This system is adapted to drought during the growing season, and has evolved several mechanisms to tolerate frequent, low intensity surface fires. Historic management practices including but not limited to logging, fire suppression and overgrazing have transformed many of these forests across the context area and region (Cooper 1960; Covington and Moore 1994; Lynch et al. 2000). Today many of these forests have been transformed into dense, even-aged thickets of young trees that are prone to high-intensity fire (Kaufman et al. 1990).

Figure 19 and Figure 20 show that the majority of this ERU occurs in the northern portion of both the context area and Forest.

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[8] All common names and scientific nomenclature follow USDA NRCS 2016. The PLANTS Database (http://plants.usda.gov, 2016). National Plant Data Team, Greensboro, NC 27401-4901 USA.

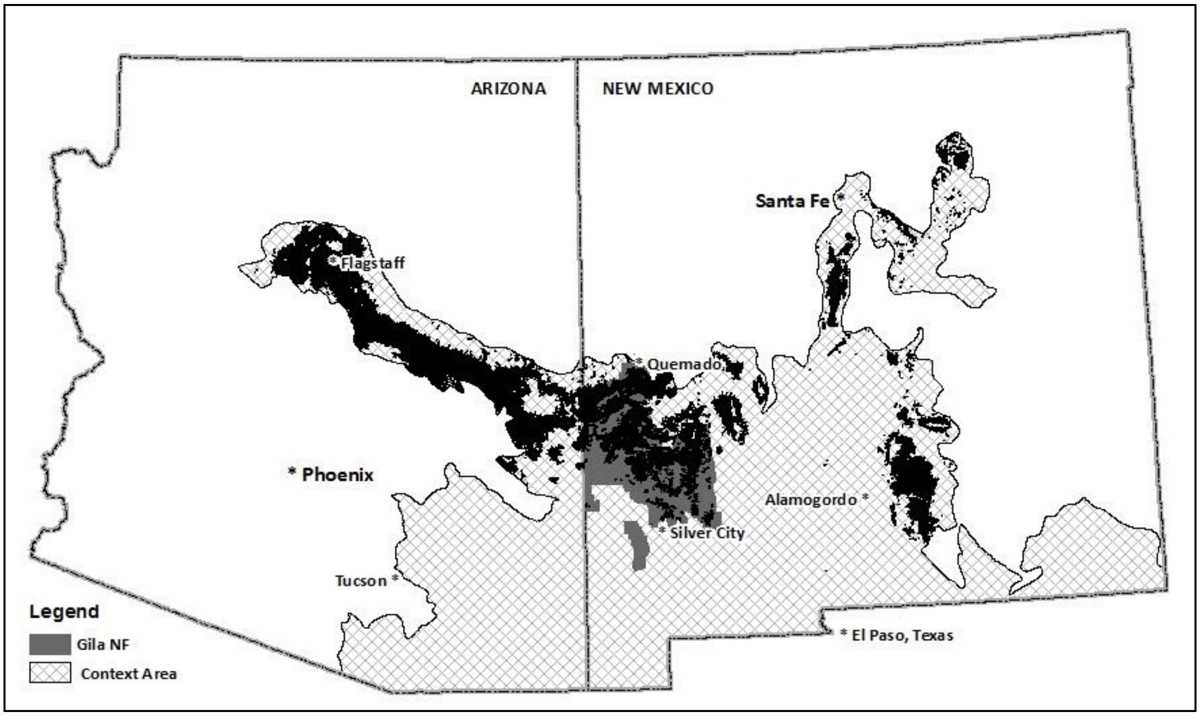

Figure 19. General location (in black) of the PPF ERU within the context area

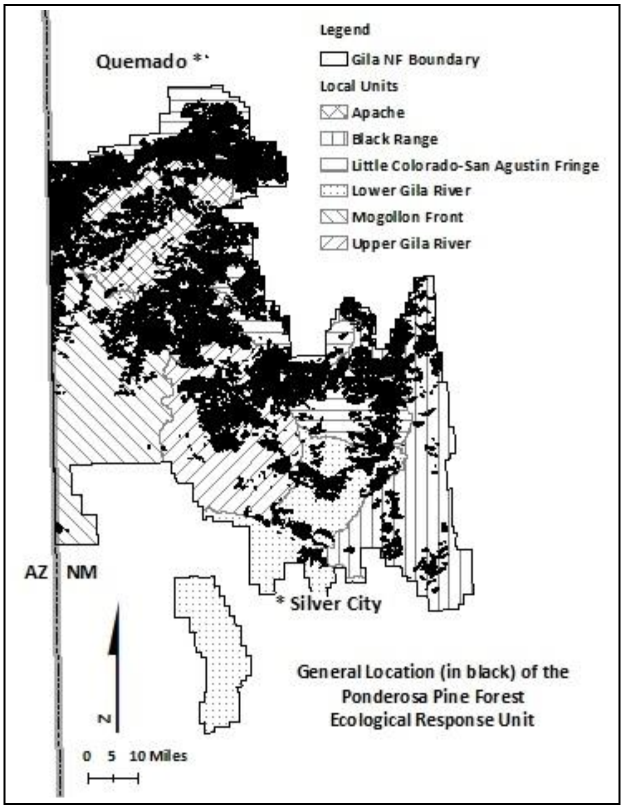

Figure 20. General location (in black) of the PPF ERU within the Gila NF and the six local units

The PPF ERU contains two subclasses:

Ponderosa Pine/Bunchgrass: This subclass makes-up roughly 54% or 340,300 acres of the PPF on the Forest. It is generally characterized by open stands supporting an understory of primarily herbaceous species, and is commonly found above the Mogollon Rim. A grassy understory, and ample needle cast/duff are the primary carriers of fire, and support frequent, non-lethal fires. The role of fire in this subclass is essential to maintain canopy openings and prevent excess young tree establishment. Common grass species include blue grama, Arizona fescue, and mountain muhly.

Ponderosa Pine/Gambel Oak: This subclass makes-up roughly 46% or 290,000 acres of the PPF on the Forest. While structurally similar to its counterpart subclass, the ponderosa pine/Gambel oak subclass is primarily distinguished by the presence of the deciduous Gambel oak in the sub-canopy. Other common species include alligator juniper (*Juniperus deppeana* Steud.), twoneedle piñon, and New Mexico locust (*Robinia neomexicana* A. Gray).

Seral State Proportion

Under reference conditions the majority of the PPF ERU was comprised of multistoried, medium to very large size trees with typically an open canopy nature (Table 32). Historically these forests were dominated by shade intolerant shrub and tree species that were adapted to the open canopy characteristics. Fire suppression has allowed the development of several younger age classes of trees and the accumulation of dead material on the forest floor (Covington and Moore 1992).

Table 32. Seral state make-up of the PPF ERU under reference condition (RC) and current conditions for both the Gila NF and context area (CA).

Seral State	**Seral State Structure, Composition and Cover Class Description**	**Percent Proportion**			**Similarity Values to RC†**	
		RCǂ	current			
			GNF	CA	GNF	CA
A, B, F, N	EARLY-SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs, seedling/sapling size (< 5" dbh/drc[9]) trees with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover *(occurs on contemporary landscapes, historically rare/localized)*	0	4	12	0	0
C	MID-SERAL: Small size (≥ 5" & < 10" dbh/drc) trees with open woody canopy cover *(occurs on contemporary landscapes, historically rare/localized)*	0	4	5	0	0
D, E	LATE-SERAL: Medium to very large size (≥ 10" dbh/drc) trees, single storied with open woody canopy cover *(occurs on contemporary landscapes, historically rare/localized)*	0	11	7	0	0
G	MID-SERAL: Small size trees with closed woody canopy cover *(occurs on contemporary landscapes, historically rare/localized)*	0	11	15	0	0
H, I, L, M	LATE-SERAL: Medium to very large size trees, single storied or uneven-aged stands (multi-storied) with closed woody canopy cover *(occurs on contemporary landscapes, historically rare/localized)*	0	61	55	0	0
J, K	LATE-SERAL: Medium to very large size trees, uneven-aged stands (multi-storied) with open woody canopy cover	100	9	6	9	6
Total		100	100	100	9	6

Departure Index Rating⧺ from RC = 100 - ∑ similarity values: Gila NF = (100-9) = 91% = HIGH; Context Area = (100-6) = 94% = HIGH

ǂ Smith 2006b; LANDFIRE 2007b; USDA FS 2015a

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

⧺ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

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[9] Diameter at breast height (dbh), tree diameter in inches outside bark at breast height (4-½ feet aboveground) on uphill side. All timber species are measured at dbh. Diameter at root collar (drc), tree diameter in inches outside bark at root collar or at the point nearest the ground line (whichever is higher). For multi-stemmed trees, drc is calculated from an equation that incorporates the individual stem measurements. All woodland species are measured at drc (Morgan et al. 2005).

At the plan scale, departure in seral state proportion is high. All local units are also in the high departure category. However, percent departures are likely inflated to some extent due to the limitations of the available data as discussed previously in the Key Charcteristitics, Data and Analysis Methods subsection. Regardless, there are currently more small to medium sized trees, fewer large to very large trees, and a higher degree of canopy closure in this ERU than under reference conditions. Similar to the other forested ERUs on the Gila, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of the previous forested ERUs, also applies here.

These conditions have resulted from the cumulative effects of past timber harvest practices, fire suppression, legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock as described previously in the discussion of seral state proportion for MCD. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail. Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 21. Recall that the trend analysis is conducted at the plan scale only.

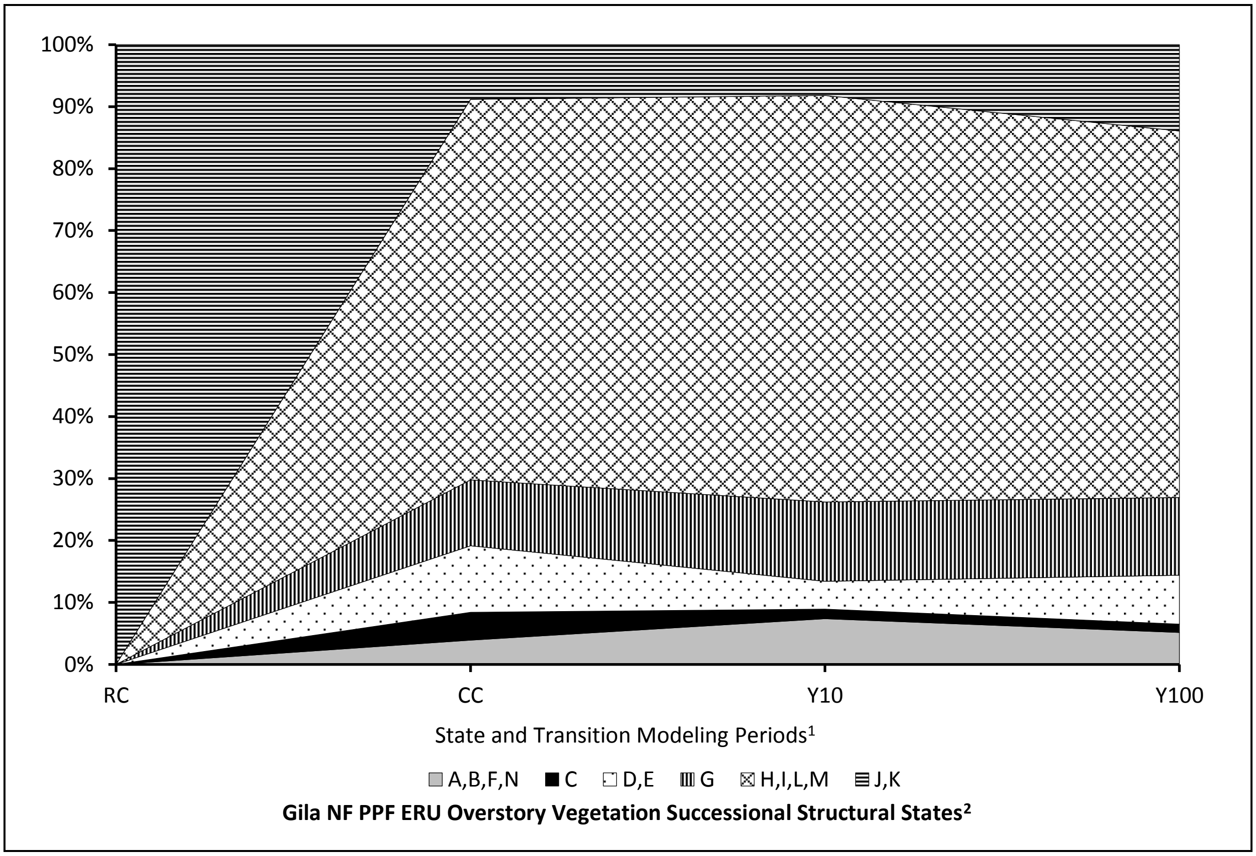

Figure 21. Gila NF overstory vegetation successional structural states for PPF ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities.

[1] RC = Reference conditions
CC = Current conditions = 91% or high departure from RC
Y10 = State and transition modeling results at 10 years = 89% or high departure from RC
Y100 = State and transition modeling results at 100 years = 86% or high departure from RC
[2] See Table 32 for a description of the overstory vegetation successional structural states

The VDDT modeling indicates that under current management (and the current climatic regime) existing departure in seral state proportion remains largely unchanged into the future (±5%). As reflected in the modeling inputs and briefly discussed in Chapter 11: Multiple Uses, most restoration emphasis and related fire and non-fire vegetation management activities occur in the Ponderosa Pine Forest and the Ponderosa Pine-Evergreen Oak ERUs. Considering the degree of departure, this may have significant implications both forest plan and project level management direction, and/or be indicative of a need to better understand and consider the local physical ecosystem factors (e.g. slope, aspect, geology, and soil characteristics) influencing vegetation structure that are not well accounted for in the current scientific literature.

Patch Size

Table 33. Gila NF current departure of patch size in Ponderosa Pine Forest

Reference Range:	0.02 to 1 ac.
Current Mean:	71 ac.
Departure:	High

This increase in patch size shown in Table 33 is likely due to the infill of open spaces and increased densities of trees less than 20 inches in diameter (seral states D, E, G, and H, I, L, M). These conditions have resulted from the the same factors influencing departure in seral state proportion. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail.

Coarse Woody Debris and Snag Density

Table 34. Gila NF current and projected departure of coarse woody debris in Ponderosa Pine Forest

	Coarse Woody Debris	Departure/Trend
Reference:	9 T/ac.	
Current:	35.1 T/ac.	High
100-years:		High/Static

As shown in Table 34, there is currently nearly 4 times the amount of coarse woody debris per acre than the science indicates is necessary for ecological sustainability (Graham et al. 1994). This is likely due to the combination of historic fire suppression, higher tree densities than under reference conditions and mortality due to increased competition and drought, as well as slow decomposition rates. While mortality due to insects and disease also adds coarse woody debris to the system, it is unlikely a significant contributor to departure at this time. Insects and disease, relative to this ERU are discussed under that subheading. Because the data used to assess this characteristic has wide ranging dates of collection, it may not accurately reflect all the restoration work that has been done in the PPF on the Forest.

Table 35. Gila NF current and projected departure of snags in Ponderosa Pine Forest

	Snag Density (8” dbh)	Departure/Trend	Snag Density (18” dbh)	Departure/Trend
Reference:	1.1/ac.		0.8/ac.	
Current:	5.9/ac.	High	1.5/ac.	High
100-years:		High/Static		High/Static

As shown in Table 35, there is currently nearly 2 to 5 times the number of snags per acre than historically (Sanchez-Meador et al. 2008). While all of the factors contributing to departure in coarse woody debris likely influence this characteristic as well, the primary factor contributing to the increase in snags is likely mortality due to drought and increased competition.

Fire Regime

In PPF ERU systems, the ponderosa pine/bunchgrass subclass supports a predominantly grass understory. Open canopy overstory results in an understory dominated by healthy, vigorous grasses, sedges and forbs providing a generally continuous fine fuels layer, except where site specific conditions, such as soils limit the understory. These structural vegetation characteristics and gentle topography support low severity fire, facilitate fire spread and flame lengths sufficient to kill conifer regeneration and maintain both over and understory structure. Frequent, low severity fire also maintained open canopy conditions (Merriam and Stejneger 1890; Woolsey 1911; Shreve 1915).

A more robust shrub component in the PPF ERU ponderosa pine/Gambel oak subclass historically supported mixed severity fire (NIFTT 2010; Wahlberg et al. 2014) which also maintained over and understory structure. Stand replacement fires were generally restricted to the closed canopy forest. Topography (aspect, substrate depth, slope, position, etc.) exerted strong control over fire behavior producing spatially and temporally mixed severity regimes (LANDFIRE 2007b).

Fire Frequency

Table 36. Reference and current Gila NF fire frequency for Ponderosa Pine Forest

Reference:	**MFRI*0-35 yrs.** (FF‡ = non-lethal rotation 10.5 yrs.)
Current:	FF = 40 yrs.
Departure:	Low

*Wahlberg et al. 2014; Krausmann and Triepke 2014

‡ Swetnam and Dieterich 1985; Crane and Fischer 1986; Barrett 1988; Bradley et al. 1992a and 1992b; Brown 1994; Baisan and Swetnam 1995; Morgan et al. 1996; Brown 2000; Sneed et al. 2002; Muldavin et al. 2003; Schussman et al. 2006; Smith 2006b; Abella and Fulé 2008; O'Connor et al. 2014; Krausmann and Triepke 2014; Swetnam and Falk 2015

As shown in Table 36, in the last 19 years (1996-2015), fire has not occurred quite as frequently, on average, in this system as it did historically, however departure at the plan scale is low. Departure is also low in the Black Range (FF=33 yrs.) and Upper Gila River (FF=13 yrs.) local units. On the other hand, it is moderate in the Lower Gila River local unit (FF=52 yrs.) and high in the Mogollon Front (FF=118 yrs.), Little Colorado-San Agustin Fringe (FF=68 yrs.) and Apache (FF=71 yrs.) local units. Departure in fire frequency is also high at the context scale (FF=295 yrs.). Restoring fire as a natural ecological process has been a management priority over the last 19 years, particularly in the PPF and PPE ERUs. Departure in fire frequency reflects factors that reduce the fine fuels necessary to carry fire, particularly livestock grazing as the herbaceous plants that provide forage are also the primary source of fine fuels. Fire suppression may also be a factor where Wildland Urban Interface, or other highly valued resources are at risk, when fire weather and fuel conditions do not support the achievement of the management objectives, or when resources needed to manage a particular fire are unavailable. Resources to manage fires may be unavailable when they are committed to managing or suppressing fires elsewhere.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfires within the PPF ERU on Forest is 15,677 acres; roughly 89% at low severity, 9% at moderate severity and 2% at high severity. Current fire severity is lower than reference condition’s 13% (Schussman et al. 2006; Krausmann and Triepke 2014), but within the natural range of variation (low departure) at the plan and local scales. Generally, fire has burned mostly at low severity levels, consistent with severity during the reference period. Lower severity may be the result of fall burning, when fuel moistures are higher and severities are expected to be lower. Burning after mechanical thinning or fuel reduction projects could also result in lower severity, as might a series of fires in the same location where pine needles are the primary fine fuel and haven't had sufficient time to accumulate between fires. All of these scenarios occur on the Forest.

Fire Regime Condition Class (FRCC)

Table 37. Gila NF reference FRCC and departure for Ponderosa Pine Forest

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 14.3%	FRCC III = 76.0%	No data = 9.7%
Departure:	High, Trend Static			

ǂ Krausmann and Triepke 2014

As shown in Table 37, most of this ERU has a FRCC of III (76%), indicating high departure. With low departure in fire frequency and severity at the plan scale, this FRCC departure is wholly attributable to departure in seral state proportion. As discussed previously, seral state proportion departure in PPF is inflated due to limitations of the data available to describe the reference condition. The importance and influence of local physical ecosystem characteristics such as slope, aspect, geology and physical and chemical soil characteristics, are not well described in the literature. However, these ecosystem characteristics strongly influence vegetation structure in PPF on the Forest.

The context area and all local units also have an FRCC of III, except the Upper Gila River local unit which has an FRCC of II. Fire frequency departure is another contributing factor to departure in FRCC in all local units except Black Range and Upper Gila River.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 6,613 acres. The highest level occurred in 2003 at 50,741 acres. Overall, nearly 19% of this ERU has been affected by insect and disease activities since 1997.

There are several species of bark beetles that attack ponderosa pines in the Southwest. The primary species on the Gila NF are: the western pine beetle (*Dendroctonus brevicomis*), the roundheaded pine beetle (*Dendroctonus adjunctus*), numerous species of ips engravers (*Ips* spp.), and less commonly the red turpentine beetle (*Dendroctonus valens*) and the larger Mexican pine beetle (*Dendroctonus approximatus*). Extensive outbreaks of ponderosa pine bark beetles in the Southwest are primarily triggered and sustained by extended drought. Drought-stress appears to make trees more vulnerable to bark beetle attacks, perhaps due to reduced defense capability. Additionally, dense, crowded stand conditions can contribute to greater levels of tree mortality during outbreaks because of tree-to-tree competition for available moisture which increases stress and decreases plants overall ability to resist insect attacks. Southwestern dwarf mistletoe (*A. vaginatum* ssp. *cryptopodum*), a parasitic plant, is the most damaging pathogen of ponderosa pine on the Gila NF. Surveys in the mid-1980s found 40% of the ponderosa pine on the Gila NF was infected (Maffei et al. 1987), which was slightly higher than the Regional average observed (36%) and higher than results from a survey conducted by Andrews and Daniels in the 1950s. Dwarf mistletoes are a persistent, chronic infection, and the overall incidence (acres affected) changes only slightly from year to year. Horizontal spread through forest stands averages one to two feet per year due to the slow development of mistletoe shoots and explosively dispersed seed (Hawksworth 1961). Dwarf mistletoes usually have a patchy distribution within infested stands and across the landscape. Root diseases typically occur at low levels in ponderosa pine stands in the Southwest, but can be more severe in localized areas. Dwarf mistletoe stressed-trees are much more susceptible to insects, disease and mortality especially when exacerbated by drought. In general, root diseases reduce tree growth and longevity, often resulting in small forest openings. For more information see Ryerson (2015).

Spatial Niche

The PPF is widespread and at 3,805,078 acres (8.1%) within the context area and 630,280 acres (19.3%) of the Gila NF, represents the second largest ERU within both the context area and Forest. The Gila NF represents approximately 17% of the total ERU acres within the context area. However, it has a greater proportional representation on the Forest (0.41) than in the context area (Table 38). This ERU has a high departure in seral state proportion at all scales (Table 32). In general, this ERU has gone from a normally large (20 in. +) size tree-open canopy nature to a medium (< 20 in.) sized tree-closed canopy condition throughout its range within the context area.

Table 38. PPF ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	**Total ERU Area on Gila NF (column 2)**		**Total ERU Area within CA (column 3)**		**Gila NF's Contribution to Total ERU within CA (column 4)**	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
PPF	630,280	19.3	3,805,078	8.1	16.6	0.41

Table 39. PPF ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		**Black Range**		**Little Colorado-San Agustin Fringe**		**Lower Gila River**		**Mogollon Front**		**Upper Gila River**		**Gila NF**		**Context Area**	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	219,333	34.8	62,032	9.8	197,615	31.4	28,408	4.5	32,647	5.2	90,245	14.3	630,280	19.3	3,805,078	8.1
Percent seral state departure	89 High		85 High		91 High		96 High		92 High		94 High		91 High		94 High	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with both its higher proportional representation on the Forest and the high departure ratings at all scales (Table 39). Although PPF is not rare, it is relatively more common on the Forest than in the context areas as a whole; therefore the Forest has a greater influence on the integrity and sustainability of this system. The degree of departure in seral state proportion at all scales heightens the management responsibility of the Forest.

PONDEROSA PINE-EVERGREEN OAK (PPE) ERU

General Description

Figure 22. PPE ERU (photo by M.R. White 2002)

The PPE ERU (Figure 22) occurs in the mild climate gradients of central and southern Arizona and in southern New Mexico, particularly below the Mogollon Rim, where warm summer seasons and bi-modal (winter-summer) precipitation regimes are characteristic. Generally, annual precipitation ranges from 13 to 25 inches, with 40-45% coming between October 1st and March 31st. This ecological type occurs at elevations ranging from 5,500 to 7,200 feet, on sites slightly cooler-moister than the Madrean Piñon-Oak ERU, and with a much greater plurality of ponderosa pine. This system is dominated by ponderosa pine and can be distinguished from the PPF ERU by well-represented evergreen oaks (e.g., Emory oak (*Quercus emoryi* Torr.), Arizona white oak, silverleaf oak, gray oak (*Quercus grisea* Liebm.)), alligator juniper, and piñon pine. Though not an indicator in the ponderosa pine life zone, border piñon (*Pinus discolor* D.K. Bailey & Hawksw.), along with oneseed juniper (*Juniperus monosperma* (Engelm.) Sarg.) can occur as a dominant or codominant component of the PPE ERU. In terms of disturbance, the PPE averaged greater fire severity than the PPF above the Mogollon Rim, and greater patchiness with less horizontal uniformity and more even-aged conditions. Site potential, fire history, and the importance of perennial grasses versus shrubs in the understory vary on a gradient between two provisional subclasses (described below). Understory shrubs include manzanita (*Arctostaphylos* spp. Adans.), Sonoran scrub oak (*Quercus turbinella* Greene), skunkbush sumac (*Rhus trilobata* Nutt.), and mountain mahogany (*Cercocarpus montanus* Raf.). Historic management practices including but not limited to logging, fire suppression and overgrazing have transformed many of these forests across the context area and region (Barton 1995, 1999, 2002; Swetnam and Baisan 1996; Arno 2000; Brown and Smith 2000).

Figure 23 and Figure 24 show the majority of this ERU occurs within the central portion of the context are and throughout the Forest.

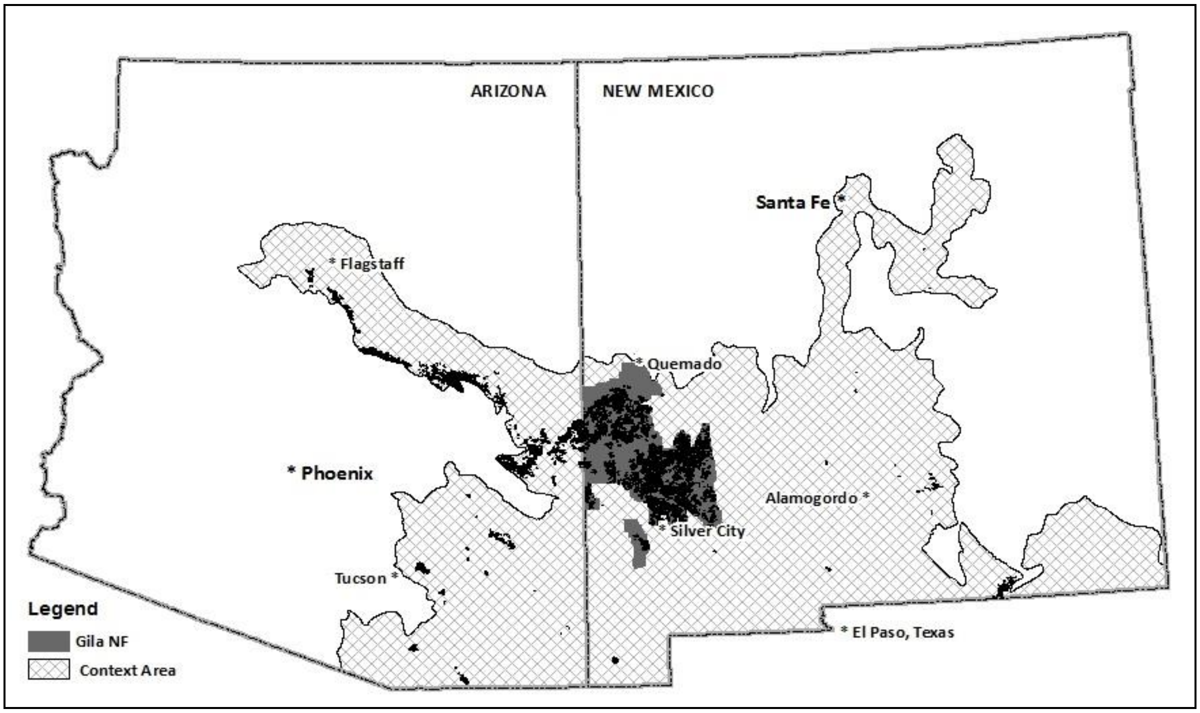

Figure 23. General location (in black) of the PPE ERU within the context area

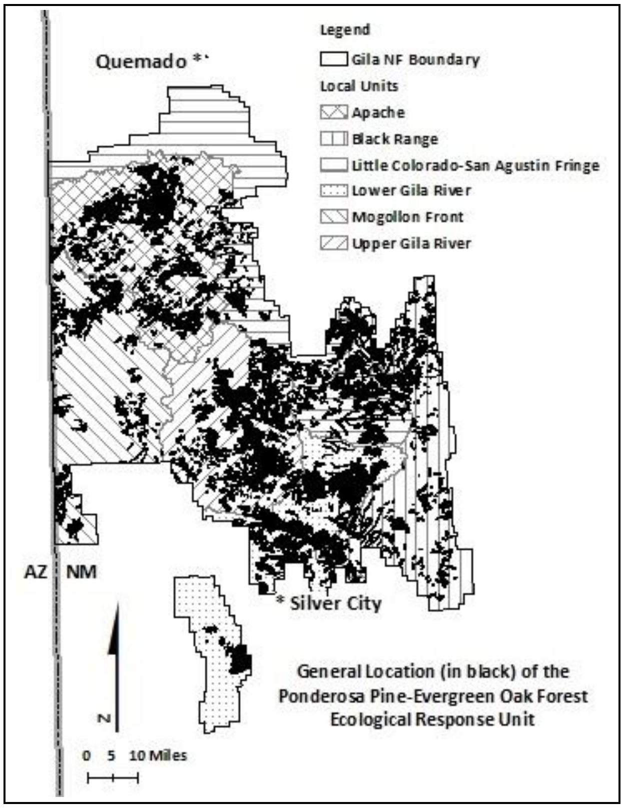

Figure 24. General location (in black) of the PPE ERU within the Gila NF and the six local units

The PPE ERU contains two subclasses:

> *Ponderosa Pine-Evergreen Oak (Perennial Grass Subclass)*: This subclass is distinguished from the Ponderosa Pine–Evergreen Shrub subclass (described below) by a more continuous layer of perennial grasses in the understory and a relatively minor shrub component. These circumstances may be less evident in the current condition depending on the degree of shrub encroachment. Trees occur as individuals or in smaller groups and range from young to old, but were historically more uneven-aged in structure. The understory is dominated by low to moderate density shrubs, with herbaceous plants in the interspaces. Common grass species include sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), hairy grama (*B. hirsuta* Lag.) a variety of muhly's (e.g. *Muhlenbergia longiligula* Hitchc., *M. dubia* Fourn. ex Hemsl., and *M. torreyi* (Kunth) Hitchc. ex Bush). Fire frequency varied, but averaged higher with less severity. These disturbance patterns create and maintain the uneven-aged (grouped) low to moderately-closed canopy nature of this type. Site potential and disturbance history also maintained oak, juniper, and piñon as subdominant tree components, with herbaceous plants in the interspaces.
>
> *Ponderosa Pine-Evergreen Oak (Evergreen Shrub Subclass)*: This subclass differs from the former subclass, typically favoring moderate to high shrub cover, limited grass cover, higher fire severity, and more even-aged conditions characteristic of mixed-severity fire regimes. This type is found on well-drained soils, frequently with coarse-textured or gravelly (stony) soil characteristics, that favor shrub layer development (particularly oaks). Trees occur as individuals or in small groups and patches and range from young to old, but typically groups or patches are even-aged in structure.

Seral State Proportion

Under reference conditions the majority of the PPE ERU was comprised of multistoried, medium to very large size trees with typically an open canopy nature. Historically these forests were dominated by shade intolerant shrub and tree species that were adapted to the open canopy characteristics. Reference conditions for seral state proportion are taken from The Nature Conservancy's Madrean Pine-Oak Woodlands model (Shussman and Gori 2006).

Table 40. Seral state make-up of the PPE ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC[1]	current			
			GNF	CA	GNF	CA
A	EARLY-SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	4	3	3	3	3
B	MID-SERAL: Small size (≥ 5" & < 10" dbh/drc) trees with closed woody canopy cover	3	12	18	3	3
C	MID-SERAL: Small size trees with open woody canopy cover	24	8	6	8	6
D	LATE-SERAL: Medium to very large size (≥ 10" dbh/drc) trees, single-storied or uneven-aged (multi-storied) with open woody canopy cover	60	20	10	20	10
E	LATE-SERAL: Medium to very large size trees, single-storied or uneven-aged (multi-storied) with closed woody canopy cover	4	53	60	4	4
F	EARLY-SERAL: Seedling/sapling size (< 5" dbh/drc) trees with open or closed woody canopy cover	5	4	3	4	3
Total		100	100	100	42	29

Departure Index Rating‡‡ = 100 – ∑ similarity values: Gila NF = (100 – 42) = 58 = MODERATE; and Context Area = (100 – 29) = 71 = HIGH

‡ Schussman and Gori 2006; USDA FS 2010b

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

‡‡ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

As shown in Table 40, at the plan and context scale, departure in seral state proportion is moderate. All local units within the plan area are also in moderate departure with the exception of the Lower Gila River local unit which is in high departure. The majority of the PPE ERU consists of medium size trees, single or multi-storied with closed woody canopy cover. Currently there is a sizeable over representation of small and medium size trees, single or multi-storied with closed woody canopy cover (seral states B, E) and a significant under representation of medium to very large size trees, multi-storied with open woody canopy cover (seral states C, D). Similar to the other forested ERUs on the Gila, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of the previous forested ERUs, also applies here.

These conditions have resulted from the cumulative effects of past timber harvest practices, fire suppression, legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail. Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 25. Recall that the trend analysis is conducted at the plan scale only.

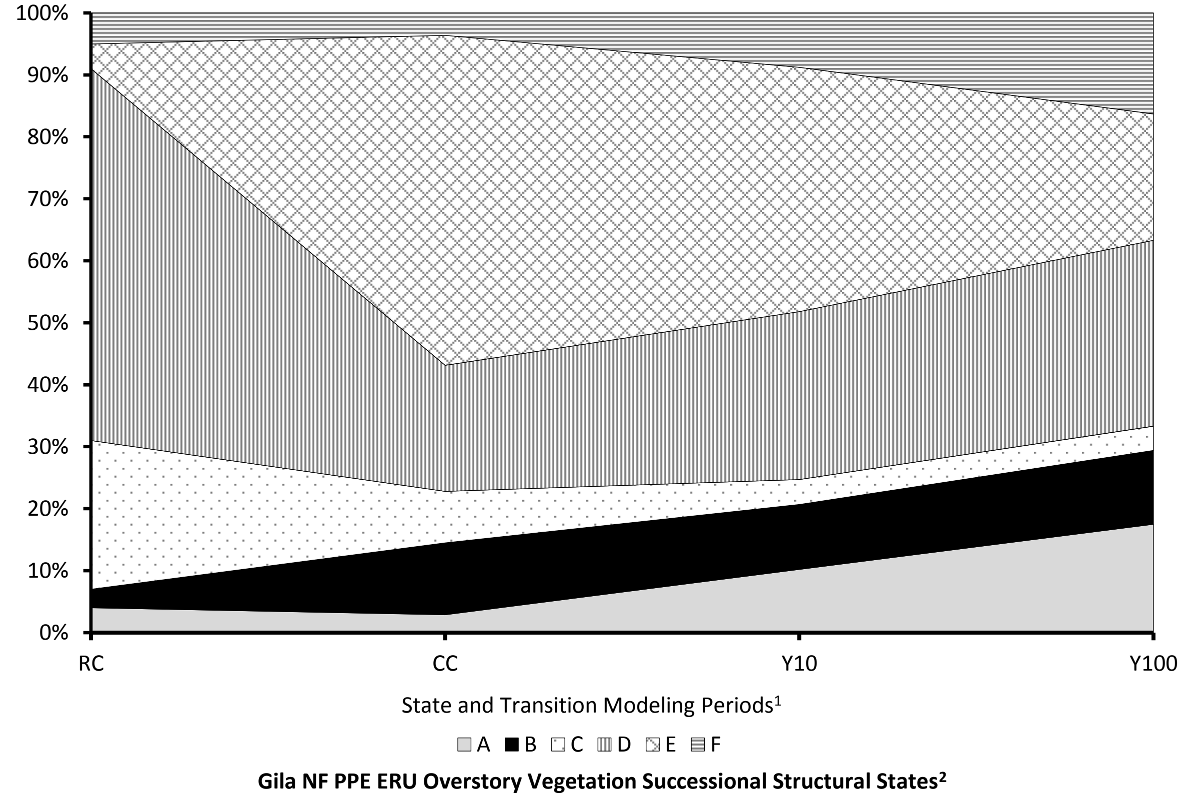

Figure 25. Gila NF overstory vegetation successional structural states for PPE ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions

CC = Current conditions = 58% or moderate departure from RC

Y10 = State and transition modeling results at 10 years = 53% or moderate departure from RC

Y100 = State and transition modeling results at 100 years = 50% or moderate departure from RC

[2] See Table 40 for a description of the overstory vegetation successional structural states

The VDDT modeling indicates that under current management (and the current climatic regime) existing departure in seral state proportion improves by approximately eight percentage points, with a slight increase in early seral states and a corresponding decrease in mid and late seral states. As reflected in the modeling inputs and briefly discussed in Chapter 11: Multiple Uses, most restoration emphasis and related fire and non-fire vegetation management activities occur in the PPF and PPE ERUs. However, it is curious that current management is apparently moving this ecosystem toward the reference, but is not having a measurable impact on vegetation structure in the PPF. Better understanding and consideration of local physical ecosystem factors (e.g. slope, aspect, geology soil characteristics) influencing vegetation structure not well described in the current scientific literature, may increase the effectiveness of restoration efforts in these ERUs.

Patch Size

Table 41. Gila NF current departure of patch size in Ponderosa Pine Evergreen Oak

Reference Range:	0.02 to 50 ac.
Current Mean:	34 ac
Departure:	Low

As shown in Table 41, patch size departure is low in the PPE ERU. With the increase in smaller trees and shrubs and degree of canopy closure indicated by high departure in seral state proportion, low departure in patch size may depict increased density within patches, rather than infill of openings. However, additional information from field investigations would be required to confirm or disprove this interpretation.

Coarse Woody Debris and Snag Density

Table 42. Gila NF current and projected departure of coarse woody debris in Ponderosa Pine Evergreen Oak

	Coarse Woody Debris	Departure/Trend
Reference:	4.0 T/ac.	
Current:	23.8 T/ac.	High
100-years:	23.8 T/ac.	High/Static

As shown in Table 42, currently, there is nearly 6 times the amount of coarse woody debris per acre than historically (Weisz et al. 2011). This is likely due to the combination of historic fire suppression, higher tree densities than under reference conditions and mortality due to increased competition and drought, as well as slow decomposition rates. While mortality due to insects and disease also adds coarse woody debris to the system, it is unlikely a significant contributor to departure at this time. Insects and disease, relative to this ERU are discussed under that subheading. Because the data used to assess this characteristic has wide ranging dates of collection, it may not accurately reflect all the restoration work that has been done in the PPE on the Forest.

Table 43. Gila NF current and projected departure of snags in Ponderosa Pine Evergreen Oak

	Snag Density (8" dbh)	Departure/Trend	Snag Density (18" dbh)	Departure/Trend
Reference:	6.0/ac.		1.0/ac.	
Current:	6.4/ac.	Low	1.5/ac.	Moderate
100-years:	6.4/ac.	Low/Static	1.5/ac.	Moderate/Static

As shown in Table 43, there is currently nearly 1 to 1-½ times the number of snags per acre than historically (Weisz et al. 2011). While all of the factors contributing to departure in coarse woody debris likely influence this characteristic as well, the primary factor contributing to the increase in snags is likely mortality due to drought and increased competition.

Fire Regime

The PPE ERU supported a range of fire regimes. Frequent, low intensity fire was historically typical of this ERU where it supports a predominantly grassy understory, similar to the PPF ERU. In systems with a more robust shrub component, fires were historically mixed severity and occurred less frequently, similar to woodland systems such as the Madrean Piñon-Oak Woodland ERU. Frequent low intensity surface fires allow fire resistant pines to dominate a site and maintain an open stand structure. Additionally, short fire-free periods, between 20 and 30 years in length, are necessary to allow for periodic pine regeneration (Barton et al. 2001).

Given the Madrean influence on the floristics of the ERU, it is worth noting that relatively little is known, about the role of fire in the Madrean vegetation that covers portions of the mountains in southern New Mexico (Ffolliott et al. 1996). According to LANDFIRE (2007c), the fire regime of this ecological system is almost completely unknown. It would seem that fire occurrence was determined primarily by fire occurrence in the surrounding matrix vegetation, and was ignited by lightning (Gottfried et al. 1995) during early summer (LANDFIRE 2007c). However, McPherson and Weltzin (2000) and Barton (2002), reported that this ecosystem was characterized by frequent, moderate-intensity fire during presettlement times. This system is likely predisposed to stand-replacement fires during the earliest stage of stand development. Replacement fires are assumed to have occurred every century or so, and mixed severity fires slightly less frequently (LANDFIRE 2007c).

Fire Frequency

Table 44. Reference and current Gila NF fire frequency for Ponderosa Pine Evergreen Oak

Reference:	**MFRI*2-200+ yrs.** (FF‡ = average rotation = 12.5 yrs., non-lethal rotation = 6.6 yrs., and mixed severity rotation = 110 yrs.)
Current:	FF = 36 yrs.
Departure:	Low

*Barrett et al. 2010; Wahlberg et al. 2014; Krausmann and Triepke 2014

‡ Baisan and Swetnam 1990; Swetnam et al. 1992; Kaib et al. 1996; Kaib 2001; Schussman and Gori 2006, Abella and Fulé 2008; LANDFIRE 2007b, 2008a; Krausmann and Triepke 2014; Swetnam and Falk, 2015

As shown in Table 44, in the last 19 years (1996-2015), average fire frequencies at the plan scale are similar to what is known about the reference period for those systems with a predominantly grassy understory (perennial grass subclass) but may be too frequent for those systems with a predominately shrubby understory (evergreen shrub subclass) which naturally tend to lower fire frequencies (less often) and mixed severity. Where fire occurs frequently in the evergreen shrub subclass of this ERU on the Forest, increasing densities of oak and juniper species are often observed. This is also the case for any management activity that decreases overstory canopy cover where oak and/or juniper species are present (see Chapter 9: System Drivers and Stressors for additional discussion of these dynamics). Fire frequency departure is also low within the context area (FF=219 yrs.) and all local units (FF range between 13 and 166 yrs.) However, fire frequencies in the context area may not be frequent enough in the perennial grass subclass or in the Forest's Apache, Lower Gila or Mogollon Front local units. Fire frequencies in the Black Range, Little Colorado-San Agustin Fringe and Upper Gila River local units may be too frequent for the evergreen shrub subclass. Site specific evaluation and differentiation between the two subclasses is particularly important to inform fire management in this ERU. These differences in subclass fire regimes add to the uncertainty associated with departure in fire frequency. Of course, some of this may simply be due to patterns natural ignitions during the time frame used in the analysis.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfires within the PPE ERU on Forest is 10,632 acres; roughly 85% at low severity, 12% at moderate severity and 2% at high severity. Current average fire severity at the plan scale higher (~19%) than reference condition's 15% (Krausmann and Triepke 2014), but still within the low departure category. Fire severities are also higher in all local units to varying degrees with Mogollon Front in high departure (~73% avg. severity), Black Range in moderate departure (~22%) and the remaining local units in low departure with average severities ranging from approximately 15% to 26%. Generally, fire has burned at low severity levels within the PPE ERU. Average severities higher than the reference, may indicate the presence of a stronger oak component and/or increased tree and/or shrub densities as compared to the reference condition.

Fire Regime Condition Class (FRCC)

Table 45. Gila NF Reference FRCC and Departure for Ponderosa Pine-Evergreen Oak

Reference:	FRCC I		
Current:	FRCC I = 0%	FRCC II = 100%	FRCC III = 0%
Departure:	High, Trend Static		

ǂ Barrett et al. 2010; Wahlberg et al. 2014; Krausmann and Triepke 2014

As shown in Table 45, the entirety of this ERU falls within the FRCC II category at the plan scale and in all local units, indicating a moderate departure from the historic fire regime. This is primarily attributable to moderate departure in seral state proportion, although higher fire severities contribute in some local units. As discussed previously, seral state proportion departure may be inflated due to limitations of the data available to describe the reference condition. The importance and influence of local physical ecosystem characteristics such as slope, aspect, geology and physical and chemical soil characteristics, are not well described in the literature. However, these ecosystem characteristics strongly influence vegetation structure on the Forest. The context area has a FRCC of III indicating high departure, again reflecting high departure in seral state proportion. Again, because of the sparse information describing the reference condition and that this analysis does not distinguish between the perennial grass and evergreen shrub subclasses, there is a degree of uncertainty associated with departure ratings.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 2,145 acres. The highest level occurred in 2003 at 13,731 acres. Nearly 10% of this ERU has been affected by insect and disease activities since 1997.

Due to the fact that many of the same tree and shrub species that occur within the PPF and the woodlands (JUG, MPO, PJC, PJG and PJO ERUs) also occur within the PPE ERU, it is likely that many of the insect and diseases that affect those ERUs, affect the PPE ERU. Those of the PPF likely affect the higher elevations of the PPE and those from the woodlands affect the lower elevations.

Spatial Niche

The PPE is not widespread within the context area at 622,820 acres (1.3%). However, within the Gila NF this ERU is 378,156 acres (11.6%) of the Forest. Within the context area landscape this ERU is represents the 9th largest ERU, but represents the 4th largest ERU on the Forest. In addition it has a greater proportional representation on the Forest (0.79) than in the context area (Table 46). In fact, it has the highest proportional representation of any ERU on the Forest. This ERU has a moderate departure rating in seral state proportion on the Forest and most local units, but a high departure in the Lower Gila River local unit and the context area (Table 40). In general, this ERU has gone from a normally large (20 in. +) size tree-open canopy nature to a medium (< 20 in.) sized tree-closed canopy condition throughout its range within the ecoregion.

Table 46. PPE ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
PPE	378,156	11.6	622,820	1.3	60.7	0.79

Table 47. PPE ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
Percent seral state departure	87,665	23.2	54,123	14.3	56,971	15.1	70,161	18.6	36,037	9.5	73,199	19.4	378,156	12.1	622,820	1.3
	56 Moderate		51 Moderate		57 Moderate		72 High		53 Moderate		57 Moderate		58 Moderate		71 High	

[1] Seral state departure from reference condition: Low = 0-33%;   = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with both its higher proportional representation on the Forest and the difference in seral state departure between the Forest and the context area (Table 47). The Gila NF has a greater influence on the sustainability of this system because it is relatively more common than it is within the context area, and the higher degree of departure in the context area heightens this influence. These factors may also indicate the potential of the Forest to act an important refuge for this ERU, which again increases the responsibility of the Forest to restore and maintain ecological integrity.

Woodland ERUs

MADREAN PIÑON-OAK WOODLAND (MPO) ERU

General Description

Figure 26. MPO ERU (Wahlberg et al. 2014)

The Madrean Piñon-Oak Woodland ERU (Figure 26) is concentrated in the Madrean province and is dominated by an open to closed canopy of evergreen oaks such as Arizona white oak, alligator juniper, Mexican piñon (*Pinus cembroides* Zucc.), Chihuahua pine, and other various pines with a grassy understory. Understories may be variable and may be dominated by shrubs such as manzanita, Mexican cliffrose (*Purshia mexicana* (D. Don) Henrickson), Apache plume (*Fallugia paradoxa* (D. Don) Endl. ex Torr.), or barberry (*Berberis* spp. L.). Common herbaceous species include sideoats grama, cane bluestem (*Bothriochloa barbinodis* (Lag.) Herter), and several species of muhlys. In general, graminoids decrease in cover and biomass with increasing cover of woody plants (LANDFIRE 2008c) Elsewhere in the region, as far east as the southern Rocky Mountains, plant communities dominated by tree-form evergreen oaks with or without piñon and juniper codominants have been placed in the Madrean Piñon-Oak Woodland as a provisional resort, pending revision of the ERU framework. Some of the MPO mapped on the Forest falls within this provisional classification. In these cases, the composition differs from communities of the Madrean province, though the form and dynamics of the system are consistent with the ERU concept. Vegetation structural development is apparently determined by soil type and depth (Gottfried et al. 1995). Stands commonly are located in a variety of sites including along drainages, on rocky slopes, and on alluvial basin fill and fans (USDA FS 1997). This ERU is transitional with the Ponderosa Pine-Evergreen Oak ERU but lacks dominance of large pine species (i.e. Arizona pine, Apache pine, and Chihuahuan pine). Madrean Piñon-Oak Woodlands usually occupy foothills and mountains ranging from approximately 4,000 to 7,000 ft. in elevation. Climate generally consists of mild winters and wet summers with mean annual precipitation ranging from about 10 to 25 inches with 55-60% coming between April 1st and September 31st. Historically this ERU had over 10% tree canopy cover, with the exception of early, post-fire plant communities. This ERU was previously named “Madrean Pine-Oak Woodland” but was changed to better reflect the woodland nature of the unit, and avoid confusion with other classification approaches with regards to “Madrean Pine” (Wahlberg et al. 2014).

Figure 27 and Figure 28 show that the show the distribution of this ERU within the context area and Forest.

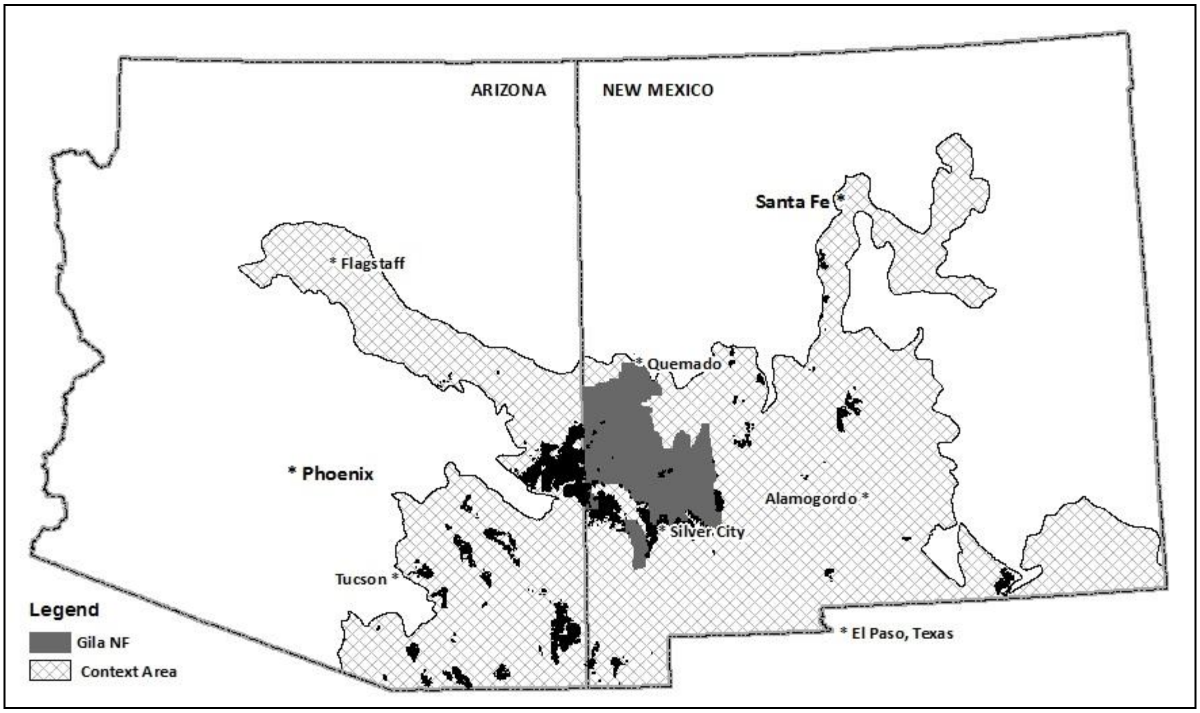

Figure 27. General location (in black) of the MPO ERU in the context area

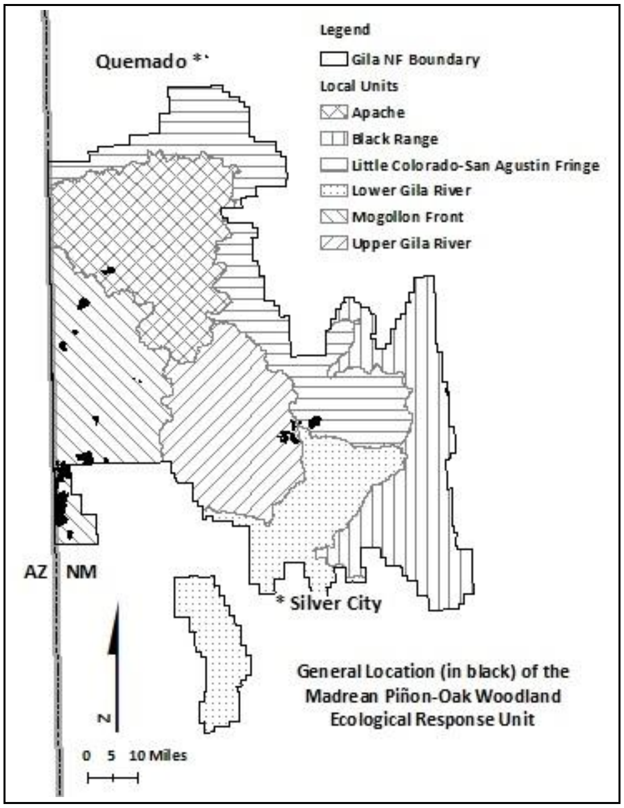

Figure 28. General location (in black) of the MPO ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the MPO ERU was comprised of small and medium to very large size trees with open woody canopy cover. Currently it is a mix of grass, forb, sparsely vegetated or recently burned with very open woody canopy cover, and shrubs with open or closed woody canopy cover, and seedling/sapling size trees with open or closed woody canopy cover.

Table 48. Seral state make-up of the MPO ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A	Early-seral: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	4	8	12	4	4
B, E	Early-seral: Seedling/sapling size (< 5” dbh/drc) trees with open or closed woody canopy cover	5	8	2	5	2
C	Mid-seral: Small size (≥ 5” & < 10” dbh/drc) trees with open woody canopy cover	24	26	10	24	10
D	Late seral: Medium to very large size (≥ 10” dbh/drc) trees with open woody canopy cover	60	41	17	41	17
F	Mid-seral: Small size trees with closed woody canopy cover	3	5	23	3	3
G	Late-seral: Medium to very large size trees with closed woody canopy cover	4	13	36	4	4
Total		100	100	100	81	40

Departure Index Rating⧺ = 100 – ∑ similarity values: Gila NF = (100 – 81) = 19 or LOW; and Context Area = (100 – 40) = 60 or MODERATE

‡ USDA FS 2010f; Schussman and Gori 2006; LANDFIRE 2007d and 2007h

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

⧺ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

At the plan scale and most local units where the MPO ERU is mapped, seral state departure is low. Departure is moderate in the Black Range and Little Colorado-San Agustin Fringe local units and within the context area. Where departure is moderate, there is a small over representation of grass, forb, sparsely vegetated or recently burned with very open woody canopy cover, and shrubs with open or closed woody canopy cover (seral state A), seedling/sapling size trees with open or closed woody canopy cover (seral state B, E), medium to very large size trees with closed woody canopy cover (seral state G); with a concurrent under representation of medium to very large size trees with open woody canopy cover (seral state D). Similar to the forested ERUs on the Gila, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of the previous forested ERUs, also applies here. Where departure exists, current conditions have resulted from the cumulative effects of fire suppression, firewood harvesting, legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 29. Recall that the trend analysis is conducted at the plan scale only.

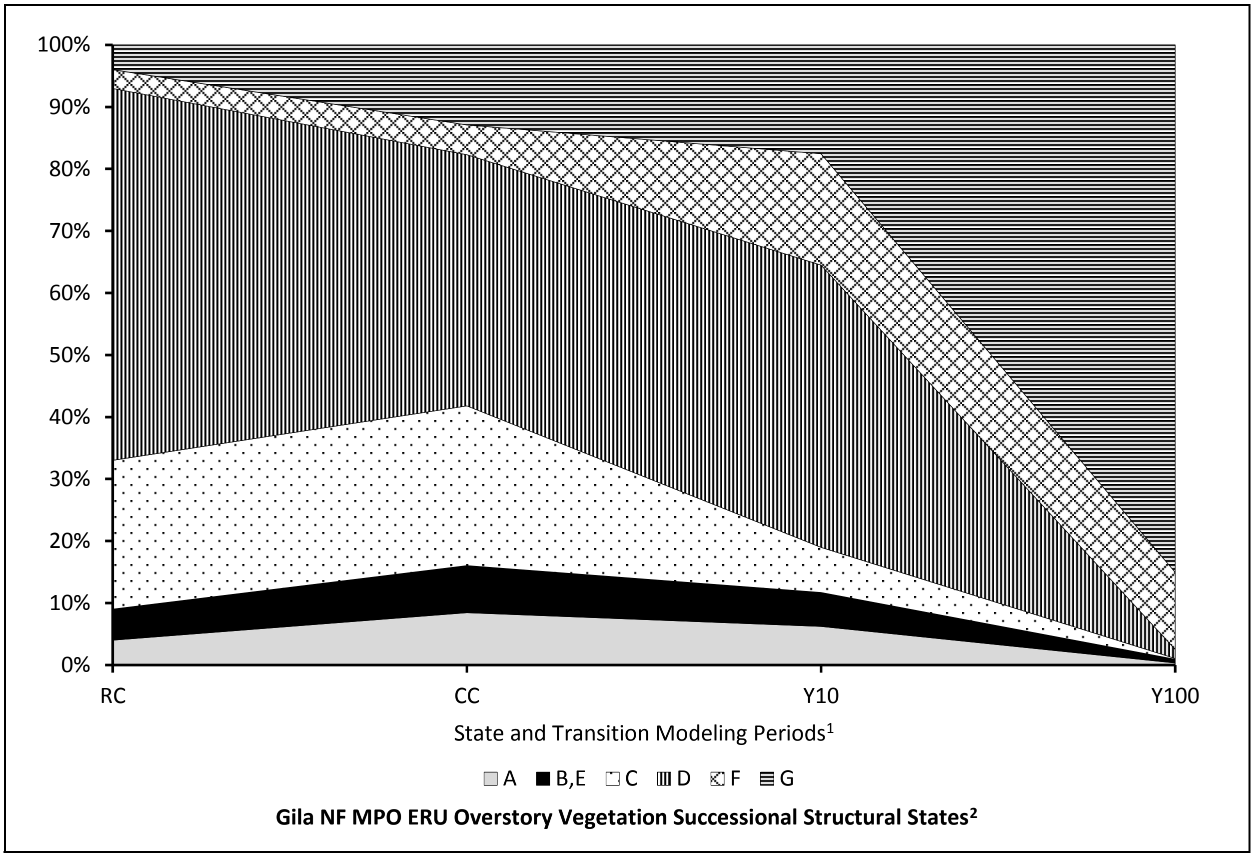

Figure 29. Gila NF overstory vegetation successional structural states for MPO ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 19% or low departure from RC
Y10 = State and transition modeling results at 10 years = 31% or low departure from RC
Y100 = State and transition modeling results at 100 years = 90% or high departure from RC

[2] See Table 48 for a description of the overstory vegetation successional structural states

Currently, the MPO is similar to reference conditions. However, under continuation of current management, projected departure is high as early seral conditions decrease over time and late seral state states move from a predominantly open canopy structure to a closed canopy structure.

Patch Size

There is no data to assess patch size for this ERU.

Coarse Woody Debris and Snag Density

Table 49. Current and projected departure of coarse woody debris in Madrean Piñon-Oak Woodland

	Coarse Woody Debris	Departure/Trend
Reference:	3.3 T/ac.	
Current:	18.3 T/ac.	High
100-years:	18.3 T/ac.	High/Away from Reference

As shown in Table 49, there is currently nearly 5 times the amount of coarse woody debris per acre than historically (Weisz et al. 2011). This is likely due to departure in fire frequency (see below), drought and insect and disease related mortality, and slow decomposition rates.

Table 50. Gila NF current and projected departure of snags in Madrean Piñon-Oak Woodland

	Snag Density (8" dbh)	Departure/Trend	Snag Density (18" dbh)	Departure/Trend
Reference:	4.0/ac.		1.0/ac.	
Current:	4.3/ac.	Low	0.7/ac.	Low
100-years:	4.3/ac.	Low/Away from Reference	0.7/ac.	Low/Away from Reference

As shown in Table 50, snag density departure is low which most likely reflects low departure in seral state proportion. It also indicates that drought and insect and disease related mortality have not yet affected this ERU to the degree they have other ERUs, despite the fact that there is insect or disease outbreaks have been widespread in the MPO (see below). Additionally, some mortality of junipers due to abrupt declines in winter temperatures has been observed within some areas of the Forest, however these observations have not been tied to a particular ERU as the Gila NF ERU framework was not in place at the time.

Fire Regime

The fire regime of the MPO ERU is characterized by frequent and infrequent mixed severity fire. The limitations of the current scientific understanding in Madrean systems, presented previously in the discussion of the PPE fire regime are also relevant to the MPO.

Fire Frequency

Table 51. Reference and current Gila NF fire frequency for Madrean Piñon-Oak Woodland

Reference:	**MFRI*=35-200+ yrs.** (FF‡ = average fire rotation = 13 yrs. and non-lethal fire rotation = 13 yrs. Surface fire and mixed severity, 6 to 12 yrs.; Stand replacement fire, 500 yrs.
Current:	FF = 633 yrs.
Departure:	High

*Barret et al. 2010; Wahlberg et al. 2014; Kraussman and Triepke 2014

‡ Fulé and Covington 1996, 1997, 1998 and 1999; Kaib et al. 1996; Swetnam and Baisan 1996; Barton 1999 and 2002; Fulé et al. 2000 and 2005; Swetnam et al. 1992 and 2001; Schussman and Gori 2006; Schussman et al. 2006; LANDFIRE 2007d and 2008c; Krausmann and Triepke 2014

As shown in Table 51, in the last 19 years (1996-2015), fire has likely not occurred as frequently, on average, at the plan scale and in the Mogollon Front local unit as it did historically. This However, the context scale (FF=259 yrs.) and the Forest's Upper Gila River local unit (FF= 60 yrs.) are in low departure. There is no data to assess fire frequency in other local units where MPO is mapped. Restoring fire as a natural ecological process has been a management priority over the last 19 years, but the major focus has not necessarily been on this ERU. Of course, patterns of natural ignitions during the time frame used in the analysis, and the limited number of MPO acres on Forest also have some explanatory value. That is to say, there isn't very much of this ERU on the Forest, it tends to occur in relatively small and isolated patches which lowers the likelihood that a lightning strike might occur in or adjacent to this ERU and initiate a fire is less than it would be if it was more common. The Forest may not have been presented with the opportunity to manage a natural ignition in the MPO, and the management focus has been elsewhere.

On the other hand, departure in fire frequency may also reflect factors that reduce the fine fuels necessary to carry fire, particularly livestock grazing, as the herbaceous plants that provide forage are also the primary source of fine fuels. Fire suppression may also be a factor where Wildland Urban Interface, or other highly valued resources are at risk, when fire weather and fuel conditions do not support the achievement of the management objectives, or when resources needed to manage a particular fire are unavailable. Resources to manage fires may be unavailable when they are committed to managing or suppressing fires elsewhere.

Fire Severity

The 19-year (1996-2015) average annual area burned by wildfire within the MPO ERU on Forest is 27 acres; roughly 97% at low severity, 3% at moderate severity and 0% at high severity. Current average fire severity is approximately the same as the reference condition's 13% (Schussman et al. 2006) (13-14% average severity), across the Forest and within each local unit that contains MPO and has severity data, indicating low departure. This is attributable to low departure in seral state proportion.

Fire Regime Condition Class (FRCC)

Table 52. Gila NF Reference FRCC and Departure for Madrean Piñon-Oak Woodland

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 79.5%	FRCC III = 0.0%	No data = 20.5%
Departure:	High, Away from Reference			

‡ Krausmann and Triepke 2014

As shown in Table 52, all of this ERU with available data is classified as FRCC II, indicating a moderate departure in the fire regime. This is primarily due to high departure in fire frequency, which is lower than under the reference time period.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 655 acres. The highest level occurred in 2003 at 8,170 acres. Overall, nearly 68% of this ERU has been affected by insect and disease activities since 1997, giving it a high departure rating. There is no information regarding specific insects or diseases active in the MPO ERU, but it is likely that the same drivers and stressors as in the other woodlands are active within this ERU.

Spatial Niche

The MPO is generally limited to the southwestern portion of the context area at 902,219 acres or 1.9%. On the Gila NF its 17,361 acres or 0.5% is scattered, but found primarily within the southwestern portion of the Forest. The MPO represents the 8th largest ERU in the context area and the 2nd smallest upland ERU on the Forest. In addition, it has a lower proportional representation on the Forest (-0.57) than in the context area (Table 53). This ERU has a low seral state proportion departure rating on the Forest, however, departure varies from low to moderate within the Forest's local units (Table 54). Departure is moderate within the context area.

Table 53. MPO ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
MPO	17,361	0.5	902,219	1.9	1.9	-0.57

Table 54. MPO ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	855	4.9	252	1.5	869	5.0	0	0.0	13,794	79.5	1,591	9.2	17,361	0.5	902,219	1.9
Percent seral state departure	26 Low		36 Moderate		49 Moderate				19 Low		27 Low		19 Low		60 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with both its lower proportional representation on the Forest and the lower overall departure in seral state proportion as opposed to the context area. The Gila NF has a smaller influence on the sustainability of this system because it is relatively less common than it is within the context area, but the higher degree of departure in the context area raises the importance of the Gila NF's management of this ERU as it may serve as an important refuge for this ERU in the future. Therefore, the Forest has a high degree of responsibility to maintain and/or restore ecological integrity in the MPO ERUs.

PIÑON-JUNIPER/EVERGREEN SHRUB WOODLAND (PJC) ERU

General Description

Figure 30. PJC ERU (photo by L.J. WhiteTrifaro 2008)

The PJC ERU (Figure 30) is typically found on lower slopes in transition zones, often between interior chaparral and montane forests, and is most extensive in geographic areas dominated by mild climate gradients and bi-modal precipitation regimes. The PJC ERU is a broad grouping of different plant associations for descriptive purposes, with tree and shrub species composition varying throughout the Region. Historically this ERU had greater than 10% tree canopy cover in later successional stages, expressed by twoneedle piñon, single leaf piñon, Utah juniper, oneseed juniper, or alligator juniper. Piñon is occasionally absent, but one or more juniper species are always present. Oak trees (i.e., Arizona white oak, gray oak, Emory oak) are subordinate, but are consistently present in mild climate zones between central Arizona and southwestern New Mexico. Trees occur as individuals or in smaller groups and range from young to old, but typically small stands or clumps are even-aged in structure as a consequence of mixed severity fire (at least historically). The understory is dominated by low to moderate density shrubs, with herbaceous plants in the interspaces. Shrub species include species of manzanita, mountain mahogany, antelope bitterbrush (*Purshia tridentata* (Pursh) DC.), silktassles *(Garrya* spp. Douglas ex Lindl.), Stansbury cliffrose (*Purshia stansburiana* (Torr.) Henrickson), Sonoran scrub oak, and sumacs (*Rhus* spp. L.).

Typical drivers and stressors (fire, insects, and disease) are mixed severity and moderate, although some evergreen shrub woodland types exhibit infrequent fire/high severity effects (FR IV, 35-200 years, replacement severity; e.g., piñon-juniper/manzanita). These disturbance patterns create and maintain tree-age diversity and low to moderately-closed canopy typical of this type. Understory plants consisting of perennial native grasses and both annuals and perennial forbs comprise the remainder of the inter-canopy interspaces. Climate generally consists of mild winters and wet summers with mean annual precipitation ranging from about 10 to 25 inches with 55-60% coming between April 1st and September 31st. The PJC ERU is found on well-drained soils, frequently with coarse-textured or gravelly (stony) soil characteristics. Aside from disparities in structure and composition, PJC can also be differentiated from interior chaparral by longer fire intervals and less severe fire events. Due to the effects of long-term fire suppression, in many locations the current condition is severely departed from historic conditions. Typically these changes include in-filling of the canopy gaps, increased density of tree groups, and reduced composition, density and vigor of the herbaceous understory plants. Many of these sites currently are closed-canopy woodlands, with insufficient understory vegetation to support surface fires.

Figure 31and Figure 32 show that the show the distribution of this ERU within the context area and Forest.

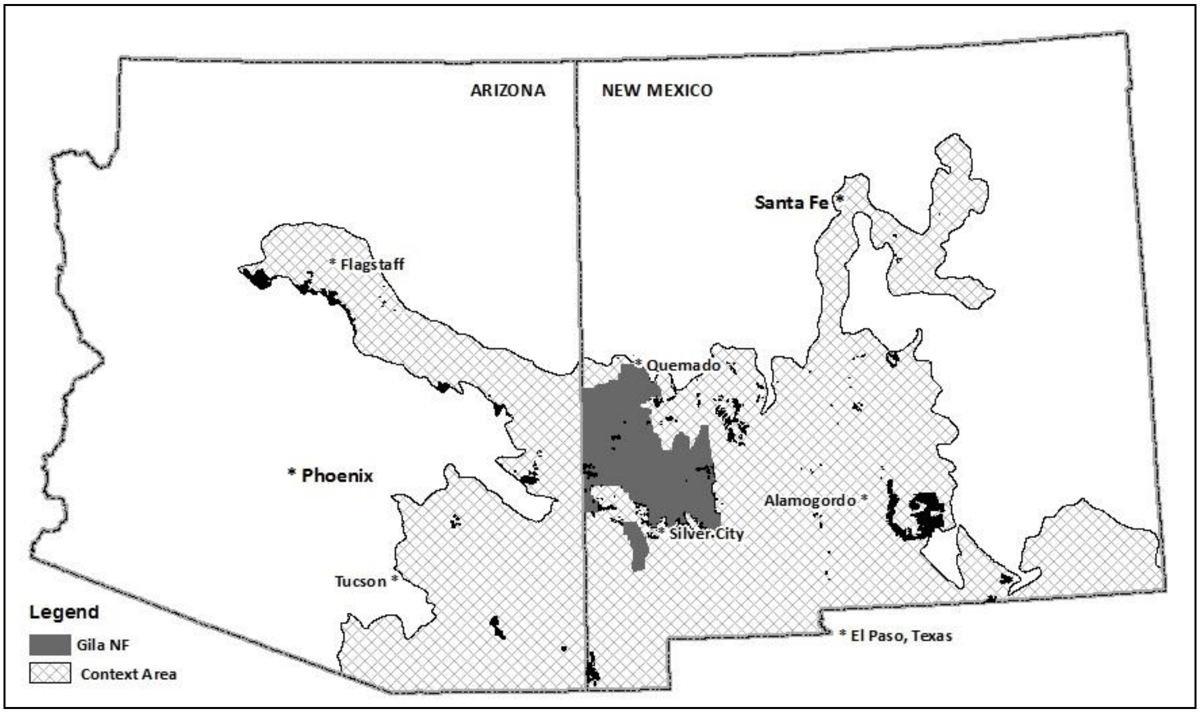

Figure 31. General location (in black) of the PJC ERU within the context area

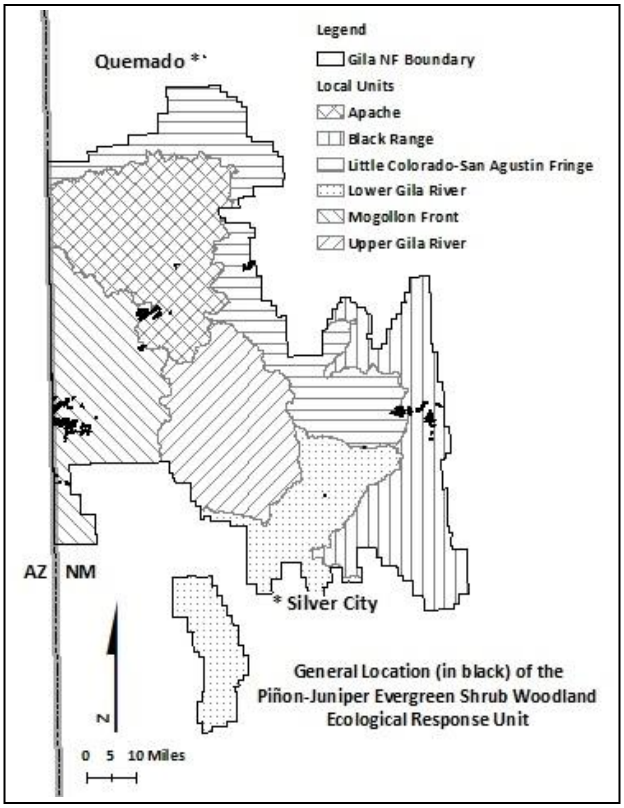

Figure 32. General location (in black) of the PJC ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the PJC ERU was comprised of seedling/sapling size trees with open or closed woody canopy cover, and small size trees with open woody canopy cover and medium to very large size trees with open woody canopy cover (Table 55). Historically, the disturbance patterns caused by the drivers and stressors, mentioned above, created and maintained tree-age diversity and low to moderately-closed canopy typical of this type. Understory plants consisting of perennial native grasses and both annuals and perennial forbs comprise the remainder of the inter-canopy interspaces (Wahlberg et al. 2014).

Table 55. Seral state make-up of the PJC ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A	Early seral: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	5	1	12	1	5
B, C, E	Mid-seral: Seedling/sapling size (< 5” dbh/drc) trees with open or closed woody canopy cover, and small size (≥ 5” & < 10” dbh/drc) trees with open woody canopy cover	55	15	13	15	13
D	Late-seral: Medium to very large size (≥ 10” dbh/drc) trees with open woody canopy cover	40	34	40	34	40
F	Mid-seral: Small size trees with closed woody canopy cover	0	12	11	0	0
G	Late-seral: Medium to very large size trees with closed woody canopy cover	0	38	21	0	0
Total		100	100	100	50	58
Departure Index Rating⫲ = 100 – ∑ similarity values: Gila NF = (100 – 50) = 50 or MODERATE; and Context Area = (100 – 58) = 42 or MODERATE						

‡ USDA FS 2010g; LANDFIRE 2007d, 2007i, 2008c

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

⫲ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High)

At the plan and context scale, seral state proportion departure is moderate. However, within the Forest’s local units, departure varies from moderate to high. In the Mogollon Front and Little Colorado-San Agustin Fringe local units, where most of the PJC on the Forest occurs, departure is moderate. Departure is high in all other local units except Upper Gila River, where PJC does not occur. Currently there is an over representation of small size trees with closed woody canopy cover (seral state F), and medium to very large size trees with closed woody canopy cover (seral state G); with a concurrent under representation of seedling/sapling size trees with open or closed woody canopy cover, and small size trees with open woody canopy cover (seral state B, C, E), and medium to very large size trees with open woody canopy cover (seral state D). Similar to the forested ERUs on the Gila, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of the previous forested ERUs, also applies here. Departure has resulted from the cumulative effects of past fire suppression, firewood harvesting, legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 33. Recall that the trend analysis is conducted at the plan scale only.

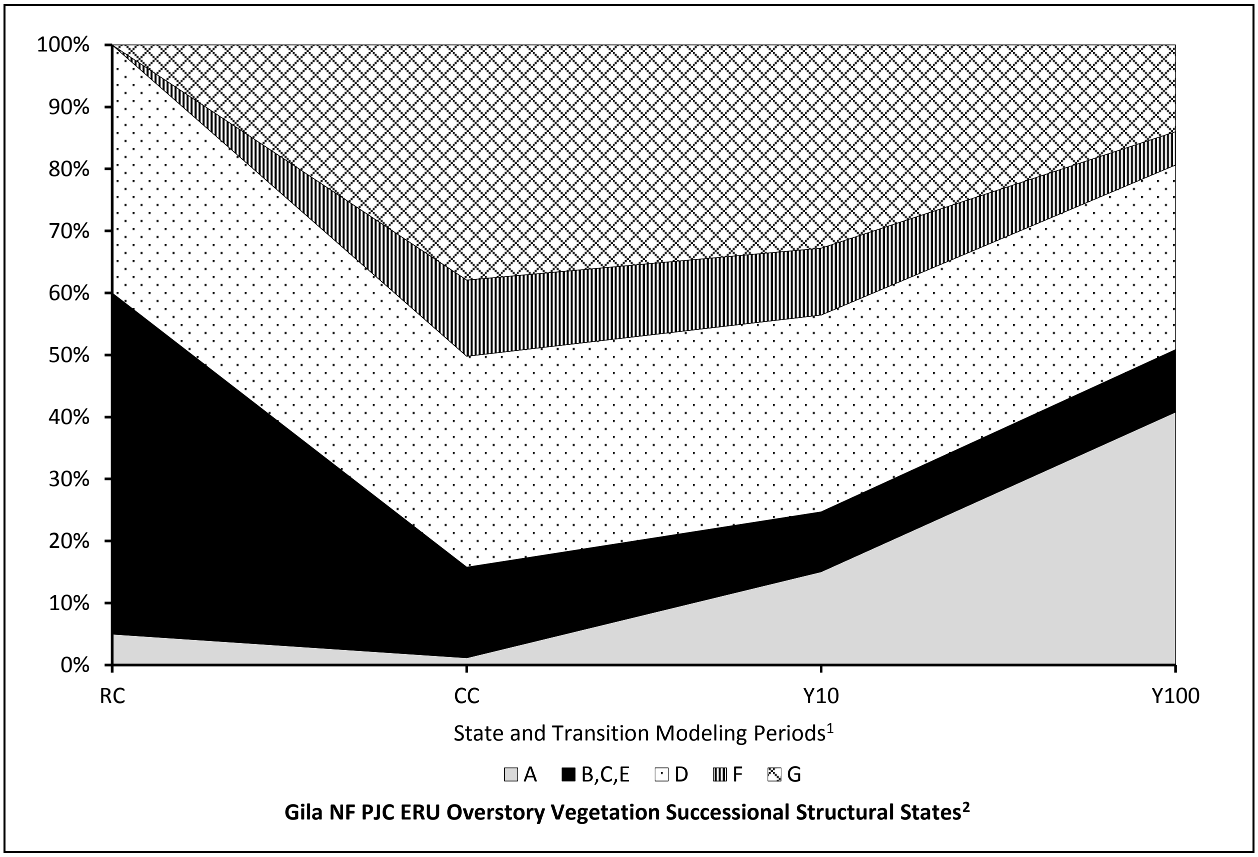

Figure 33. Gila NF overstory vegetation successional structural states for PJC ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 50% or moderate departure from RC
Y10 = State and transition modeling results at 10 years = 54% or high departure from RC
Y100 = State and transition modeling results at 100 years = 55% or moderate departure from RC

[2] See Table 55 for a description of the overstory vegetation successional structural states

Under continuation of current management (and under the current climatic regime), projected departure remains moderate. However, early seral and closed canopy mid-seral conditions increase over time as open canopy mid-seral states decline. This is most likely a reflection of the oak and alligator juniper components of the PJC ERU, which typically re-sprouts and regenerates easily after disturbances that decrease canopy closure and/or restarts successional processes, and suggests a shift in species composition might accompany these changes in seral states.

Patch Size

There is no data to assess patch size for this ERU.

Coarse Woody Debris and Snag Density

Table 56. Gila NF current and projected departure of coarse woody debris in PJ-Evergreen Shrub

	Coarse Woody Debris	Departure/Trend
Reference:	3.1 T/ac.	
Current:	13.3 T/ac.	High
100-years:	13.3 T/ac.	High/Static

As shown in Table 56, there is currently nearly 4-½ times the amount of coarse woody debris per acre than historically (Weisz et al. 2011). This is primarily due to departure in fire frequency, mortality caused by interactions between increased competition, drought and insects and disease, as well as slow decomposition rates.

Table 57. Gila NF current and projected departure of snags in PJ-Evergreen Shrub

	Snag Density (8" dbh)	Departure/Trend	Snag Density (18" dbh)	Departure/Trend
Reference:	3.0/ac.		1.0/ac.	
Current:	4.7/ac.	Moderate	1.5/ac.	Low
100-years:	4.7/ac.	Moderate/Static	1.5/ac.	Low/Static

As shown in Table 57, there is currently nearly 1 to 1-½ times the number of snags per acre than historically (Weisz et al. 2011). This is likely due to the same factors influence coarse woody debris. Additionally, some mortality of junipers due to abrupt declines in winter temperatures has been observed within some areas of the Forest, however these observations have not been tied to a particular ERU as the Gila NF ERU framework was not in place at the time.

Fire Regime

The PJC ERC fire regime is characterized by both frequent and infrequent mixed severity fire.

Fire Frequency

Table 58. Reference and current Gila NF fire frequency for PJ Evergreen Shrub

Reference:	**MFRI*= 35-200 yrs.** (FF‡ = average rotation = 206.3 yrs., mixed severity rotation = 213 yrs., and stand replacement rotation = 200 yrs.)
Current:	FF = 429.4 yrs.
Departure:	Moderate

*Wahlberg et al. 2014; Krausmann and Triepke 2014
‡ LANDFIRE, 2007d and 2007i, and 2008c; Wahlberg et al. 2014; Krausmann and Triepke 2014

As shown in Table 58, in the last 19 years (1996-2015), fire has not occurred as frequently, on average, in this system as it did historically. Departure is moderate at the context scale (FF= 672 yrs.), plan scale (Table X) and in the Black Range (FF=633 yrs.) and Mogollon Front (FF= 443 yrs.). Departure is low in the Little Colorado-San Agustin Fringe local unit (FF= 192 yrs.). There is no data to available to analyze fire frequency in the Apache and Lower Gila local units and there is no PJC in Upper Gila River.

Restoring fire as a natural ecological process has been a management priority over the last 19 years, but the major focus has been on other ERUs. Of course, patterns of natural ignitions during the time frame used in the analysis, and the limited number of MPO acres on Forest also have some explanatory value. That is to say, there isn't very much of this ERU on the Forest, it tends to occur in relatively small and isolated patches; the likelihood that a lightning strike might occur in or adjacent to this ERU and initiate a fire is less than it would be if it was more common. The Forest may not have been presented with the opportunity to manage a natural ignition in the PJC, and the management focus has been elsewhere.

On the other hand, departure in fire frequency may also reflect factors that reduce the fine fuels necessary to carry fire, particularly livestock grazing, as the herbaceous plants that provide forage are also the primary source of fine fuels. Fire suppression may also be a factor where Wildland Urban Interface, or other highly valued resources are at risk, when fire weather and fuel conditions do not support the achievement of the management objectives, or when resources needed to manage a particular fire are unavailable. Resources to manage fires may be unavailable when they are committed to managing or suppressing fires elsewhere.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire within this ERU on Forest is 25 acres; roughly 95% at low severity, 5% at moderate severity and 0% at high severity. Current average fire severity is at the plan scale is approximately 15%, much lower than reference condition's 70% (Schussman et al. 2006), giving it a high departure rating. Similar average severity percentages in all local units containing PJC also indicate high departure. Generally, fire has burned mostly at low severity levels within the PJC ERU, rather than the mixed severity characteristic of the natural fire regime. Lower severity is likely tied to lower fire frequencies.

Fire Regime Condition Class (FRCC)

Table 59. Gila NF Reference FRCC and Departure for PJ Evergreen Shrub

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 71.7%	FRCC III = 19.7%	No data = 8.6%
Departure:	Moderate, Trend Static			

‡ Krausmann and Triepke 2014

As shown in Table 59, while almost 20 percent of this ERU is categorized as being in FRCC III, most is in FRCC II which is indicative of moderate departure from the natural fire regime at the plan scale. Departure is also moderate at the context scale and in all local units containing PJC with all data components available except the Black Range local unit which is in high departure (FRCC III). This correlates with seral state proportion, fire frequency and average severity departures; the Black Range local unit is the only analysis area with two of these characteristics in a high departure category. At the context scale, departure in the natural fire regime is also moderate (FRCC II).

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 811 acres. The highest level occurred in 2003 when the entire ERU was affected. Overall, nearly 100% of this ERU has been affected by insect and disease activities since 1997. There is no information regarding specific insects or diseases active in the PJC, but it is likely that the same drivers and stressors as in the other woodlands are also active within this ERU.

Spatial Niche

The PJC is generally limited to scattered location within the context area, however, the greatest concentration is in the southeastern portion of the context area at 401,552 acres or 0.9% it is the context area's 12th largest ERU (Table 5). On the Gila NF its 10,678 acres or 0.3% is scattered, but primarily found within the southwestern portion of the Forest. The PJC represents the smallest upland ERU on the Forest. In addition, it has a lower proportional representation on the Forest (-0.45) than in the context area (Table 60). This ERU has a moderate seral state proportion departure rating at both the plan and context scales (Table 61), however, departure varies from moderate to high across the Forest's local units where PJC occurs.

Table 60. PJC ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
PJC	10,678	0.3	401,552	0.9	2.7	-0.45

Table 61. PJC ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	909	8.5	2,100	19.7	1,449	13.3	17	0.2	6,203	58.1	0	0.0	10,678	0.3	401,552	0.9
Percent seral state departure	96 High		76 High		62 Moderate		99 High		46 Moderate				50 Moderate		42 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with both its lower proportional representation on the Forest, the departure in seral state proportion and its relative rarity on the Forest and across the context area. The Gila NF has a smaller influence on the sustainability of this system. Although it has less opportunity to contribute to sustainability, the rarity of the PJC heightens the responsibility of the Forest to restore and maintain ecological integrity in this ecosystem as it may serve as an important refuge in the future.

PIÑON-JUNIPER WOODLAND (PJO) ERU

General Description


Figure 34. PJO ERU (photo by M.R. White 2002)

Also called the "piñon-juniper persistent woodland," the PJO ERU (Figure 34) serves as a broad grouping of different plant associations for descriptive purposes. Trees may occur as individuals or in smaller groups and range from young to old, but more typically as large even-aged structured patches. The site is characteristically dominated by moderate to high density tree canopy, and a limited understory of herbaceous plants and shrubs. It is mostly found on lower slopes of mountains and in upland rolling hills at approximately 4,500 to 7,500 feet in elevation. Generally, annual precipitation ranges from 11 to 22 inches, with 40-45% coming between October 1st and March 31st.

Tree and shrub species composition varies throughout the Southwest and common trees include twoneedle piñon (*Pinus edulis*), singleleaf piñon (*Pinus monophylla* Torr. & Frém.), Utah juniper (*Juniperus osteosperma* (Torr.) Little), oneseed juniper, and alligator juniper. Typically, sparse native understory grasses are perennial species, such as several species of grama (*Bouteloua* spp. Lag.), common wolftail (*Lycurus phleoides* Kunth), and threeawns (*Aristida* spp. L), while forbs consist of both annuals and perennials. Shrubs are characteristically sparse to moderately distributed.

Typical stressors and drivers (fire, insects, disease, etc.) are high severity and occur infrequently. These disturbance patterns create and maintain the even-aged nature of this vegetation type. According to Gori and Bate (2007), climate variation, insect outbreaks, fire and seed dispersal by birds and small mammals appear to be the most important drivers and stressors that determined the historical structure of piñon-juniper woodlands and their distribution and abundance across the landscape. Woodland development occurs in distinctive phases; ranging from open grass-forbs, to mid-aged open canopy to mature closed canopy woodland. Woodland expansion began during the late 1800s (Cottam and Stewart 1940; Miller and Rose 1999). This expansion is frequently attributed to alteration of fire's natural role, historic overgrazing by domestic livestock, climate change and increased atmospheric carbon dioxide (Miller and Rose 1999), singularly or in combination. However, fire suppression has not exhibited the far-reaching effects on this ERU, as compared to other woodland types, since the fire frequency in infrequent fire systems such as this may or may not have been altered during the period since Euro-American settlement.

According to Miller and Tausch (2001) many woodlands, are currently continuing to experience increasing density and canopy cover of trees, declines in understory composition, cover, productivity and diversity (Pieper 1995), which has contributed to higher soil loss rates and changes in the quality of wildlife habitat provided by these ecosystems (Baker et al. 1995; Wilcox and Breshears 1995).

Figure 35 and Figure 36 show that the majority of this ERU occurs in the northern and eastern portions of the context area and the northwestern and southeastern portions of the Forest

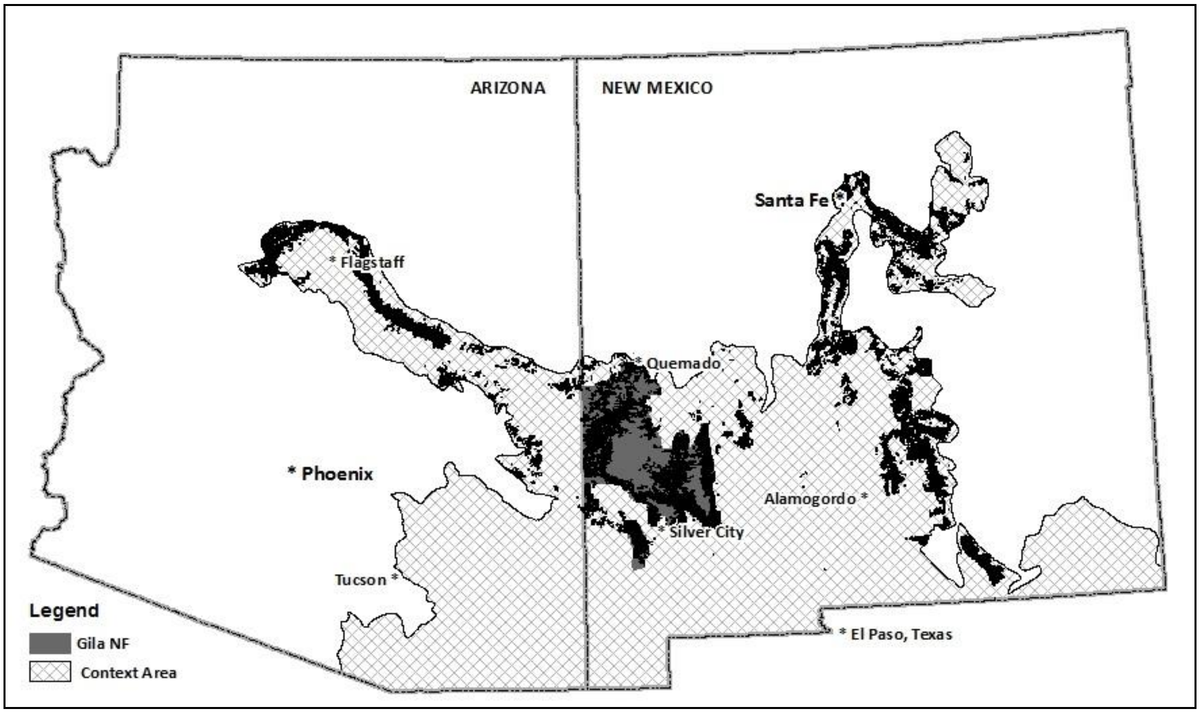

Figure 35. General location (in black) of the PJO ERU within the context area

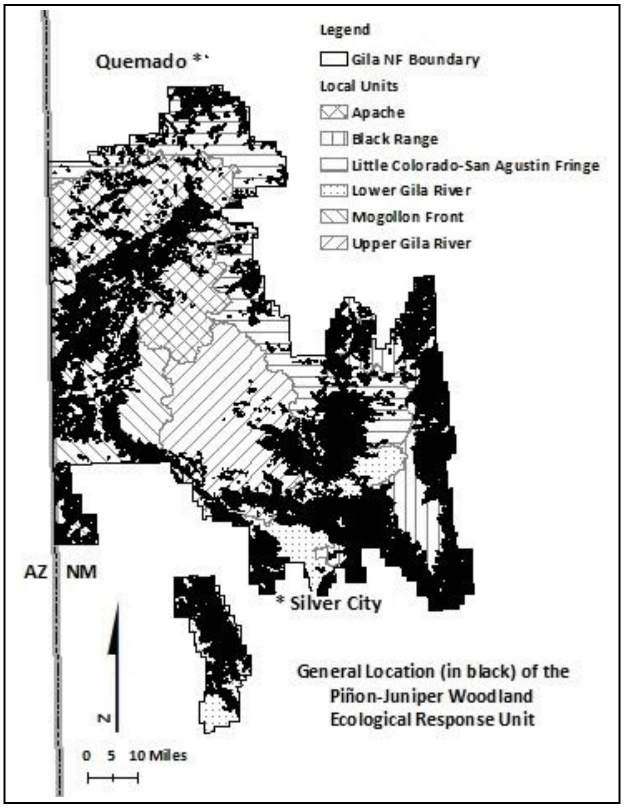

Figure 36. General location (in black) of the PJO ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the PJO ERU was comprised of medium to very large size trees with a closed canopy nature (Table 62). Historically, these woodlands were characterized by even-aged or multi-aged stand structure with a range of tree densities and canopy cover, depending on site conditions (USDI NPS 2016).

Table 62. Seral state make-up of the PJO ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A	Early-seral: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	10	5	14	5	10
B, C, E	Mid seral: Seedling/sapling size (< 5” dbh/drc) trees with open (≥ 10% & < 30%) or closed woody canopy cover, and small size (≥ 5” & < 10” dbh/drc) trees with open woody canopy cover	5	23	28	5	5
D	Late-seral: Medium to very large size (≥ 10” dbh/drc) trees with open woody canopy cover	10	28	25	10	10
F	Mid-seral: Small size trees with closed woody canopy cover	15	11	12	11	12
G	Late-seral: Medium to very large size trees with closed woody canopy cover	60	33	22	33	22
Total		100	100	100	64	59

Departure Index Rating‡‡ = 100 – ∑ similarity values: Gila NF = (100 – 64) = 36 or MODERATE; and Context Area = (100 – 59) = 41 or MODERATE

‡ USDA FS 2010c; LANDFIRE 2005a

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

‡‡ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

At both the plan and context scales, departure is moderate. Local unit departure within the Forest is mostly moderate, with the exceptions of Little Colorado-San Agustin Fringe and Lower Gila River which are in low departure. In general, there is a sizeable over representation seedling/sapling size trees with open or closed woody canopy cover, small size trees with open woody canopy cover (seral states B, C, E), and medium to very large size trees with open woody canopy cover (seral state D). There is a significant under representation of medium to very large size trees with closed woody canopy cover (seral state G). Similar to the forested ERUs on the Gila, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of the previous forested ERUs, also applies here. Departure has resulted from the cumulative effects of past fire suppression, firewood harvesting, legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 37. Recall that the trend analysis is conducted at the plan scale only.

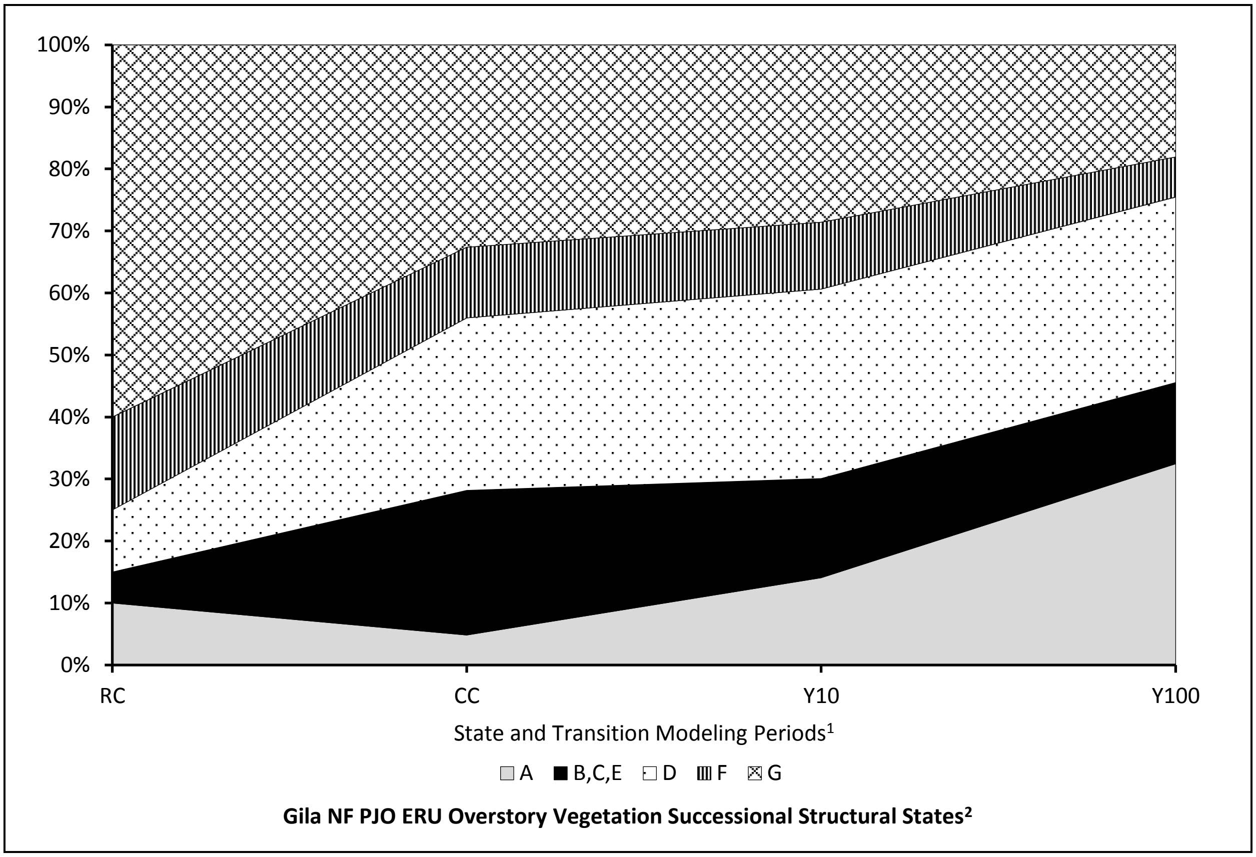

Figure 37. Gila NF overstory vegetation successional structural states for PJO ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 36% or moderate departure from RC
Y10 = State and transition modeling results at 10 years = 36% or moderate departure from RC
Y100 = State and transition modeling results at 100 years = 50% or moderate departure from RC

[2] See Table 62 for a description of the overstory vegetation successional structural states

Under the continuation of current management, departure remains moderate. However, early seral state conditions increase over time, as do closed canopy late seral states. Management may be more effective in restoring and maintaining ecological integrity of this ERU by monitoring and evaluating the outcomes restoration activities, and selective treating appropriate seral states. Additionally, the reduction in closed canopy late seral states within this ERU signifies a need to further ground truth the ERU map and determine whether thinning activities are ERU appropriate, or if they have contributed to departure. It may be that chaining/cabling, pushing and other thinning activities more appropriate for restoring PJ Grass and Juniper Grass ecosystems have been applied before the ERU concepts and Gila NF map were available to support project development and implementation. Some management activities are limited within this ERU by the large percentage of its area occurring on steep slopes (≥40%).

Patch Size

Table 63. Gila NF current departure of patch size in PJ Woodland

Reference Range:	50 to 400 ac.
Current Mean:	20 ac.
Departure:	Moderate

As shown in Table 63, mean patch size is lower than under the reference time period, reflecting infill of woodland openings by smaller trees and shrubs. This is primarily due to drought and historic overgrazing which provided the competitive advantage to regenerating conifer seedlings and altered ecological processes by reducing the herbaceous component. Increasing tree densities within patches, or clumps is also occurring.

Coarse Woody Debris and Snag Density

Table 64. Gila NF current and projected departure of coarse woody debris in PJ Woodland

	Coarse Woody Debris	Departure/Trend
Reference:	2.9 T/ac.	
Current:	15.4 T/ac.	High
100-years:	15.4 T/ac.	High/Static

As shown in Table 64, there is currently almost 5 times the amount of coarse woody debris per acre than historically (Weisz et al. 2011). This is primarily due to mortality caused by interactions between increased competition, drought and insects and disease, as well as slow decomposition rates.

Table 65. Gila NF current and projected departure of snags in PJ Woodland

	Snag Density (8” dbh)	Departure/Trend	Snag Density (18” dbh)	Departure/Trend
Reference:	2.0/ac.		1.0/ac.	
Current:	6.3/ac.	Moderate	1.6/ac.	Moderate
100-years:	6.3/ac.	Moderate/Static	1.6/ac.	Moderate/Static

As shown in Table 65, there is currently nearly 2 to 3 times the number of snags per acre than historically. This is likely due to the same factors influence coarse woody debris. Additionally, some mortality of junipers due to abrupt declines in winter temperatures has been observed within some areas of the Forest, however these observations have not been tied to a particular ERU as the Gila NF ERU framework was not in place at the time.

Fire Regime

Fire regimes for piñon-juniper woodlands are difficult to reconstruct owing to scant fire scar evidence (Baker and Shinneman 2004). However, the general consensus is that piñon-juniper woodland developed after infrequent stand-replacing fire and was most likely maintained by patchy mixed-severity fires that occurred with moderate to low frequency (Arnold et al. 1964; Tausch et al. 1981; Tress and Klopatek 1987; Despain and Mosley 1990; Miller 1999; Floyd et al. 2000 and 2004; Muldavin et al. 2003; Romme et al. 2003; Huffman et al. 2006).

Fire Frequency

Table 66. Reference and current Gila NF fire frequency for PJ Woodland

Reference:	**MFRI*= 35-200 yrs.** (FF‡ = average rotation = 255 yrs., mixed severity rotation = 200 yrs., and stand replacement rotation = 350 yrs.)
Current:	FF = 144 yrs.
Departure:	Low

‡ Gottfried et al. 1995; Floyd et al. 2000; Muldavin et al. 2003; Floyd et al. 2004; Vander Lee et al. 2006; Brown et al. 2008; Floyd et al. 2008; Romme et al. 2009b; Barrett et al. 2010; Swetnam and Brown 2010; Wahlberg et al. 2014; Krausmann and Triepke 2014; Swetnam and Falk 2015

As shown in Table 66, in the last 19 years (1996-2015), fire frequency is roughly consistent with what is known about the reference fire regime. Departure is low at the plan scale and in the Apache (FF=129 yrs.), Little Colorado-San Agustin Fringe (FF= 99 yrs.) and Lower and Upper Gila River local units (FFs= 182 and 39 yrs. respectively), although in Upper Gila River, fire frequency approaches the lower limit of the reference MFRI. Departure is moderate in the Mogollon Front (FF=326 yrs.) and high in the Black Range local unit (FF=625 yrs.). Infrequent fire systems such as the PJO ERU have been less disrupted by past fire suppression than frequent fire systems. Where departure exists, a reduction in fine fuels is likely a limiting factor, as discussed for other ERUs. Fire suppression may also be a factor where Wildland Urban Interface, or other highly valued resources are at risk, when fire weather and fuel conditions do not support the achievement of the management objectives, or when resources needed to manage a particular fire are unavailable. Resources to manage fires may be unavailable when they are committed to managing or suppressing fires elsewhere.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire within the PJO ERU on Forest is 5,894 acres; roughly 86% at low severity, 11% at moderate severity and 2% at high severity. Current average fire severity is approximately 19%, much lower than reference condition’s 64% (Krausmann and Triepke 2014), giving it a high departure rating. Departure is also high at the local unit scale except in Mogollon Front, where it is moderate. However, average severity in the Mogollon Front local unit is right on the threshold between moderate and high departure (~66%). Generally, fire has burned at low severity levels within the PJO ERU, which is inconsistent with what is known about the natural fire regime. Lower severity is primarily the result of fine fuel reductions that limit fire spread and flame lengths. Lower flame lengths may not result in conifer mortality, thus lowering severity.

Fire Regime Condition Class (FRCC)

Table 67. Gila NF Reference FRCC and Departure for PJ Woodland

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 95.0%	FRCC III = 0.0%	No data = 5.0%
Departure:	Moderate, trend is expected to continue away from reference conditions			

ǂ Krausmann and Triepke 2014

As shown in Table 67, all of this ERU for which there is data falls within FRCC II which is indicative of moderate departure from the natural fire regime. Departure is moderate at all scales. While fire frequency is within the natural range of variation, there has not been enough moderate and/or high severity to maintain ecological integrity of this system. This is likely due to reduction in fine fuels that limits fire spread and flame lengths as discussed above under the fire severity subheading. This reduction in fine fuels is the result of both drought and herbivory by domestic livestock. For more information on the effects and status of drought, herbivory and fire on the Forest, see Chapter 9: System Drivers and Stressors.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 4,700 acres. The highest level occurred in 2003 at 60,449 acres. Overall, just 10% of this ERU has been affected by insect and disease activities since 1997.

As mentioned above, the PJO ERU has recently undergone dramatic drought-induced mortality, producing some structural changes in this extensive vegetation type. Given that climate projections for the region suggest widespread conifer mortality is likely to continue into the next century (Krofcheck et al. 2014). Insect and disease activity and mortality within this ecosystem is greatly enhanced by drought. A long-term perspective on the extent of past insect and disease activity in the piñon-juniper woodlands is often lacking because it has not often been recorded in historical reports. The PJO woodland is susceptible to attacks by several species of bark beetles. Localized mortality of piñon trees caused by the native piñon ips bark beetle (*Ips confusus*) is not uncommon throughout New Mexico and on the Gila NF. During periods when piñon ips populations are at endemic levels, individual or small groups of stressed, damaged, or diseased trees are attacked. Defoliating agents are present in the PJO, however, they typically do not cause substantial or long-term damage (Ryerson 2015). There are also several species of mistletoes present in the woodland which add to mortality as drought stress increases in the future as a result of climate change.

Spatial Niche

The PJO is widespread and at 2,585,904 acres (5.5%) within the context area and 848,440 acres (25.9%) of the Gila NF, represents the 5th largest ERU within the context area and the largest ERU on the Forest. However, it has a greater proportional representation on the Forest (0.65) than in the context area (Table 68). This ERU has a moderate seral state proportion departure rating within the context area and at the plan scale, however departure is low in the Little Colorado-San Agustin Fringe and Lower Gila River local units on the Forest (Table 69). In general, this ERU has gone from a normally medium to large (20 in +) size tree-closed canopy nature to a smaller tree size with open or closed canopy and medium to large (<20 in.) size trees with open canopy characteristics throughout its range within the context area.

Table 68. PJO ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	**Total ERU Area on Gila NF (column 2)**		**Total ERU Area within CA (column 3)**		**Gila NF's Contribution to Total ERU within CA (column 4)**	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
PJO	848,440	25.9	2,585,904	5.5	32.8	0.65

Table 69. PJO ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		**Black Range**		**Little Colorado-San Agustin Fringe**		**Lower Gila River**		**Mogollon Front**		**Upper Gila River**		**Gila NF**		**Context Area**	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
Percent seral state departure	97,007	11.4	260,351	30.7	111,055	13.1	191,213	22.5	146,107	17.2	42,707	5.0	848,440	26.4	2,585,904	5.5
	39 Moderate		39 Moderate		30 Low		32 Low		45 Moderate		36 Moderate		36 Moderate		41 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with its greater proportional representation on the Forest; the Gila NF has a greater influence on ecological integrity and sustainability of this system.

PIÑON-JUNIPER GRASS WOODLAND (PJG) ERU

General Description


Figure 38. PJG ERU (photo by T. Palmer 2006)

The PJG ERU (Figure 38) occurs across the states of Arizona and New Mexico, in what were historically more open woodlands with grassy understories. It is mostly found on lower slopes of mountains and in upland rolling hills at approximately 4,500 to 7,500 feet in elevation. Tree species include one seed juniper, Utah juniper, Rocky Mountain juniper (*Juniperus scopulorum* Sarg.), and alligator juniper. Piñon trees include twoneedle piñon. Native understories were made up of perennial grasses, with both annual and perennial forbs, and shrubs that were absent or scattered. Contemporary understories often include invasive grasses and uncharacteristically high shrub cover. The PJG ERU including its various vegetation states, occurs on deep, fine-textured soils in valley bottoms and on gentle plains with few barriers to fire spread; within areas of warm summer seasons and a bi-modal precipitation regime. Generally, annual precipitation ranges from 11 to 22 inches, with 40-45% coming between October 1st and March 31st. According to Wahlberg et al. (2014), empirical information on the historic condition of this type is lacking; however, site productivity provides inference for the development of a grass/fine fuels layer, in turn, providing inference of frequent fire and open, uneven-aged forest dynamics. At least one study, substantiating multiple tree cohorts in similar plant communities, corroborates these assumptions (Gottfried 2003). As such, trees would have occurred as individuals or in smaller clumps and range from young to old. Scattered shrubs and a dense herbaceous understory of native grasses and forbs characterize this type. Typical drivers and stressors (fire, insects, disease, etc.) are low severity and high frequency. These disturbance patterns would have created and maintained uneven-aged and open-canopied conditions. The tree and grass species composition varies throughout the Region, consisting a mix of one species of piñon (ranges are typically distinct) and one or more juniper species. Typically, native understory grasses are perennial species, while forbs consist of both annuals and perennials. Shrubs are characteristically absent or scattered. Due to the effects of long-term fire suppression and grazing in this type, in many locations the current condition is severely departed from historic conditions. Typically these changes include in-filling of the canopy gaps, increased density of tree groups; and reduced composition, density and vigor of the herbaceous understory plants. Many of these sites currently are closed-canopy woodlands, with insufficient understory vegetation to support surface fires.

Figure 39 and Figure 40 show that the majority of this ERU occurs in the northern and eastern portions of the context area and the northwestern and central portions of the Forest.

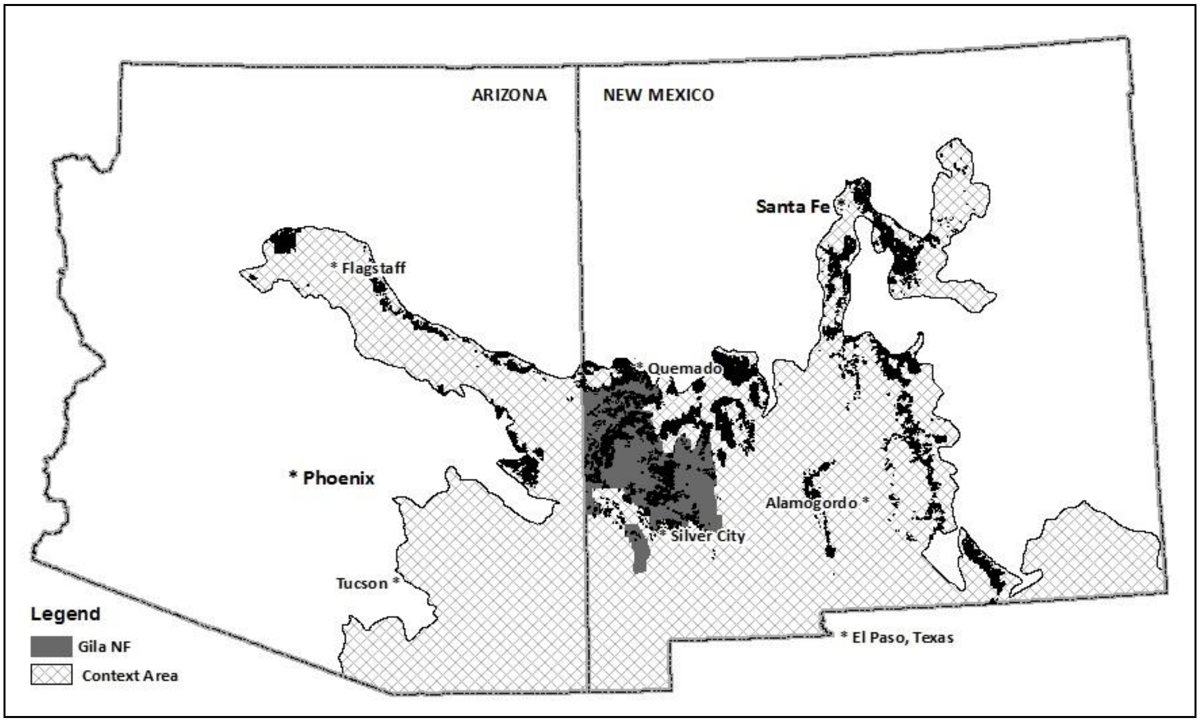

Figure 39. General location (in black) of the PJG ERU within the context area

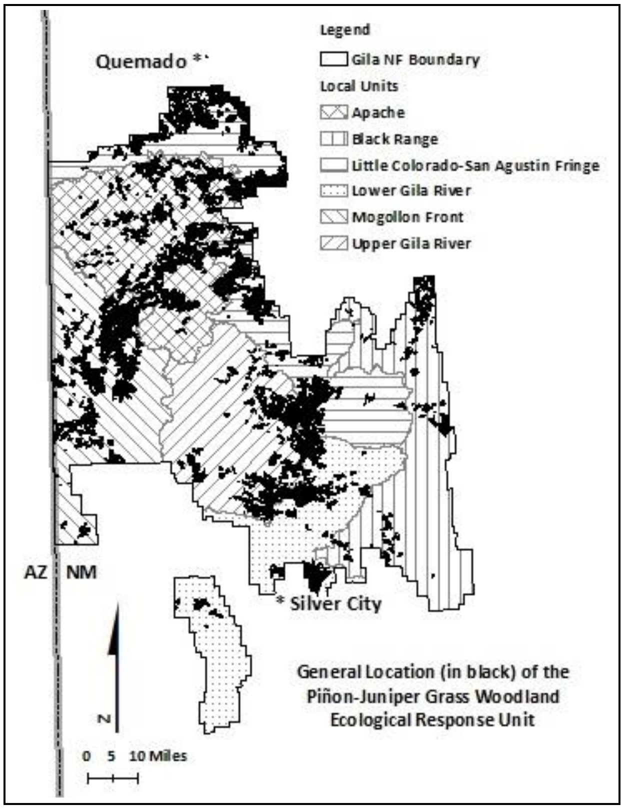

Figure 40. General location (in black) of the PJG ERU within the Gila NF and the six local units

Seral State Proportion

In general this ERU has gone from a normally seedling/sapling size trees with open or closed woody canopy cover, and small to very large size trees with open woody canopy cover to a medium to very large size trees with closed woody canopy cover nature (Table 70). Historically, this ecotype supported stands of uneven-aged trees and open-canopied conditions.

Table 70. Seral state make-up of the PJG ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A	EARLY-SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	5	5	22	5	5
B, C, E	MID-SERAL: Seedling/sapling size (< 5” dbh/drc) trees with open or closed woody canopy cover, and small size (≥ 5” & < 10” dbh/drc) trees with open woody canopy cover	25	11	20	11	20
D	LATE-SERAL: Medium to very large size (≥ 10” dbh/drc) trees with open woody canopy cover	50	25	18	25	18
F	MID-SERAL: Small size trees with closed woody canopy cover	10	12	16	10	10
G	LATE-SERAL: Medium to very large size trees with closed woody canopy cover	10	47	24	10	10
Total		100	100	100	61	63

Departure Index Rating⫲ = 100 – ∑ similarity values: Gila NF = (100 – 61) = 39 or MODERATE; and Context Area = (100 – 63) = 37 or MODERATE

‡ USDA FS 2010d; LANDFIRE 2005b

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

⫲ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

At all scales, departure in seral state proportion is moderate. Currently there is a sizeable over representation medium to very large size trees with closed woody canopy cover (seral state G). This condition is very uncharacteristic for this ERU (LANDFIRE 2008b). This uncharacteristic closed canopy condition is also accompanied by a significant under representation of seedling/sapling size trees with open or closed woody canopy cover, and small to very large size trees with open woody canopy cover. Similar to the forested ERUs on the Gila, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of the previous forested ERUs, also applies here. Departure has resulted from the cumulative effects of past fire suppression, firewood harvesting, legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 41. Recall that the trend analysis is conducted at the plan scale only.

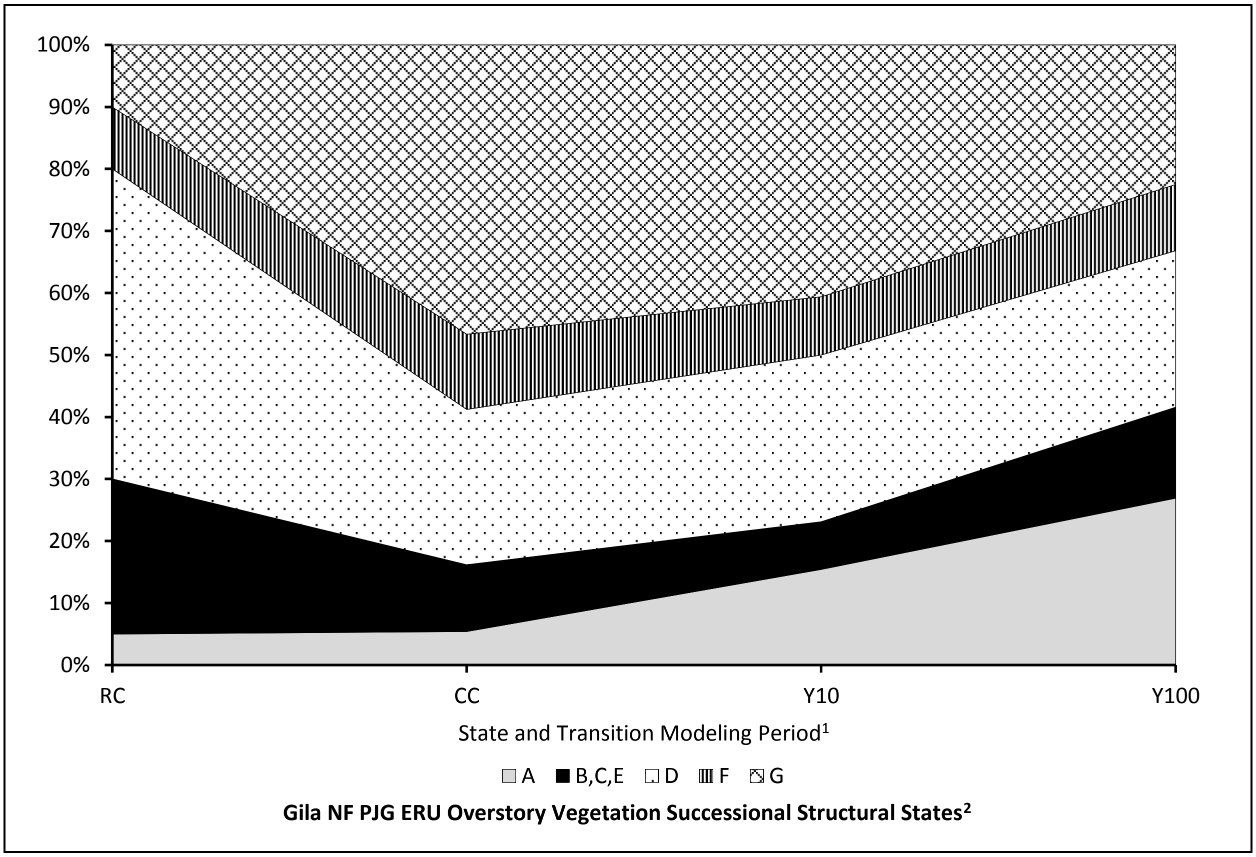

Figure 41. Gila NF overstory vegetation successional structural states for PJG ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 39% or moderate departure from RC
Y10 = State and transition modeling results at 10 years = 41% or moderate departure from RC
Y100 = State and transition modeling results at 100 years = 35% or moderate departure from RC
[2] See Table 70 for a description of the overstory vegetation successional structural states

Under the continuation of current management, departure remains moderate with a static trend (± 5%). Management may be more effective in restoring and maintaining ecological integrity of this ERU by monitoring and evaluating the outcomes restoration activities, and selectively treating appropriate seral states.

Patch Size

Table 71. Gila NF current departure of patch size in PJ Grass

Reference Range:	0.07 to 1 ac.
Current Mean:	28 ac.
Departure:	High

As shown in Table 71, the increase in mean patch size reflects infill and encroachment of trees into the historically large grassy openings in this ecosystem. This is primarily due to drought and historic overgrazing which provided the competitive advantage to regenerating conifer seedlings and altered ecological processes by reducing the herbaceous component. Increasing tree densities within patches, or clumps is also occurring. For more information about fire and herbivory, see Chapter 9: System Drivers and Stressors.

Coarse Woody Debris and Snag Density

Table 72. Gila NF current and projected departure of coarse woody debris in PJ Grass

	Coarse Woody Debris	Departure/Trend
Reference:	2.4 T/ac.	
Current:	13.4 T/ac.	High
100-years:	13.4 T/ac.	High/Static

As shown in Table 72, there is currently nearly 5-½ times the amount of coarse woody debris per acre than historically (Weisz et al. 2011). This is primarily due to high departure in fire frequency (see below), higher tree densities and slow decomposition rates. Tree mortality is probably not a significant contributing factor as snag density (see below) is within the natural range of variability.

Table 73. Gila NF current and projected departure of snags in PJ Grass

	Snag Density (8" dbh)	Departure/Trend	Snag Density (18" dbh)	Departure/Trend
Reference:	5.0/ac.		1.0/ac.	
Current:	4.4/ac.	Low	0.7/ac.	Low
100-years:	4.4/ac.	Low/Static	0.7/ac.	Low/Static

As shown in Table 73, there are currently less snags per acre than historically, reflected by a moderate departure rating. Given a higher proportion of open canopy conditions in this system as compared to PJO and PJC, increased competition due to increased tree densities and drought may not create the same degree of water stress and mortality in this ERU as compared to others.

Fire Regime

The natural fire regime of the PJG ERU was characterized by freqent, low severity fire which maintained the mulit-aged and open canopy conditions.

Fire Frequency

Table 74. Reference and current Gila NF fire frequency for PJ Grass

Reference:	**MFRI*= 0-35 yrs.** (FF‡ = average fire rotation = 20 yrs. and non-lethal fire rotation = 20 yrs.)
Current:	FF = 154 yrs.
Departure:	High

‡ Allen 1989; Despain and Mosley 1990; Baisan and Swetnam 1995; Grissino-Mayer et al. 1995; Gottfried et al. 1995; Romme et al. 2003; Baker and Shinneman 2004; Vander Lee et al. 2006; LANDFIRE 2008b; Poulos et al. 2009; Barrett et al. 2010; Margolis 2014; Wahlberg et al. 2014; Krausmann and Triepke 2014; Swetnam and Falk 2015

As shown in Table 74, in the last 19 years (1996-2015), fire has occurred less often than characteristic of the reference time period due to reductions the fine fuels necessary to support fire. Departure is high at the context, plan and local unit scales except in the Upper Gila River local unit where departure is low (FF= 30 yrs.). The causes of fine fuels reductions have been identified previously are discussed in detail in the fire and herbivory subsections of Chapter 9: System Drivers and Stressors.

Where departure exists, a reduction in fine fuels is likely a limiting factor, as discussed for other ERUs. Fire suppression may also be a factor where Wildland Urban Interface, or other highly valued resources are at risk, when fire weather and fuel conditions do not support the achievement of the management objectives, or when resources needed to manage a particular fire are unavailable. Resources to manage fires may be unavailable when they are committed to managing or suppressing fires elsewhere.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire within the PJG ERU on the Forest is 1,894 acres; roughly 89% low severity, 10% moderate severity and 1% at high severity. Current average fire severity at the plan scale is approximately 17%, slightly higher than the reference condition's 13% (Krausmann and Triepke 2014), giving it a low departure rating. Average fire severity is also roughly consistent with reference severity in the Apache, Little Colorado-San Agustin Fringe and Lower Gila River local units. Departure is moderate in the Black Range (~21%), Mogollon Front and Upper Gila River local units (~18% in both cases). Generally, fire has burned at low severity within the PJG ERU. Where average severity is higher than the reference, it is likely attributable to increases in tree densities and coarse woody debris.

Fire Regime Condition Class (FRCC)

Table 75. Gila NF Reference FRCC and Departure for PJ Grass

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 95.5%	FRCC III = 0.0%	No data = 4.5%
Departure:	Moderate, Static Trend			

‡ Krausmann and Triepke 2014

As shown in Table 75, all of this ERU for which there is data falls within the FRCC II category, indicating a moderate departure from the natural fire regime. This departure is primarily a reflection of departure in fire frequency and seral state proportion.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 850 acres. The highest level occurred in 2003 at 7,034 acres. Overall, just 5% of this ERU has been affected by insect and disease activities since 1997.

As mentioned in the PJO ERU write-up, a long-term perspective on the extent of past insect and disease activity in the piñon-juniper woodlands is often lacking because it has not often been recorded in historical reports. The PJG woodland is susceptible to attacks by several species of bark beetles. Localized mortality of piñon trees caused by the native piñon ips bark beetle (*Ips confusus*) is not uncommon throughout New Mexico and on the Gila NF. During periods when piñon ips populations are at endemic levels, individual or small groups of stressed, damaged, or diseased trees are attacked. Defoliating agents are present in the PJG, however, they typically do not cause substantial or long-term damage (Ryerson 2015). There are also several species of mistletoes present in the woodland.

Spatial Niche

The PJG is widespread and at 1,411,018 acres (3.0%) within the context area and 291,649 acres (8.9%) of the Gila NF, represents the 6th largest ERU within the context area and the 5th largest ERU on the Forest (Table 5). However, it has a greater proportional representation on the Forest (0.50) than in the context area (Table 76). This ERU has a moderate seral state proportion departure rating at all scales (Table 77). In general, this ERU has gone from a normally seedling/sapling size trees with open or closed woody canopy cover, and small to very large (20 in. +) size trees with open woody canopy cover to a medium to very large (< 20 in.) size trees with closed woody canopy cover nature.

Table 76. PJG ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
PJG	291,649	8.9	1,411,018	3.0	20.7	0.50

Table 77. PJG ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	65,676	22.5	13,225	4.5	93,597	32.1	33,158	11.4	54,838	18.8	31,155	10.7	291,649	9.1	1,411,018	3.0
Percent seral state departure	42 Moderate		37 Moderate		43 Moderate		47 Moderate		37 Moderate		49 Moderate		39 Moderate		37 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with its greater proportional representation on the Forest. The Gila NF has a greater influence on ecological integrity and sustainability of this system. The Forest's responsibility is heightened by the departure in seral state proportion.

JUNIPER-GRASS WOODLAND (JUG) ERU

General Description

Figure 42. JUG ERU (photo by M.R. White 2007)

The JUG ERU (Figure 42) is typically found on warmer and drier settings beyond the environmental limits of piñon, and just below and often intergrading with the piñon-juniper zone. The juniper-grass ecosystem is generally uneven-aged and very open in appearance (savanna-like). Trees occur as individuals or in smaller groups and range from young to old. A dense herbaceous matrix of native grasses and forbs characterize this type. Typical drivers and stressors (i.e., fire, insects, and disease) are low severity and high frequency. These disturbance patterns create and maintain the uneven-aged, open-canopy nature of this type. The tree and grass species composition varies throughout the Region, consisting of a mix of one or more juniper species. Typically, native understory grasses are perennial species, while forbs consist of both annuals and perennials. Shrubs are characteristically absent or scattered. This type is typically found on sites with well-developed, loamy soil characteristics, generally at the drier edge of the woodland climatic zone. Generally these types are most extensive in geographic areas dominated by warm (summer) season or bi-modal precipitation regimes. Generally, annual precipitation ranges from 11 to 22 inches, with 55-60% coming between April 1st and September 31st. It is mostly found on lower slopes of mountains and in upland rolling hills at approximately 4,500 to 7,500 feet in elevation. Common grass species found in JUG include blue grama and other species of grama grass (sideoats, hairy, black *(Bouteloua eriopoda* (Torr.) Torr.*),* New Mexico muhly (*Muhlenbergia pauciflora* Buckley), curlyleaf muhly (*Muhlenbergia setifolia* Vasey), western wheatgrass (*Pascopyrum smithii* (Rydb.) Á. Löve), and needle and thread grasses (*Hesperostipa* spp. (Elias) Barkworth). It is hypothesized that a regime of frequent, low-intensity surface fires is responsible for maintaining the open stand structure and dense herbaceous growth of piñon-juniper savanna (USDI NPS 2016). Overall these sites are less productive for tree growth than the piñon-juniper woodland type.

Due to the effects of long-term fire suppression and grazing in this type, in many locations the current condition is severely departed from historic conditions. Typically these changes include in-filling of the canopy gaps, increased density of tree groups, and reduced composition, density and vigor of the herbaceous understory plants. Many of these sites currently are closed-canopy woodlands, with insufficient understory vegetation to support surface fires.

Figure 43 and Figure 44 show that the majority of this ERU occurs in the southwestern and northeastern portions of the context area and the southwestern portion of the Forest and in the Burro Mountains.

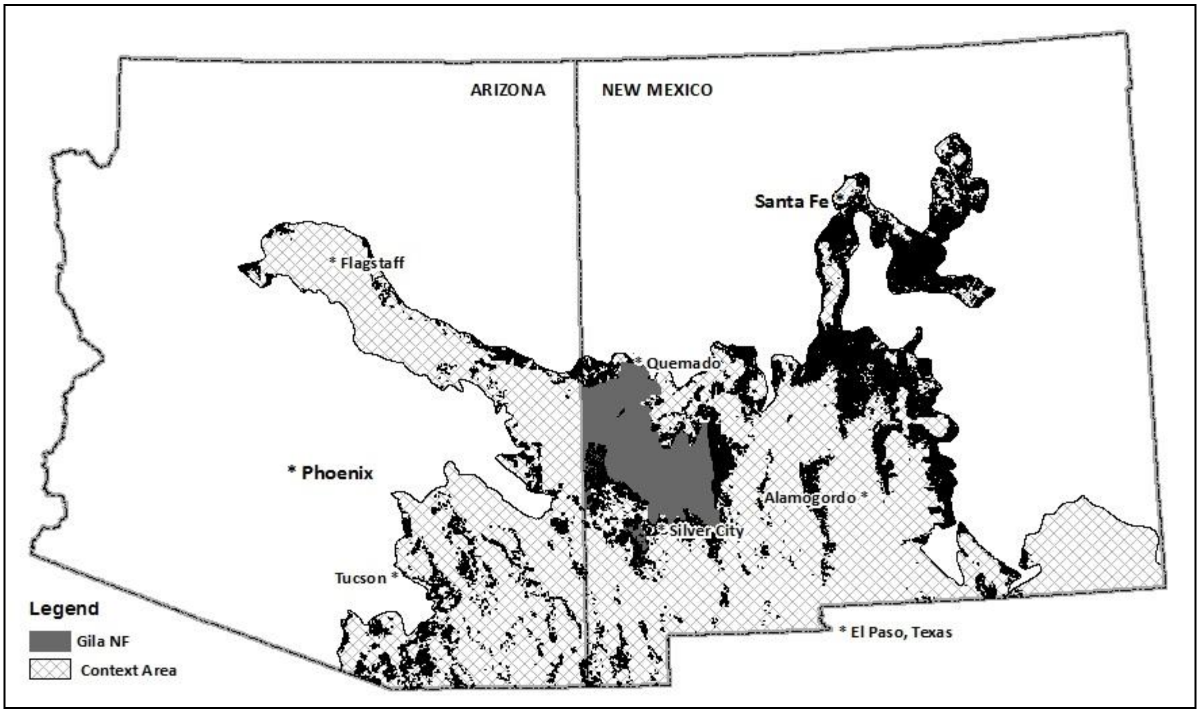

Figure 43. General location (in black) of the JUG ERU within the context area

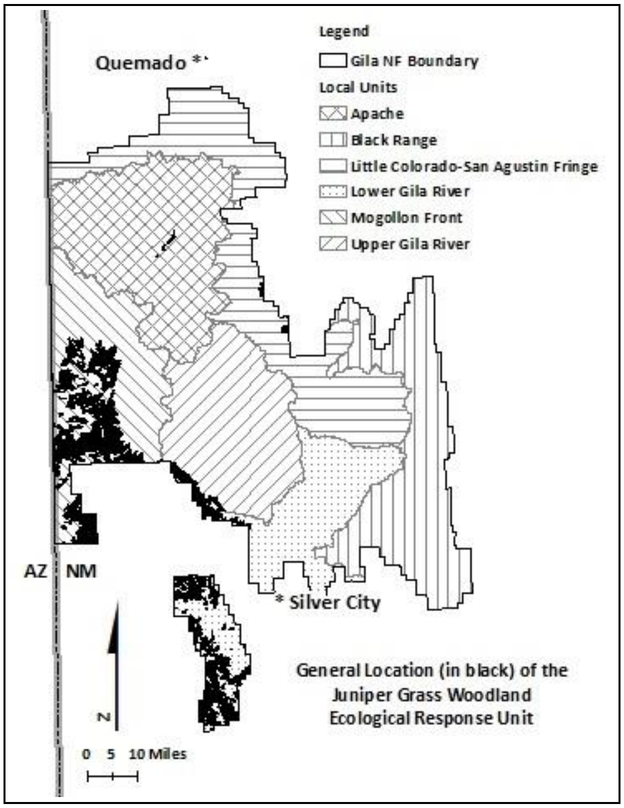

Figure 44. General location (in black) of the JUG ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the JUG ERU was comprised of small and medium to very large size trees with open woody canopy cover, and seedling/sapling size trees with open or closed woody canopy cover (Table 78). Currently it is a mix of grass, forb, sparsely vegetated or recently burned with very open woody canopy cover, and shrubs with open or closed woody canopy cover, small and medium to very large size trees with open woody canopy cover, and seedling/sapling size trees with open or closed woody canopy cover. Historically, this ecotype supported an open savanna-like stand structure, low densities of trees and shrubs, and dense herbaceous growth: grasses, forbs, and annuals (UDSI NPS 2016).

Table 78. Seral state make-up of the JUG ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			NF	CA	GNF	CA
A	Early seral: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover, and shrubs with open (≥ 10% & < 30%) or closed (≥ 30%) woody canopy cover	5	28	35	5	5
B, C, E	Mid-seral: Seedling/sapling size (< 5” dbh/drc) trees with open or closed woody canopy cover, and small size (≥ 5” & < 10” dbh/drc) trees with open woody canopy cover	25	31	13	25	13
D	Late-seral: Medium to very large size (≥ 10” dbh/drc) trees with open woody canopy cover	50	30	27	30	27
F	Mid-seral: Small size trees with closed woody canopy cover	10	3	7	3	7
G	Late-seral: Medium to very large size trees with closed woody canopy cover	10	8	18	8	10
Total		100	100	100	71	62

Departure Index Rating⧣ = 100 – ∑ similarity values: Gila NF = (100 – 71) = 29 or LOW; and Context Area = (100 – 62) = 38 or MODERATE

‡ USDA FS 2010e; LANDFIRE 2005b

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

⧣ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

Departure is low at the plan scale, but varies within the Forest’s local units. Departure is moderate in the Upper Gila River and Lower Gila River local units, low in the Apache and Mogollon Front local units, and is not mapped in the Black Range or Little Colorado-San Agustin Fringe local units. Context area departure is moderate. Where departure occurs, there is an over representation of grass, forb, sparsely vegetated or recently burned with very open woody canopy cover, and shrubs with open or closed woody canopy cover (seral state A), with a concurrent under representation of medium to very large size trees with open woody canopy cover (seral state D). Similar to the forested ERUs on the Gila, there is almost no (<1%) representation of very large size trees (20 in. +). The discussion of what this may or may not imply for the status of old growth presented in the seral state proportion analysis of the previous forested ERUs, also applies here. Departure has resulted from the cumulative effects of past fire suppression, firewood harvesting, legacy issues related to past historic overgrazing and in some places, current herbivory by wildlife and livestock. Chapter 9: System Drivers and Stressors discusses these management factors in greater detail.

Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 45. Recall that the trend analysis is conducted at the plan scale only.

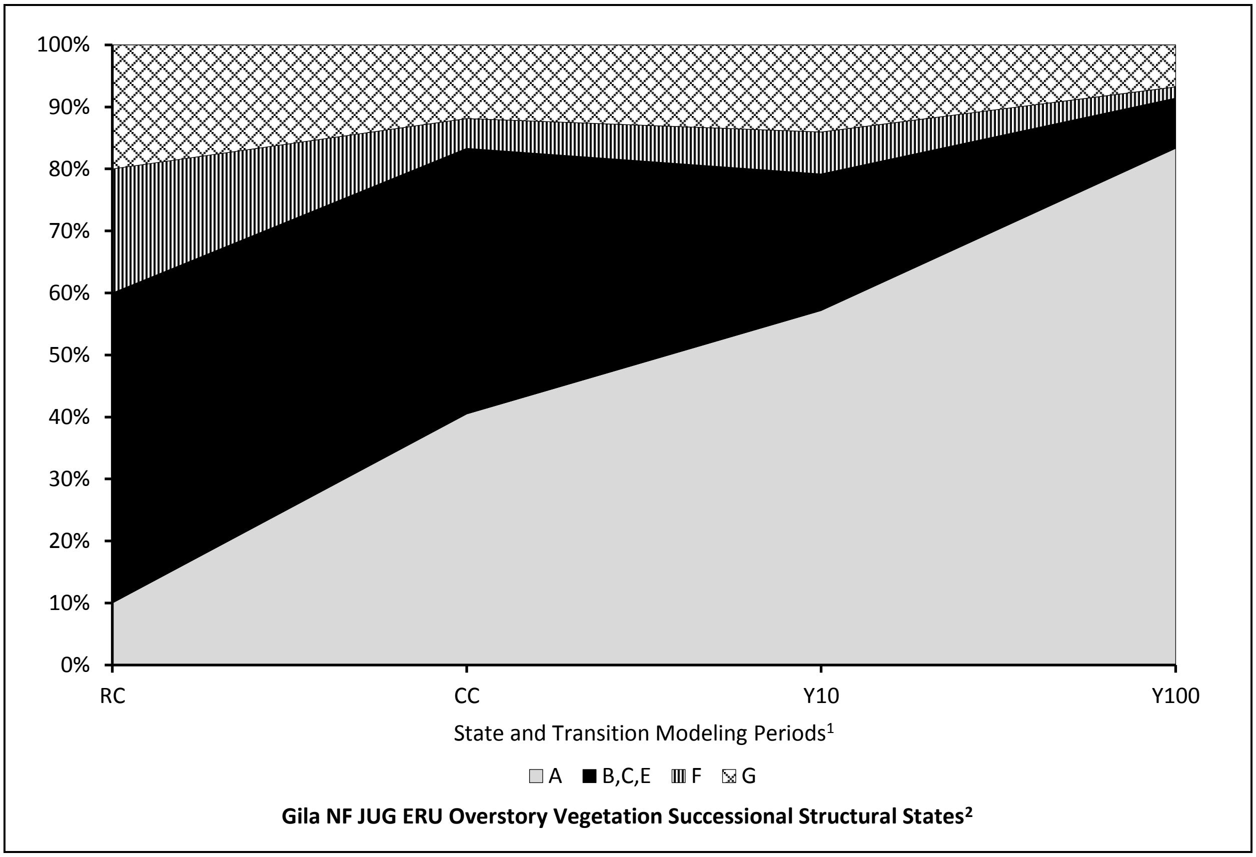

Figure 45. Gila NF overstory vegetation successional structural states for JUG ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities.

[1] RC = Reference conditions
CC = Current conditions = 29% or low departure from RC
Y10 = State and transition modeling results at 10 years = 36% or low departure from RC
Y100 = State and transition modeling results at 100 years = 59% or moderate departure from RC
[2] See Table 78 for a description of the overstory vegetation successional structural states

The increase in early seral state conditions into the future under continuation of current management produces a trend in departure away from reference conditions by approximately 30 percentage points. This may reflect restoration activities under current management are better designed for grassland systems, rather than this woodland system, which signifies a need to incorporate the ERU map and concepts into the development and implementation of projects. As with other woodland systems, further field validation of the ERU map which have not been available previously, will be beneficial in guiding restoration efforts.

Patch Size

Table 79. Gila NF current departure of patch size in Juniper Grass

Reference:	0.07 to 1 ac.
Current:	5 ac.
Departure:	High

As shown in Table 79, mean patch size is larger than under reference condition, reflecting encroachment of juniper into the large grassy openings in this woodland which reflects the dynamics between past fire suppression and historic overgrazing, described repeatedly in other ERU analyses.

Coarse Woody Debris and Snag Density

Table 80. Gila NF current and projected departure of coarse woody debris in Juniper Grass

	Coarse Woody Debris	Departure/Trend
Reference:	3.0 T/ac.	
Current:	13.8 T/ac.	High
100-years:	13.8 T/ac.	High/Static

As shown in Table 80, there is currently nearly 4-½ times the amount of coarse woody debris per acre than historically (Weisz et al. 2011). Given the low departure in snag density, increases in coarse woody debris likely reflect a combination of the extent of attempts at juniper removal and/or control in this ERU in the past, mortality that occurred long enough ago that trees are no longer standing, and slow decomposition rates.

Table 81. Gila NF current and projected departure of snags in Juniper Grass

	Snag Density (8” dbh)	Departure/Trend	Snag Density (18” dbh)	Departure/Trend
Reference:	3.0/ac.		1.0/ac.	
Current:	3.4/ac.	Low	0.6/ac.	Low
100-years:	3.4/ac.	Low/Static	0.6/ac.	Low/Static

As shown in Table 81, there are currently nearly as many snags per acre as historically. Juniper snags are one of the most favored firewood species found on the Gila NF; given the same probable causes of increases in coarse woody debris also influence snag density, it is likely that the removal of standing dead juniper is the most likely explanation for low departure.

Fire Regime

The natural fire regime of the JUG ERU is characterized by frequent, low severity fire.

Fire Frequency

Table 82. Reference and current Gila NF fire frequency for Juniper Grass

Reference:	**MFRI*= 0-35 yrs.** (FF‡ = average fire rotation = 13 yrs. and non-lethal fire rotation = 13 yrs.)
Current:	FF = 1,308 yrs.
Departure:	High

‡ Johnsen 1962; Wright and Bailey 1982; Gottfried et al. 1995; Paysen et al. 2000; Baker and Shinneman 2004; Schussman et al. 2006; Hauser 2007; Margolis 2014; Krausmann and Triepke 2014

As shown in Table 82, in the last 19 years (1996-2015), fire has occurred less often than characteristic of the reference time period due to past fire suppression and reductions the fine fuels necessary to carry fire. Departure is high at the context, plan and local scales, with the exception of the Black Range and Little Colorado-San Agustin Fringe local units where there are no acres of JUG mapped. The Apache and Upper Gila River local units do not have data to assess fire frequency. The causes of fine fuels reductions have been identified previously are discussed in detail in the fire and herbivory subsections of Chapter 9: System Drivers and Stressors.

Where departure exists, a reduction in fine fuels is likely a limiting factor, as discussed for other ERUs. Fire suppression may also be a factor where Wildland Urban Interface, or other highly valued resources are at risk, when fire weather and fuel conditions do not support the achievement of the management objectives, or when resources needed to manage a particular fire are unavailable. Resources to manage fires may be unavailable when they are committed to managing or suppressing fires elsewhere.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire within the JUG is 88 acres; roughly 97% at low severity, 3% at moderate severity and 0% at high severity. Current average fire severity at the plan scale is 14%, which is quite similar to the reference condition's 13% (Krausmann and Triepke 2014), giving it a low departure rating. Average severity in the two local units containing both JUG and severity data (Mogollon Front and Lower Gila River) are within one percentage point of the reference average severity. Generally, fire has burned mostly at low severity levels within the JUG ERU, consistent with severity in the reference time period. Low departure in severity may be related to high departure in fire frequency; with more frequent and larger extents of fire, severity might be expressed differently.

Fire Regime Condition Class (FRCC)

Table 83. Gila NF Reference FRCC and Departure for Juniper Grass

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 92.4%	FRCC III = 0.0%	No data = 7.6%
Departure:	High, Trend Away from Reference			

‡ Krausmann and Triepke 2014

As shown in Table 83, all of this ERU on Forest with data available is categorized as FRCC II, indicating a moderate departure from the natural fire regime. Departure is also moderate at the context scale. This is attributable to departure in seral state proportion and fire frequency.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 205 acres. The highest level occurred in 2003 at 1,991 acres. Overall, nearly 3% of this ERU has been affected by insect and disease activities since 1997.

As mentioned in the PJO ERU write-up, a long-term perspective on the extent of past insect and disease activity in the piñon-juniper woodlands is often lacking because it has not often been recorded in historical reports. The JUG woodland is susceptible to attacks by several species of bark beetles. Localized mortality of piñon trees caused by the native piñon ips bark beetle (*Ips confusus*) is not uncommon throughout New Mexico and on the Gila NF. During periods when piñon ips populations are at endemic levels, individual or small groups of stressed, damaged, or diseased trees are attacked. Defoliating agents are present in the JUG, however, they typically do not cause substantial or long-term damage (Ryerson 2015). There are also several species of mistletoes present in the woodland.

Spatial Niche

The JUG is widespread and at 3,703,181 acres (7.9%) within the context area and 114,396 acres (3.6%) of the Gila NF, represents the 3rd largest ERU within the context area and the 7th largest ERU on the Forest. In addition, it has a lower proportional representation on the Forest (-0.39) than in the context area (Table 84). This ERU has a moderate seral state proportion departure rating at the context scale, and a low departure rating at the plan scale although two local units within the Forest are in moderate departure (Table 85).

Table 84. JUG ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
JUG	114,396	3.5	3,703,181	7.9	3.1	-0.39

Table 85. JUG ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	442	0.4	0	0.0	0	0.0	39,759	34.8	65,898	57.6	8,317	7.3	114,396	3.6	3,703,181	7.9
Percent seral state departure	29 Low						34 Moderate		24 Low		41 Moderate		29 Low		38 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The Gila NF's spatial niche, or influence on this particular ERU has to do with its lower proportional representation on the Forest and low departure in seral state proportion as opposed to the context area. The Gila NF has a smaller influence on ecological integrity and sustainability of this system. Given the same degree of departure on the Forest and across the context area, the Forest is not currently well positioned to act as a refugia for JUG.

Shrubland ERU

MOUNTAIN MAHOGANY MIXED SHRUBLAND (MMS) ERU

General Description

The mountain mahogany mixed shrubland ERU (Figure 46) occurs in the foothills, canyon slopes, and lower slopes of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico extending north into Colorado. These shrublands are often associated with exposed sites, rocky substrates, and dry conditions. Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically dominated by a variety of shrubs including mountain mahogany and skunkbush sumac. Historically this ERU had less than 30% tree canopy cover. The mountain mahogany mixed shrubland ERU is characterized by infrequent, stand replacement fire, with an average fire return interval of 35-200 years.

Figure 46. MMS ERU (Wahlberg et al. 2014)

Figure 47 and Figure 48 show that the show the distribution of this ERU within the context area and Forest.

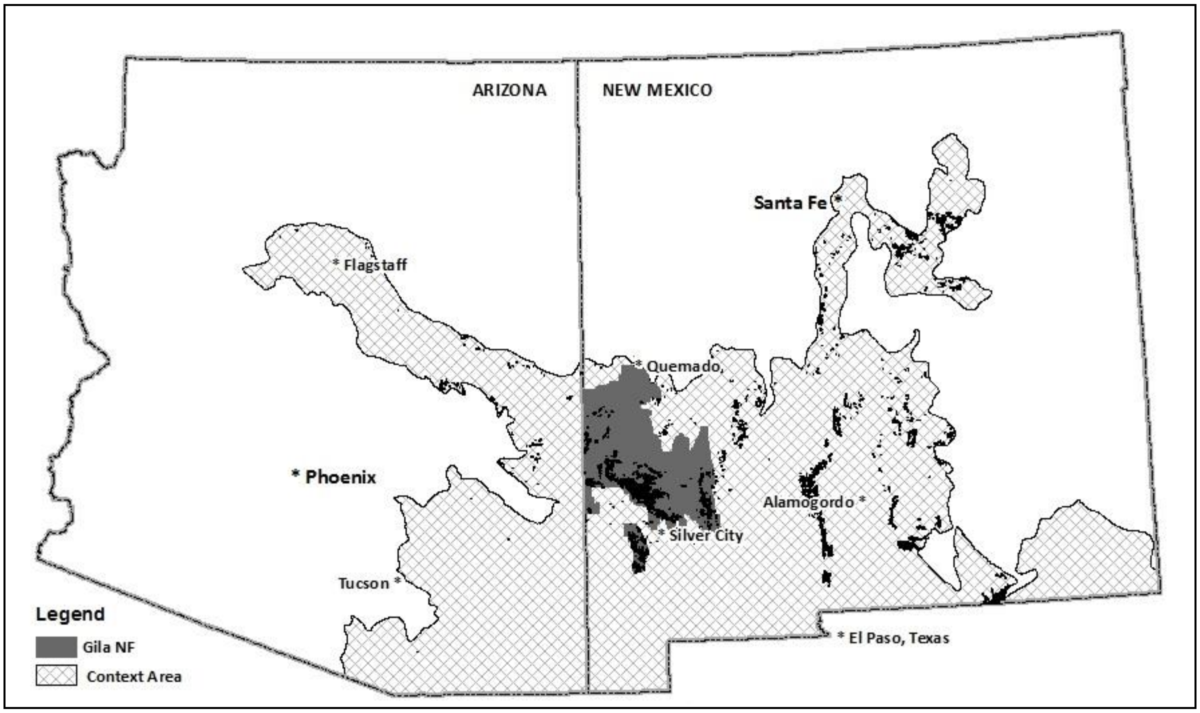

Figure 47. General location (in black) of the MMS ERU within the context area

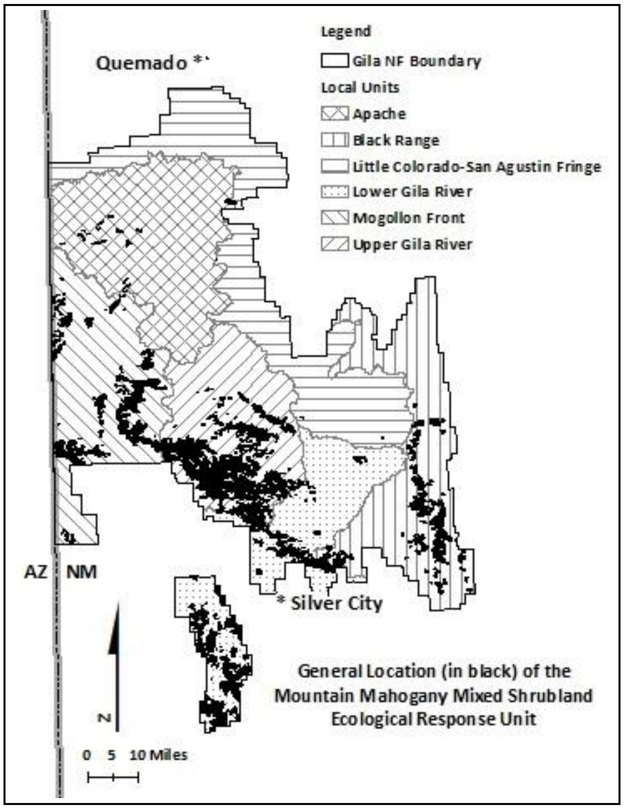

Figure 48. General location (in black) of the MMS ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the MMS ERU was dominated by all size shrubs with open or closed canopy cover (Table 86). Currently, this ERU is dominated by all size trees with open or closed canopy cover.

Table 86. Seral state make-up of the MMS ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A	EARLY SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover	5	2	9	2	5
B	MID-SERAL: All size shrubs with open (≥ 10% & < 30%) canopy cover	50	3	17	3	17
C	LATE-SERAL: All size shrubs with closed (≥30%) canopy cover	15	1	6	1	6
D	LATE-SERAL: All size trees with open or closed canopy cover	30	94	68	30	30
Total		100	100	100	36	58

Departure Index Rating‡‡ = 100 – ∑ similarity values: Gila NF = (100 – 36) = 64 or MODERATE; and Context Area = (100 – 58) = 42 or MODERATE

‡ USDA FS 2015e; LANDFIRE 2007e

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker, 1992, page 93)

‡‡ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High)

At the context and plan scale, departure in seral state proportion is moderate. Departure is also moderate for all local units within the Forest, with the exception of Little Colorado-San Agustin Fringe which is in high departure. Also of note, the Black Range local unit is at the threshold between moderate and high departure (66%). Currently there is an over representation of all size trees with open or closed canopy cover (seral state D) and concurrent under representation of all size shrubs with open or closed canopy cover (seral states B and C). Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 49. Recall that the trend analysis is conducted at the plan scale only.

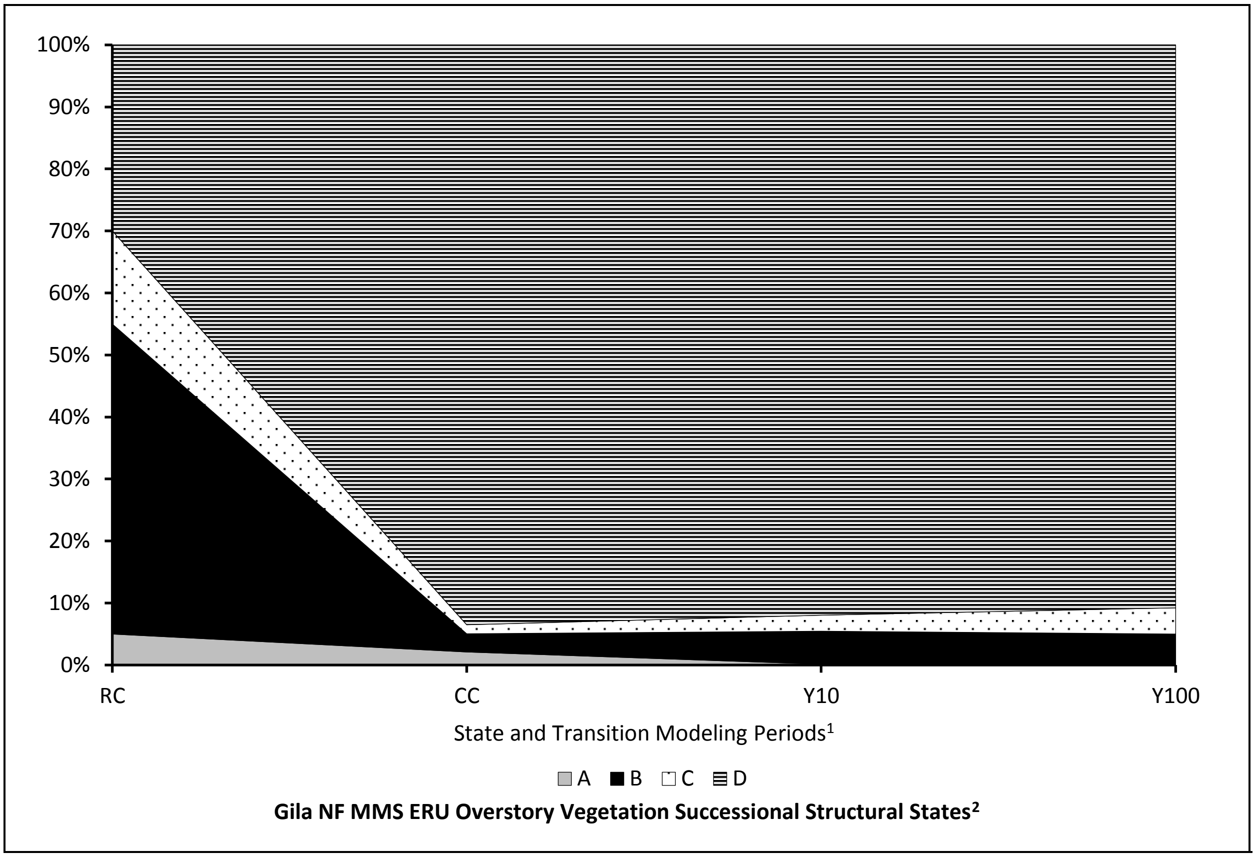

Figure 49. Gila NF overstory vegetation successional structural states for MMS ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities.

[1] RC = Reference conditions
CC = Current conditions = 64% or low departure from RC
Y10 = State and transition modeling results at 10 years = 62% or moderate departure from RC
Y100 = State and transition modeling results at 100 years = 61% or moderate departure from RC
[2] See Table 86 for a description of the overstory vegetation successional structural states

Under continuation of current management (and under the current climate regime), seral state proportion conditions in the MMS ERU remain relatively unchanged (static trend).

Patch Size

There is inadequate information on which to base a reference condition for analysis of patch size in this ERU (Wahlberg et al. 2014).

Coarse Woody Debris and Snag Density

There is no coarse woody debris and snag density assessment data for this ERU.

Fire Regime

The natural fire regime associate with the MMS ERU is characterized by infrequent, stand-replacment type fires.

Fire Frequency

Table 87. Reference and current Gila NF fire frequency for Mountain Mahogany Mixed Shrubland

Reference:	MFRI* 35-200 yrs.
Current:	FF = 32 yrs.
Departure:	Low

* Wahlberg et al. 2014; Krausmann and Triepke 2014

As shown in Table 87, over the last 19 years (1996-2015), fire frequency has been within what is known about the natural range of variability at the plan scale, and in the Black Range (FF= 29 yrs.), Little Colorado-San Agustin Fringe (FF= 99 years) and Mogollon Front (FF= 40 yrs.) local units on the Forest. However, there is moderate departure in the Upper Gila River local unit, where fire frequency is approximately 18 years, and high departure in the Lower Gila River and Apache local units with fire frequencies at approximately 1,262 and 606 years respectively. More frequent fire within the Upper Gila River local unit is driven by steep topography and patterns of natural ignitions. Lower fire frequencies in the Apache local unit is partly due to its proximity to the Wildland Urban Interface and private land near the communities of Luna and Reserve, NM and as well as patterns of natural ignitions, and relatively few ERU acres. Wildland Urban Interface (and private land) near the communities of Pinos Altos and Silver City, as well as smaller communities in the Burro Mountains also influence management of the MMS in the Lower Gila River local unit, as does patterns of natural ignitions.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire within the MMS ERU on the Forest is 5,166 acres; roughly 74% low severity, 21% moderate severity and 5% at high severity. Current average severity is approximately 24% much lower than reference condition's 73% (Fryer and Luensmann 2012), giving it a high departure rating. Generally, fire has burned at low severity levels within the MMS ERU which is uncharacteristic of this infrequent, stand replacement type ecosystem which is the primary explanation for seral state departure at the Forest scale. Departure is also high in the Apache, and Lower and Upper Gila River local units ranging from 13 to 24 percent average severity. It is moderate in the remaining local units with average severities ranging from 25 to 40 percent. Lower severities in Upper Gila River are likely a reflection of fires that occurred prior to 1996. In the other local units, this is most likely driven by herbaceous productivity that is relatively low due to inherent soil characteristics or drought. Soil characteristics undoubtly play a role in Upper Gila River as well, but given all the TEUI data describing MMS is from locations in the Burro Mountains with local physical characteristics (e.g. soils and steepness of slope) very different from the majority of the ERU, it is impossible to know with any certainty without field verification.

Fire Regime Condition Class (FRCC)

Table 88. Gila NF Reference FRCC and Departure for Mountain Mahogany Mixed Shrubland

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 31.7%	FRCC III = 67.0%	No data = 1.3%
Departure:	High, Static Trend			

ǂ Krausmann and Triepke 2014

As shown in Table 88, while a significant portion of this ERU on the Forest is in the FRCC II category, the majority is in the FRCC III category, indicating a high departure from the natural fire regime. This is primarily a reflection of departure in seral state proportion and fire severity. Within the Forest's local units, Lower Gila River is also in high departure due to seral state proportion, longer fire free periods and lower fire severity. The remaining units. The remaining units with all necessary data elements are within the FRCC II and moderate departure categories, likewise reflecting their departures seral state proportion, fire frequency and average severity.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 94 acres. The highest level occurred in 2013 at 633 acres. Overall, nearly 1% of this ERU has been affected by insect and disease activities since 1997, indicating a low departure. There is no information regarding specific insects or diseases active in the MMS ERU, but it is likely that the same drivers and stressors as in the woodlands are active within this ERU.

Spatial Niche

The MMS ERU is generally located within the New Mexico portion of the context area; at 356,451 acres (or 0.8% of the context area) it is tied with MSG as the 11th largest ERU (Table 5). On the Gila NF its 166,488 acres (or 5.1% of the Forest) (Table 90) is scattered about the Forest, found primarily within the southern portion of the Forest. The MMS represents the 6th largest upland ERU on the Forest. In addition it has a greater proportional representation on the Forest (0.74) than in the context area (Table 89). In fact, it has the 2nd highest proportional representation of any ERU on the Forest. This ERU has a moderate seral state proportion departure rating, however departure varies within the Forest local units from moderate to high (Table 90).

Table 89. MMS ERU acreage, percent, and relative proportion on Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
MMS	166,488	5.1	356,451	0.8	46.7	0.74

Table 90. MMS ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	1,946	1.2	20,577	12.4	151	0.1	45,624	27.4	32,225	19.4	65,965	39.6	166,488	5.2	356,451	0.8
Percent seral state departure	65 Moderate		66 Moderate		68 High		59 Moderate		65 Moderate		65 Moderate		64 Moderate		42 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The influence of the Gila NF on this particular ERU has to do with both its higher proportional representation on the Forest, its seral state departure on and off Forest, and its rarity within the context area. The high proportional representation on the Forest indicates a greater influence on ecological integrity and sustainability. Its' moderate departure on the Forest and across the context area heightens the responsibility of the Forest. It is also rare within the context area, but is relatively common on the Forest which again, adds to the Forest's responsibility.

Grassland ERUs

MONTANE/SUBALPINE GRASSLANDS (MSG) ERU

General Description

Figure 50. MSG ERU (photo by M.R. White 1998)

Also referred to as montane grasslands, the MSG ERU (Figure 50) occurs at elevations ranging from 8,000 to 10,900 feet. Size of montane/subalpine grasslands range from small park-like openings to extensive landscapes covering several thousand acres. This ERU contains a mix of dominant and co-dominant species in both dry and moister environments and often harbors several plant associations with varying prominent grasses and herbaceous species. Such dominant species may include Parry's oatgrass (*Danthonia parryi* Scribn.), Arizona fescue, Thurber's fescue (*Festuca thurberi* Vasey), pine dropseed, non-native bluegrasses (*Poa pratensis* L. and *P. compressa* L.), mountain muhly, various sedges, shooting star (*Dodecatheon jeffreyi* Van Houtte), fowl mannagrass (*Glyceria striata* (Lam.) Hitchc.), Sierra rush (*Juncus nevadensis* S. Watson), Rocky Mountain iris (*Iris missouriensis* Nutt.), Parry's bellflower (*Campanula parryi* A. Gray), California false hellebore (*Veratrum californicum* Durand), and species of bulrush (*Scirpus* spp. L. and/or *Schoenoplectus* spp. (Rchb.) Palla). Historically this ERU had less than 10% tree canopy cover and less than 10% shrub cover. However, tree encroachment may occur along the periphery of the grasslands, trees may include Engelmann and blue spruce, Rocky Mountain Douglas-fir, white and subalpine fir, ponderosa and limber pine, depending on elevation and adjacent forest ERUs. Some shrubs may also be present. Some portions of the MSG are seasonally wet, which is closely tied to snowmelt, though they typically do not experience flooding events. The montane/subalpine grasslands are often interspersed with the herbaceous riparian (RU190) ERU. Soils in swales and on riparian benches are usually moist throughout the year, and often harbor several plant associations with varying dominant grasses and herbaceous species. Upland and swale vegetation composition are characterized by different dominant species. Generally, annual precipitation ranges from 20 to 31 inches, with 50-55% coming between October 1st and March 31st. Because of the broad nature of this ERU, future work may develop subclasses splitting out montane grassland from the subalpine grassland.

Figure 51 and Figure 52 show that the show the distribution of this ERU within the context area (primarily located in the northern and eastern portions of the context area) and northern and central portions of the Forest.

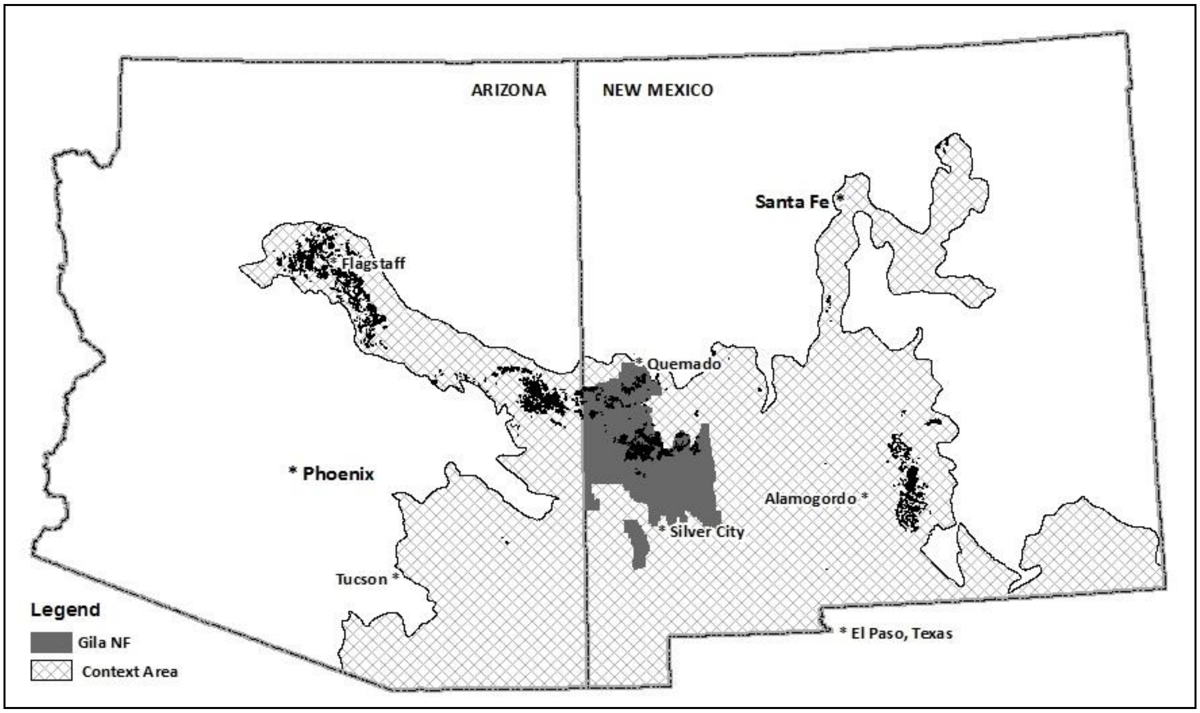

Figure 51. General location (in black) of the MSG ERU within the context area

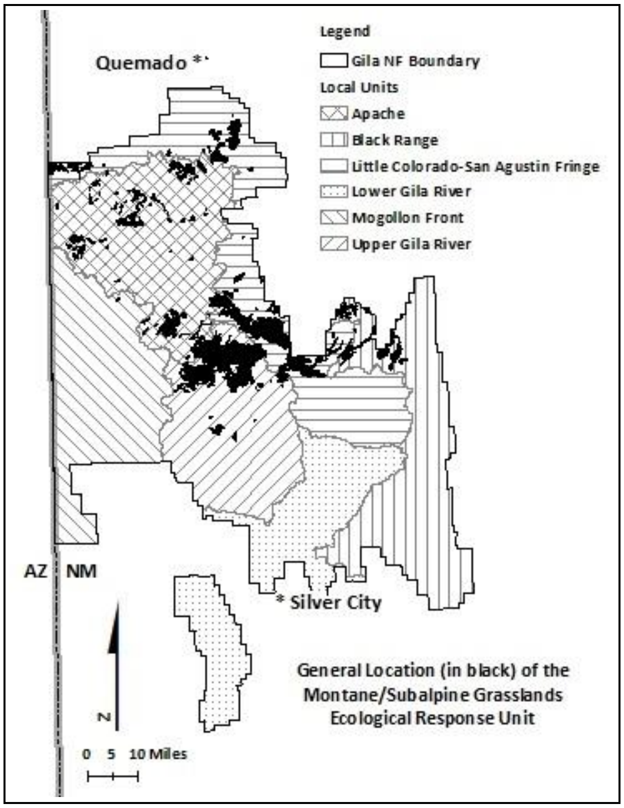

Figure 52. General location (in black) of the MSG ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions this ERU was dominated by herbaceous vegetation (Table 91). Grasses provided the largest amount of biomass, however, forbs provided the greatest number of individual plant species (White 2002). At present, these grasslands have a significant amount of woody species encroachment. Encroachment by woody plants into grasslands across all elevations should be expected to continue in the absence of active fire management programs (Bond and Keeley 2005).

Table 91. Seral state make-up of the MSG ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	**Seral State Structure, Composition and Cover Class Description‡**	**Percent Proportion**			**Similarity Values to RC†**	
		RC	current			
			GNF	CA	GNF	CA
A,C	Early-seral: Short-term recently burned, sparsely vegetated, high species diversity and high condition < 10% tree cover & < 10% shrub cover; and early- to mid-seral: Short-term recently burned, sparsely vegetated, low to moderate species diversity and < 10% tree cover & < 10% shrub cover	20	0	20	0	20
B	Late-seral: All herb dominance types with high species diversity and condition < 10% tree cover & < 10% shrub cover	45	55	18	45	18
D	Early- to mid-seral: All herb dominance types of low-moderate diversity and condition and < 10% tree cover & < 10% shrub cover	35	10	30	10	30
E, F, G	Early- to mid-seral; woody encroachment: All shrub dominance types of low-moderate seral condition, low to moderate species diversity and condition, and ≥ 10% shrub cover and < 10% tree cover; and all tree dominance types of early to mid-seral condition, low to moderate species diversity and condition, and < 10% shrub cover and ≥ 10% tree cover *(occurs on contemporary landscapes only…)*	0	35	33	0	0
Total		100	100	100	55	68

Departure Index Ratingǂǂ = 100 – ∑ similarity values: Gila NF = (100 – 55) = 45 or MODERATE; and Context Area = (100 – 68) = 32 or LOW

‡ USDA FS 2016a; LANDFIRE 2007f

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

ǂǂ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High)

Departure in seral state proportion is moderate at the plan scale and in all local units except Mogollon Front which is in high departure and in Lower Gila River where MSG does not occur. Departure is low within the context area, although close to the threshold between the low and moderate categories. Currently there is a sizeable over representation of shrub and tree encroachment, and under representation of seral states A, C and D. However, there is a relatively small difference in the representation of seral state B (all herb dominance types with high species diversity and condition) between the reference and current conditions. A sizeable over representation of shrub and tree encroachment also occurs within the context area, however, it is due to a significant decrease in seral state B, rather than A, C and D. The influence of historic overgrazing and current herbivory by both livestock and wildlife, particularly elk, as well as past fire suppression have altered the outcomes of competition between herbaceous and woody vegetation. These dynamics are the driver for woody species encroachment and increasing densities of those species. For more information on fire and herbivory, refer to Chapter 9: System Drivers and Stressors. Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 53. Recall that the trend analysis is conducted at the plan scale only.

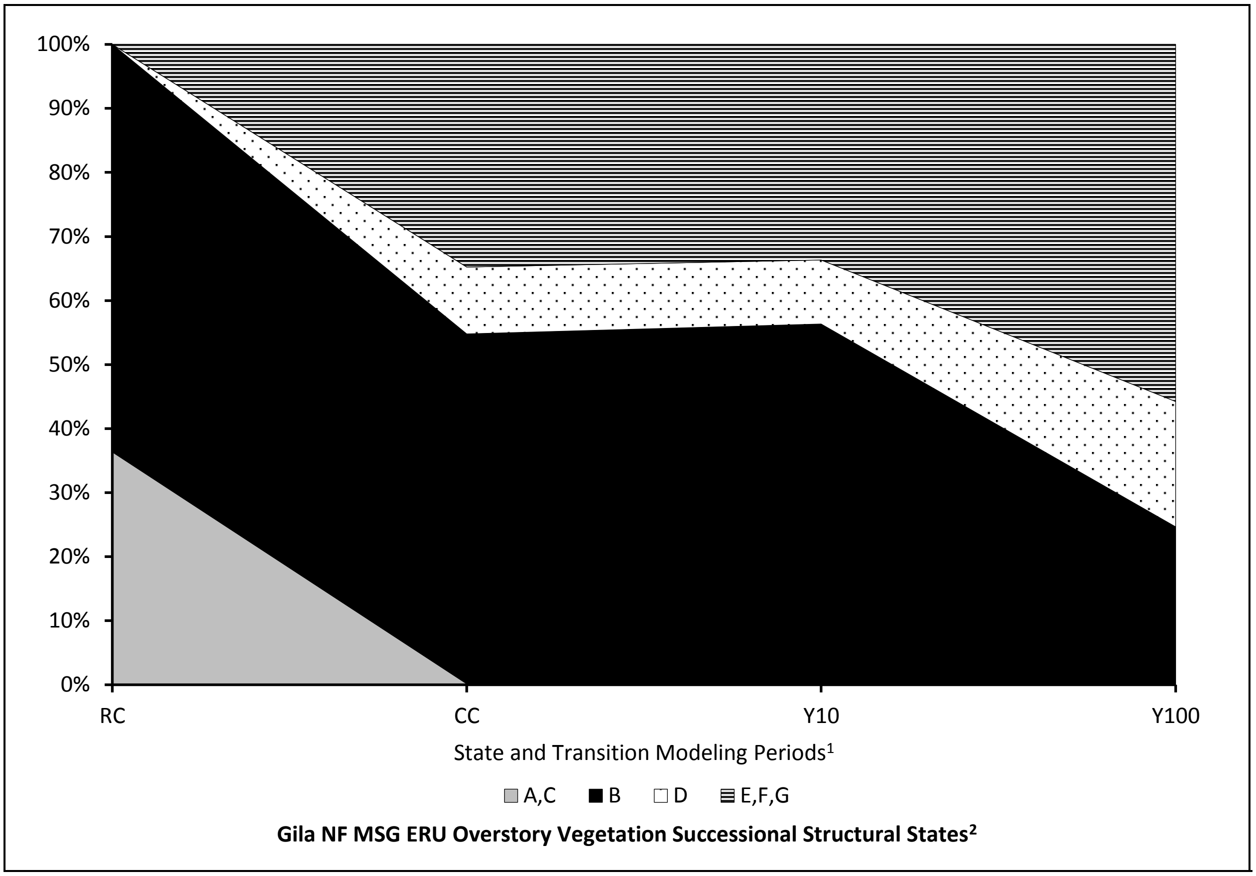

Figure 53. Gila NF overstory vegetation successional structural states for MSG ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 45% or moderate departure from RC
Y10 = State and transition modeling results at 10 years = 41% or moderate departure from RC
Y100 = State and transition modeling results at 100 years = 56% or moderate departure from RC
[2] See Table 91 for a description of the overstory vegetation successional structural states

Under the continuation of current management (and the current climatic regime) the MSG continues to trend away from the reference condition. The large segment of these grasslands are dominated by shrubs and trees (seral states E, F, G), and that carries on into the future under current management.

Patch Size

There is inadequate information on which to base a reference condition for analysis of patch size in this ERU (Wahlberg et al. 2014).

Coarse Woody Debris and Snag Density

There is no coarse woody debris and snag density assessment data for this ERU. However, as a result of past management activities, and possible effects of climate change, MSG ERU has experienced significant woody species encroachment (seral states E, F, G) therefore, coarse woody debris and number of snags have increased.

Fire Regime

The Montane/Subalpine Grasslands are a frequent fire ERU. However, there are a few factors related to describing and analyzing fire severity that merit discussion. Fire that consumes overstory vegetation is often described as high severity, stand replacement type fire which leads to classification of fire severity in grasslands as such. However, there is a key difference between high severity or stand replacement fire in grassland systems and in forest or woodland systems. High severity fire results in tree mortality, but does not typically result in perennial grass mortality. In fact, grasses may begin to produce new growth within days given favorable moisture conditions. This leads the MTBS dataset to classify most severity in grasslands as low (see Key Characteristics, Data and Analysis Methods subsection for more information). Therefore, direct analysis of fire severity results in what appears to be high departure when in fact this is not the case. Given the limitations of the MTBS, reference severity in the MSG and other grassland ERUs may be more accurately described as low, creating a higher level of uncertainty associated with severity departure in grasslands than in other ecosystems.

Fire Frequency

Table 92. Reference and current Gila NF fire frequency for Montane/Subalpine Grasslands

Reference:	**MFRI*= 2-22 yrs.** (FF‡ = average fire rotation = 12 yrs. and stand replacement fire rotation = 12 yrs.)
Current:	FF = 32 yrs.
Departure:	Moderate

*Kraussman and Triepke 2015

‡ Schussman et al. 2006; Wahlberg et al. 2014; Krausmann and Triepke 2014

As shown in Table 92, over the last 19 years (1996-2015), fire has not occurred quite as frequently in the MSG at the plan scale than it did during the reference time period. However, at the context scale and in several of the Forest's local units, departure in fire frequency is high; fire frequency at the context scale is 887 years, 189 years in the Apache local unit, 60 years in the Black Range local unit, and 65 years in the Little Colorado, San Agustin Fringe local unit. Departure is low in the Upper Gila River (FF= 18 yrs.) and Mogollon Front (FF= 19 yrs.) local units. The MSG ERU is not mapped in the Lower Gila River local unit. More time between fires is the result of factors that have been described previously for the woodland ERUs.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire within the MSG ERU is 3,512 acres; roughly 88% at low severity, 7% at moderate severity and 5% at high severity. Current fire severity at the plan scale is approximately 18%, lower than reference condition's 88% (Schussman et al., 2006) which would result in a high departure rating if fire-grassland vegetation dynamics and the limitations of the MTBS dataset were not considered. In reality, the likelihood of actual departure in fire severity is low. While reductions in fine fuels, for the reasons discussed many times throughout this chapter, are as much of a factor in this and the other grassland ERUs on the Forest, the effects are different. Given the same fuel moisture conditions and fire weather as might occur in forest or woodland systems, in the case of grasslands, fewer fine fuels might reduce fire occurrence, size, rate of spread and effects to any encroaching woody vegetation in the overstory, but the effects to the understory herbaceous vegetation remain the same.

The severity analysis also indicates high departure at the context scale (~18%) and in the Apache, Black Range, Little Colorado-San Agustin Fringe and Upper Gila River local units within the Forest with average severity between 13 and 20%. Severity departure in the Mogollon Front local unit is moderate (~58%).

Differences in average severity are most likely tied to the time of the fire and the time of the satellite imagery used to develop the MTBS for a particular fire. However, further investigation, including site visits, would be necessary to determine if differences were due to these factors or had additional causes.

Fire Regime Condition Class (FRCC)

Table 93. Gila NF Reference FRCC and Departure for Montane/Subalpine Grasslands

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 43.7%	FRCC III = 50.2%	No data = 6.1%
Departure:	Moderate, Trend Away from Reference			

‡ Schussman et al. 2006; Krausmann and Triepke 2014

As shown in Table 93, at the plan scale, this ERU is relatively closely split between FRCC II, indicating moderate departure from the natural fire regime, and FRCC III, indicating high departure. With the uncertainty regarding average severity departure, a moderate seral state proportion departure and a low fire frequency departure at this scale, FRCC departure is best described as moderate to high, rather than assigning a single departure category. Within the Forest’s local units, Upper Gila River has an FRCC of II, and the Little Colorado-San Agustin Fringe and Apache local units have an FRCC of III. The Black Range and Mogollon Front local units do not have all necessary data elements to classify FRCC, and MSG is not mapped in the Lower Gila River local unit. Differences in FRCC categories reflect differences in seral state proportion, fire frequency and severity departures. At the context scale, MSG has an FRCC of II, indicating moderate departure.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 485 acres. The highest level occurred in 2014 at 3,497 acres. Overall, nearly 8% of this ERU has been affected by insect and disease activities since 1997. How much of this apparent insect and disease occurrence is due to the spatial accuracy of the aerial detection data and/or the ERU map is unknown. However, there is no information regarding specific insects or diseases activities in the MSG ERU which may indicate that these acres belong to adjacent ERUs rather than the MSG.

Spatial Niche

The MSG ERU is limited at 379,720 acres (0.8%) within the context area and it is tied with MMS as the 11th largest ERU. MSG contributes 113,785 (3.5%) to the Gila NF, and represents the 8th largest ERU on the Forest. In addition, it has a greater proportional representation on the Forest (0.62) than in the context area (Table 94). This ERU has a moderate seral state proportion departure at the plan scale, however it ranges from moderate to high across the Forest’s local units (Table 95). At the context scale, seral state proportion departure is low. In general, this ERU has a sizeable representation of woody vegetation encroachment. On the Forest, this contemporary state exists at the expense of early to mid seral states.

Table 94. MSG ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

Gila NF Upland ERUs (column 1)	**Total ERU Area on Gila NF (column 2)**		**Total ERU Area within CA (column 3)**		**Gila NF’s Contribution to Total ERU within CA (column 4)**	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
MSG	113,785	3.5	379,720	0.8	30.0	0.62

Table 95. MSG ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		**Black Range**		**Little Colorado-San Agustin Fringe**		**Lower Gila River**		**Mogollon Front**		**Upper Gila River**		**Gila NF**		**Context Area**	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
Percent seral state departure	20,028	17.6	6,835	6.0	37,045	32.6	0	0.0	137	0.1	49,740	43.7	113,785	3.5	379,720	0.8
	56 Moderate		41 Moderate		42 Moderate				91 High		37 Moderate		45 Moderate		32 Low	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The influence of the Gila NF on this particular ERU has to do with both its higher proportional representation and moderate departure in seral state proportion on the Forest; the Forest has a higher level of responsibility for the restoration and maintenance of the MSG, which is heightened by its departure.

COLORADO PLATEAU/GREAT BASIN GRASSLANDS (CPGB) ERU

General Description

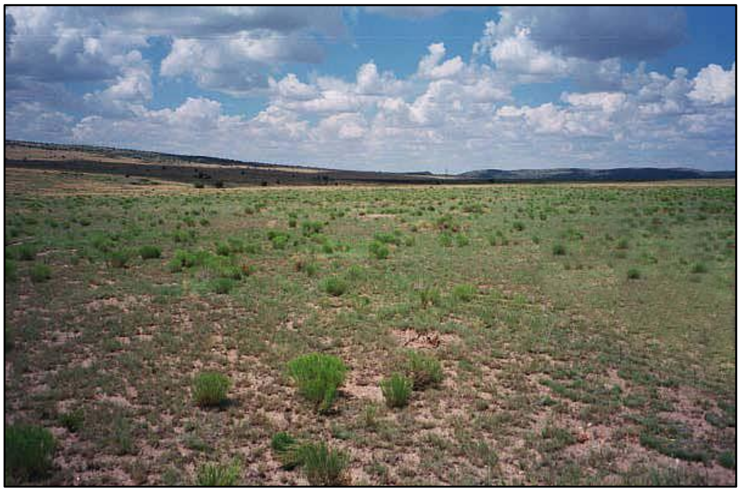

Figure 54. CPGB ERU (Wahlberg et al. 2014)

The CPGB ERU (Figure 54) is typically found along elevational and temperature gradients above semi-desert grassland and below montane/subalpine grasslands. It occupies cooler and wetter sites than semi-desert grasslands and is common above the Mogollon Rim in Arizona. This ERU is typically associated with piñon-juniper grass along the grassland-woodland ecotone in cool climates. Generally, annual precipitation ranges from 12 to 18 inches, with 40% coming between October 1st and March 31st. Vegetation coverage consists of mostly grasses and interspersed shrubs. Grass species may include but are not limited to: Indian ricegrass (*Achnatherum hymenoides* (Roem. & Schult.) Barkworth), threeawns, blue grama, fescues, needle and thread grass (*Hesperostipa comata* (Trin. & Rupr.) Barkworth), spike fescue (*Leucopoa kingii* (S. Watson) W.A. Weber), muhlys, James' galleta (*Pleuraphis jamesii* Torr.), western wheatgrass, and Sandberg bluegrass (*Poa secunda* J. Presl). Shrub species may include but are not limited to: big sagebrush (*Artemesia tridentate* Nutt.), saltbushes (*Atriplex* spp. L.), jointfir (*Ephedra* spp. L), snakeweed (*Gutierrezia* spp. Lag.), winterfat (*Krascheninnikovia lanata* (Pursh) A. Meeuse & Smit), one-seeded juniper, Utah juniper and wax currant (*Ribes cereum* Douglas). As described, this ERU may have had over 10% shrub cover historically, but had less than 10% tree cover. Other works (e.g., Robbie, 2004) have treated the Colorado Plateau grassland separately from Great Basin grassland. While the floristic distinction between these two is recognized here, the coarse ecosystem dynamics driving the two systems are similar, and therefore they are considered to be a common ERU. As the understanding of ecosystem processes evolves for these systems, and as state and transition models are developed, subclasses may be developed in the future. The reader is referred to Robbie (2004) for a description of the differences between the two grassland types.

Figure 55 and Figure 56 show that the majority of this ERU occurs in the northern and eastern portion of the context area and the northern portion of the Forest.

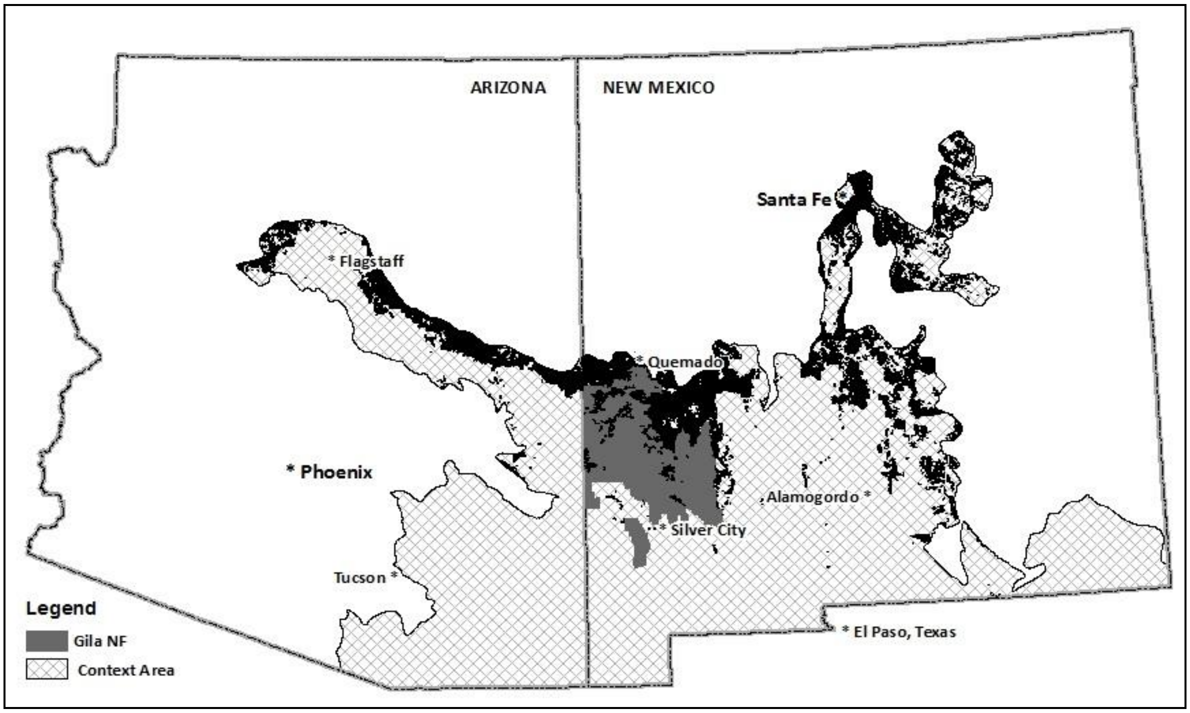

Figure 55. General location (in black) of the CPGB ERU within the context area

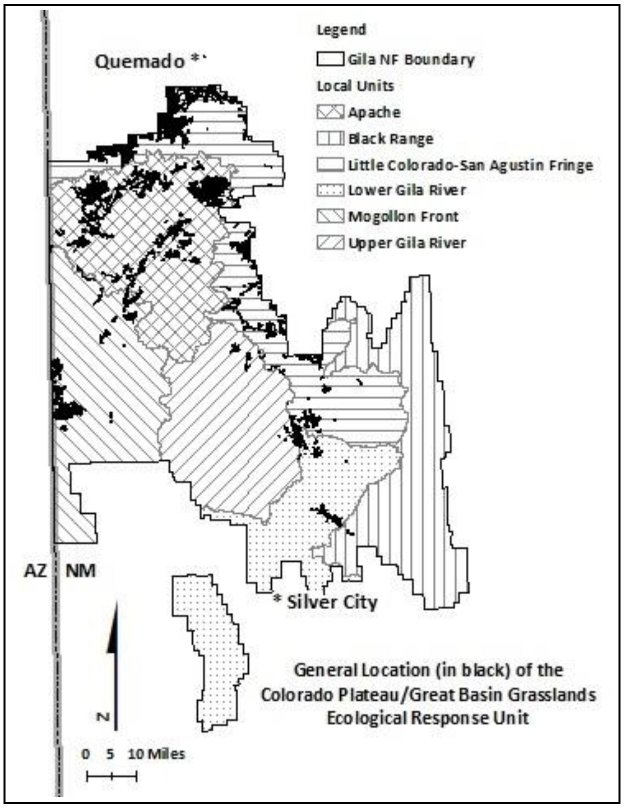

Figure 56. General location (in black) of the CPGB ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions this ERU was dominated by herbaceous vegetation (Table 96). Grasses provided the largest amount of biomass, however, forbs provided the greatest number of individual plant species (White 2002). At present, these grasslands have a significant amount of woody species encroachment.

Table 96. Seral state make-up of the CPGB ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	**Seral State Structure, Composition and Cover Class Description‡**	**Percent Proportion**			**Similarity Values to RC†**	
		RC	current			
			GNF	CA	GNF	CA
A	EARLY- TO MID-SERAL: Grass, forb, sparsely vegetated or recently burned with very open (< 10%) woody canopy cover	5	13	2	5	2
B	LATE-SERAL: Herbaceous layer dominated by late successional perennial grasses with very open woody canopy cover	70	0	7	0	7
C,E	EARLY- TO MID-SERAL, woody encroachment: Herbaceous layer dominated by early-mid successional vegetation, and all size shrubs and trees with open (≥ 10% & < 30%) woody canopy cover	25	62	74	25	25
D	EARLY- TO MID-SERAL, WOODY ENCROACHMENT: Herbaceous layer dominated by early successional weedy species, and all size shrubs and trees with closed (≥ 30%) woody canopy cover (*occurs on contemporary landscapes only…)*	0	24	17	0	0
Total		100	100	100	30	34
Departure Index Rating⧺ = 100 – ∑ (similarity values): Gila NF = (100 – 30) = 70 or HIGH; and Context Area = (100 – 34) = 66 or MODERATE						

‡ TNC 2006; USDA FS 2016b

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

⧺ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High)

At the plan scale and in all local units within the Forest that contain CPGB, departure in seral state proportion is high with a sizeable over representation of shrub and tree encroachment (seral states C, E and D) with a concurrent under representation of an herbaceous layer dominated by late successional perennial grasses with very open woody canopy cover (seral state B). Two of the primary encroaching shrub species within seral states C, E and D, are broom snakeweed (*Gutierrezia sarothrae* (Pursh) Britton & Rusby), and rubber rabbitbrush (*Ericameria nauseosa* (Pall. ex Pursh) G.L. Nesom & Baird.). Departure at the context scale is moderate, but the pattern of departure is similar to that on Forest. The same dynamics influencing seral state proportion departure in the MSG ERU are also factors in the CPGB ERU. Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 57. Recall that the trend analysis is conducted at the plan scale only.

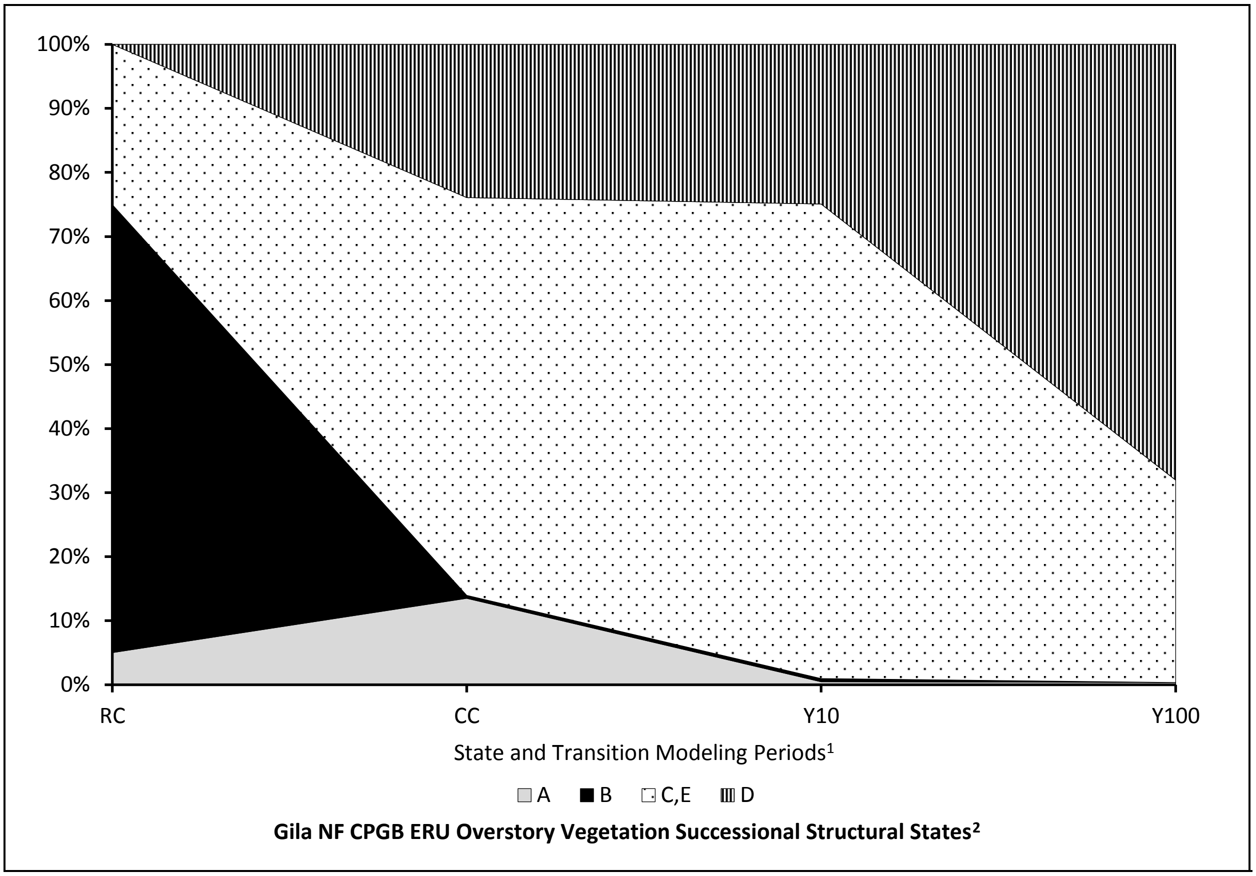

Figure 57. Gila NF overstory vegetation successional structural states for CPGB ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 70% or high departure from RC
Y10 = State and transition modeling results at 10 years = 74% or high departure from RC
Y100 = State and transition modeling results at 100 years = 75% or high departure from RC

[2] See Table 96 for a description of the overstory vegetation successional structural states

Under the continuation of current management (and under the current climatic regime), the degree of departure remains largely unchanged (±5%). There remains a large segment of these grasslands dominated by trees and shrubs (seral state C, E and D) and that carries on into the future. The general absence of late seral, high diversity and condition herbaceous vegetation (seral state B) within this ERU also persists into the future.

Patch Size

There is inadequate information on which to base a reference condition for analysis of patch size in this ERU (Wahlberg et al. 2014).

Coarse Woody Debris and Snag Density

There is no coarse woody debris and snag density assessment data for this ERU. However, as a result of past management activities, and possible effects of climate change, CPGB ERU has experienced significant woody species encroachment (seral states C, E, and D) therefore, coarse woody debris and number of snags have increased.

Fire Regime

The CPGB ERU is characterized by a fire regime similar to the MSG. The discussion of that ERU's fire regime, and the limitations associated with assessing fire severity are also relevant to this discussion.

Fire Frequency

Table 97. Reference and current Gila NF fire frequency for Colorado Plateau-Great Basin Grassland

Reference:	MFRI*=0-35 yrs. (FF‡ = average fire rotation = 15 yrs. and stand replacement fire rotation = 15 yrs.)
Current:	FF = 564 yrs.
Departure:	High

* Wahlberg et al. 2014

‡ Schussman et al. 2006; Wahlberg et al. 2014; Krausmann and Triepke 2014

As shown in Table 97, over the last 19 years (1996-2015), fire has not occurred nearly as frequently in the CPGB at the plan scale than it did during the reference time period. All local units within the Forest are also in high departure with fire frequencies ranging from 89 to 2,883 years, except in the Upper Gila River local unit which is low departure (FF= 25 yrs.). Departure is high at the context scale with a fire frequency of more than 38,000 years. These departures occur for the same reasons described for woodland ERUs.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire is 160 acres; roughly 98% at low severity, 2% at moderate severity and 0% at high severity. Current average fire severity is approximately 13%, lower than reference condition's 88% (Schussman et al. 2006), which would result in a high departure rating if fire-grassland vegetation dynamics and the limitations of the MTBS dataset were not considered. The analysis also indicates high departure in all local units and at the context scale. The discussion of fire severity and the associated uncertainty as it occurs in the MSG assessment also applies here.

Fire Regime Condition Class (FRCC)

Table 98. Gila NF Reference FRCC and Departure for Colorado Plateau-Great Basin Grassland

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 93.7%	FRCC III = 0.0%	No data = 6.3%
Departure:	Low, trend is expected to continue away from reference conditions			

‡ Schussman et al. 2006; Krausmann and Triepke 2014

As shown in Table 98, at the plan and context scales, this ERU falls into the FRCC II category, indicating a moderate departure from the natural fire regime. All local units on the Forest for which all data elements are available and in which CPGB occurs (Apache, Little Colorado-San Agustin Fringe and Mogollon Front) fall within the FRCC III category. These classifications reflect departure in seral state proportion, fire frequency and fire severity.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 450 acres. The highest level occurred in 2003 at 5,334 acres. Overall, nearly 9% of this ERU has been affected by insect and disease activities since 1997. How much of this apparent insect and disease occurrence is due to the spatial accuracy of the aerial detection data and/or the ERU map is unknown. However, there is no information regarding specific insects or diseases activities in the CPGB ERU which may indicate that these acres belong to adjacent ERUs rather than the CPGB.

Spatial Niche

The CPGB ERU is widespread and has 2,804,141 acres (6.0%) within the context area and 89,186 acres (2.7%) of the Gila NF. This ERU ranks 4th largest in the context area and 9th largest on the Forest. In addition, it has a lower proportional representation on the Forest (-0.37) than in the context area (Table 99). This ERU has a high seral state proportion departure at the plan and local unit scales (Table 100). The context area departure for this ERU is moderate, however it is on the threshold between moderate and high (66%). In general, this ERU is experiencing a significant amount of woody vegetation encroachment, has lower species diversity and vegetation condition than the reference.

Table 99. CPGB ERU acreage and percent, and seral state departure from reference conditions within the local units, Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
CPGB	89,186	2.7	2,804,141	6.0	3.2	-0.37

Table 100. CPGB ERU acreage and percent, and seral state departure from reference conditions within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
Percent seral state departure	31,992	35.9	214	0.2	38,759	43.5	3,505	3.9	12,815	14.4	1,901	2.1	89,186	2.8	2,804,141	6.0
	70 High		83 High		70 High		70 High		70 High		70 High		70 High		66 Moderate	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The influence of the Gila NF on the sustainability of this system within the broader landscape is limited because of its lower proportional representation of this ERU on the Forest. However, the Forest is still responsible for ecological integrity and sustainability of this ecosystem where it occurs on Forest. Due to the degree of departure, the Forest is not positioned to serve as a refugia for CPGB at this time.

SEMI-DESERT GRASSLAND (SDG) ERU

General Description

Figure 58. SDG ERU (Photo by M.R. White 2002)

The SDG ERU (Figure 58) occurs throughout southeastern Arizona and southern New Mexico at elevations ranging from 3,000 to 4,500 feet. These grasslands are bounded by Sonoran or Chihuahuan desert at the lowest elevations and woodlands or chaparral at the higher elevations. Species composition and dominance varies across the broad range of soils and topography that occur within the two states. Generally, annual precipitation ranges from 13 to 21 inches, with 40% coming between October 1st and March 31st. Dominant grassland associations/types are black grama grassland, blue grama grassland, curly mesquite (*Hilaria belangeri* (Steud.) Nash) grassland, tobosagrass (*Pleuraphis mutica* Buckley) grassland, big sacaton (*Sporobolus wrightii* Munro ex Scribn.) grassland, mixed native perennial grassland, and non-native perennial grassland. Shrubs (mesquite (Prosopis spp. L.), catclaw acacia (*Senegalia greggii* (A. Gray) Britton & Rose), catclaw mimosa (*Mimosa aculeaticarpa* Ortega), etc.) also occupy these grasslands and their abundance and species composition also varies. As described, this ERU may have had over 10% shrub cover historically, but had less than 10% tree cover. Semi-desert grassland tends to occur adjacent to and above desert communities, and below interior chaparral and woodlands. The boundary between semi-desert grassland and desert communities is sometimes hard to distinguish as desert shrub species can be common in this ERU (Girard and Robbie 2003) as they share similar overarching ecosystem properties (Wahlberg et al. 2014).

Subclasses: There are currently four subclasses described for this ERU – Piedmont Grassland, Foothill Grassland, Semi-Desert Lowland Grassland, and Sandy Plains Grassland. Other works (R3 Climate Change Vulnerability Assessment (Triepke et al. 2015)) have split Semi-Desert Grassland into more general subclasses based on moisture gradient.

The foothill grassland model best describes the SDG on the Gila NF. The SDG found on the Forest is typical of colluvial foothill slopes of desert mountain ranges. These often rocky sites are typically dominated by sideoats grama, curlyleaf muhly, New Mexico feathergrass (*Hesperostipa neomexicana* (Thurb. ex J.M. Coult.) Barkworth), and bullgrass (*Muhlenbergia emersleyi* Vasey). Other dominant or co-dominant grasses may include purple grama (*Bouteloua radicosa* (Fourn.) Griffiths), tanglehead (*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.), blue grama, hairy grama, southwestern needlegrass *(Achnatherum eminens* (Cav.) Barkworth), and slim tridens (*Tridens muticus* (Torr.) Nash). While shrubs and sub-shrubs are clearly subordinate in these grasslands, they are always common and sometimes abundant, forming a shrub-steppe. The most diagnostic tall shrubs are mesquite, catclaw acacia, common sotol (*Dasylirion wheeleri* S. Watson), sacahuista (*Nolina microcarpa* S. Watson), soaptree yucca (*Yucca elata* (Engelm.) Engelm.), banana yucca (*Y. baccata* Torr.), Torrey's yucca (*Y. torreyi* Shafer), ocotillo (*Fouquieria splendens* Engelm.), resinbush (*Viguiera stenoloba* S.F. Blake), along with sub-shrubs such as mariola (*Parthenium incanum* Kunth), featherplume (*Dalea formosa* Torr.), agaves (*Agave* spp. L.), and plumed crinklemat (*Tiquilia greggii* (Torr. & A. Gray) A.T. Richardson). Where the combination of drought, livestock grazing, and reduced fire frequency have impacted sites, shrubs typical of Chihuahuan Desert scrub can encroach. These include viscid acacia (*Acacia neovernicosa* (Britton & Rose) Seigler & Ebinger), American tarwort (*Flourensia cernua* DC.), and turpentine bush (*Ericameria laricifolia* (A. Gray) Shinners).

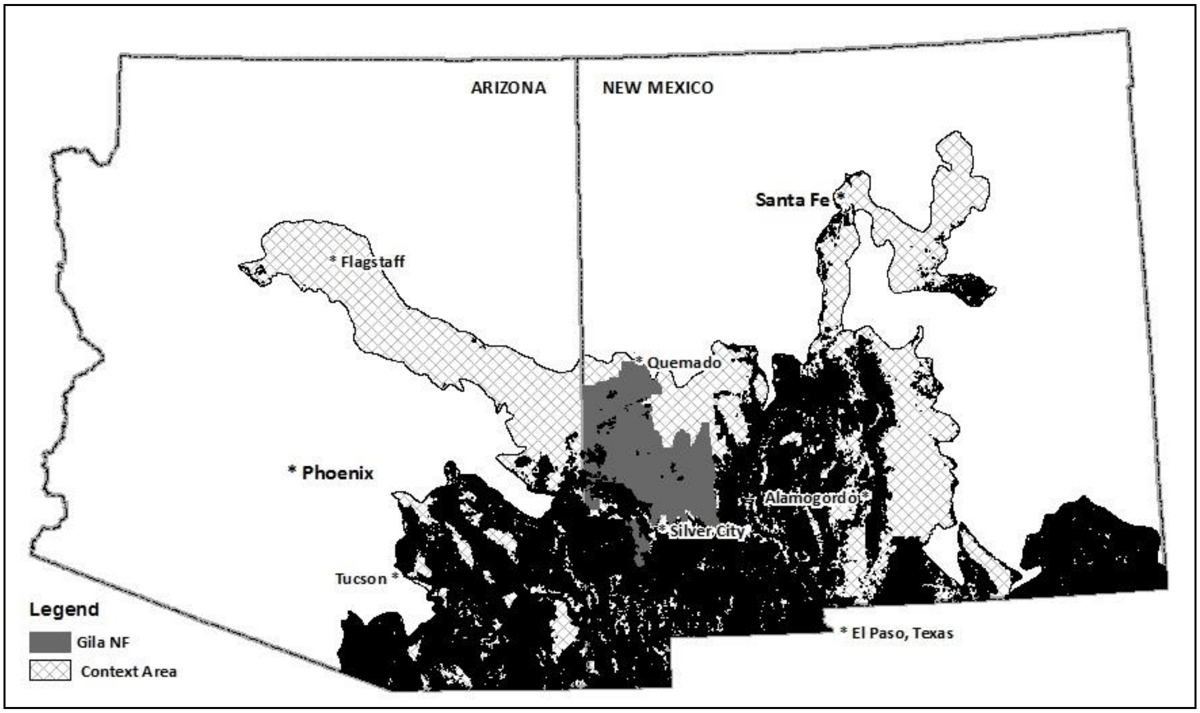

Figure 59. General location (in black) of the SDG ERU within the context area

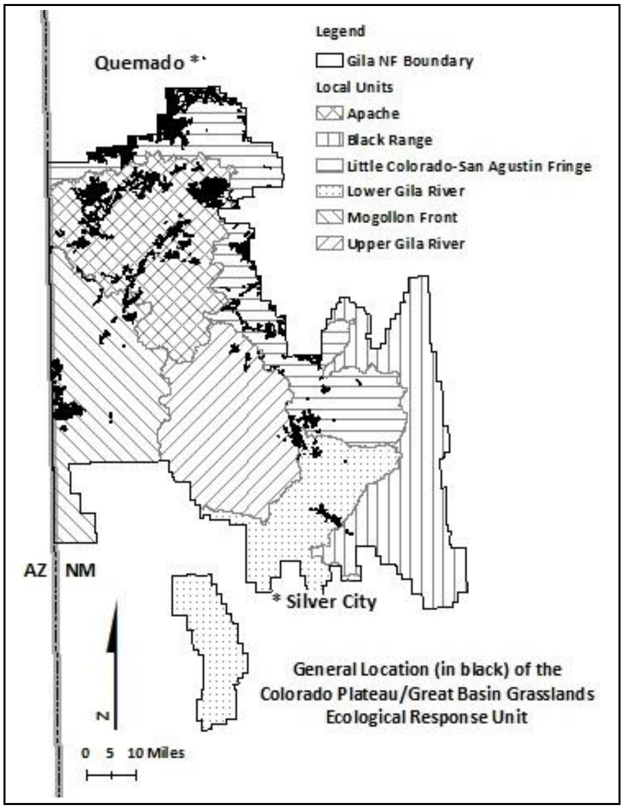

Figure 60. General location of the SDG ERU within the Gila NF and the six local units

Seral State Proportion

Under reference conditions the majority of the SDG was comprised of herbaceous layers dominated by late successional perennial grasses with very open woody canopy cover (Table 101). As mentioned in the general description, historically this ERU may have had over 10% shrub cover historically, but had less than 10% tree cover.

Table 101. Seral state make-up of the SDG ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current			
			GNF	CA	GNF	CA
A	EARLY- TO MID-SERAL: Sparsely vegetated or recently burned with very open (< 10%) woody canopy cover	23	0	2	0	2
B	LATE-SERAL: Herbaceous layer dominated by late successional perennial grasses with very open woody canopy cover	74	1	0	1	0
C,D	EARLY- TO MID-SERAL, WOODY ENCROACHMENT: Shrub and tree dominated (encroached) with open (≥ 10 & > 29%) woody canopy cover, low species diversity, herbaceous layer dominated by early-mid successional vegetation	3	91	54	3	3
E,F,G,H	EARLY- TO MID-SERAL, WOODY ENCROACHMENT: Shrub and tree dominated (encroached) with closed (≥ 30%) woody canopy cover, low species diversity herbaceous layer dominated by low species diversity and exotic dominated herbaceous layer (*occurs on contemporary landscapes only…)*	0	8	44	0	0
Total		100	100	100	4	5
Departure Index Rating‡‡ = 100 – ∑ similarity values: Gila NF = (100 – 4) = 96 or HIGH; and Context Area = (100 – 5) = 95 or HIGH						

‡ Schussman 2006; USDA FS 2016c

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski (1913), as cited in Kent and Coker, 1992, page 93)

‡‡ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High)

Departure in seral state proportion is high at all scales considered in this analysis. Currently there is a sizeable over representation of an herbaceous layer dominated by early-mid successional vegetation, and all size shrubs and trees with open woody canopy cover (seral state C, D), and a significant under representation of a herbaceous layer dominated by late successional perennial grasses with very open woody canopy cover (seral state B). This is also the case within the context area landscape. In seral states E, F, G and H, the dominance of exotic species occurs within some places of the context area, but does not currently occur on the Gila NF. The same dynamics influencing seral state proportion departure in the other grassland ERUs are also factors in the SDG ERU Projected trends in seral state proportion under current management as described by the results of the VDDT modeling are displayed in Figure 61. Recall that the trend analysis is conducted at the plan scale only.

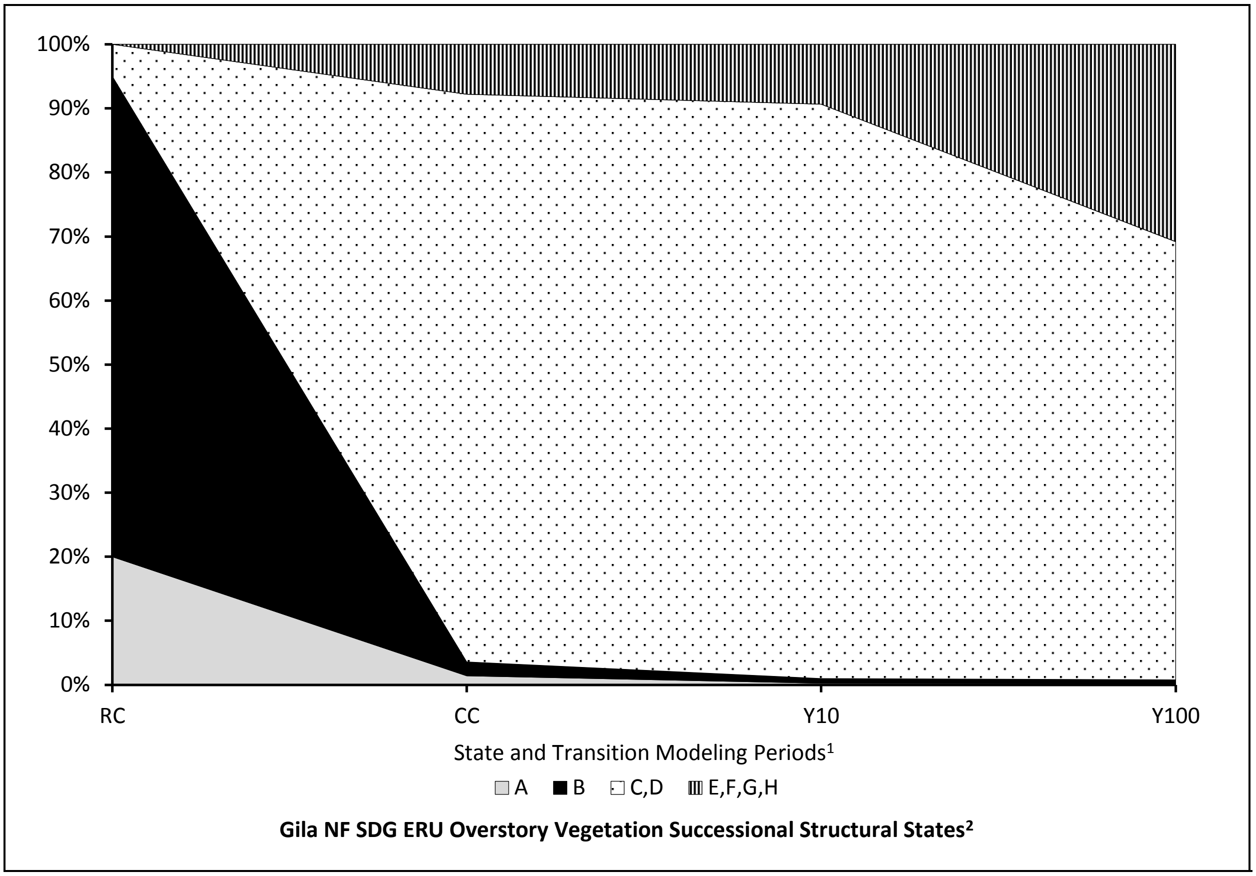

Figure 61. Gila NF overstory vegetation successional structural states for SDG ERU under reference conditions (RC), current conditions (CC), and following state and transition modeling results at 10 and 100 years, based on current Forest management activities

[1] RC = Reference conditions
CC = Current conditions = 96% or high departure from RC
Y10 = State and transition modeling results at 10 years = 94% or high departure from RC
Y100 = State and transition modeling results at 100 years = 94% or high departure from RC
[2] See Table 101 for a description of the overstory vegetation successional structural states

Under the continuation of current management (and under the current climatic regime), the degree of departure remains largely unchanged (±5%). There remains a large segment of these grasslands dominated by trees and shrubs (seral state C, D) that carries on into the future. The general absence of late seral, high diversity and condition herbaceous vegetation (seral state B) within this ERU also persists into the future.

Patch Size

There is inadequate information on which to base a reference condition for analysis of patch size in this ERU (Wahlberg et al. 2014).

Coarse Woody Debris and Snag Density

There is no coarse woody debris and snag density assessment data for this ERU. However, as a result of past management activities, and possible effects of climate change, SDG ERU has experienced significant woody species encroachment (seral states C, D), therefore, coarse woody debris and number of snags have increased. Shrub encroachment in portions of the context area is extreme and perennial grasses are virtually eliminated in many areas that were heavily grazed beginning in the early-to-mid 1800s (Brown and Makings 2014).

Fire Regime

The SDG ERU is characterized by a fire regime similar to the MSG. The discussion of that ERU's fire regime, and the limitations associated with assessing fire severity are also relevant to this discussion.

Fire Frequency

Table 102. Reference and current Gila NF fire frequency for Semidesert Grassland

Reference:	**MFRI*=3-10 yrs.** (FF‡ = average fire rotation = 6.3 yrs. and stand replacement fire rotation = 6.3 yrs.)
Current:	FF = 760 yrs.
Departure:	High

*Sussman et al. 2006; Wahlberg et al. 2014

‡ Kaib et al. 1996; Swetnam and Betancourt 1998; Schussman et al. 2006; Schussman 2006; Wahlberg et al. 2014; Krausmann and Triepke 2014

As shown in Table 102, over the last 19 years (1996-2015), fire has not occurred nearly as frequently in the SDG at the context, plan and local scales than it did during the reference time period with fire frequencies ranging from a low of roughly 100 years in the Upper Gila River local unit on the Forest to a high of over 191,000 years on the Apache local unit. The same dynamics at work in the woodland and other grassland ERUs also contribute to departure in the SDG.

Fire Severity

The 19-year (1996-2015) average annual acres burned by wildfire within the SDG ERU is 74 acres; roughly 98% at low severity, 2% at moderate severity and 0% at high severity. Current average fire severity at the plan scale is approximately 21%, lower than reference condition's 88% (Schussman et al., 2006 which would result in a high departure rating if fire-grassland vegetation dynamics and the limitations of the MTBS dataset were not considered. The analysis also indicates high departure in all local units and at the context scale. The discussion of fire severity and the associated uncertainty as it occurs in the MSG and CPGB assessments also apply here.

Fire Regime Condition Class (FRCC)

Table 103. Gila NF Reference FRCC and Departure for Semidesert Grassland

Reference:	FRCC I			
Current:	FRCC I = 0.0%	FRCC II = 0.0%	FRCC III = 88.7%	No data = 11.3%
Departure:	High, Static Trend			

ǂ Schussman et al. 2006; Krausmann and Triepke 2014

As shown in Table 103, FRCC departure is high at all scales in which SDG occurs and all data elements are available. Patterns of FRCC departure reflect patterns of seral state proportion, fire frequency and severity departure.

Insects and Disease

Over the last 18 years, on an annual average basis, insects and disease have affected nearly 87 acres. The highest level occurred in 2003 at 1,378 acres. Overall, nearly 3% of this ERU has been affected by insect and disease activities since 1997. How much of this apparent insect and disease occurrence is due to the spatial accuracy of the aerial detection data and/or the ERU map is unknown. However, there is no information regarding specific insects or diseases activities in the SDG ERU which may indicate that these acres belong to adjacent ERUs rather than the SDG.

Spatial Niche

The SDG ERU is widespread within the context area and at 16,091,824 or 34.3%, it is the largest ERU in the context area. Within the Gila NF, the SDG contributes 55,988 acres, roughly 1.7% of the Forest. It is the 11th largest ERU on the Forest. In addition, it has the lowest proportional representation on the Forest (-0.90) than any other ERU in the context area (Table 103). This ERU has a high seral state departure rating at all scales (Table 104). Seral state representation within the context area does not follows the same overall pattern as within the Gila NF. In general, this ERU is experiencing a significant amount of woody vegetation encroachment, has lower species diversity and vegetation condition than the reference. In some places within the context area, the SDG is dominated by exotic herbaceous species. This condition does not exist on the Gila NF.

Table 103. SDG ERU acreage and percent, and seral state departure from reference conditions within the local units, Forest and context area

Gila NF Upland ERUs (column 1)	Total ERU Area on Gila NF (column 2)		Total ERU Area within CA (column 3)		Gila NF's Contribution to Total ERU within CA (column 4)	
	acres (2a)	% of Gila NF (2b)	acres (3a)	% of CA (3b)	from Gila NF (4a)	proportional representation† (4b)
SDG	55,988	1.7	16,091,824	34.3	0.3	-0.90

Table 104. SDG ERU acreage and percent, and seral state departure from reference conditions[1] within the local units, Forest and context area

	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila river		Gila NF		Context Area	
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
	6,424	11.5	1,747	3.1	2,896	5.2	14,982	26.8	28,231	50.4	1,708	3.1	55,989	1.7	16,091,824	34.3
Percent seral state departure	95 High		97 High		96 High		97 High		96 High		96 High		96 High		95 High	

[1] Seral state departure from reference condition: Low = 0-33%; Moderate = 34-66%; High = 67-100%

The influence of the Gila NF on the sustainability of this system within the broader landscape is limited because of its lower proportional representation of this ERU on the Forest. However, the Forest is still responsible for ecological integrity and sustainability of this ecosystem where it occurs on Forest. Due to the degree of departure, the Forest is not positioned to serve as a refugia for SDG at this time.

Risk

Risk to the ecological integrity of upland vegetation ecosystem characteristics analyzed in this chapter is assessed for each ERU using the matrix displayed in Table 105. Where trend was not able to be assessed, risk is a direct interpretation of departure. The results of the risk assessment are displayed in Table 106 with "L" meaning low risk, "M" moderate risk, "H" high risk and "ND" meaning there was insufficient data to assess departure or risk for that characteristic at that particular scale. Where an ERU is not mapped or present, there is no risk which is indicated. While not displayed in the risk results, a moderate or greater vulnerability to climate change elevates risk one category. The CCVA analysis and results are displayed and discussed in more detail under the climate change subheading in Chapter 9: System Drivers and Stressors.

Table 105. Gila NF upland vegetation ecosystem characteristic risk assessment matrix

Departure	Trend Toward Reference	Trend Unknown or Static (±5%)	Trend Away from Reference
High	Low Risk	High Risk	Very High Risk
Moderate	Low Risk	Moderate Risk	High Risk
Low	Low Risk	Low Risk	Moderate Risk

Table 106. Gila NF upland vegetation ecosystem characteristic risk results without consideration of climate change vulnerability

ERU Code	Scale of Analysis	Key Ecosystem Characteristic						
		Seral State Proportion	Patch Size	Coarse Woody Debris	Snag Density	Average Fire Frequency	Average Fire Severity	Fire Regime Condition Class
SFF	**Gila NF**	VH	VH	VH	VH	VH	L	VH
	Local Units							
	Apache	H	ND	ND	ND	H	M	ND
	Black Range	H	ND	ND	ND	H	L	ND
	Little Colorado-San Agustin Fringe	None						
	Lower Gila River	None						
	Mogollon Front	H	ND	ND	ND	H	L	H
	Upper Gila River	H	ND	ND	ND	H	L	H
MCW	**Gila NF**	M	M	H	H	H	L	M
	Local Units							
	Apache	M	ND	ND	ND	H	L	M
	Black Range	M	ND	ND	ND	H	L	M
	Little Colorado-San Agustin Fringe	M	ND	ND	ND	L	M	M
	Lower Gila River	M	ND	ND	ND	M	L	M
	Mogollon Front	M	ND	ND	ND	H	L	M
	Upper Gila River	M	ND	ND	ND	H	L	M

MCD	**Gila NF**	M	L	H	H	L	M	M
	Local Units							
	Apache	H	ND	ND	ND	M	M	M
	Black Range	M	ND	ND	ND	L	H	M
	Little Colorado-San Agustin Fringe	H	ND	ND	ND	M	L	M
	Lower Gila River	M	ND	ND	ND	M	H	M
	Mogollon Front	M	ND	ND	ND	L	H	M
	Upper Gila River	M	ND	ND	ND	L	L	M
PPF	**Gila NF**	H	H	H	H	L	L	H
	Apache	H	ND	ND	ND	H	L	H
	Black Range	H	ND	ND	ND	L	L	H
	Little Colorado-San Agustin Fringe	H	ND	ND	ND	H	L	H
	Lower Gila River	H	ND	ND	ND	M	L	H
	Mogollon Front	H	ND	ND	ND	H	L	H
	Upper Gila River	H	ND	ND	ND	L	L	H
PPE	**Gila NF**	L	L	L	L	L	L	L
	Local Units							
	Apache	M	ND	ND	ND	L	L	M
	Black Range	M	ND	ND	ND	L	M	M
	Little Colorado-San Agustin Fringe	M	ND	ND	ND	L	L	M
	Lower Gila River	H	ND	ND	ND	L	L	M
	Mogollon Front	M	ND	ND	ND	L	H	M
	Upper Gila River	M	ND	ND	ND	L	L	M
MPO	**Gila NF**	M	ND	VH	M	H	L	H
	Local Units							

	Apache	**L**	ND	ND	ND	ND	ND	ND
	Black Range	**M**	ND	ND	ND	ND	ND	ND
	Little Colorado-San Agustin Fringe	**M**	ND	ND	ND	ND	ND	ND
	Lower Gila River	None						
	Mogollon Front	**L**	ND	ND	ND	**H**	**L**	**M**
	Upper Gila River	**L**	ND	ND	ND	**L**	**L**	ND
PJC	**Gila NF**	**M**	ND	**H**	**M**	**M**	**M**	**M**
	Local Units							
	Apache	**H**	ND	ND	ND	ND	ND	ND
	Black Range	**H**	ND	ND	ND	**M**	**H**	**H**
	Little Colorado-San Agustin Fringe	**M**	ND	ND	ND	**L**	**H**	**M**
	Lower Gila River	**H**	ND	ND	ND	ND	ND	ND
	Mogollon Front	**M**	ND	ND	ND	**M**	**H**	**M**
	Upper Gila River	None						
PJO	**Gila NF**	**M**	**M**	**H**	**M**	**L**	**H**	**M**
	Local Units							
	Apache	**M**	ND	ND	ND	**L**	**H**	**M**
	Black Range	**M**	ND	ND	ND	**M**	**H**	**M**
	Little Colorado-San Agustin Fringe	**L**	ND	ND	ND	**L**	**H**	**M**
	Lower Gila River	**L**	ND	ND	ND	**L**	**H**	**M**
	Mogollon Front	**M**	ND	ND	ND	**M**	**M**	**M**
	Upper Gila River	**M**	ND	ND	ND	**L**	**H**	**M**
PJG	**Gila NF**	**M**	**H**	**H**	**L**	**H**	**L**	**M**
	Local Units							
	Apache	**M**	ND	ND	ND	**H**	**L**	**M**

	Black Range	**M**	ND	ND	ND	**H**	**M**	**M**
	Little Colorado-San Agustin Fringe	**M**	ND	ND	ND	**H**	**L**	**M**
	Lower Gila River	**M**	ND	ND	ND	**H**	**L**	**M**
	Mogollon Front	**M**	ND	ND	ND	**H**	**M**	**M**
	Upper Gila River	**M**	ND	ND	ND	**L**	**M**	**M**
JUG	**Gila NF**	**M**	**H**	**VH**	**M**	**H**	**L**	**H**
	Local Units							
	Apache	**L**	ND	ND	ND	ND	ND	ND
	Black Range	None						
	Little Colorado-San Agustin Fringe	None						
	Lower Gila River	**M**	ND	ND	ND	**H**	**L**	**M**
	Mogollon Front	**L**	ND	ND	ND	**H**	**L**	**M**
	Upper Gila River	**M**	ND	ND	ND	ND	ND	ND
MMS	**Gila NF**	**M**	ND	ND	ND	**L**	**H**	**H**
	Local Units							
	Apache	**M**	ND	ND	ND	**H**	**H**	ND
	Black Range	**M**	ND	ND	ND	**L**	**H**	**M**
	Little Colorado-San Agustin Fringe	**H**	ND	ND	ND	**L**	**H**	ND
	Lower Gila River	**M**	ND	ND	ND	**H**	**H**	**H**
	Mogollon Front	**M**	ND	ND	ND	**L**	**H**	**M**
	Upper Gila River	**M**	ND	ND	ND	**M**	**H**	**M**
MSG	**Gila NF**	**H**	ND	ND	ND	**M**	**H**	**H-VH**
	Local Units							
	Apache	**M**	ND	ND	ND	**H**	**H**	**H**
	Black Range	**M**	ND	ND	ND	**H**	**H**	ND

	Little Colorado-San Agustin Fringe	M	ND	ND	ND	H	H	H
	Lower Gila River	None						
	Mogollon Front	H	ND	ND	ND	L	M	ND
	Upper Gila River	M	ND	ND	ND	L	H	M
CPGB	**Gila NF**	H	ND	ND	ND	H	H	M
	Local Units							
	Apache	H	ND	ND	ND	H	H	H
	Black Range	H	ND	ND	ND	ND	ND	ND
	Little Colorado-San Agustin Fringe	H	ND	ND	ND	H	H	H
	Lower Gila River	H	ND	ND	ND	H	H	ND
	Mogollon Front	H	ND	ND	ND	H	H	H
	Upper Gila River	M	ND	ND	ND	L	H	ND
SDG	**Gila NF**	H	ND	ND	ND	H	H	H
	Local Units							
	Apache	H	ND	ND	ND	H	H	H
	Black Range	H	ND	ND	ND	ND	ND	ND
	Little Colorado-San Agustin Fringe	H	ND	ND	ND	H	H	H
	Lower Gila River	H	ND	ND	ND	H	H	H
	Mogollon Front	H	ND	ND	ND	H	H	H
	Upper Gila River	H	ND	ND	ND	H	H	H

In the forested ERUs (SFF, MCW, MCD, PPF, PPE), risk associated with key ecosystem characteristics of upland vegetation are interrelated and dependent on factors both within and outside the control of Gila NF management. Legacy issues related to past management also vary in their contribution to risk. The legacy of past fire suppression has not had a significant effect on SFF and MCW as they are infrequent fire systems with mean fire return intervals greater than the duration of fire suppression policy. Neither are they influenced to any significant degree by other past or current management activities such as timber harvest and livestock grazing. This is due to the percentage of these ERUs that occur on steep slopes and with respect to timber harvest, the relatively high percentage of these ERUs that occur within designated wilderness. All risk associated with these two ERUs is the product of drought and fire frequencies that are well outside the natural range of variability; fires have occurred too often in the 19 years considered in this assessment.

In fact, departure in seral state proportion and patch size may be even greater than depicted here due to the methodology used to update the Gila NF's Midscale Existing Vegetation dataset after recent wildfires such as the 2012 Whitewater Baldy Complex Fire and 2013 Silver Fire which burned large extents of these two ERUs. Furthermore, despite the assessment data not having the resolution needed to analyze old growth, these recent stand replacement wildfires are enough to draw valid inferences about risk to SFF and MCW old growth. These two ERUs also have the highest climate change vulnerability ratings and the lowest uncertainty ratings of all ERUs on the Forest, which elevates risk one category. The greater the vulnerability to climate change, the less resilient the ecosystem is likely to be and the less likely the system is to persist. This is particularly a concern for these ecosystems as there is little or no higher elevation sites for their migration. For more information about drought, climate change and the potential effect of fire management on vegetation types under a changing climate see Chapter 9: System Drivers and Stressors.

In the MCD, PPF and PPE ERUs, legacy issues associated with past fire suppression, historic timber harvest and historic overgrazing are present and have been discussed. Other disturbances and management factors have been and remain present in these systems, but do not significantly influence the vegetation characteristics assessed to a degree where they might be measurable at these scales of analysis. However, they may significantly affect the quality of wildlife habitat these ERUs provide, and certainly impact soil and water resource characteristics analyzed in those respective chapters. While improvements over historic conditions have been realized, VDDT modeling results indicate that continuation of current management (under the current climatic regime) produces a static trend for seral state proportion, coarse woody debris and snags and FRCC. Therefore, current management may not be wholly responsible for departure, but contributes to future risk.

On the other hand, departure and therefore risk, may be inflated in these ecosystems given that the scientific information available to describe reference conditions does not reflect the influence of complex terrain, steep slopes, geology and soils, or position within the geographic and climatic range of a particular ERU. These factors are important soil and vegetation drivers on the Gila NF, in these and other ERUs. Risk associated with current fire management, as demonstrated by fire frequency and severity, is low for these ERUs, which may offer validation of inflated departure in seral state proportion and FRCC due to these factors. Predominantly low departure and risk associated with fire frequency and severity speaks to the management emphasis placed on these systems and is indicative of successes associated with the work that the Gila NF and partners have accomplished over the last 20 years. However, the available coarse woody debris and snag data used in this assessment suggests there may still risk associated with heavy fuel accumulations in PPF, PPE, and MCD, as does a higher proportion of moderate and high fire severity departures and risk in MCD. However, higher fire severity departure and risk in MCD may be significantly influenced by topography, not solely stand conditions. Another factor that may contribute to fire related risks is related to departure in seral state proportion; when fire is frequent and fine fuels are sufficient to support its fire occurrence and spread, but insufficient to produce the flame lengths necessary to kill undesired conifer regeneration in the understory, fire is not a tool to restore vegetation structure. Insufficient fine fuels may play a role in lower fire severity in the PPF than compared to the reference.

Additionally in PPF, a few local units in low departure that do not contain the majority of the ERU acres are disproportionally influencing low departure at the plan scale indicating that the Forest may have the opportunity to be more strategic about where to manage fire in this ERU. The MCD, PPF and PPE ERUs have a moderate or higher vulnerability to climate change at all scales, which elevates risk one category. For more information about the potential effect of fire management on vegetation types under a changing climate, non-fire vegetation treatments and herbivory, see Chapter 9: System Drivers and Stressors. In the PPE, or PPF systems that contain re-sprouting oak and/or juniper species, or have the potential for these species to exist, there is a potential feedback between vegetation type conversions predicted to accompany climate change and Forest management: the conversion from forest to woodland conditions associated with any management activity that reduces overstory canopy to the extent that these shade intolerant, re-sprouting species are favored, including crown fires (Barton 2002), or silvicultural practices. Although this may not have been detectable at the scales considered in this assessment, field observations on the Gila NF have validated this as a concern.

In the woodland ERUs (MPO, PJC, PJO, PJG and JUG), legacy issues associated with past management, (considering past firewood harvesting practices instead of timber harvest), are also present, contribute to risk. Again, current management has realized improvements over historic, but VDDT models indicate continuation of current management does not reduce departure and risk over time (static trend). The JUG and MPO are exceptions in which current management increases risk to seral state proportion, coarse woody debris, snag density and FRCC. In the JUG and PJG ERUs, risk is primarily associated with infrequent fire in these characteristically frequent fire ecosystems, but in the JUG, non-fire vegetation management activities that may be designed for grassland systems may also be contribute to risk. In the infrequent fire PJO ERU, fire frequency is within the natural range of variation but there is risk associated with lower fire severities; a mosaic of mixed severity is more characteristic of this system and might reduce risk to vegetation structure (seral state proportion and patch size). Lower severity in the PJO, and less frequent fires in JUG and PJG are likely due to insufficient fine fuels to support fire occurrence and spread (JUG ad PJG) or to support higher severity (PJO). The MPO and PJC ERUs are also generally considered infrequent fire systems, but are under a degree of risk due to longer fire free periods than the available science indicates occurred historically.

In the MMS ERU, moderate to high departure and risk in seral state proportion, which reflects an over representation of late seral conditions. The majority of this ERU is located on steep slopes (≥ 40%) and climate and fire have been and remain the predominant influences seral conditions. In all local units except the Upper Gila River, fire is not occurring as often and when it occurs, on average, severity is lower than under reference conditions. This is perhaps explained insufficient fine fuels to support stand replacement type fires. Fine fuel production in most locations within the MMS is influenced by drought and soil characteristics, but where this ERU occurs on gentler terrain, primarily in the Burro Mountains of the Lower Gila River local unit, the legacy of historic overgrazing and associated soil loss and current livestock grazing have a stronger influence on the supply of fine fuels. However, lightning simply hasn’t started a fire in proximity to some of these locations recently and the close proximity to private property and the Wildland Urban Interface has resulted in fire suppression strategies in others. In the Upper Gila River local unit, seral state proportion is probably not due to an over representation of late seral states, as fire has occurred more frequently over the last 19 years than under the reference condition; lower average severity in the Upper Gila River local unit is likely a reflection of stand replacement fires in the Gila Wilderness that occurred prior to 1996.

All woodland ERUs with climate change vulnerability ratings generally have a moderate or greater vulnerability at all scales with the exception of the Little Colorado-San Agustin Fringe local unit in which there is low vulnerability for PJG and PJO and in the Upper Gila River local unit where vulnerability is low for the PJO ERU. The MMS ERU generally has low to moderate vulnerability to climate change ratings at all scales, except in the Black Range and Mogollon Front local units where vulnerability is low; vulnerability is highest in the Lower Gila River local unit. As previously stated, where vulnerability is moderate or greater, climate change elevates risk one category.

In the Gila NF's grassland ERUs, legacy issues related to historic overgrazing and fire suppression contribute to departure, and therefore risk. Although current management has allowed for improvement over historic conditions and moderate and low departure and risk occur more often, as compared to the other grasslands and generally favoring higher species diversity and vegetation condition as compared to the context area, the MSG trend projected by the VDDT modeling is away from reference. This is a reflection of woody vegetation encroachment that is expected to continue under current management. Departure and risk is high with respect to most or all characteristics in the CPGB and SDG ERUs at all scales, but the trend is static under current management. Woody vegetation encroachment, lower species diversity and vegetation condition are prevalent in these two grasslands. An exception for the CPGB ERU lies within the Upper Gila River local unit where departure and risk associated with seral state proportion is moderate and fire frequency departure and risk is low. Although trends were projected at the Forest level only, lower departure and risk in this local unit may signify a trend toward the reference condition. Insufficient fine fuels, either to support fire occurrence and spread or to produce flame lengths sufficient to kill encroaching conifers or both are the primary issues related to current management in the Gila NF's grassland ERUs, and to varying degrees in all ERUs except SFF and MCW, which reflects competing priorities associated with forage production and restoring the natural fire regime in these systems.

Summary

This assessment reviews the best available vegetation information related to the Gila NF's upland Ecological Response Units (ERUs), at the context, plan and local unit scales to explore the ability of the vegetation to sustain the ecosystem services it provides under current Forest Plan direction and under the current climatic regime. Sustainability was assessed by exploring key ecosystem characteristics related to vegetation including: seral state proportion, patch size, coarse woody debris and snag densities, fire frequency, fire severity and Fire Regime Condition Class (FRCC). Insects and disease relative to each ERU were briefly discussed. Current conditions related to these characteristics were compared to what is known about natural range of variability to determine departure and, where the data and analysis methods allow, trends were projected assuming continuation of current management. Departure and trend were then used to infer risk to sustainability. The degree of risk is commensurate with departure, unless a trend indicates otherwise.

While there is always measure of risk associated with all management actions or inactions, as well as factors outside of management authority or ability to control, such as drought, there is a significant amount of departure and risk associated with combination of the legacy issues and current management in most of the Forest's ERUs. This departure is typically expressed by increasing densities of woody vegetation, infill of forest and woodland openings and encroachment of grasslands. In the SFF, JUG, MPO and MSG, there is a significant degree of risk, which is projected to increase as a result of current management. Current management may be ameliorating risk in the PPE ERU and is expected to maintain current departure and risk levels in all other ERUs.

Fire is occurring too frequently in the high elevation, infrequent fire SFF and MCW ERUs as a result of drought. At the Forest scale, current management supports the natural role of fire with respect to how often it occurs in the MCD, PPF and PPE ERUs, but fire severity averages too low to support fire as a tool to restore vegetation structure in the PPF and PPE. Fire severity averages higher in the MCD than is characteristic of this system, which is influenced an increase in tree density, live ladder fuels, topography, fuel moisture, fire weather and perhaps additional factors. In the woodland ERUs, fire is generally not occurring as frequently as the current scientific information suggests they did in the past, whether those fire regimes were characteristically frequent or infrequent. This is contributing to departure and risk in vegetation structure and patch size. The exception being in the infrequent fire PJO ERU, in which fire frequency roughly reflects the natural range of variability. On the other hand, average fire severity is lower in all woodland ERUs, than is characteristic of these systems, including the PJO, which limits the utility of fire as a restoration tool. The same pattern with respect to the role of fire as a natural ecological process is true in the grassland systems. The fine fuels necessary to support characteristic fire in all ERUs except SFF and MCW are also the forage on which livestock and wildlife depend. The current situation with regard to coarse woody debris and snag densities are completely opposite; all ERUs have accumulations of these fuels that are outside what is known about the natural range of variation or the calculated amount necessary to support system sustainability. Within the Forest, patterns of departure and risk are illuminated by the local unit departure which may be higher or lower than the overall Forest ratings. Departure and risk are lower for most characteristics and ERUs in the Upper Gila River local unit.

In general, conditions are better on the Forest than within the context area in the MPO, JUG and PPE. Conditions are generally more departed on the Forest than within the context area in the PJC, MMS and MSG, however with respect to the MSG, these results are somewhat misleading. The proportion of the MSG in late seral conditions, with high species diversity and vegetation condition on the Forest is quite similar to the reference condition, which is not the case in the context area where those conditions are nearly absent; rather it is woody species encroachment that is being reflected. Conditions within the remaining ERUs considered in this assessment are similar both on and off-Forest.

Except for the SFF, MCW and MPO ERUs, the Forest is closer to the reference mean fire return interval than is the context area. Fire frequency is within the natural range of variation at the context scale in MCW. As mentioned previously, SFF on Forest is experiencing fire with greater frequency than the reference and is outside the natural range of variation. In the context area, fire frequency is outside the natural range of variability, but fires are occurring less frequently than the science suggests is characteristic of this system. In contrast, fire frequency is within the natural range of variation for the MPO in the context area, but is highly departed on Forest. This is interesting because the distribution of vegetation structural states is within the natural range of variation on the Forest, but is departed within the context area.

This is perhaps one of many illustrations regarding the limitations of even the best available scientific data, information and understanding. The most important limitations to note are:

- The science defining reference conditions may not adequately account for natural variations in vegetation structure, composition, patch size, etc. that occur due to local physical environmental factors such as slope, aspect, geology and soils. All of these factors exert strong influences on most ERUs in most places on the Gila NF.
- The data available to describe coarse woody debris and snag densities are of varying ages and may or may not reflect actual current conditions.
- The resolution of the data used to assess seral state proportion cannot be used alone to draw valid inferences on the status of old growth.
- While the concepts supporting the ERU framework are scientifically solid and useful, and the Gila NF's ERU map is founded in field data, it is ultimately a remote sensing product that has not been field validated. The extent to which this influences the results of this analysis is unknown.

Nature is complex. Climate change increases these complexities and introduces additional uncertainties. In terms of this assessment, ecosystem vulnerability to climate change increases the risk to sustainability.

Stakeholder Input

It was nearly universally recognized that the forests are denser and more overgrown compared to historical conditions, which has many ecological and socioeconomic implications. There were concerns about encroachment of woody species into grasslands where meadows and open spaces have disappeared leading to less understory vegetation for livestock/wildlife and to slow erosion. Many people attribute the under representation of early seral habitat on the National Forest to historic wildfire suppression policy and lack of active management. There is broad interest in the collaborative restoration of these ecosystems to restore the natural mosaic of habitats and functions using extensive prescribed burning programs and various timber harvest, firewood gathering (esp. more fuelwood areas), thinning and livestock grazing practices. It was further suggested to work with willing partners across the Forest boundary to promote landscape level restoration in conjunction with entities such as the Bureau of Land Management, State Forestry, and Soil and Water Conservation Districts. A need was identified to develop infrastructure and industry to make it economically feasible to accept/process the amount of material that needs to be removed, which would also benefit local economies. It was also suggested to use herbicide to control alligator juniper resprouting after thinning treatments for maintenance of treated areas.

Negative changes witnessed also include more insect infestations and invasive species, and extreme events such as uncharacteristic fire, drought and floods. Overall, participants felt the system has weakened and has less ability to recover from these extreme events.

After the release of the draft assessment report, the Forest received comments echoing the concerns and ideas offered at the beginning of the assessment phase. Additional input related to upland vegetation included detailed ideas for plan components. Some were concerned about the season in which the Forest managed fires, the way in which prescribed burning is conducted, invasive species inventory, monitoring and treatment, and the number of field going Forest Service employees. Recommendations to conduct grassland studies to help identify historic grasslands were also received. Others had alternative ideas about how the stand exam data should have been used and were concerned about the Forest's overall monitoring program. The majority of the comments on the upland vegetation analysis sought clarification of the chapter content, identified contradictory data and/or interpretations they perceived, or suggested alternate language.

Chapter 3. Baseline Carbon Assessment

Introduction

The emission of greenhouse gases (GHGs) by human activities and natural processes contribute to the warming of the Earth's climate. Warming could have significant ecological, economic, and social impacts at regional and global scales (IPCC 2007). In 2005, US forests were estimated to be sequestering nearly 220.5 million tons of carbon (Cameron et al. 2013), suggesting that forests and woodlands of the Southwest could have a significant role to play in the sequestration of carbon and climate change mitigation. The USDA Forest Service has directed a baseline assessment of carbon stocks as part of the forest plan revision assessment process (36 CFR 219.6(b)(4)).

In this chapter, the major carbon components of Southwest ecosystems are considered including biomass, carbon emissions, and soil organic carbon. Some estimates are provided for biomass and soil carbon on the Gila NF in southwestern New Mexico. For the moment, the carbon emissions component has been characterized by using a case study synthesis from the Apache-Sitgreaves NFs. The description of other carbon components, such as forest products, would provide a fuller accounting of carbon stocks and flux; for the time being, inclusion of the major components of biomass, emissions, and soil carbon will suffice for strategic purposes of Forest planning.

Carbon Stocks on the Gila NF

Biomass (vegetative carbon)

Vegetative biomass serves an integral component in forest carbon cycles. Forest vegetation, through the process of photosynthesis, converts atmospheric carbon dioxide to carbohydrates (referred to as carbon fixation). These carbohydrates (sugars) are used by plants to grow both aboveground biomass in the form of stems and leaves, and belowground biomass in the form of roots and tubers. Conversely, through the process of decay, dead plant material slowly releases carbon into the atmosphere as it decomposes. Total carbon stored in vegetative biomass is referred to as the biomass carbon stock, and this is a value that changes through time. The primary influences on biomass carbon stock are plant growth (primary productivity) which serves to increase biomass carbon stock, decay and decomposition which slowly decreases biomass carbon stock, and disturbance in the form of fire and harvest. Wildland fire provides a major source of carbon emissions in a forest setting, and is discussed in detail in the carbon emissions section of this document. Biomass harvest plays a varying role in carbon emissions, depending largely on the use of the wood products. For example, wood products utilized as saw timber in construction or for furniture tend to provide long term carbon storage with slow release, while wood products used as fuelwood and burned for heat provide increased carbon emissions into the atmosphere. As forest and grassland ecosystems are constantly changing through natural succession and disturbance, biomass carbon stock also changes through time. This section will focus on biomass carbon stocks over time on lands of the Gila National Forest (NF). For the purpose of this chapter, biomass carbon stock includes aboveground live biomass, standing dead biomass, downed woody debris, litter and duff, and belowground live biomass (in forest and woodland systems; not yet quantified for grassland and shrubland systems); Belowground nonliving plant material is considered in soil organic carbon. The methods for deriving biomass values for seral states within forest and woodland ecosystems are included in Appendix B, and below for seral states within grassland and shrubland systems.

Current Conditions: Biomass Carbon Quantities

The Gila NF can be stratified into fourteen major ecosystem types referred to as Ecological Response Units or ERUs (Table 107). Each ERU contributes differently to carbon stocks and their flux based on its spatial extent, vegetation community composition and structure, and ecosystem dynamics. Generally speaking, relative contributions to carbon stocks are lowest in desert and grassland ERUs, with increasing contributions by shrubland, woodland, and forest ERUs, respectively.

Table 107. Major Ecological Response Units on the Gila NF in acres and percent.

System Type	Ecological Response Unit	ERU Code	Acres	Percent of Gila NF
Grassland	Colorado Plateau Great Basin Grasslands	CPGB	89,187	2.7%
	Montane Subalpine Grasslands	MSG	113,784	3.5%
	Semi-Desert Grassland	SDG	55,988	1.7%
Shrubland	Mountain Mahogany Mixed Shrubland	MMS	166,489	5.1%
Woodland	Juniper Grassland	JUG	114,396	3.5%
	Madrean Piñon Oak Woodland	MPO	17,361	0.5%
	Piñon Juniper Evergreen Shrub	PJC	10,679	0.3%
	Piñon Juniper Grassland	PJG	291,648	8.9%
	Piñon Juniper Woodland	PJO	848,443	25.9%
Forest	Ponderosa Pine – Evergreen Oak	PPE	378,156	11.6%
	Ponderosa Pine Forest	PPF	630,278	19.3%
	Mixed Conifer – Frequent Fire	MCD	395,573	12.1%
	Mixed Conifer with Aspen	MCW	74,072	2.3%
	Spruce Fir Forest	SFF	23,778	0.7%
	Total Area of Major ERUs on Gila NF		3,209,832	100%
	Total Area of Gila NF Planning Unit		3,271,487	98.1%

The figures and tables presented in this chapter represent carbon stock for current conditions, reference conditions, and for select ERUs, modeled future conditions under current management intensities. Each ERU is referred to by its assigned two- to three-letter code; for reference, these appear in the third column of Table 107. Carbon stock values are presented below both by ERU and collectively for the Gila NF. For each seral (or successional) state in each ERU, carbon stock coefficients were assigned based on either information gleaned from the scientific literature and web resources (for desert, grassland, and shrubland ERUs: Boyd and Bidwell 2001, Brooks and Pyke 2001, Scott and Burgan 2005, USDA FS 2012a) or (for woodland and forest ERUs) from FIA sample data and the carbon submodel of the Forest Vegetation Simulator (Weisz et al. 2010) – Fire and Fuels Extension (Rebain et al., 2015). Carbon stock totals for each ERU are derived by multiplying the current or forecasted total acreage in each seral state by the corresponding carbon coefficient, and summing across all seral states.

It is worthwhile to consider changes in biomass carbon stocks in two ways. Looking at the percent change within an ERU reveals information about the degree of change within that ERU alone. However, ERUs vary greatly in their reference biomass carbon stocks, and a large percent change in one ERU may not translate to as many tons of carbon as a smaller percent change in another ERU. The impact of the percent change per ERU on overall biomass carbon stock levels also depends on the spatial extent of the ERU on the Gila NF. Looking at the tonnage of biomass carbon on its own reveals a clearer portrait of the actual amount of carbon stored in each ERU and accounts for spatial extent, but these figures on their own do not adequately reflect the degree of change within the ERU. The analyses shared here include both sets of figures.

As demonstrated below, the current overall Gila NF biomass carbon stock is about 116% of that present in reference (historic) conditions in the Gila's major ERUs, which translates to almost 14M tons over the historic 85.6M tons. While this increase suggests little percent change over reference conditions, a more complete picture can be drawn by looking at relative contributions from individual ERUs.

As illustrated in Table 108 and Figure 62, several of these changes are quite dramatic. Three woodland systems hold a third to 50% more carbon than in reference conditions. Two of the dry forest systems hold from 40% more to over double the carbon held by these systems in reference conditions. Conversely, the system with the most infrequent fire regime under reference conditions – Spruce Fir Forest (SFF) – holds less than half the carbon it would have historically.

Carbon increases have occurred in all but five of the fourteen ERUs examined on the Gila NF. Carbon increases in the frequent-fire forest systems (PPE, PPF and MCD), the shrubland system (MMS) and three of the woodland systems (MPO, PJC and PJG) are presumably associated with land management patterns, including the decades-long policy of fire suppression, and limited harvest of trees in the most recent years and decades. The reduction in biomass in two of the woodland systems (JUG and PJO) may be associated, at least in part, with historic chaining and other modifications that resulted in overstory removal. While wildfires are expected to occur only after long intervals in the infrequent fire forests, MCW and SFF, both of these systems have experienced large fires in recent years and biomass carbon stocks are presently lower than the average reference condition portrait.

Table 108. Biomass carbon stock per ERU in reference and current conditions.

System Type	ERU	Reference Condition (tons)	Current Condition (tons)	Percent Departure from Reference Condition
Grassland	CPGB	263,460	497,290	89%
	MSG	412,498	1,216,784	195%
	SDG	172,312	149,076	-13%
Shrubland	MMS	2,929,457	4,287,219	46%
Woodland	JUG	1,664,786	1,158,639	-30%
	MPO	241,468	323,785	34%
	PJC	129,631	179,544	39%
	PJG	4,143,103	6,096,919	47%
	PJO	18,609,466	15,370,609	-17%
Forest	PPE	6,234,129	12,883,777	107%
	PPF	18,839,009	26,523,826	41%
	MCD	23,200,258	24,479,078	6%
	MCW	6,486,009	5,324,106	-18%
	SFF	2,278,489	1,053,616	-54%
	Totals	85,604,075	99,544,268	16%

Note: Shading in orange (warmer) indicates an increase in carbon stock, and shading in blue (cooler) indicates a reduction in carbon stock. In both cases, deeper hues reflect greater departure from reference conditions.

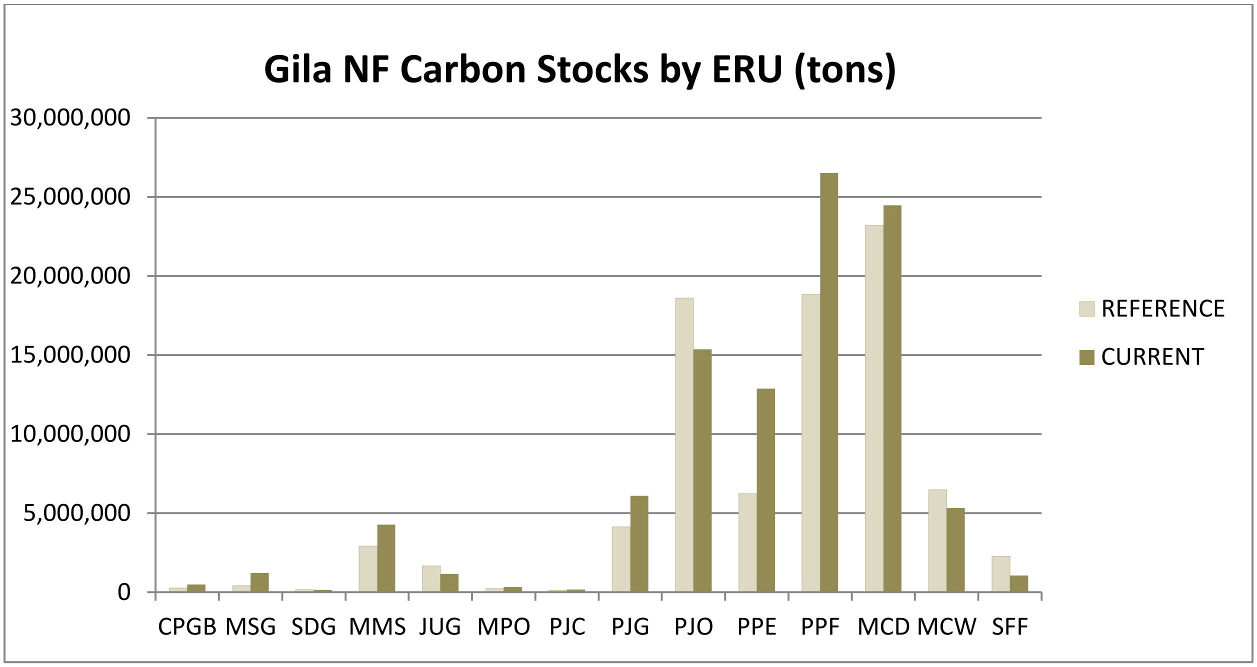

Figure 62. Biomass carbon stock by ERU in current and reference conditions.

Also of note is the considerable shift in biomass regimes of the grassland systems. Our results show an increase in biomass carbon from reference conditions in two of the three grassland systems due to encroachment of woody species, also likely attributable to fire suppression. Conversely, semi-desert grassland show a decline of nearly 13%; while this ecosystem too has experienced encroachment of woody species, this effect is overshadowed by the large reduction in extent of the carbon-rich, high ecological status grassland state.

The largest reductions from reference conditions, in terms of tonnage, occur in PJO (over 3.2M tons below reference conditions), MCW (1.2M tons below reference) and SFF (at 1.2 tons below reference).

Trends: Biomass Projections

Many factors will influence future carbon stocks on the Gila NF, and this assessment is in no way a comprehensive accounting of all possible outcomes. Factors such as climate change, fire frequency and severity, and management budgets are all outside the control of Gila Forest managers, and as such, this assessment may be useful in conveying only general patterns and trends. However, general ecosystem dynamics in southwestern systems are fairly well understood, and provide a good starting point for assessing trends in biomass carbon stocks. Vegetation conditions on the Gila NF have been modeled into the future for most of its predominant ERUs using State and Transition Modeling (STM), including assumptions based on current management and disturbance patterns[10]. This allows the projection of relative biomass carbon contributions through time for key ERUs (see a full description of process and methodology in Appendix B). Using past observations of stand development dynamics and management applications for future projections is, admittedly, inherently problematic in light of projected climate changes.

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[10] Modeling was conducted by the Gila National Forest and Region 3 staff, October 2015 – March 2016.

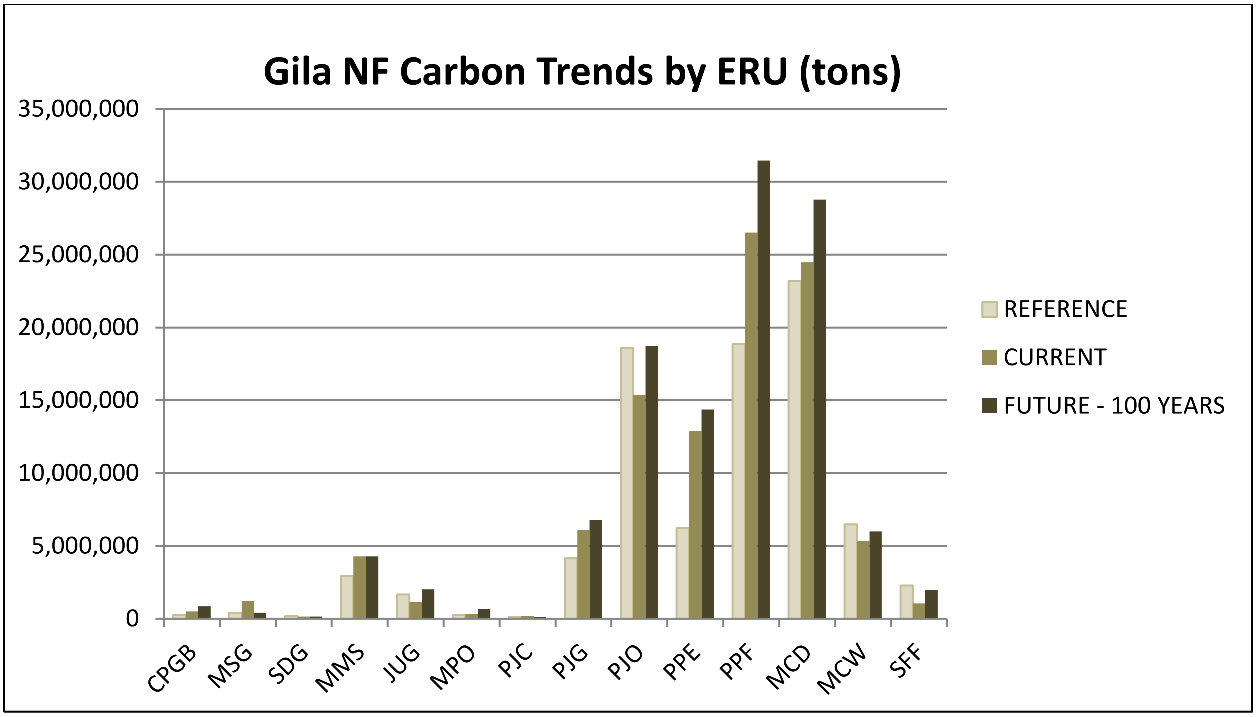

Figure 63. Trends in Carbon Stocks for Gila NF ERUs.

Table 109. Projected Carbon Stocks for Major ERUs of the Gila NF

ERU	Current Condition (tons)	Projected +100yrs (tons)	*Projected +100yrs % Change from Current*
CPGB	497,290	857,447	72%
MSG	1,216,784	408,581	-66%
SDG	149,076	149,837	1%
MMS	4,287,219	4,270,530	-0.4%
JUG	1,158,639	2,005,632	73%
MPO	323,785	668,340	106%
PJC	179,544	109,179	-39%
PJG	6,096,919	6,770,931	11%
PJO	15,370,609	18,743,390	22%
PPE	12,883,777	14,361,608	11%
PPF	26,523,826	31,469,048	19%
MCD	24,479,078	28,788,781	18%
MCW	5,324,106	5,989,276	12%
SFF	1,053,616	1,965,124	87%
Total	***99,544,268***	***116,557,705***	***17%***

Figure 63 and Table 109 depict 100-year projections for primary Gila NF ERUs paired with current and reference condition biomass carbon stocks. These projections assume a continuation of current management, and are not reflective of changes in management that may emerge from the Gila's ongoing effort to revise its land management plan. However, these results do provide meaningful trend information regarding biomass carbon storage in the near future. The overarching pattern of biomass carbon stock projections on the Gila NF indicates an increase in total carbon storage above current conditions in most modeled ERUs, with an overall increase of 17% (just over 17M tons). The greatest proportional increases in biomass carbon stocks are predicted to occur in one grassland ERU (CPGB), two woodland systems (JUG, MPO) and one infrequent-fire forest system (SFF) in which biomass has recently been greatly reduced by wildfires. Broader patterns exist, with increases occurring in all woodland ERUs but one (PJC), all frequent fire forest systems, and all infrequent fire systems. Exceptions, which display decreases in vegetation biomass carbon stocks, include MSG, PJC and to a slight degree, MMS.

The greatest changes in the tons of biomass carbon held within an ERU are predicted to occur in the frequent fire forest systems, where 10.7M tons are expected to be added over the next 100 years. Over 5.1M tons are expected to be added to biomass carbon stocks in the woodland ERUs over this period. While biomass carbon stocks are expected to recover greatly in the infrequent fire forest systems that have recently been heavily impacted by fire, in 100 years these two systems are still expected to hold 0.8M tons less carbon than in reference conditions.

Carbon Emissions – Synthesis of Study by Vegh et al. (2013)

Introduction

For the Gila NF assessment, carbon emissions have been characterized below by using a case study synthesis from the Apache-Sitgreaves NFs (Vegh et al., 2013), relevant to forested ecosystems of the Southwest in terms of natural processes and common management activities. The study provides a surrogate solution for emissions assessment in lieu of emissions data and analysis specific to the Gila NF.

Background

To date there has been no binding commitment by the federal government or USDA Forest Service for the regulation of carbon dioxide (CO_2), though there has been increasing activity at state and regional levels to control carbon emissions to the atmosphere, prompting regulation, voluntary carbon exchanges, and carbon inventory and monitoring programs (Wiedinmyer and Neff 2007). The USDA Forest Service Planning Rule directs forests to assess baseline carbon stocks as part of the forest planning process *(*36 CFR 219.6(b)(4))*,* and though there are other carbon constituents released in wildfire and prescribed burning, CO_2 is the primary carbon compound and primary greenhouse gas associated with fire emissions (Table 110).

Table 110*.* Proportion of constituents of wildfire emissions for both greenhouse gases (GHG) and carbon compounds (NRC 2004).

Species	Proportion GHG	Proportion Carbon Constituents
Carbon Dioxide	72.14%	90.82%
Water	21.18%	
Carbon Monoxide	5.57%	7.02%
Atmospheric particulate matter <2.5µ		0.60%
Nitric Oxide	0.39%	
Methane	0.27%	0.34%
Volatile Organic Compounds	0.24%	0.31%
Organic Carbon		0.31%
Non-methane Hydrocarbon	0.20%	0.25%
Particulate Matter > 10µ		0.22%
Particulate Matter <10µ and >2.5µ		0.11%
Elemental Carbon		0.03%
	100.00%	100.00%

Though emissions by fire and other forest processes (e.g., methane from the decomposition of wood) have a relatively minor impact on carbon stocks and flux, atmosphere-based emissions are strongly impacted by biosphere-atmosphere carbon fluxes at regional scales, and represent the carbon component directly involved in the positive feedback of greenhouse gas forcing on climate change. In a given year in the

Southwest, carbon emission from fire can exceed fossil fuel emissions at regional scales (Wiedinmyer and Neff 2007). In their study of fire emissions, Wiedinmyer and Neff (2007) found that on average carbon emissions were 4–6% of the total anthropogenic emissions for the US. In a separate study, Woodbury et al. (2007) estimated that 10% of total anthropogenic emissions in the US are captured by forest vegetation, to suggest that forests can sequester more carbon than they emit and become an offsetting solution for anthropogenic emissions. The Intergovernmental Panel on Climate Change (IPCC) recognizes the potential for forest and woodland ecosystems, in particular, to perform climate change mitigation (IPCC 2007). In assessing carbon dynamics and emissions in the Southwest, Hurteau and others (e.g., Hurteau et al. 2008, North et al. 2009, Hurteau and North 2010) went further and proposed that large releases of carbon to the atmosphere could be minimized by reducing stand densities. Prior to the Apache-Sitgreaves NF study (presented below), it had been hypothesized, and shown through dynamical modeling and observation (Kobziar et al. 2009, Martinson and Omi 2013, Pollet and Omi 2002), that the reduction of stand densities precludes large pulses of wildfire emissions with a reduction in uncharacteristic fire, such as stand replacement fire in ponderosa pine forests. Preliminary research indicates that the sustainable management of forests, along with careful consideration of byproducts and management residues, would not only balance forest carbon stocks but could also partially mitigate global climate change through increased carbon storage.

Apache-Sitgreaves Study Overview

Recent research on carbon dynamics and emissions related to various conventional forest management activities, focused specifically on the Apache-Sitgreaves (A-S) National Forests in eastern Arizona, provides surrogate information to guide National Forests of the Southwest in the assessment and management of carbon (Vegh et al. 2013), which we are using here in lieu of more specific analysis of carbon emissions.

A key objective of the A-S study was to determine the long-term (100 years) difference in carbon stocks and carbon emissions between treated and untreated forest ecosystems. While the study was focused on the Ponderosa Pine Forest ERU, the results can be abstracted to other forest and woodland ecosystem types for purposes of characterizing general trends among reference condition, no-action, and treatment scenarios, in terms of 1) fire carbon emissions, 2) total (live and dead) above-ground biomass, and 3) live above-ground biomass. And while the Vegh et al. (2013) study did not consider the effects of forest restoration per se (sensu Region 3 desired conditions), they did evaluate the effects of reduced tree densities on carbon stocks and flux.

Analysis

In their study, Vegh et al. (2013) compare the effects of different management alternatives on overall carbon stocks and emissions. They apply three management alternatives – no action, light thinning, heavy thinning – to determine the overall management effects on carbon sequestration and emissions flux. The researchers used the Forest Vegetation Simulator (FVS) to model stand dynamics over a 100-year simulation and report outcomes for carbon stocks and emissions. For annual treatment in the analysis simulation, all suitable stands on the A-S NFs were prioritized in order of the following conditions:

1. Wildland Urban Interface (WUI) areas in high departure plant communities
2. WUI areas in moderate departure plant communities
3. non-WUI areas in high departure plant communities
4. non-WUI areas in moderate departure plant communities
5. WUI areas in low departure plant communities
6. non-WUI areas in low departure plant communities

In all cases, “departure” is a measure of similarity between the current and reference (historic) vegetation structure, with high departure reflecting vegetation heavily altered from past structural conditions, and low departure indicating a distribution of structural states that are highly similar to those we would have expected pre-European settlement. In the FVS simulations, individual stands were further prioritized for treatment according to basal area (BA) and quadratic mean diameter (QMD), so that stands with the greatest stocking (i.e., BA) and the smallest trees (i.e., QMD) would be given highest priority for treatment.

In their modeling, the investigators assumed conventional treatment scenarios and contemporary wildfire frequencies. Stands with a preponderance of large trees over 16” in diameter were not included, due to some social constraints. Carbon emissions were estimated for wildfires, prescribed burning, and pile burning. In the simulations, all thinning harvests were followed by pile burning in the second year, and by broadcast burning in the tenth year. The researchers also assumed that trees would regenerate successfully after burning.

Findings and Discussion

In their results, Vegh et al. (2013) reported that carbon emissions and stocks were affected by both management alternatives and wildfire frequency. In the reporting, carbon stocks were divided into above-ground live biomass and into total carbon occurring above- and below-ground, both live and dead. The following results were generated from the 100-year model simulation:

- The no-action alternative resulted in the lowest total carbon emissions since no treatments would occur under these alternatives. The alternatives with management treatments produced approximately five times the total carbon emissions of the no-action alternative.
- Carbon emissions by wildfire were lower in the treatment alternatives than in the no-action, and wildfire emissions were lowest in the alternative with the greatest degree of thinning. Resulting wildfire emissions associated with the heavy thinning alternative were up to half the amount of emissions of the light thinning alternative, and about one third less than the no-action alternative.
- Total carbon stocks (above- and below-ground, live and dead) were lower in the treatment alternatives than in the no-action alternative, due to thinning and the removal of live tree biomass, assuming similar wildfire frequency and severity as the last three decades (1980-2009). The lowest carbon stocks were found in the heavy thinning alternative.
- Carbon stocks for live above-ground biomass alone were highest in the treatment alternatives, particularly in the second half of the simulation due to the accumulation of carbon in large fire-resistant trees.

We might also conclude that at landscape scales, total above-ground carbon stocks would remain somewhat higher in the treatment scenarios than in the reference condition, because of the number of untreated plant communities and because of a lower overall fire frequency compared to reference (due to fire suppression activities and loss of fine fuels in some ecological systems).

Soil Organic Carbon

Soil organic carbon (SOC) is the energy source for soil organisms which, through their activity and interactions with mineral matter, impart the structure to soil that affects its stability and its capacity to provide water, air, and nutrients to plant roots. The amount and kind of soil organic carbon reflects and controls soil development and, ultimately, ecosystem productivity (Van Cleve and Powers 1995).

Globally, SOC contains more than three times as much carbon as either the atmosphere or terrestrial vegetation (Schmidt et al. 2011). Forest soils are the largest active terrestrial carbon pool and account for 34 percent of the global soil carbon (Buchholtz et al. 2013). Accurate quantification of SOC stocks is key to modeling atmospheric CO_2, soil productivity, and global climate. Soils represent a significant portion of the active carbon cycle, with estimates of organic C ranging from 1,500 to 2,000 Pg C, or roughly two thirds of the terrestrial organic C stocks (Rasmussen 2006).

Attempts to characterize regional soil carbon stocks include both ecosystem- and soil taxa-based approaches. The ecosystem approach involves averaging soil C data within a specific plant community or biome and multiplying the average soil C content by the estimated biome land area (Rasmussen 2006). This approach does not account for soil spatial heterogeneity and results in large variability of soil C estimations within an ecosystem or biome. The soil taxa approach has been extensively described in the soil science literature (Rasmussen 2006) and includes segregating landscapes by soil taxa (instead of biomes) and using average taxa soil C and estimated land area to calculate soil C stocks. However a soil taxa as mapped may have more than one associated biome.

The process used for the Gila NF soil C stock assessment involved the ecosystem-based approach through the aggregation of terrestrial ecological units (soil/vegetation/climate) into ecological response units (ERU) that represent the major potential natural vegetation communities on the Gila NF.

Methods

Soil organic carbon was calculated from multiple sources for this assessment. Soil pedons (basic units of soil classification) that were selected for physical and chemical characterization within the Gila National Forest Terrestrial Ecosystem Survey and forests within New Mexico (Cibola and Santa Fe NFs) were also used to establish average soil organic carbon reference values for Ecological Response Units (ERU). Soil organic carbon pedon data on the Gila NF were limited. The Cibola and Santa Fe NFs have soil organic carbon pedon data for similar soil taxa as found within Gila NF ERUs.

The soil pedons chosen were representative for each ERU. Other kinds of soil may also occur within ERUs. Soil pedon data were also downloaded from the National Cooperative Soil Survey Characterization Database (NCSS 2016) that were within the Gila NF ERU context scale.

Ecological Response Units at the Gila National Forest context scale were intersected with New Mexico and Arizona STASTGO2 data and the associated soil organic carbon 0-100 cm attribute table.

Bulk density was calculated from representative values from known soil textures using the Soil Water Characteristics: Hydraulic Properties Calculator (Saxton et al. 2009).

The Gila National Forest has a wide variety of soils that support many different terrestrial ecosystems. These soils have originated from igneous, sedimentary and metamorphic geologic sources and occur on a wide array of landforms. The differential weathering of soils by various climates and plant communities leads to the development of soil organic carbon.

Current Conditions

Considerable SOC variation exists between ERUs due to the variable numbers of soils sampled, the different kinds of soil taxa per ERU, and the scale for which map unit composition values represent both fine and coarse scales (Table 111). Soil pedon data were not available for all soil taxa within each ERU.

The Piñon Juniper Woodland, Ponderosa Pine Forest, Mixed Conifer Frequent Fire and Ponderosa Pine Evergreen Oak ERUs contribute significantly to the overall SOC stock for the Gila NF. Collectively they account for approximately 77,106,878 tons of SOC or 69% of the SOC stock by land area (Figure 64).

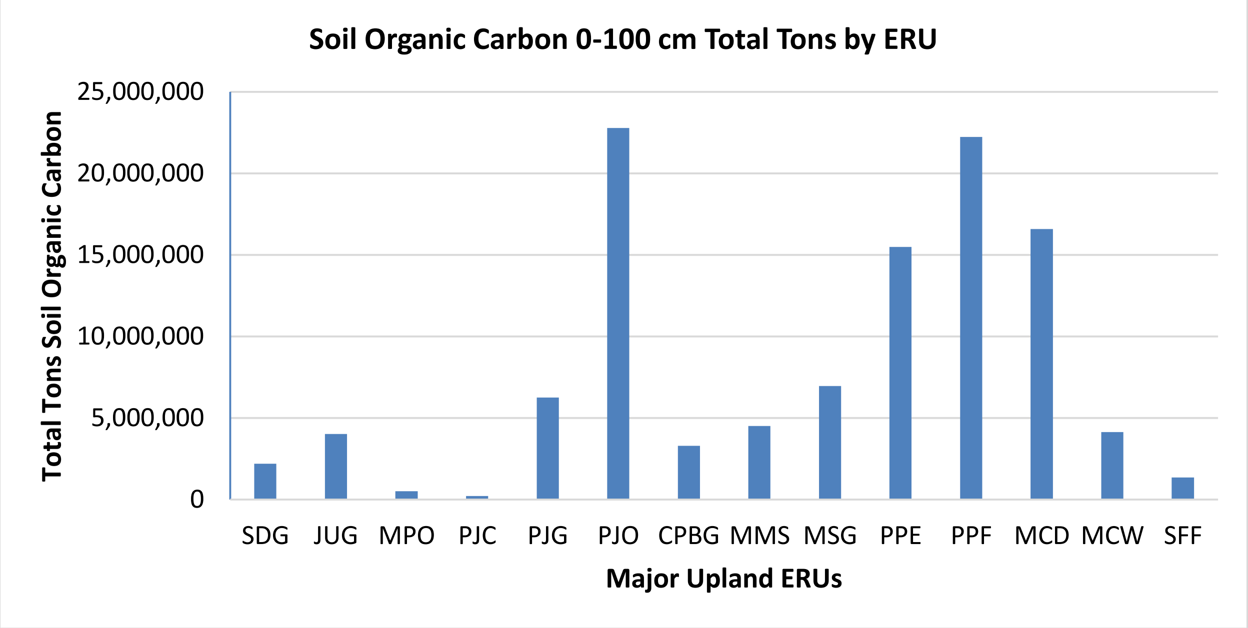

Figure 64. Soil organic carbon (tons) for major Gila NF ERUs

Average soil organic carbon stock for ecological sites (pedons) on upland ERUs of the Gila NF is generally greatest in the Montane Subalpine Grassland (61 tons/ac), Spruce Fir Forest (57 tons/ac) and Mixed Conifer with Aspen (56 tons/ac) (Figure 65). Although these ERUs have high average soil organic carbon (tons/ac) they account for relatively small land area within the Gila NF.

Riparian systems are ecologically important on the Gila NF, but account for only 2% of the total land area. These Riparian ERUs all have very similar and relatively low average SOC (when compared to upland ERUs) ranging from 9 tons/ac to 13 tons/ac. These ERUs account for 722,683 tons of SOC or less than 1% of the SOC stock by land area (Table 111).

Table 111. Soil Organic Carbon by ERU

System Type	Ecological Response Unit	ERU Code	ERU % of Gila NF	SOC (tons/acre)	SOC (tons)
Riparian	**Desert Willow**	130	0.35%	12.57	143,910
	Cottonwood Group				
	Sycamore - Fremont Cottonwood	270	0.34%	12.68	140,407
	Fremont Cottonwood - Oak	170	0.003%	10.93	924
	Fremont Cottonwood / Shrub	180	0.10%	9.35	29,294
	Narrowleaf Cottonwood / Shrub	230	0.93%	9.75	301,510
	Walnut-Evergreen Tree Group				
	Arizona Walnut	300	0.04%	10.92	15,591
	Little Walnut - Ponderosa Pine	370	0.01%	10.46	3,872
	Montane Conifer-Willow Group				
	Ponderosa Pine / Willow	350	0.03%	10.05	8,902
	Arizona Alder - Willow	110	0.10%	9.34	31,853
	Willow - Thinleaf Alder	290	0.03%	9.58	10,382
	Upper Montane Conifer / Willow	280	0.02%	9.8	6,565
	Herbaceous Wetland	190	0.10%	8.73	29,474
Grassland	**Colorado Plateau / Great Basin Grassland**	CPGB	2.70%	37.05	3,304,098
	Semi-Desert Grassland	SDG	1.70%	39.24	2,197,108
	Montane / Subalpine Grassland	MSG	3.50%	61.25	6,969,634
Shrubland	**Mountain Mahogany Mixed Shrubland**	MMS	5.10%	27.18	4,525,386
Woodland	**Juniper Grassland**	JUG	3.50%	35.27	4,034,949
	Piñon Juniper Grassland	PJG	8.90%	21.44	6,254,320
	Madrean Piñon-Oak Woodland	MPO	0.50%	29.22	507,352
	Piñon Juniper Evergreen Shrub	PJC	0.30%	21.07	224,995
	Piñon Juniper Woodland	PJO	25.90%	26.85	22,780,141
Forest	**Ponderosa Pine - Evergreen Oak**	PPE	11.60%	40.98	15,496,830
	Ponderosa Pine Forest	PPF	19.30%	35.28	22,235,313
	Mixed Conifer w/ Aspen	MCW	2.30%	55.99	4,147,144
	Mixed Conifer - Frequent Fire	MCD	12.10%	41.95	16,594,593
	Spruce-Fir Forest	SFF	0.70%	57.09	1,357,484

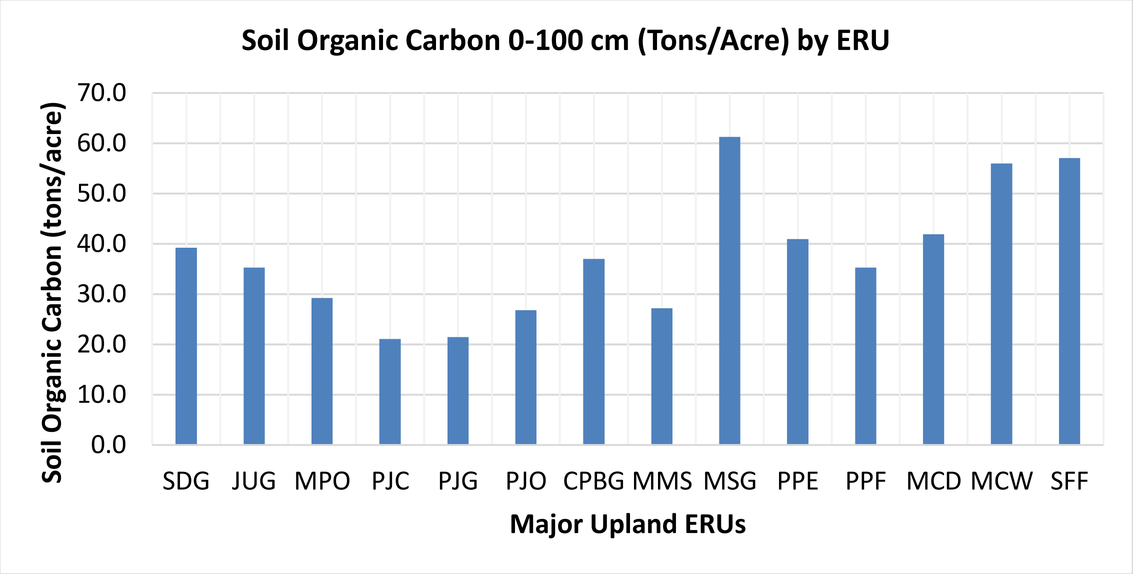

Figure 65. Average Soil Organic Carbon by ERU

Trends

The current trend of sustaining SOC is strongly influenced by growth and yield of vegetation inherent to the ERUs and by those activities that remove biomass from the soil surface; including climatic factors that provide temperature and moisture conditions for weathering and decomposition of above- and belowground biomass. Given the projection that biomass carbon will potentially increase into the future, it is logical to assume that SOC will remain the same or potentially increase under current rates of decomposition. Current Forest Service Southwestern Region soil quality technical guidance is to maintain surface coarse woody material in woodlands and forests to ensure microbial populations for nutrient cycling (Graham et al. 1994).

The exception to this would be the Grassland and Shrubland ERUs where surface biomass has decreased due to consumptive harvesting by ungulates, erosion (wind and water) and other disturbances (e.g., fire).

Summary and Conclusions

Biomass

Table 108 summarizes reference (historic) and current carbon conditions for ERUs of the Gila NF. As one might expect, on an acre-for-acre basis the grassland ecosystems (SDG, MSG and CPGB) had the least biomass carbon concentration historically (about 3-4 tons/ac), while the infrequent fire forest systems had the greatest (88 and 96 tons/acre in MCW and SFF, respectively). The remaining ERUs ranged from 12 to 59 tons per acre, with forest ERUs having the greatest concentrations, followed by woodland and shrubland ERUs.

Of all of the ERUs on the Gila NF, SFF has experienced the largest reduction from reference conditions in biomass carbon stocks. While stand replacing fire is to be expected in this system, across a large landscape there would have been stands that did not burn, and overall carbon stocks would remain high. On the Gila there are just under 24,000 acres of SFF and in the last several years nearly 100% of this ERU has been burned, or reburned mostly (76%) at the moderate to high severity levels, resulting in over a 50% reduction in carbon stocks in this system. Model projections indicate recovery of this carbon stock in the future, with carbon stocks almost reaching reference condition levels after 100 years. Carbon stocks in the other infrequent fire forest system, MCW, also show a reduction from reference conditions, though far less dramatic. Carbon stock recovery after 100 years does not quite reach historic levels due primarily to insect and disease driven mortality effects, and also due to more frequent wildfires than occurred in reference conditions.

The greatest relative increases in current carbon stocks from reference conditions are observed in two of the three grassland systems (CPGB and MSG, with 89% and 195% increases in biomass carbon, respectively), and two of the three frequent fire forest systems (PPE and PPF, with 107% and 41% increases, respectively). In both cases, these increases are likely the result of a history of fire suppression that has resulted in high fuel loading in forests, and woody species encroachment into grasslands. Interestingly, carbon stocks in MCD, the remaining frequent fire forest system, are only 6% greater than those present under reference conditions. Carbon stocks within this ERU have been reduced because nearly 85% of it has burned or reburned in the last 20 years and at least a third of that was at the moderate to high severity level. Future predictions are for further increases in carbon stocks in all three frequent fire forest systems, and these ERUs continue to be the largest sources of biomass carbon stocks on the Gila. It is important to note that these models do not account for any future increases in fire frequency with increased fuel loading, and such a dynamic should be expected to reduce carbon stocks, perhaps strongly so.

In the grassland systems, future predictions indicate a reduction in carbon stock in MSG, while the pattern of increased carbon in CPGB is expected to continue. The reduced future carbon stock in MSG is driven by thinning treatments targeted at restoring these areas to their historically open, meadow-like condition and also by insect and disease driven tree mortality. The current level of fuel treatments and prescribed fire are not expected to keep pace with woody species encroachment in CPGB, thus the continued increase in carbon stocks into the future. While compositional shifts are expected to continue in SDG, the overall biomass carbon stock level in this system is expected to remain fairly static.

Carbon stocks have decreased from reference conditions in two woodland ERUs. In JUG this is a result of a shift toward early seral stages that hold less biomass than stages with larger trees. In PJO this is a result of a shift toward both earlier and more open seral stages than the more mature and closed canopy stages that would have dominated under reference conditions. In both systems, this pattern is expected to reverse in the modeled future, with biomass carbon stocks increasing toward reference condition levels.

In the remaining three woodland systems (MPO, PJC, PJG), carbon stocks are greater than in reference conditions, likely due to a history of wildfire suppression. In all three of these ERUs there are presently more acres of larger, closed canopy, carbon-rich stands than would have existed in reference conditions. In MPO and PJG, models predict a continued shift further in this direction, resulting in a doubling of the carbon stock present in current conditions in MPO and an 11% increase in PJG. Conversely, in PJC we expect reductions in closed canopy stands due to prescribed fire, bringing carbon stock levels closer to those existing in reference conditions.

Overall, current management appears to be moving the biomass carbon levels on the Gila's ecological systems away from reference condition biomass carbon stock levels, though again, it is important to look at patterns within each ERU. Across the Gila, while the current biomass carbon stock levels are 16% greater than in reference conditions, the current management regime is projected to result in carbon stocks that exceed reference conditions by 36%. This will leave biomass carbon stocks at almost 31M tons greater than reference condition levels in 100 years.

Carbon Emissions

Similar to implications of biomass conditions and resource management, the research synthesis on carbon emissions convey significant trade-offs among potential carbons strategies. Although the total carbon emissions were higher for the harvest alternatives in the study considered here (Vegh et al. 2013), thinning and fuels reduction did reveal lower wildfire emissions and reduced risk of uncharacteristic wildfire. The study also suggests that, in the long term, systematic thinning and burning ultimately lead to greater live above-ground sequestration. It's also important to keep in mind that the A-S is starting with uncharacteristically high levels of biomass on the heels of a century of fire suppression, and that strategies to maximize carbon sequestration and sustain carbon stores are not necessarily compatible (Hurteau and Wiedinmyer 2010). The indirect goal of contemporary management goals is to reduce, at least in part, current carbon stocks to pre-settlement levels.

In the future, the benefits to reduced emissions and increased carbon sequestration may be more pronounced. First, because live trees continually sequester carbon and are a more stable carbon sink than dead biomass generated in particular by uncharacteristic fire, insect outbreaks, drought, and other stress, proactive management and broad-scale fuel reduction may be preferable for the long-term mitigation of atmospheric carbon. Second, there is the related issue of trees regenerating poorly or not at all following uncharacteristic fire in some forest types (Savage and Mast 2005). Others investigators (Dore et al. 2008) also show that poor regeneration may occur for many years following stand replacement fire in ponderosa pine forests, resulting in little carbon sequestration over that time and casting further doubt on the sustainability of a strategy that intends to maximize sequestration while indirectly promoting uncharacteristic fire and reduced ecosystem productivity (Hurteau and Wiedinmyer 2010).

The A-S study by no means represents a comprehensive analysis of the carbon emissions involved with forest management scenarios. A full accounting would include emissions involved in the harvest, transfer, and processing of any wood products, along with the sequestration and decomposition of those products and other forest residues, and the emissions involved with the associated energy consumption (Cameron et al. 2013). Cameron and others (2013) determined, on a 100-year model simulation, that even with an industrial forestry theme that the ratio of storage to emissions was 0.58. They also showed that if wood destined for paper and pulp was instead redirected to less lucrative biomass consumption that the storage ratio could increase substantially to 2.7.

Also for consideration are the effects by increased CO_2 levels on vegetation productivity and the potential for negative feedback by emissions on climate forcing. Such a feedback loop would involve carbon emitting processes, increased CO_2 levels and fertilization of the atmosphere, followed by an increase in vegetation production and increased carbon capture and sequestration (mitigation). Some research indicates that vegetation productivity does increase with elevated CO_2 levels, but productivity rates soon level off as other factors appear to compete with the growth benefits (Archer 2011, Penuelas et al. 2011).

Finally, some have forwarded the notion of carbon carrying capacity as a potential foundation for carbon management plans (Keith et al. 2009, 2010; Hurteau et al. 2010). Carbon carrying capacity is the maximum amount of above-ground carbon that can be sustainably stored, according to climatic conditions and the disturbance regime of a system. Carbon carrying capacity may be a useful consideration for optimizing carbon stocks according to the inherent capabilities and processes of a given ecosystem.

Soil Organic Carbon

While most woodland and forest ERUs will maintain biomass carbon in support of SOC for the future, the continued loss or displacement (patchiness) of grassland and shrublands surface biomass could result in slower and diminished contributions to SOC stocks, and influence long-term soil productivity. Ecological response units where existing soil conditions that are rated impaired or unsatisfactory, due to the lack of surface litter, are most susceptible to continued reductions of SOC over time. Soil conditions that are rated satisfactory will continue to maintain SOC values and a loss of long-term soil productivity is unlikely.

The effects of climate change on the decomposition rates and stability of SOC are currently being researched (Davidson and Janssens 2006).

Chapter 4. Soil

Introduction

Soil is a complex and dynamic system that consists of a mineral component, organic matter, air, water and living soil organisms. It is formed over time by interactions between climate, parent material, topography, and organisms, both above and below ground. Due to the slow rate of formation in the arid Southwestern climate, soils are essentially a non-renewable resource (USDA FS 1986a).

Key ecosystem characteristics of the soil resource include those that determine the capacity of soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health (Doran and Parkin 1994). This analysis describes upland soil diversity and distribution on the Gila NF and evaluates three key characteristics:

- Ecological status (canopy cover by species)
- Soil loss
- Soil condition

The subsections that follow include:

- Ecosystem services of soils
- Data
- Analysis methods
- System drivers and stressors
- Soil diversity and distribution
- Analysis of key ecosystem characteristics
- Risk assessment
- Stakeholder input received
- Summary

Riparian soils are analyzed in Chapter 7: Riparian. Assumptions, limitations and uncertainty associated with this analysis are disclosed in the Analysis Methods section and discussed in greater detail where relevant in this chapter.

Ecosystem Services of Soils

Soil provides many ecosystem services but is often overlooked and undervalued (Bridges and Van Baren 1997; Comerford et al. 2013). It provides provisioning services in the form of construction, landscaping and industrial materials. Many important medicines, such as penicillin and other antibiotics, are produced by soil microorganisms. The activities of soil microorganisms are also the primary means by which nitrogen, a necessary nutrient, is made available to plants. Soil provides supporting ecosystem services as it is the primary medium for plant growth and provides habitat for micro and macro soil organisms. A single handful of soil can contain more biodiversity than an entire forest.

Regulating services provided by the soil resource include cycling of nutrients, water and energy. It contributes to global regulation of greenhouse gases including carbon dioxide which is stored as soil organic carbon. It regulates water storage and release, water filtration and purification, and provides for erosion control and sediment retention. Soil also provides thermal regulation, absorbing heat energy when temperatures are high, and releasing it when temperatures are cool. Soil microorganism provide for biological control of crop pests and bioremediation of contaminants. Soil is the land that provides economic, recreation, education, research and personal enrichment opportunities and as such, provides many cultural ecosystem services.

Data

Terrestrial Ecological Unit Inventory

The Terrestrial Ecological Unit Inventory (TEUI), previously referred to as the Terrestrial Ecosystem Survey, maps relationships between climate, geographic location, geology, geomorphology, aspect, slope, soil and vegetation at the scale of a standard United States Geological Survey (USGS) map.[11] The TEUI classifies ecological types and maps ecological units to interpret both site potential and current ecosystem characteristics. The conditions under site potential are those that exist at the latest successional stage, or steady-stable-state as reflected by stable, diverse and functioning climate-soil-vegetation systems.

The Gila NF's draft TEUI, which includes data from several surveys completed at the project level, is the primary dataset for this analysis. Completed surveys provide statistical summaries of survey data and management interpretations,[12] including those equivalent to key characteristics analyzed for the assessment. Due to draft status of the Gila NF's TEUI, updates to interpretation protocol currently in progress, and differences in the summary process,[13] interpretations developed for the final TEUI may or may not produce the same results as this assessment.

Analysis Methods

The TEUI mapping process includes three general types of documentation: observations, transects, and ecological site descriptions. Observations and transects are the least intensive form of documentation and are used to develop quantitative descriptions of characteristics defining site potential for a given map unit. In the process of gathering data, conditions that represent site potential, and those that represent other successional states are documented. Ecological site descriptions are the most intensive form of sampling and are used to document site potential, once it has been defined through observations and transects. In this analysis, representative[14] observations and transects are used to describe current conditions and ecological site descriptions are used as a contemporary reference condition.

There are multiple TEUI units in each ERU. Departure is assessed at the TEUI level using a similarity analysis (Czekanowski 1913 as cited in Kent and Coker 1992) to describe variability in conditions within each ERU. Departure is simply the inverse of similarity. The TEUI unit departure rating that represents the largest percentage of the ERU area is used as a single departure rating for each ERU.

Because TEUI data are point in time measurements of representativeness, not repeat measurements, trends cannot be identified. Monitoring data collected using methods and measures compatible with TEUI would be required to assess trend.

Not all TEUI units contain the same number of observations, transects and ecological site descriptions. There is less uncertainty associated with larger datasets and greater uncertainty associated with smaller datasets. Spruce-Fir Forest, Madrean Piñon-Oak Woodland, PJ Evergreen Shrub and Mountain Mahogany

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[11] The scale of a standard USGS map is 1:24,000 meaning that one inch on the map equals just under 0.4 miles on the ground.

[12] Interpretations are "predictions of soil behavior for specified land uses and specified land management practices. They are based on soil properties that directly influence the specified use of the soil" (USDA NRCS 2005).

[13] This assessment is driven by the data contained in each map unit, rather than by the draft map unit legend which will change as more data is collected and map unit concepts are refined. Only the major component, or ecological type in each TEUI map unit is used in this assessment unless other components represent limitations, or lack thereof. Soil depth, clay content and particle size class were the basis for determining limitations, or lack thereof. The 2012 Planning Rule does not require modification of datasets or statistical analysis. Furthermore, a more statistical summary of the draft dataset is prohibited by the size and condition of the dataset and assessment timeframes.

[14] See previous footnote.

Mixed Shrubland are associated with smaller datasets. However, there is low uncertainty associated with the Spruce-Fir Forest analyses because of the large extent of stand replacement fire that this ERU has experienced. Assumptions can be and are made about the status of key ecosystem characteristics within areas of recent high and moderate burn severities as described below. There is low uncertainty associated with these assumptions because of both formal and informal post-fire monitoring. Additionally, it is possible that ERUs with the highest actual departure from historic conditions can demonstrate a low analysis departure due to the inability to find reference sites that still represent historic conditions.

Ecological Status

Current conditions resulting from high and moderate burn severity that are not captured in the TEUI dataset are accounted for by scaling the degree of departure from the date of the burn to established values for recovery time. With respect to ecological status in forested systems, time scales were taken from literature produced by the Nature Conservancy (Smith 2006a, 2006b, 2006c, 2006d). Limited information to set a time scale from stand replacement fire to recovery of pre-fire shrub species and canopy cover exists for Mountain Mahogany Mixed Shrubland. Due to the relatively small proportion of acres burned at high and moderate severity each year in this ERU, the analysis was not sensitive to the time scale used. Any length of time produced the same departure and trend results as discussed below. No adjustments were made for those ERUs with high and moderate severities over less than five percent of their area. Acres that were seeded and seeded/mulched for emergency stabilization, as described in the fire discussion in Chapter 9: System Drivers and Stressors, were scaled to a time frame five years shorter than the literature values based on formal and informal BAER monitoring.

As applied to the ecological status characteristic, departure is categorized at the TEUI unit level using the following thresholds:

- 0-33% Departure = Low
- 34-66% Departure = Moderate
- 67-100% Departure = High

Soil Loss

A certain amount of soil loss occurs as a natural geologic process, even under reference conditions. This is referred to as the baseline, minimum or natural rate of soil loss (NSL). Some amount of soil loss greater than the minimum rate can occur without impairing natural soil productivity. This rate varies by soil and ecological system. The reference condition for soil loss is based on the assumption that soil loss rates would have been below some threshold in most places on the Gila NF. Under previous modeling protocol, this rate was described as a tolerance rate (TSL). However, this protocol is not compatible with the model used in this analysis.

Annual soil loss rates are predicted from the Rangeland Hydrology and Erosion Model (RHEM) v2.3, developed by the Agricultural Research Station. This model is in the public domain and available at http://apps.tucson.ars.ag.gov/rhem. In the past, the only available soil loss models were based on cropland data. The RHEM model is based on rangeland data and is the most current, accepted model for use in rangeland and forest systems by the Southwestern Region. Instead of a TSL rate, a Threshold rate is determined using the RHEM (v2.3) risk function. Departure is not categorized as low, moderate or high. The Regional soil condition guidance discussed in the next subsection, differentiates the modeled soil loss indicator of soil stability function between condition categories based on whether or not CSL exceeds TSL. As applied to departure, this means departure either exists or it does not. Where they are below the Threshold rate, departure is low for that TEUI unit. Where CSL rates exceed the Threshold rate, departure from the reference is categorized as significant for that TEUI unit. ERU departure is determined by applying the same 33 percent threshold as is used in the assessment of vegetation related characteristics. If more than 33 percent of the ERU area is represented by TEUI units in significant departure, than departure is significant for that ERU.

CSL rates are those occurring under vegetative canopy and groundcover conditions as documented by TEUI observation and transect data and NSL by ecological site descriptions. ERU acres burned at high and moderate severities are not represented by modeled data. It is assumed that CSL rates exceed the NSL and Threshold rates on these acreages for five years post-fire. This assumption is based on soil loss modeling for BAER assessments, and formal and informal post-fire monitoring.

The RHEM model is only capable of modeling sheet and rill erosion. Therefore, gully and wind erosion are not considered. The processes involved in gully erosion are more like stream channel processes, and while there may be some capable watershed models, it is beyond the scope of this assessment. Gully erosion is considered qualitatively based on notes that accompany the TEUI documentation and on the ground knowledge but is not used to assess soil loss, rather it is accounted for in the soil condition assessment.

Wind erosion is generally considered a larger issue in cropland systems than in forest and rangeland systems. Currently, no wind erosion models developed from forest or rangeland data are available. Although Chapter 5: Air does include quantitative data on particulate matter, it cannot be used to estimate wind erosion on the Forest as the origins of that particulate matter cannot be traced to a specific area of land.

The value in modeling soil loss, or anything for that matter, is not to arrive at an absolutely correct number or answer. It is the relative difference between management scenarios that is important.

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 soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health (Doran and Parkin 1994). It is interpreted here using the USDA Forest Service Southwestern Regional guidance (USDA FS 2012b). The interpretation rates soils as they exist currently and reflects the effects of management (historic and current) and disturbance history. Condition assessed is based on three soil functions: the ability of soil to capture, store and release water (hydrologic function); to resist erosion (stability function); and to recycle nutrients (nutrient cycling function). The TEUI documentation, and the ecological status, and soil loss results are used to assess these functions. Soil condition categories are: satisfactory, impaired, and unsatisfactory (USDA FS 2012b).

The status of the stability function was determined using modeled soil loss rates, documentation of visible sheet, rill and gully erosion in the TEUI data and vegetative groundcover summary prepared for the soil loss analysis. The status of the nutrient cycling function was determined using the results of the ecological status results and the TEUI vegetative groundcover data summarized for soil loss modeling. Because hydrologic function influences the volume of soil in which nutrient cycling may take place, as well as the types and rates of reactions that can occur, it was also a consideration in determining nutrient cycling status.

The determination of hydrologic function status relied on documentation of soil surface structure, crusting, compaction and the stability and nutrient cycling status. Soil stability is required for hydrologic function and soil loss may expose subsurface layers that have different hydrologic properties than the naturally occurring topsoil.

The soil condition interpretation also assumed that any TEUI unit in a zootic disclimax state, could not be in satisfactory condition. Zootic disclimax states can occur under sustained or periodic use of vegetation by wild or domestic animals. Under such conditions vegetation can depart markedly in the structure and composition of the natural vegetation community under late seral “climax” conditions (USDA FS 1986a).

Prior to European settlement, soil loss, hydrologic function and nutrient cycling would probably have been within functional limits for most soils that are not naturally unstable. Exceptions would have occurred during periods of drought and possibly localized areas impacted Native American populations and herbivory by native species. Natural fire disturbance would have had a limited effect on the extent of soil loss, only causing accelerated erosion in localized areas where total consumption of vegetative canopy and groundcover occurred. Most areas that are currently rated impaired or unsatisfactory for soil condition would probably have been rated satisfactory. The reference condition is “satisfactory” and is represented by the ecological site description documentation with current conditions described by observations and transects. Impaired and unsatisfactory ratings are associated with moderate and high departure ratings respectively.

The satisfactory rating indicates that soil function is being sustained within ecosystem boundaries and the ability of the soil to maintain resource values and sustain outputs is high. An impaired rating indicates a reduction of soil function, a reduced capacity to maintain resource values and sustain outputs, and an increased vulnerability to degradation. It should signal further investigation to determine causes and degrees of decline in soil function. Such investigations may identify a need for change in management (USDA FS 2012b), whether in project level work, or Forest scale planning such as the case here. The unsatisfactory rating indicates a loss of soil function has occurred and that degradation of vital soil functions is such that the soil is unable to maintain resource values, sustain outputs and recover from impacts. Soils rated in the unsatisfactory category signify a need for improved management practices or restoration designed to recover soil functions (USDA FS 2012b).

Previous soil condition protocols considered only the soil stability function when determining soil condition, with categories of satisfactory, unsatisfactory and unsuited. The unsuited category was reserved for soils that are naturally unstable.[15]

Soil System Drivers and Stressors

Primary system drivers for all soil characteristics are climate, topography, parent material, biota (living organisms), and time. These are known as the five soil forming factors. Patterns in precipitation, temperature and wind influence the potential natural vegetation community, natural rates of soil formation and soil loss. The canopy and ground cover provided by the vegetation community and the timing, duration and intensity of precipitation and wind events greatly influence the ability of the soil to resist erosion. The vegetation community, including its composition and structure, determine the types and rates of organic matter contributions to the soil. Water availability and temperature largely determine the types and rates of physical and chemical weathering processes and the biological reactions involved in decomposition and nutrient cycling. Both of these factors are important determiners in the natural fertility and productive capacity of the soil. Climate change, including increased frequency and severity of drought conditions (IPCC 2007; Seager et al. 2007) is a stressor that is expected to have cascading effects. The predominant climate regime and climate change are characterized and discussed in Chapter 9: System Drivers and Stressors.

Topography is a system driver in its influence on climate, vegetation and natural soil stability. Erosional and depositional areas are defined by the position they occupy on the landscape and the steepness of slope.

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[15] Unsuited was defined as those soils where NSL rate is greater than the Threshold soil loss rate. In other words, the geologic rate of soil loss is greater than the rate of soil formation. The RHEM model automatically identifies the lowest soil loss rate as the NSL (RHEM calls it “baseline”), which means that all other scenarios (current or otherwise) will be represented by a soil loss rate greater than NSL. Soil loss modeling with RHEM cannot serve as the basis on which to identify naturally unstable soils.

The steepness of slope also influences the lateral movement and redistribution of soil water. Regardless of elevation, differences in solar radiation between north and south facing slopes influences temperature and moisture regimes that control the rate of weathering and soil formation, and influence vegetative composition, productivity and the accumulation of soil organic matter. North facing slopes tend to be cooler and wetter than south facing slopes, which is reflected in both the degree of soil development and vegetation patterns across the Forest. At the lower elevational ranges of a given vegetation community, that community may only be found on north facing slopes, where at the upper end of its elevational range it may only occur on south facing slopes.

The term "parent material" describes both the primary origin of the matter from which soil is formed, either geologic or organic, and its last mode of transport. Parent materials on the Gila NF are geologic in nature and are dominated by volcanic and sedimentary rock types. Modes of transportation include flowing water, wind and gravity and those materials are referred to as alluvium, eolian and colluvium respectively. Lake deposits, such as those in the Buckhorn, NM area, are referred to as lacustrine, however soils formed from these lake deposits occur on a very limited extent on the Forest. If the material was not transported after its original deposition, it is referred to as residuum.

Parent material is a system driver in that the physical structure and chemical composition of the rock are largely responsible for the physical and chemical properties of the resulting soil. It is the combination of climate and these soil properties that ultimately determines the potential natural vegetation community.

For example, within the elevational-climatic gradient of woodlands on the Forest, the dominance of Emory oak a good indicator of soils formed from granite, while silver leaf oak tends to be more prevalent on soils formed from rhyolitic ash tuff.

In general, soils across the Forest formed from basalt or andesite are relatively stable and productive due to the types and amounts of clay minerals formed from weathering. Soils formed from basalt or andesite residuum or colluvium tend to be more stable than those formed from alluvium. Limestone also typically produces relatively productive and stable soils.

Datil soils, or those formed from volcanic sediment, can be productive, but are highly erodible if vegetative groundcover is not maintained. These soils are located in the northwestern portion of the Forest, primarily west of Highway 180 from the northern Forest boundary south to the Pueblo Park area. Soils formed from granite are primarily found in the Burro Mountains area. These soils have moderate productivity potentials and can also be very erodible if vegetative groundcover is not maintained. Sandstone and shale soils have similar tendencies.

Soils derived from Gila conglomerate, and other conglomerates are highly variable in their productivity depending on their composition, and generally tend to be very erodible, as do most soils derived from rhyolite. The Kneeling Nun rhyolite in the southern portion of the Forest is very productive and more stable than other rhyolites. Differences in the productivity and stability of soils derived from rhyolite are due to the age of the geologic formation, and hence the time over which weathering has occurred, and concentrations of potassium and calcium bearing minerals that make up the rock. Rhyolitic ash tuff soils tend to have lower productivity potentials and are highly erosive.

There is a high specificity between plant species and species of soil microorganisms, meaning that the relationships are often, but not always exclusive. This is important because soil microorganisms are responsible for the majority of nutrient cycling. As a general principle, the greater the above ground diversity, the greater the below ground diversity which leads to a wider range of nutrient pathways under a wider range of climatic conditions, and ultimately a more productive soil. Soil microorganisms have been linked not only to vegetative diversity, but also patterns of seedling establishment and interplant competition (Simard and Durall 2004). Biota other than microorganisms are important both as agents of natural disturbance and as contributors to the soil nutrient pool. The discussion of natural vegetation succession, in the Chapter 9: System Drivers and Stressors, also applies to biota as a soil system driver.

Renewable resources are commonly defined as those that can be replenished or replaced within a single human life span. It has been estimated that in the Southwestern climate, the time it takes for an inch of soil to form under natural conditions can vary between 300 and 1,000 years (USDA FS 1986a). While vegetative groundcover, soil condition and ecological status can change within a single human lifespan, the loss of productivity potential and alteration of hydrologic function that accompanies soil loss cannot be renewed in that same time period.

As described in Chapter 9: System Drivers and Stressors, fire, ungulate grazing, insects and disease, mineral resource extraction, roads and trails, terrestrial invasive species and mechanical vegetation manipulation are all disturbance regimes that impact the soil resource. Those impacts are described in detail in that chapter. A summary is provided here.

Fire, ungulate grazing and insects and disease can be both soil system drivers and stressors. They are drivers when they are within the magnitude, extent and frequency of the Natural Range of Variation (NRV). When they are outside NRV, they are stressors. At present, insects and disease remain a system driver but are predicted to become a stressor as climate change progresses, potentially impacting ecological status and increasing the risk of high and moderate burn severities. Fire is both a primary system driver and stressor, and is expected to remain so into the future. When fire frequency and severity are with NRV, it serves to mitigate large scale negative effects to the soil resource that occur as a result of large extents of high and moderate burn severities. Ungulate grazing is a potential system stressor that has varied in significance after the arrival of Europeans. The legacy of historic overgrazing by livestock prior to current management remains evident in terms of ecological status departure, and in some cases altered hydrologic function, nutrient cycling status and gully erosion. Under the NRV approach recommended in the 2012 Planning Rule and directives, the continued presence of livestock under current management is still a stressor, but impacts are substantially less than historic management. Nevertheless, because time is a primary system driver the effects of historic and current management are cumulative.

Mineral resource extraction, roads and trails, invasive species and mechanical vegetation manipulation are all soil system stressors to varying degrees. Roads and trails currently have the greatest impact, primarily due to lack of maintenance but soil type, gradient and in some cases road density can contribute to that impact. Mineral resource extraction and terrestrial invasive species have small, localized impacts on Gila NF soil resources at this time. Invasive species have the potential to become a greater stressor as climate change progresses. Mechanical vegetation manipulation also has a large impact on soil characteristics when and where it occurs, depending on a variety of factors including but not limited to: soil clay and moisture content, temperature and time between entries for treatment. Slope restrictions and other measures or methods designed to reduce impacts to the soil resource and protect water quality are recommended and implemented at the project level. Currently, the extent and frequency at which these manipulations occur are relatively limited but could foreseeably increase with continued emphasis on landscape scale restoration.

Soil Diversity and Distribution

The Gila NF lies within the Mogollon-Datil section of the Colorado Plateau and the Mexican Highland section of the Basin and Range physiographic provinces. Physiographic provinces are land areas characterized by their prominent landscape features, topography, geology and related processes (Fenneman and Johnson 1946), all of which influence soil diversity and distribution.

The Colorado Plateau Mogollon-Datil section is a transition zone in and of itself, as geologic structure and topography begins to change between those that define the Colorado Plateau north of the Mogollon Rim and the Basin and Range to the south. It is characterized by volcanic fields of various ages, lava flow plateaus, rugged uplifted mountain ranges and ancient lake bed sediments. Mesas and buttes formed from sedimentary materials and capped by lava flows also occur and can indicate areas prone to mass wasting.

The Basin and Range Mexican Highland section is characterized by broad depositional basins and the north-northwestern trending, relatively narrow mountain ranges. Playa lakes, where salts and clays accumulate, are often formed in lowland areas. These lowlands are influenced by the higher elevation Chihuahuan desert, where precipitation occurs more often during the summer, or the lower elevation Sonoran desert where precipitation occurs during both summer and winter months. These sometimes isolated mountain ranges produce abrupt changes in elevation, greatly influence jetstream flow patterns, and produce diverse climatic regions with highly variable rates of soil formation.

As the Forest is within a transitional zone between these physiographic provinces, it contains remnant volcanoes and calderas, high sedimentary plateaus capped with basaltic or andesitic lava flows, contiguous and isolated uplifted mountains made of volcanic, sedimentary and metamorphic rock, and valleys created by lowering of the land surface due to faults along the adjacent mountains. All of these features are dissected by ephemeral, intermittent and perennial streams.

Elevations in the southern portion of the Forest are generally higher than those found in the typical Chihuahuan deserts and Madrean woodlands, but is still influenced by the regional weather patterns and floristics of both of these systems. The Chihuahuan influence is more prominent and is strongest along the south and east of the Forest boundary. The Sonoran influence is greatest in the Burro Mountains and along southwestern side of the Forest.

Soil classification uses a taxonomic structure similar to that used in biotic taxonomy. This system is described in Table 112 and followed by a summary of the major types of soils found on the Forest.

Table 112. Comparison of soil and biotic taxonomic classifications

Soil Taxonomy	Biotic Taxonomy
Order	Kingdom
Suborder	Phylum
Great Group	Class
Subgroup	Order
Family	Family
Series	Genus
Phase	Species

Of the twelve soil orders, six have been mapped on the Gila NF: Mollisols, Alfisols, Vertisols, Andisols Entisols and Inceptisols. Andisols are not prevalent.

Mollisols have a dark-colored surface layer, are relatively high in organic matter and are highly fertile. Globally, this soil order occupies seven percent of the total ice-free land area (Brady and Weil 2008). These soils were first described in the grassland steppes of Russia and are frequently the dominant soils in grassland systems. This has contributed to the misconception that the occurrence of these soils is limited to grasslands. While there are soil indicators of historic grasslands,[16] soil order is not one of them. Mollisols can and do occur in other ecological types. In fact, they are found in every ERU, on most landforms and all

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[16] Phytoliths are very small particles of precipitated silica that accumulate in plants. Their assemblages in the soil are particular to the plant communities they formed in and can be used to identify historic grasslands (Fisher et al. 1995).

parent materials except recent alluvium, and slopes ranging from zero to 80 percent across the Forest. They account for approximately 85 percent of the Forest.

Alfisols are also fertile soils, but less so than Mollisols. They typically develop in woodland or forest ecological types, but are known to occur in grassland systems on the Forest. Globally, Alfisols occupy about 10 percent of the total ice-free land area (Brady and Weil 2008). Alfisols are the second most common soil on the Forest. They occur on most ERUs but are more often found in the Mixed Conifer with Aspen, Ponderosa Pine Evergreen Oak, Ponderosa Pine Forest and Mountain Mahogany Mixed Shrubland on all landforms with slopes ranging from zero to 80 percent. They primarily form on rhyolite and tuff, but have been documented on alluvium, granite and basalt. They account for approximately six percent of the Forest.

Vertisols contain high amounts of clay minerals that visibly shrink and swell with changes in moisture. The shrink-swell properties of these soils often result in high amounts of surface rock as over time the churning action pushes subsurface rock upward. It is a common misconception that Vertisols are not productive soils. Vertisols and Mollisols with vertic properties, also referred to as vertic intergrades, are naturally fertile and productive soils. Productivity ranges from moderate to high, depending on the amount of surface and near surface rock fragments. Clayey soils such as these generally have high load bearing capacity (strength) when dry, but become increasingly susceptible to compaction with increasing moisture content because of their high cohesion and plasticity. Compaction reduces the volume of pore space available for the movement of air and water, increases bulk density and changes soil structure. When compacted, these soils have low productivity. Freeze-thaw action is a natural mechanism that can loosen or break-up compaction over time. True Vertisols are the least common of the five dominant soil orders on the Forest. They generally form on basalts or basaltic conglomerate on valley or elevated plains and mesas with slopes ranging from zero to 15 percent. They have been documented in the Colorado Plateau-Great Basin Grassland, Juniper Grass and PJ Grass. True Vertisols account for approximately one percent of the Forest. Vertic intergrades are included in the Mollisol percent of the Forest.

Entisols are relatively young soils with little to no subsurface development. These soils form in landscape positions where the parent material has not been in place long enough for soil-forming processes to create distinctive soil layers such as floodplains, alluvial fans or stream terraces. In general, these soils exist in setting where erosion or deposition is happening faster than the rate of soil formation. Globally, Entisols occupy 16 percent of the total ice-free area. Soil productivity ranges from very high to very low. Entisols may have very high productivity when formed in recent alluvium where topography is nearly level, there is a close proximity to water and periodic nutrient replenishment occurs with deposition of floodwater sediments. These Entisols are common in the Forest’s riparian areas. Entisols are likely to have very low productivity if formed in shifting sand or on steep rocky slopes (Brady and Weil 2008). Most of the Entisols on the Forest occur along valley bottoms in riparian ERUs, although they are found on rhyolite in the Madrean Piñon-Oak Woodland and on steep mountain slopes in Mixed Conifer with Aspen. They account for approximately two percent of the Forest.

Inceptisols are more developed than Entisols but typically lack significant clay accumulations in the subsoil. They generally occur on relatively young landforms that are stable enough to allow for soil development. Globally, Inceptisols occupy 17 percent of the total ice-free land area (Brady and Weil 2008). The natural productivity of Inceptisols varies widely depending on clay and organic matter content. They are found primarily on rhyolite parent material in the forest ERUs. They are occasionally found on rhyolite in Madrean Piñon-Oak Woodland, and on alluvium in the Juniper Grass and Colorado Plateau-Great Basin Grassland. They account for approximately seven percent of the Forest.

Across the Gila NF, soils have predominantly dry moisture regimes and mild temperature regimes at the lower elevations and humid to sub-humid moisture regimes and cold temperature regimes at the higher elevations.[17] Soils range from fine (< 35 percent clay) to loamy, and skeletal (>35 percent rock fragments) to non-skeletal in nature. They occur on slopes ranging from 0-80 percent, with flat and vertical rock outcrops present in some areas. Soil texture varies with parent material.

Soil productivity is highly variable across the Forest depending on many factors including, but not limited to: soil climate, soil depth, stability, hydrologic function, nutrient cycling, soil biology, soil-water holding capacity, filtering and buffering capacities and the nature of the parent material.

Analysis of Key Characteristics

As previously stated, the three key ecosystem characteristics analyzed for soils include ecological status, soil loss and soil condition. This section includes a subheading for each of these characteristics and includes a discussion of its importance to ecosystem integrity, reference and current conditions as described by the TEUI data, and factors contributing to departure from the reference condition.

Ecological Status

Ecological status is a vegetative characteristic that describes canopy cover by species. It is relevant to the assessment of soil resources for two reasons. First, regardless of species, canopy cover is an important factor in soil stability as it intercepts raindrops and reduces the impact energies responsible for soil particle detachment. Second, as described in the soil system drivers and stressors subsection, above and below ground biodiversity are directly related. Therefore, ecological status is an indicator of nutrient cycling status (USDA FS 2012b). The following figure illustrates the variability in conditions across each ERU based on the TEUI data as described under Analysis Methods.

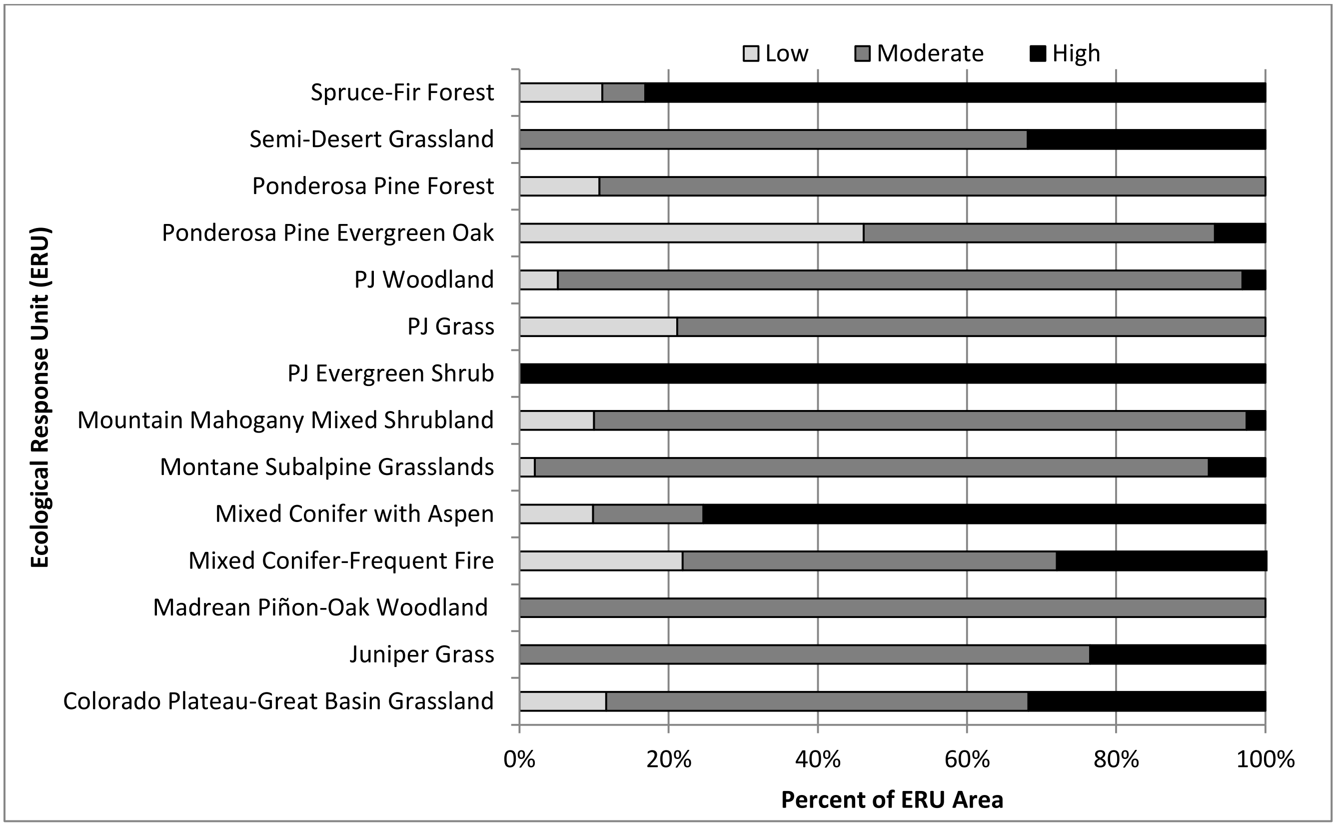

Figure 66. Area weighted ecological status departure ratings across the Gila NF's upland ERUs

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[17] For a complete explanation of soil temperature and moisture regimes, see Keys to Soil Taxonomy, (Soil Survey Staff 2014).

With most of its area represented by TEUI units in low departure, Ponderosa Pine Evergreen Oak is considered to be in low departure overall. Spruce-Fir Forest, Mixed Conifer with Aspen and PJ Evergreen Shrub are in high departure, with the remaining ERUs in moderate departure overall.

However, there are limitations associated with the lack of a more robust statistical summary and other factors that merit discussion. Ecological status includes both over and understory structural components. There tends to be greater species richness in the understory, which is subject to a larger degree of seasonal and annual variability than the overstory due to species specific responses to weather patterns. The data describing each TEUI unit is composed of documentation taken at different times of the year and high species diversity is favored in the selection of sample point locations. The statistical summary conducted in the preparation of a final TEUI product results in a species composition summary that defines and describes the potential and current dominant tree, shrub, forb and graminoid species, and excludes species that are not defining components of the map unit. The analysis approach used in this assessment includes all species. The result is that understory conditions reflecting high species diversity, but not the same species at all sample sites, seasonal and annual variability, and/or variability due to site specific characteristics such as aspect, are interpreted as departure.

Species diversity tends to be higher in transition zones, which is reflected in the TEUI documentation. The PJ Evergreen Shrub (less than one percent of the Forest), Ponderosa Pine Evergreen Oak (12 percent of the Forest) and Madrean Piñon-Oak Woodland (one percent of the Forest) are all transitional ERUs on the Gila NF.[18] Considering these factors, there is a fair amount of uncertainty associated with these analysis results, which may overestimate departure in most ERUs. On the other hand, seral state proportion and patch size departure, as discussed in Chapter 2: Upland Vegetation, suggest that ecological status departure is still likely as species composition is generally not the same across seral states.

In the grassland, shrubland and woodland ERUs, this departure is typically associated with lower diversity and abundance of grass species and higher percentages of woody species canopy cover. The Madrean Piñon-Oak Woodland has higher percentages of both shrub and tree species, but understory diversity remains high. The data describing the Mountain Mahogany Mixed Shrubland ERU is primarily from the Burro Mountains where historic grazing impacts were severe and extensive, very likely leading to higher shrub canopy cover and lower diversity and cover of grasses. However, much of this ERU occurs on steep slopes within designated wilderness areas and is not described in the TEUI data; it is reasonable to suspect that departure would be lower in this ERU if it included data collected in the wilderness.

These departures are due primarily to the interrelationships between historic and current fire and livestock grazing management, although herbivory by large herds of elk on the Quemado and Reserve Ranger Districts may be an additional stressor in those areas. Ungulate grazing and browsing has been a disturbance regime in these ecological types both before and after the arrival of Europeans. Domestic livestock grazing began in the late 1800s. Livestock grazing practices reduced herbaceous vegetation (fine fuels) and contributed to an increase in woody vegetation as a result of reduced competition for water and nutrients (Boucher and Moody 1998; Rummel 1951; Madany and West 1983, Savage and Swetnam 1990). At the turn of the 19th century, the policy of fire suppression disrupted the natural role of fire in these ecosystems and contributed to an increase in woody vegetation and fuel loading. Although the Gila NF began using fire as a restoration tool in the 1970s, and current grazing management has allowed for improvement in conditions, fire regimes remain departed in the grassland, shrubland and woodland ERUs (see Chapter 2: Upland Vegetation) as the herbaceous understory vegetation that provides forage, is also

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[18] PJ Evergreen Shrub is a transitional ecological unit between Interior Chaparral and montane units. Ponderosa Pine Evergreen Oak is a transitional ecological unit between the Ponderosa Pine Forest on the Mogollon Rim and the woodland zone (USDA FS 2015a). As the southwestern portion of the Forest lies at the northern most edge of the Madrean influence, the Madrean Piñon-Oak Woodland, also represents a transitional zone.

the fine fuels needed to carry fire. Non-fire vegetation treatments (e.g. fuelwood harvest or pushing[19]) have been conducted in these ERUs. However, these activities have been fairly limited due to budget, staffing levels and Regional priorities. Without restoring ecological processes, like fire, these treatments that restore or otherwise alter existing vegetation structure or composition require maintenance. The historic and current status of non-vegetation treatments, fire and herbivory on the Gila NF are discussed in detail in Chapter 9: System Drivers and Stressors.

In some of the Mixed Conifer-Frequent Fire, this departure is associated with higher tree species canopy cover over reference condition and lower in others. There is corresponding lower abundance, but not necessarily diversity, of understory vegetation where tree canopy is higher. Where percentage of tree species canopy cover is lower, the canopy cover of juniper species, evergreen oaks and/or grass species tends to be higher depending on soil type, elevation and aspect. On the other hand, some of this departure is due to shifts in the relative dominance of individual tree species which is a reflection of the elevational-climatic gradient of this ERU, and not ecological status departure. Higher tree species canopy cover and lower diversity and abundance of understory vegetation between reference and current condition are all factors in the Ponderosa Pine Forest ERU. The TEUI data also documents some areas where Douglas fir is becoming established or may be higher in relative abundance in ponderosa pine stands between the reference and current condition. There are some map units that demonstrate departure in the opposite sense, with a lower percentage of ponderosa pine canopy cover accompanied by a shift in the dominant oak from Gambel oak to gray oak between current and reference condition. Gray oak prefers relatively warmer, drier sites as compared to Gambel oak. Again, some of this departure is due to shifts in the relative dominance of individual tree species which is a reflection of the elevational-climatic gradient of this ERU, and not ecological status departure. While this analysis categorizes departure in the Ponderosa Pine Evergreen Oak ERU as low, the TEUI data do show lower percentages of ponderosa pine and higher percentages of juniper and oak between reference and current conditions, as well as differences in the relative abundance of grass species.

The interrelationships between historic and current fire and livestock grazing management and their roles in ecological status departure in the grassland, shrubland and woodland ERUs also applies to the Mixed Conifer-Frequent Fire, Ponderosa Pine Forest and Ponderosa Pine Evergreen Oak ERUs, although herbivory has somewhat less explanatory value in the Mixed Conifer-Frequent Fire. Non-fire vegetation treatments (e.g. timber harvest) have more explanatory value in all three of these forested ERUs. While restoration or hazardous fuels reduction is the primary purpose for non-fire vegetation treatments, economics are a driving factor in where and what happens, or doesn't happen on the ground. Because Mixed Conifer-Frequent Fire, Ponderosa Pine Forest and Ponderosa Pine Evergreen Oak contain species that have higher economic value than the woodland and shrubland ERUs, more acres of non-fire vegetation treatments have occurred. Under current plan direction, these treatments are generally driven by single species wildlife habitat management concepts (e.g. goshawk or Mexican spotted owl), old growth management emphasis or hazardous fuels objectives, and not Terrestrial Ecological Unit or Ecological Response Unit concepts.

With respect to the Spruce-Fir Forest and Mixed Conifer with Aspen, there is greater accuracy and very little uncertainty associated with ecological status departure as it is driven by the extent of recent stand replacement fire that occurred due to drought and the legacy of past fire suppression.

Soil Loss

A certain amount of soil loss occurs as a natural geologic process, even under reference conditions. As described under Analysis Methods, the reference soil loss rate is the minimum or natural rate (NSL). Some

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[19] Pushing refers to uprooting individual trees with heavy machinery.

amount of soil loss greater than the minimum rate can occur without impairing natural soil productivity. However, when accelerated erosion exceeds a threshold, the productivity of the land is impaired and hydrologic function is altered. Reductions in vegetative canopy and/or groundcover can lead to accelerated erosion rates. Vegetative canopy cover intercepts raindrops and reduces the associated impact energies that detach soil particles and make them mobile. While the species that provide that cover are less important, not all vegetative lifeforms (e.g. bunch grass, sod grass, shrub, etc.) support soil stability to the same degree.

Vegetative groundcover includes basal area, litter, microbiotic crusts, lichens and mosses. Basal area is the area covered by tree trunks and stems of shrubs, forbs and graminoid species where they meet the ground. Effective litter includes all coarse woody and finer plant debris, a half inch or more in depth (USDA FS 1986a). Litter less than this depth is not considered effective in supporting soil stability. The distribution of litter is also important. Where litter is unevenly distributed and/or only associated with some vegetative layers, soil stability is lower than it would be if it were evenly distributed and associated with all vegetative layers (USDA FS 2012b). Microbiotic crusts can be a key component in helping hold soils in place and prevent erosion in some ecological types. On the other hand, they can also reduce infiltration rates. While these crusts exist all across the Forest to varying degrees, those with thicknesses great enough to contribute to overall soil stability are not extensive. The same can be said for lichens and mosses, except at high elevation where mosses can play a large role in soil stability after fire.

Vegetative groundcover plays a critical role in soil stability and site productivity as it also reduces the raindrop impact energy responsible for detachment of soil particles, limits the movement of detached particles and reduces the potential for concentration of surface runoff water that contributes to rill and gully erosion. Vegetative groundcover is also an indicator of nutrient cycling status.

Figure 67 displays the results of the soil loss modeling. Where departure is low, current soil loss rates are below the threshold rate. Significant departure indicates current soil loss exceeds the threshold rate.

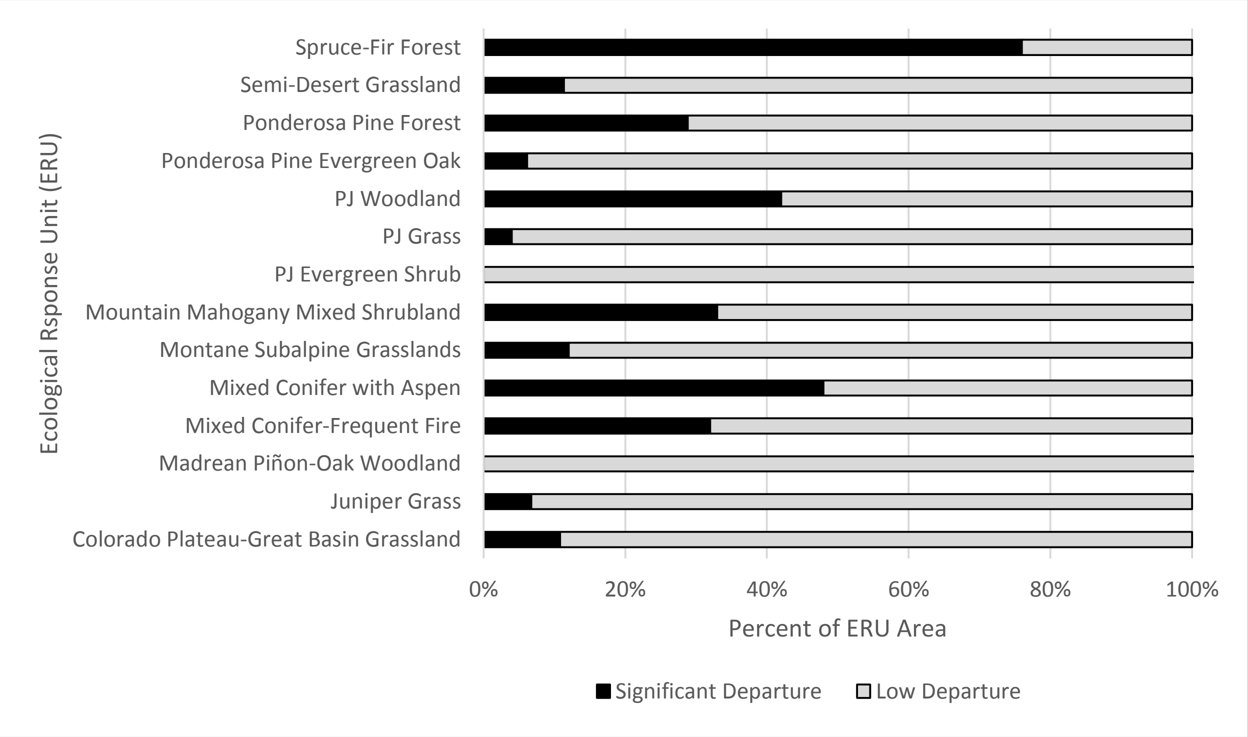

Figure 67. Soil loss departure for Gila NF upland ERUs

As described in the Analysis Methods, all ERUs with more than 33 percent of their area represented by TEUI units in significant departure are considered significantly departed as a whole. Those ERUs are Mixed Conifer with Aspen, PJ Woodland and Spruce-Fir Forest. While the remaining ERUs may be in low departure overall, most contain areas of significant soil loss departure.

The Spruce-Fir Forest and Mixed Conifer with Aspen ERUs are in high departure due to the large extents of high and moderate burn severities they have experienced. In the Mixed Conifer with Aspen, 76 percent of those areas in low departure have current soil loss rates within 25 percent of the threshold rate.

The reasons for significant departure in PJ Woodland, include a relatively large difference between the canopy cover of grasses between reference (more grass and litter) and current conditions (less grass and litter). Sixty three percent of those areas within the PJ Woodland that are in low departure are within 25 percent of the Threshold soil loss rate. The distribution of vegetative groundcover is also more uneven in the current condition as indicated by generally higher percentages of bare soil. Although overall departure in the PJ Grass, Juniper Grass and the grassland ERUs is low, there are areas where current soil loss rates do exceed the Threshold rate. The differences in the canopy cover of grasses, litter and bare soil between reference and current conditions described for PJ Woodland also occur here. These differences are not offset by the higher canopy cover of trees and/or shrubs between the reference and current condition. Seventy eight percent of the PJ Grass area in low departure is represented by TEUI units with current soil loss rates within 25 percent of the Threshold rate. The equivalent percentages in Juniper Grass, Colorado Plateau-Great Basin Grassland, Montane Subalpine Grasslands, and Semi-Desert Grassland are 72, 46, 96 and 74 respectively. PJ Evergreen Shrub and Madrean Piñon-Oak Woodland are both in low departure overall and contain no TEUI units with modeled current soil loss over the Threshold rate. However, the single TEUI map unit representing the Madrean Piñon-Oak Woodland is within 25 percent of the Threshold rate, while just 25 percent of PJ Evergreen Shrub is within that range.

As previously stated the TEUI data describing the Mountain Mahogany Mixed Shrubland ERU is primarily from the Burro Mountains where historic grazing impacts on soils formed from rhyolite, andesite and very erodible granitic soils were severe and extensive and is in high soil loss departure. With 33 percent of its area represented by TEUI units that exceed the Threshold soil loss rate, this ERU sits on the threshold between low and significant departure. Eighty seven percent of those areas within this ERU that are in low departure are within 25 percent of the threshold rate. Natural recovery in this area is relatively slow as it is located at the warmer, drier end of the Forest's elevational-climatic gradient. Current grazing management has allowed for improvement in vegetative canopy and groundcover, but slows the natural rate of recovery. On the other hand, much of this ERU occurs on steep slopes within designated wilderness areas and is not described in the data.

High and moderate burn severities explain a small percentage of the departure in Mixed Conifer-Frequent Fire. Recall that the RHEM model inputs include both vegetative canopy cover by life form and vegetative groundcover. Although this ERU is not significantly departed overall, there are areas that are. Of those areas that are in low departure, 72 percent are within 25 percent of the Threshold soil loss rate. Where departure within this ERU is significant, there tends to be less canopy cover of trees and less litter associated with current conditions as opposed to the reference. For the most part, the difference is not offset by higher canopy cover of grasses. Past thinning activities explain both the lower tree canopy cover and litter. After removing trees, coarse woody debris is typically piled and burned. Coarse woody debris is also important for long-term nutrient cycling and soil productivity. The finer material can be displaced or redistributed during these activities.

Ponderosa Pine Forest and Ponderosa Pine Evergreen Oak ERUs, are in low soil loss departure overall, but both contain areas where current soil loss exceeds the Threshold rate. Thirty seven percent of the Ponderosa Pine Evergreen Oak area in low departure and 45 percent of Ponderosa Pine Forest area in low departure are within 25 percent of the Threshold rate. The previous discussion of thinning activities, and the discussion regarding the interrelationships between historic and current fire and livestock grazing management apply to both of these ERUs.

The discussion of the interrelationships between historic and current fire and livestock grazing management in the ecological status analysis also applies here. Where fire regimes are departed from historic conditions, there is a greater risk of large extents of high and moderate burn severities and accelerated erosion to occur. Drought increases this risk. Low severity fire, prescribed or natural, does not typically cause soil loss rates to exceed the Threshold and therefore serves to mitigate the risk of accelerated soil loss due to high and moderate burn severities. However, significant rill erosion has been observed post-fire in mixed conifer on some rhyolite and rhyolite ash tuff soils that experienced low severities. While current livestock management has allowed for improvements in soil condition over historic management, and range condition trends across the Forest are generally stable to slightly upward (Chapter 11: Multiple Uses), current management does slow natural recovery.

Drought also plays a large role in both vegetative canopy and groundcover departures, particularly with regard to grass species. During periods of drought, vegetation may not be as vigorous, able to withstand disturbance, and may die, impacting both vegetative canopy cover and groundcover. The death of some grass plants has been observed in some places on the Forest over the last several years of drought. Some ponderosa pine that experienced low severity fire during the 2013 Silver and 2014 Signal Fires and were expected to survive did not, presumably due to drought stress.

Another very important factor in soil loss departure is slope. In areas where slopes are steeper, smaller differences in vegetative canopy and groundcover are required to accelerate erosion. In areas that are relatively flat, larger differences are typically required to accelerate erosion. In some ERUs, a percentage of what is interpreted as departure in this analysis, is actually a reflection of natural instability. Natural instability is defined by soils where NSL rate is greater than the Tolerance, or Threshold soil loss rate. In other words, the geologic rate of soil loss is greater than the rate of soil formation. The RHEM model automatically identifies the lowest soil loss rate as the NSL (RHEM calls it “baseline”), which means that all other scenarios (current or otherwise) will be represented by a soil loss rate greater than NSL. Soil loss modeling with RHEM cannot serve as the basis on which to identify naturally unstable soils. Natural instability is due to interrelationships between bedrock composition and structure, parent material, soil texture, rock content, landform, and slope.

While slope is only one of many factors, slopes over 40 percent have been excluded from mechanical vegetation treatments on the Forest because of stability considerations. As a general rule, these slopes are also infrequently utilized by livestock. The most important disturbance regimes on these slopes are drought and fire. Roads and trails are also an important disturbance regime in some cases (USDA FS Gila NF 2013a). Approximately 29 percent of the Forest occurs on slopes 40 percent or greater. All ERUs contain some areas with slopes over 40 percent, but the largest percentages occur in the Mixed Conifer-Frequent Fire and Mixed Conifer with Aspen (>50 percent of each) and Mountain Mahogany Mixed Shrubland (65 percent). The ERU with the greatest number of acres on slopes over 40 percent are Mixed Conifer-Frequent Fire, Mountain Mahogany Mixed Shrubland and PJ Woodland. The Watershed and Soils Specialist Report for Travel Management (USDA FS Gila NF 2013a) references the General Terrestrial Ecosystem Survey, which mapped the same things at a broader scale (1:250,000) and rates 21 percent of the Forest as unsuited. However, the use of the soil loss model was the basis for that interpretation has been discontinued in favor of the RHEM model. While this information provides some idea of the extent and distribution of naturally unstable soils, natural instability cannot be identified using slope alone, or with RHEM. The protocol for delineating these areas is in the process of being updated.

Gully erosion has been documented by the TEUI in all grassland ERUs, PJ Woodland, PJ Grass, and Juniper Grass. Most of these processes were initiated as a result of historic grazing practices that are no longer practiced. However, some remain active to the current day as it takes long periods of time for natural processes to stabilize gully erosion. Just because the TEUI has not documented gully erosion in other ERUs does not necessarily mean they do not exist. In fact, gully erosion (as well as hillslope failure) has been observed in recent high and moderate burn severities within the mixed conifer. Gully erosion is not used to modify the results of the modeling analysis, but is considered in the analysis of soil condition that follows.

Soil Condition

As described in the Analysis Methods subsection, the soil condition characteristic relies on USDA Forest Service Southwestern Regional guidance (USDA FS 2012b) which rates soils as satisfactory, impaired or unsatisfactory based on hydrologic, stability and nutrient cycling functions. Departure is a direct interpretation of the soil condition rating with satisfactory ratings being low departure, impaired ratings being moderate departure and unsatisfactory ratings being high departure. Current soil conditions aggregated to the ERUs are displayed in Figure 68.

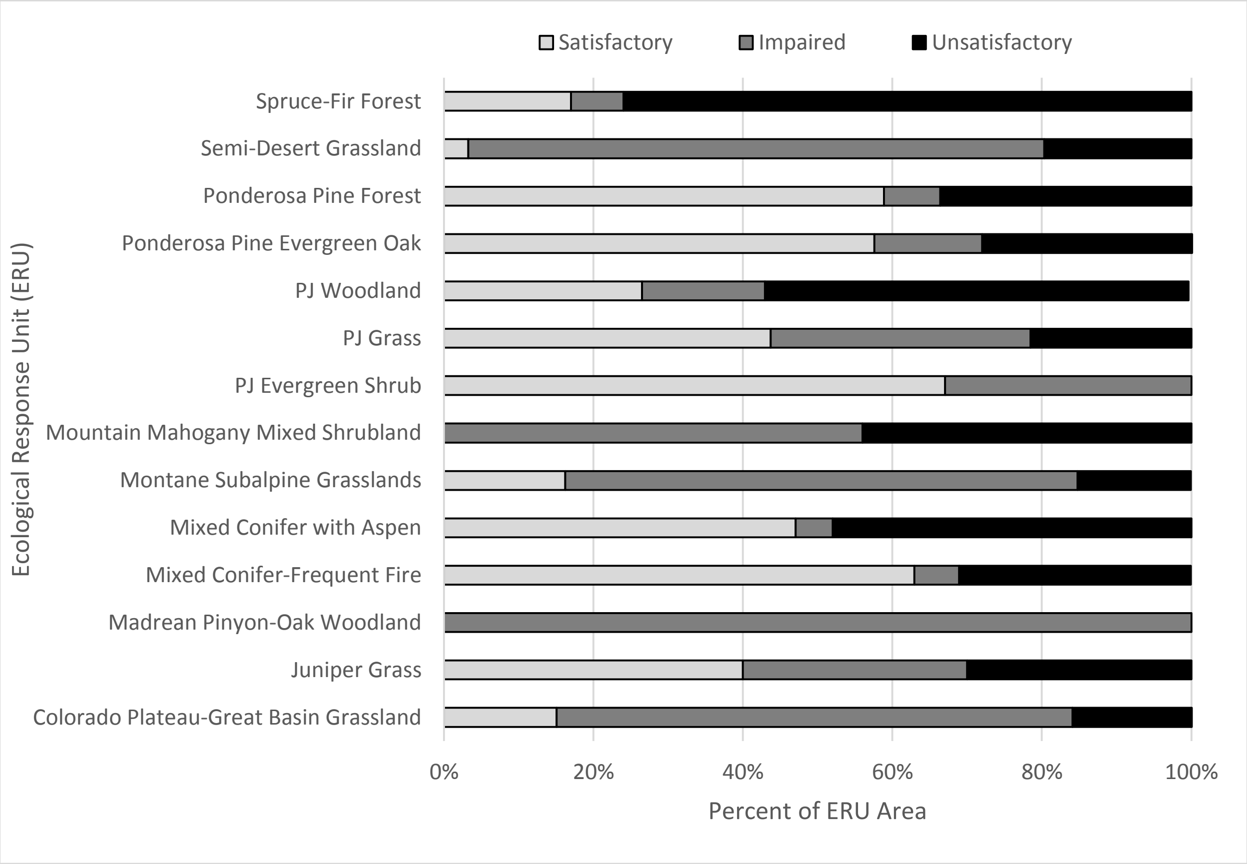

Figure 68. Current soil condition across the Gila NF's upland ERUs

Spruce-Fir Forest and Mixed Conifer with Aspen are in high departure overall with reductions in hydrologic, stability , and nutrient cycling functions for the same reasons discussed in the ecological status and soil loss analyses. PJ Woodland is also in high departure. Documentation of visible erosion, including gully erosion, deposition, and pedestalling of grasses not reflected in the soil loss analysis, as well as zootic disclimaxes. Zootic disclimax states can occur under sustained or periodic use of vegetation by wild or domestic animals. Under such conditions vegetation can depart markedly in the structure and composition of the natural vegetation community under late seral conditions (USDA FS 1986a). There is also documentation of these conditions in the grassland and shrubland ERUs, which are in moderate departure overall. Additionally, there is documentation of reductions in hydrologic function as a result of compaction in the Semi-Desert Grassland, which does not experience the same amount of freeze-thaw action as the other grasslands do. Freeze-thaw action is a natural process that breaks up compaction. That said, compaction has been observed in other grassland systems, often on Vertisols or on vertic intergrades (see Soil Diversity and Distribution). With respect to the Madrean Piñon-Oak Woodland which is also in moderate departure, visible erosion was observed within portions of the ERU during 2014 TEUI field reviews. The remaining ERUs may be in low departure overall, but all contain areas of moderate and high departure. Again, the factors contributing to these departures have been discussed.

The soil condition indicator of the watershed condition classification (see Chapter 6: Water) considers attributes of soil erosion, productivity (nutrient cycling and hydrologic function) and contamination at a subwatershed scale (Potyondy and Geier 2011). Although the risk of soil contamination, as represented by the soil contamination attribute, is not reflected using the Regional soil condition guidance (USDA FS 2012b), it does merit discussion. Contamination has been identified as an issue in approximately 38 percent subwatersheds with the risk of atmospheric deposition of nutrient nitrogen and/or acidic compounds being cited as the reason in most cases. Deposition of nutrient nitrogen can alter natural soil fertility which can affect plant growth, species composition, and above and below ground biodiversity. All of these can contribute to long-term alteration of nutrient cycling.

The data available for the Gila (period of record 1985-2012) shows nitrogen deposition rates have held constant. However, critical loads have only been developed for lichens on the Gila NF. Critical loads are the amount of atmospheric pollutant deposition below which no harmful ecological effects occur. No exceedances have been recorded for acid deposition. Atmospheric deposition and critical loads are discussed further in Chapter 5: Air.

In general, soils in the Southwest have a high capacity to withstand changes in pH and the risk of increased acidity is low. More information about atmospheric deposition can be found in Chapter 5: Air. On a subwatershed basis, old mines are associated with the second most common risk of soil contamination (8 percent), and leaky underground fuel tanks and old landfills accounting for one percent each.

Risk

Risk is assessed by ERU for ecological status and soil condition using the matrix displayed in Table 113, followed by Table 114 which displays the risk matrix for soil loss.

Table 113. Risk matrix for soil resource characteristics

Departure from Reference Condition	Trend		
	Toward Reference	Unknown or Static	Away From Reference
High	Moderate Risk	High Risk	Very High Risk
Moderate	Low Risk	Moderate Risk	High Risk
Low	No Risk	Low Risk	Moderate Risk

Table 114. Risk matrix for soil loss

Departure from Reference Condition		
Moderate or High	High Risk	
Low	>75 percent of low departure ERU area within 25 percent of Threshold soil loss rate	Moderate Risk
	<75 percent of low departure ERU area within 25 percent of Threshold soil loss rate	Low Risk

To assess risk at the Forest and local unit scales, ERU risk ratings are area weighted to the Forest or local unit boundary and the risk rating representing the largest percentage of that area is assigned. ERU, Forest and local unit risk is summarized in Table 115.

Table 115. Risk summary for key characteristics of soil.

ERU Name	Ecological Status Risk Rating	Soil Loss Risk Rating	Soil Condition Risk Rating
Colorado Plateau-Great Basin Grassland	Moderate	Low	Moderate
Juniper Grass	Moderate	Low	Low
Madrean Piñon-Oak Woodland	Moderate	Moderate	Moderate
Mixed Conifer-Frequent Fire	Moderate	Low	Low
Mixed Conifer with Aspen	High	High	High
Montane Subalpine Grasslands	Moderate	Moderate	Moderate
Mountain Mahogany Mixed Shrubland	Moderate	Moderate	Moderate
PJ Evergreen Shrub	High	Low	Low
PJ Grass	Moderate	Moderate	Low
PJ Woodland	Moderate	High	High
Ponderosa Pine Evergreen Oak	Low	Low	Low
Ponderosa Pine Forest	Moderate	Low	Low
Semi-Desert Grassland	Moderate	Low	Moderate
Spruce-Fir Forest	High	High	High
Gila NF	Moderate	Low	Low
Local Units			
Apache	Moderate	Low	Low
Little Colorado Headwaters-San Agustin Fringe	Moderate	Low	Low
Mogollon Front	Moderate	Low	Low
Black Range	Moderate	High	High
Upper Gila	Moderate	Low	Low
Lower Gila	Moderate	Low	Low

There is always some degree of risk as a result of management action or inaction. For ecological status, patterns of risk at the ERU scale follow patterns of departure, which is reflected at the Forest and local unit scales. That said, the uncertainty associated with ecological status departure previously discussed, translates to the same uncertainty being associated with risk.

High soil loss and soil condition risk occurs in the Spruce-Fir Forest, Mixed Conifer with Aspen and PJ Woodland ERUs. In Spruce-Fir Forest and Mixed Conifer with Aspen, which also have a high ecological status departure, this is due to the large extents of high and moderate burn severities these ERUs have experienced in recent years. Negative impacts to the soil stability and hydrologic function have been wide-spread. While high and moderate burn severities may accelerate nutrient cycling short-term as complete or nearly complete consumption of biomass releases nutrients that were previously unavailable, long term nutrient cycling is not necessarily enhanced and may be negatively impacted given the large extent of these burns. Biomass consumed is no longer available to support long-term productivity. It is not the severity of the burn that is uncharacteristic of these ERUs, rather the number of contiguous acres affected. Since 2000, 83 percent of the Spruce-Fir Forest and 60 percent of the Mixed Conifer with Aspen has seen these stand replacement type fires, most of this occurring in the Gila and Aldo Leopold wilderness areas. Approximately 65 percent of the Mixed Conifer with Aspen and 82 percent of the Spruce-Fir Forest are located within designated wilderness areas.

All of the management activities that could be justified to reduce current risk of erosion and protect soil productivity and hydrologic function have been completed as part of Burned Area Emergency Response emergency watershed stabilization activities. Over time, soil functions will return to these systems, however they may not recover to pre-fire conditions for hundreds of years. This depends on the degree of soil loss that occurs. Subsurface soil layers have different hydrologic properties than does topsoil. Climate change is a major stressor that elevates risk to all characteristics analyzed for the soil resource (see Chapter 9: System Drivers and Stressors). These two high elevation ERUs have the highest vulnerability to climate change on the Forest. Climate change vulnerability represents the likelihood of an ecological type conversion (e.g. Spruce Fir Forest to Montane Subalpine Grasslands). Spruce Fir Forest and Mixed Conifer with Aspen are then at very high risk. While management does not have the ability to control or influence climate or climate change, it does have the ability to influence the risk to ecological status, soil loss and overall soil condition in the small percentage of these forests that remain in a late successional stage. It also has the ability to influence fire frequency in those areas that are now in early successional stages.

The PJ Woodland risk is the primary reason why the Black Range local unit has a high soil loss and soil condition risk as it makes up 50 percent of this local unit. However, some of this higher risk is likely associated with slope, one of the factors in natural soil instability, as this local unit is largely comprised of steep and rugged terrain. Recall that PJ Woodland is ERU with the fourth largest percentage of its area on slopes over 40 percent, with only the mixed conifer ERUs and Mountain Mahogany Mixed Shrubland containing higher proportions of these slopes. Parent material also plays a strong role in natural soil stability, on flat or steep terrain. Soils formed from volcanic sediment, granite, tuff, many rhyolites and conglomerates, as well as sandstone and shale can be highly erodible if vegetative groundcover is not maintained. PJ Woodland occurs on all of these parent materials.

While soil loss risk is generally low across the Forest, it is moderate in the Madrean Piñon-Oak Woodland, PJ Grass, Mountain Mahogany Mixed Shrubland and Montane Subalpine Grasslands. Although departure is characterized as low based on the higher percentage of soil loss rates that do not exceed Threshold rates, most current rates are within 25 percent of the Threshold. The closer soil loss rates are to the Threshold, the greater the risk current and future management activities that reduce vegetative canopy and ground cover might have. This provision in the assessment of soil loss risk is the reason why PJ Grass has a lower risk to soil condition than it does to soil loss. The soil condition risk assessment does not have the same sensitivity.

Moderate risk in the Madrean Piñon-Oak Woodland is influenced by the parent material, increasing the importance of maintaining adequate vegetative cover in current and future management activities in this ERU. Provisions for soil stability, as well as hydrologic and nutrient cycling functions are typically made at the project level (i.e. Soil and Water Conservation Practices or Best Management Practices). Parent material is also a factor contributing to soil loss risk in the Mountain Mahogany Mixed Shrubland where it occurs on granite, but lower vegetative groundcover between the reference and current condition is the primary management consideration in this ERU, as is the case in the Montane Subalpine Grasslands and PJ Grass.

Soil condition risk is associated with both historic and current fire and livestock grazing management as described throughout this chapter. All management activities that impact vegetation, impact the soil resource and vice versa. Competition between the restoration of fire adapted ecosystems and current livestock grazing is a factor contributing to risk as the herbaceous understory vegetation that provides forage, is also the fine fuels needed to carry fire and the organic material contributing to soil stability, hydrologic and nutrient cycling functions. Moving toward the historic fire regime, particularly increasing low severity fire, mitigates the risk of high and moderate burn severities and negative impacts to the soil resource. While current livestock grazing management has allowed for improvements over historic management and resource conditions, it slows the rate of natural recovery that might be expected in the absence of this stressor.

Non-fire vegetation treatments (e.g. fuelwood or timber harvest) have been conducted in most ERUs to restore both vegetation structure and composition (ecological status), although most occur in the Ponderosa Pine Forest, Ponderosa Pine Evergreen Oak, Mixed Conifer-Frequent Fire and PJ Woodland (see Chapter 11: Multiple Uses). These activities have been fairly limited due to budget, staffing levels and Regional priorities, but could foreseeably increase with continued emphasis on landscape scale restoration. Mechanical treatments such as these can have a large impact on soil hydrologic, stability and nutrient cycling status, depending on a variety of factors including but not limited to: soil clay and moisture content, temperatures during treatment and time between entries (for maintenance treatments). Slope restrictions and other measures or methods designed to reduce impacts to the soil resource and protect water quality are recommended and implemented at the project level. However, without restoring ecological processes, like fire, these treatments require maintenance. Re-entry increases the risk to soil functions. Re-entry time could be increased, therefore decreasing the risk of negative impacts to the soil resource with the use of herbicides. Under current plan direction, these vegetation treatments are generally driven by single species wildlife habitat management concepts (e.g. goshawk or Mexican spotted owl), old growth management emphasis or hazardous fuels objectives, and not Terrestrial Ecological Unit or Ecological Response Unit concepts.

Natural cycles of drought are a significant risk factor that Forest management does not have the ability to control. Management can only adapt by preparing for and responding to drought. A moderate or greater vulnerability to climate change raises these risk ratings one level (e.g. low becomes moderate) which is the case for all ERUs, the Forest and each local unit. It also increases the importance of monitoring key ecosystem characteristics in an adaptive management strategy.

Additionally, while the best available science utilized in this assessment is based multiple corroborating lines of evidence, a need for a wider spectrum of reference condition datasets across environmental gradients has been identified in General Technical Reference (GTR)-310 (Reynolds et al. 2013). Return intervals are described by vegetation type (see Chapter 2: Upland Vegetation) and only indirectly account for soil, slope, elevation, aspect, topography and local climate variability within those vegetation types. All of these things have been directly or indirectly identified as important variables in pre-settlement fire regimes and in some cases, more important than vegetation type (Abolt 1997; Baisan and Swetnam 1990; Rollins et al. 2000; Parks et al. 2015). While such information would generate too fine-scale a portrait for use in forest plan revision, these local data are available in the form of the TEUI and can be used to guide project-level planning in the future.

Data Needs

The Forest does need a completed TEUI product. Barring that, going forward from assessment into revision may require additional interpretations be developed from the draft TEUI data. These include, but are not limited to erosion hazard,[20] threshold vegetative cover and naturally unstable soils (formerly referred to as unsuited). These interpretations in concert with monitoring data, would be more informative about current and future risks to the sustainability of the soil resource and the influence of Forest management. Some existing protocols to develop these interpretations are not compatible with the RHEM model. Updated protocol is being developed, but work is not complete.

The TEUI data are point in time measurements. Repeat measurements associated with monitoring would give the Forest a better idea of trends and the effectiveness of management activities. However these data are most informative when tiered to a finished TEUI product. Some potentially efficient and effective monitoring protocols cannot be used without a completed TEUI.

Stakeholder Input

Soil erosion and soil health are a concern to the Gila NF stakeholders. From input received during the assessment, the importance of soil stability and productivity to overall watershed condition, water quantity and quality and infrastructure were topics of concern. Observations concerning erosion related to wildfires, livestock grazing, recreation and motorized travel were common.

Some would like the Forest to take a more proactive approach to protect soil and watershed resources with more prescribed fire. Others are more concerned about motorized travel and the condition of the road system. A few were very concerned about soil health at and around recreational facilities. Some community members suggested that the construction of erosion control structures, and more road maintenance should be a priority. There are some that question the presence and numbers of cattle on the Forest, especially in riparian and areas of high erosion and would like this reassessed. These community members do not believe that adaptive livestock management has been successful. In general, the public perceives that the Gila NF is not demonstrating great enough concern for the soil resource. Some also pointed to the need for a completed and useable TEUI product.

After the release of the draft assessment report, additional comments were received regarding management of the soil resource. These comments centered on implementing BMPs to reduce negative impacts to the soil resource that may occur as a result of mechanical vegetation treatments. Stakeholders would like to see these treatments restricted to times of the year when soil is dry or frozen.

Summary

This assessment reviews the best available soils information at the Ecological Response Unit (ERU), Forest and local unit scales to explore the ability of the area's upland soils to sustain the key ecosystem services it provides under current Forest Plan direction. These ecosystem services are the product of soil

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[20] Erosion hazard describes the relative magnitude of accelerated soil loss should all vegetative groundcover be removed in terms of slight, moderate or severe ratings.

hydrologic, stability and nutrient cycling functions reflected by key characteristics that include: ecological status (vegetation composition), soil loss and condition.

Soil hydrologic, stability and nutrient cycling can be defined and assessed individually, but are interrelated and inseparable on the ground. Soil condition represents the summation of these functions and relationships, while the other characteristics indicate specific issues. Departure and risk under current climate and management varies from low to high across the Forest's ERUs, but is generally low at the Forest and local unit scales. However risk is elevated by climate change (e.g. an increase from low to moderate risk).

Because of the relationships between climate, soil and vegetation, every management activity that is implemented, or not, influences soil condition. The causal factors of departure from the reference condition, which also contribute to risk, vary by ERU. However climate, climate change and the interrelationship between historic and current fire and livestock grazing management are primary themes. Future risk due to non-fire vegetation treatments are expected to increase with the continued emphasis on landscape scale restoration. This risk can be mitigated by Forest management, both at the plan and project level.

While climate change is beyond the control of Gila NF management, opportunities exist for the Forest to manage ecological outcomes and risk with regard to the soil resource. These opportunities can be defined through better understanding and integration of watershed, ecological and fire management strategies and objectives, as well as consistent, efficient and effective monitoring designed to document outcomes and assess the effectiveness of management actions relative to key soil characteristics.

Chapter 5. Air

Introduction

Air quality has long been recognized as an important resource. The 2012 Planning Rule requires national forests and grasslands to consider air quality when developing the revised plan. The purpose of this assessment is to evaluate the best available scientific information regarding current conditions and trends in air quality, and to project future conditions on and affecting the Gila NF. This will provide the basis for the evaluation of risk at the conclusion of this chapter. Additionally, this assessment will identify information gaps and disclose any uncertainty associated with the data.

This chapter includes the following components:

- Airsheds relevant to the plan area
- Location and extent of known sensitive air quality areas
- Federal, state and tribal governmental agency implementation plans for regional haze or sensitive air quality areas
- Emission inventories
- Ambient air quality
- Visibility
- Atmospheric deposition
- Public input received during the assessment relevant to air quality
- Summary of conditions, trends and risk

Ecosystem Services of Air

Air resources on the Gila NF provide many ecosystem services from which society benefits or enjoys. Air, much like water, is necessary for the existence of life by supplying oxygen for respiration and carbon dioxide for photosynthesis. It provides both supporting ecosystem services as it contributes to primary production, nutrient cycling and soil formation; thereby contributing to provisioning services derived as fuelwood, fiber and food, such as meat from game and livestock. The chemical constituents of air provide regulating services as it influences climate and the water cycle. It also supplies cultural ecosystem services to society as the fresh air and sweeping views that high quality air provide are very much a part of the recreational value and personal enrichment experiences provided by National Forest System lands.

Data

Emissions data used in this analysis comes from the Western Regional Air Partnership and can be found at the Intermountain West Data Warehouse website at http://views.cira.colostate.edu/tsdw/. The Partnership represents voluntary collaboration between states, tribes, federal land managers and the Environmental Protection Agency (EPA). This data represents an aggregation of county emissions for those counties included in the relevant airshed and the Mexican states of Sonora and Chihuahua. Additional data for analyzing ambient air quality, visibility and atmospheric deposition were taken from state and federal monitoring stations in and near the Gila NF. These stations are identified in Figure 69. Site labels in Figure 69 and the data from each station are described in Table 116.

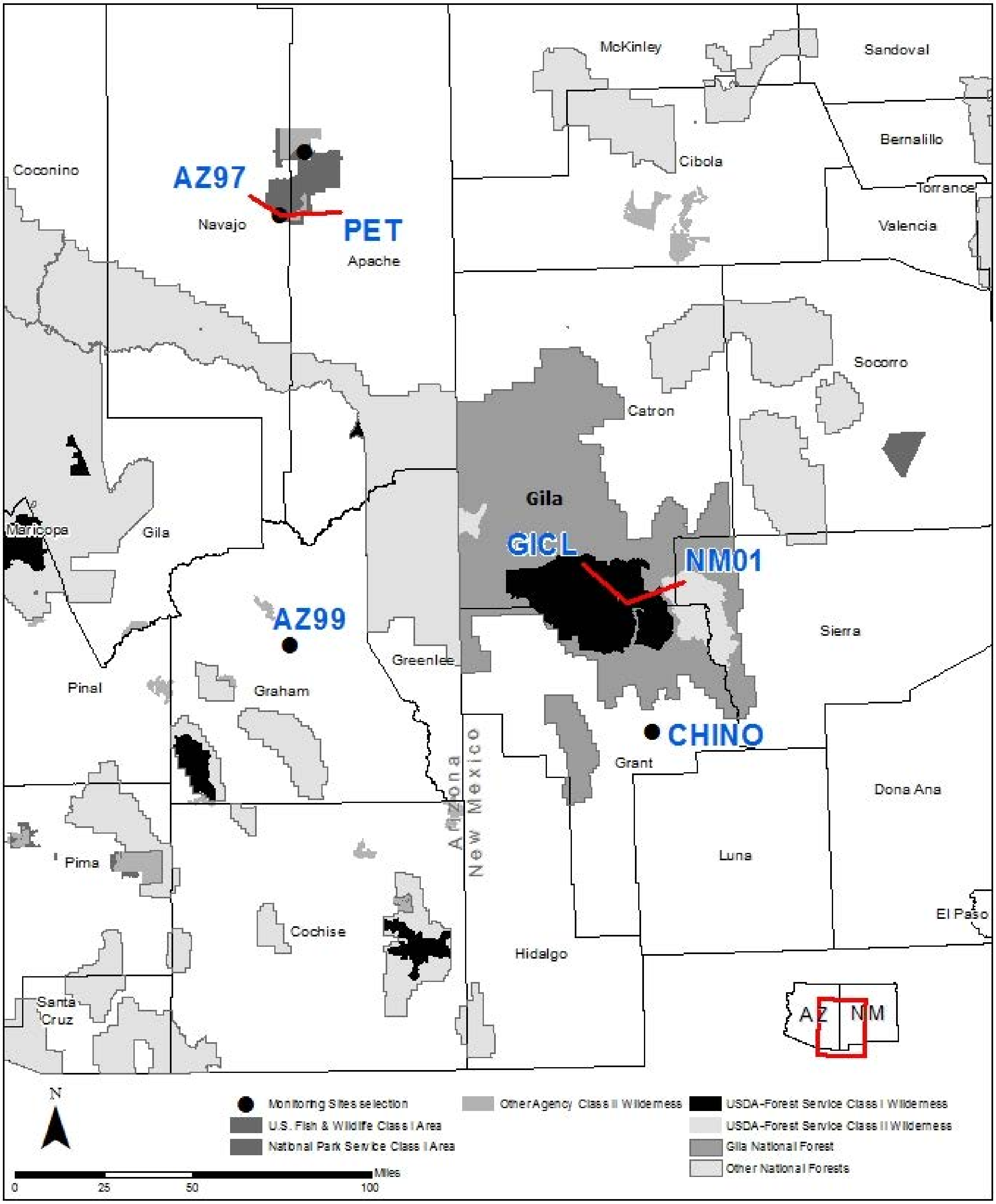

Figure 69. Air quality monitoring sites relevant to the Gila airshed

Table 116. Characteristics of air quality monitoring sites relevant to the Gila airshed

Monitoring Site	Site Label	Pollutants Monitored and Period Reviewed[1]
Chino Copper Smelter	CHINO	O_3 (2005-2014)[2], PM_{10} (2009-2014)[3], SO_2 (2000-2014)[4]
Gila Cliff Dwellings	GICL, NM01	IMPROVE Aerosol, dv (1995-2014)[5], NADP/NTN (1985-2012)[6]
Oliver Knoll	AZ99	NADP/NTN (1982-2014),
Petrified Forest National Park	PEFO-AQ , AZ97, PET427	NADP/NTN (2002-14), CASTNET (2003-2013)[7]
Chiricahua National Monument	AZ98	NADP/NTN (1999-14), CASTNET (1990-2013)

[1] For this assessment, only measurements collected in and after the year 2000 were reviewed.

[2] O_3 is ozone

[3] PM_{10} is coarse particulate matter

[4] SO_2 is sulfur dioxides

[5] IMPROVE Aerosol refers to a monitoring system that was put in place by the Interagency Monitoring of Protected Visual Environments. The system measures concentrations of atmospheric aerosols, such as sulfates and nitrates, and uses the data to assess the degree to which light is absorbed and/or scattered by air pollution. "dv" is a unit of measure that describes change in visibility conditions perceptible to the human eye.

[6] NADP refers to the National Atmospheric Deposition Program. NTN refers to the National Trends Network

[7] CASTNET is a monitoring system of the National Trends Network which collects data related to nitrogen and sulfur deposition. The Network operates these stations in cooperation with the National Park Service.

Airsheds

Airsheds are similar to watersheds in that they are defined geographic areas that are frequently affected by the same air mass because of topography, weather patterns and/or climate. The difference is that air masses and air pollutants move between airsheds based upon larger weather and/or climatic patterns, whereas surface water does not naturally move between watersheds. As with watersheds, airsheds can be defined at multiple scales. This assessment defines the relevant airshed as the area within 300 kilometers (186.4 miles) of the Gila NF. In consultation with the New Mexico Environment Department (NMED) Air Quality Bureau, this airshed was chosen using the methodology NMED uses in Regional Haze and Prevention of Significant Deterioration (PSD) reviews and is more consistent in assessing potential emissions sources that could result in impacts to the Forest, than the smaller airsheds NMED has identified (e.g. Catron, Luna, Grant and Sierra) within and surrounding the Forest. Those smaller airsheds are more appropriate for actions the Forest might take, such as prescribed burning, rather than this assessment. This airshed includes most of Arizona and New Mexico, as well as portions of three Texas counties and the Mexican states of Sonora and Chihuahua as displayed in Figure 70. This area is hereafter referred to as the Gila airshed.

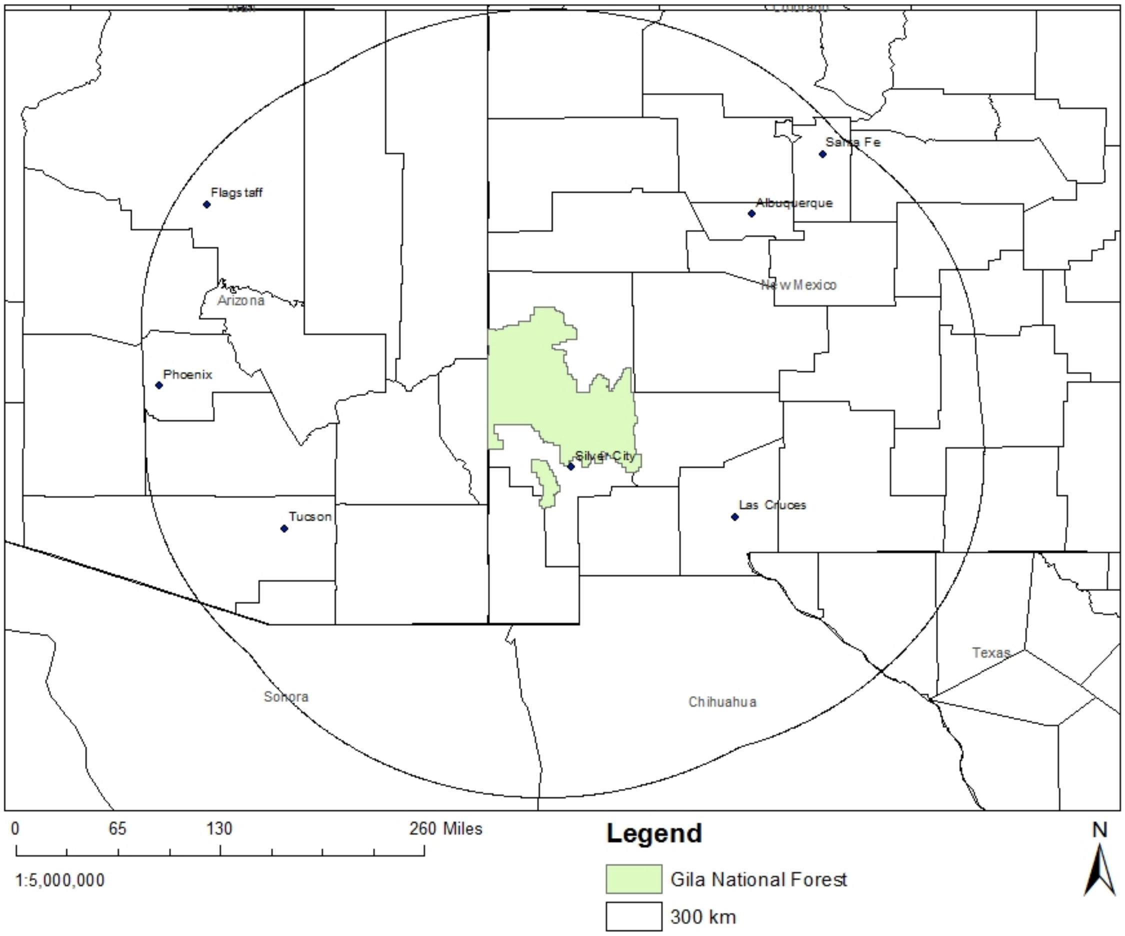

Figure 70. Airsheds and Counties relevant for Gila National Forest

Sensitive Air Quality Areas

Sensitive air quality areas include Class I, Class II, non-attainment and maintenance areas. Class I areas are designated within the Clean Air Act as deserving the highest level of air quality protection. These areas include, but are not limited to wilderness areas over 5,000 acres. The Gila Wilderness is a Class I area. Class II areas are also designated within the Clean Air Act but are subject to somewhat less stringent protection. Class I and II areas within New Mexico and Arizona are displayed in Figure 71.

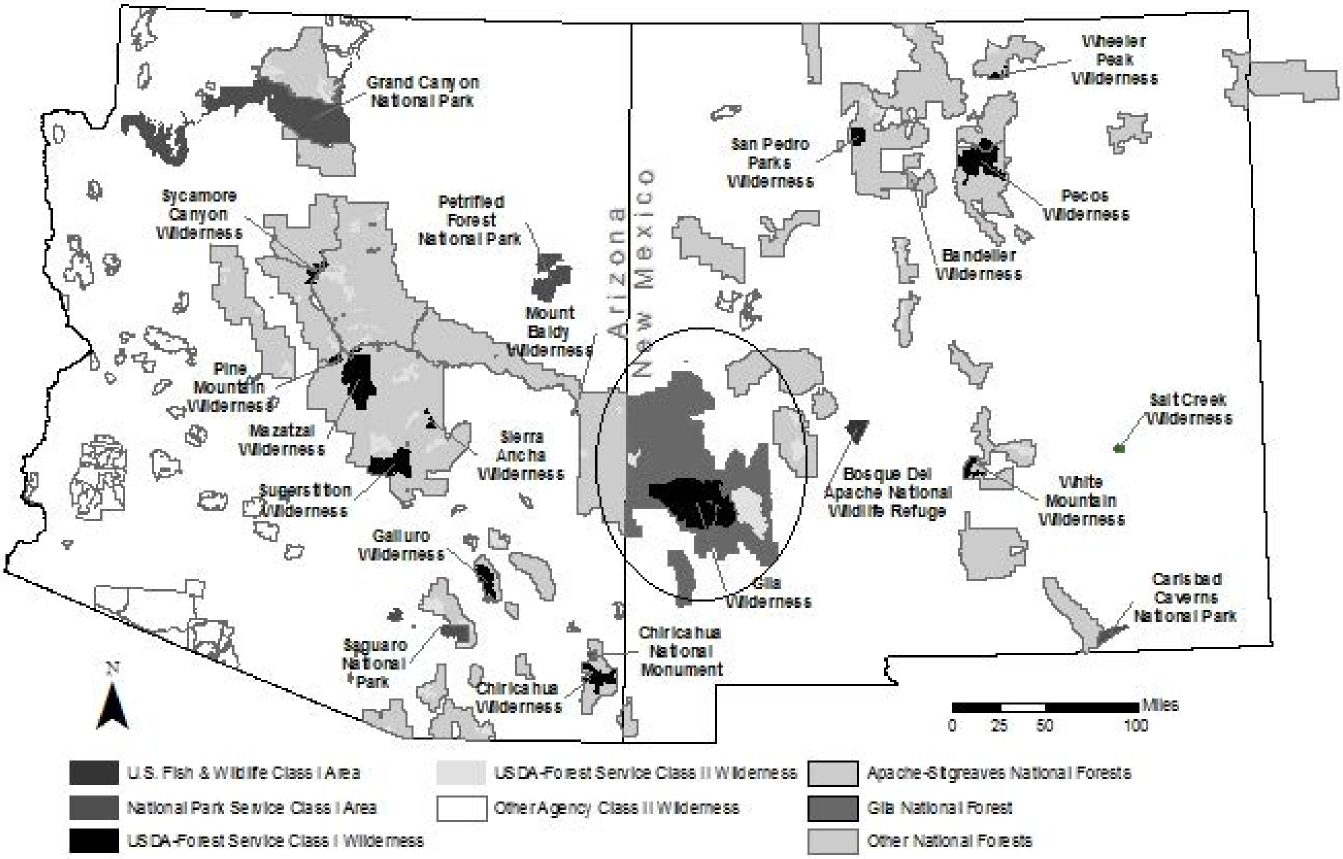

Figure 71. Class I and II Areas in New Mexico and Arizona. The circle indicates the location of the Gila NF

Non-attainment areas are those areas that are not meeting the National Ambient Air Quality Standards (NAAQS) established by the EPA. The states are delegated the primary responsibility for air quality management except on tribal lands, on which the tribal government maintains primary responsibility. States may develop their own air quality standards, provided that they are at least as restrictive as the national standards. New Mexico Ambient Air Quality Standards (NMAAQS) include standards for total suspended particulate matter (TSP), hydrogen sulfide and total reduced sulfur for which there are no national standards. The NAAQS and NMAAQS are included as Appendix C. Maintenance areas are former non-attainment areas that are now meeting air quality standards. At the present time, there are no non-attainment or maintenance areas within the plan area.

Federal, State, and Tribal State Implementation Plans

The federal Clean Air Act provides the basic framework for controlling air pollution, but as stated previously, the states or tribes are delegated the primary implementation and enforcement responsibility. Typically, air pollution generated outside National Forest System lands is the primary concern for impacts within the national forests and grasslands. The framework of the Clean Air Act provides tools relevant to protecting air quality in pristine areas from both new and existing sources of pollution.

The Prevention of Significant Deterioration (PSD) permitting program was established in 1977 to preserve the clean air usually found in pristine areas while allowing for economic growth. Its purpose is to prevent violations of NAAQS and protect air quality and visibility in pristine areas. Under this program, new major sources of air pollution or modifications to existing major sources of pollution may be required to assess the impacts of pollution on soil, water, vegetation and visibility of lands managed by the Forest Service. Unless specific issues arise, individual national forests and grasslands are not generally responsible for conducting PSD reviews. Forest Service involvement and environmental analysis are provided for at the regional level. Ultimately, the Forest Service can dispute the terms of a permit if analyses demonstrate unacceptable impacts could occur in Class I and II areas.

For existing sources of air pollution, the 1999 federal Regional Haze Rule (RHR) requires states to develop programs to assure reasonable progress toward meeting the national goal of preventing any future visibility impairment in Class I areas, and remedying any existing impairments. The RHR includes requirements for State Implementation Plans (SIPs) and revisions thereof, as well as period progress reviews. It also includes a provision for New Mexico, and other western states, to incorporate recommendations for emission reduction strategies developed by the Grand Canyon Visibility Transport Commission (GCVTC) designed to improve visibility in the 16 Class I areas on the Colorado Plateau.

The GCVTC was established in a 1990 amendment to the Clean Air Act. The commission released its final report in 1996 and initiated the Western Regional Air Partnership (WRAP), a partnership of state, tribal and federal land management agencies. The WRAP was created to help coordinate implementation of the GCVTC recommendations related to: air pollution prevention, clean air corridors, stationary and mobile sources, road dust, emissions from Mexico, fire and areas in and near parks and wilderness areas.

Since the RHR was established, the New Mexico Environment Department (NMED) has been working to establish a SIP consistent with the RHR, and GCVTC and WRAP recommendations. This process has included multiple EPA reviews, litigation and revisions. In 2012, the EPA approved NMED SIP submittals with the exception of one component. This SIP component relates to San Juan Generating Station77 and is what resulted in the litigation. The approved SIP components included Forest emissions estimates as appropriate.

The Gila NF complies with Clean Air Act, RHR and New Mexico State Smoke Management Program, as required under the approved SIP. This program includes requirements for burn registration, notification of local communities and the state of the burn date(s), visual tracking and post-fire reports for all prescribed fire or managed wildfires greater than 10 acres (NMED 2011).

Emissions

This section presents current and historical data related to emissions in the Gila airshed. Emissions information is important because adverse air quality impacts on the Forest can usually be traced back to emissions. Emissions inventories are created by quantifying the amount of pollution that comes from point and area sources. Point sources include power plants and factories. Area sources include automobile emissions and wildfires. Pollutants originating from area sources may be related to human activities, or be biogenic in nature. Biogenic sources include those originating from the natural biological processes of vegetation and soil microbes. Many pollutants emitted to the atmosphere are involved in chemical reactions following their release. Many of the compounds that are produced from these reactions are also pollutants. The original pollutants can therefore be thought of as precursor pollutants and are useful in projecting future trends. In fact, emissions data are the basis upon which air quality trends are determined in this assessment.

Baseline emissions from 2011 and projected emissions for 2020 were summarized for the following pollutants: carbon monoxide, nitrogen oxides, sulfur dioxide, volatile organic compounds (VOCs), and particulate matter. All of these pollutants except VOCs have health based standards. VOCs are included because VOCs and nitrogen oxides are precursors to the formation of ozone, which effects both human and ecosystem health. VOCs are carbon based chemical compounds that evaporate easily, like acetone or gasoline. Because health related impacts of particulate matter depend on particle size, particulate matter is described in terms of coarse (CPM) and fine (FPM). FPM represents particulate matter emissions at or below 2.5 microns in diameter and has greater health related impacts as it is more easily inhaled into the lungs. CPM represents particulate matter emissions greater than 2.5 but not more than 10 microns. Figure 72 through Figure 77 compare the emissions summaries for the Gila airshed by source for the identified pollutants between the 2011 baseline period and 2020 projections.

Figure 72. Baseline and projected carbon monoxide emissions

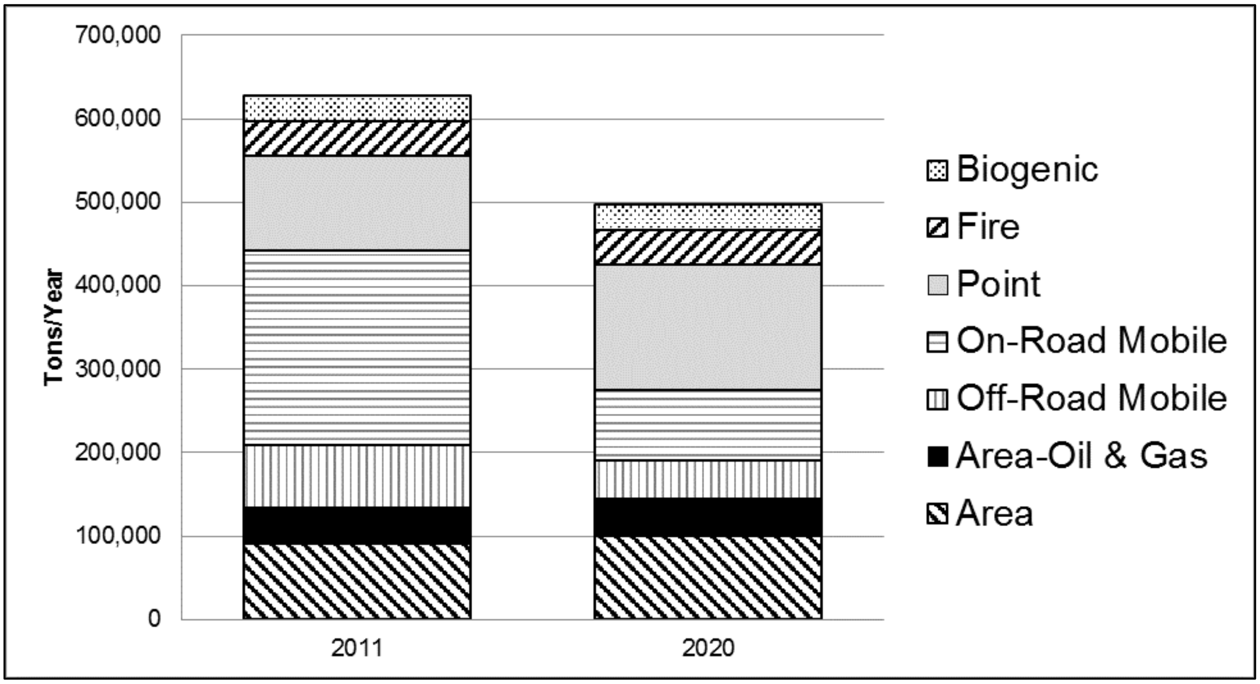

Figure 73. Baseline and projected emissions of nitrogen oxides

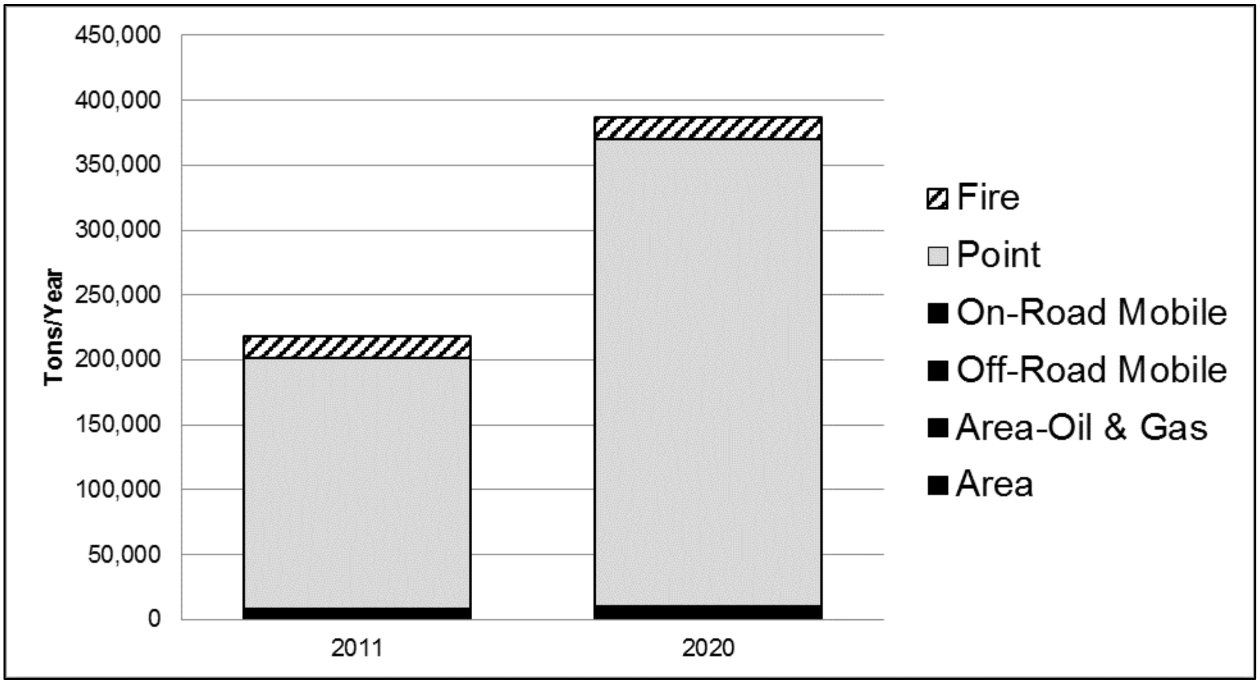

Figure 74. Baseline and projected sulfur dioxide emissions

Note: On and off road mobile, area-oil and gas and area categories are combined because they represent a proportion too small to be differentiated in the graph.

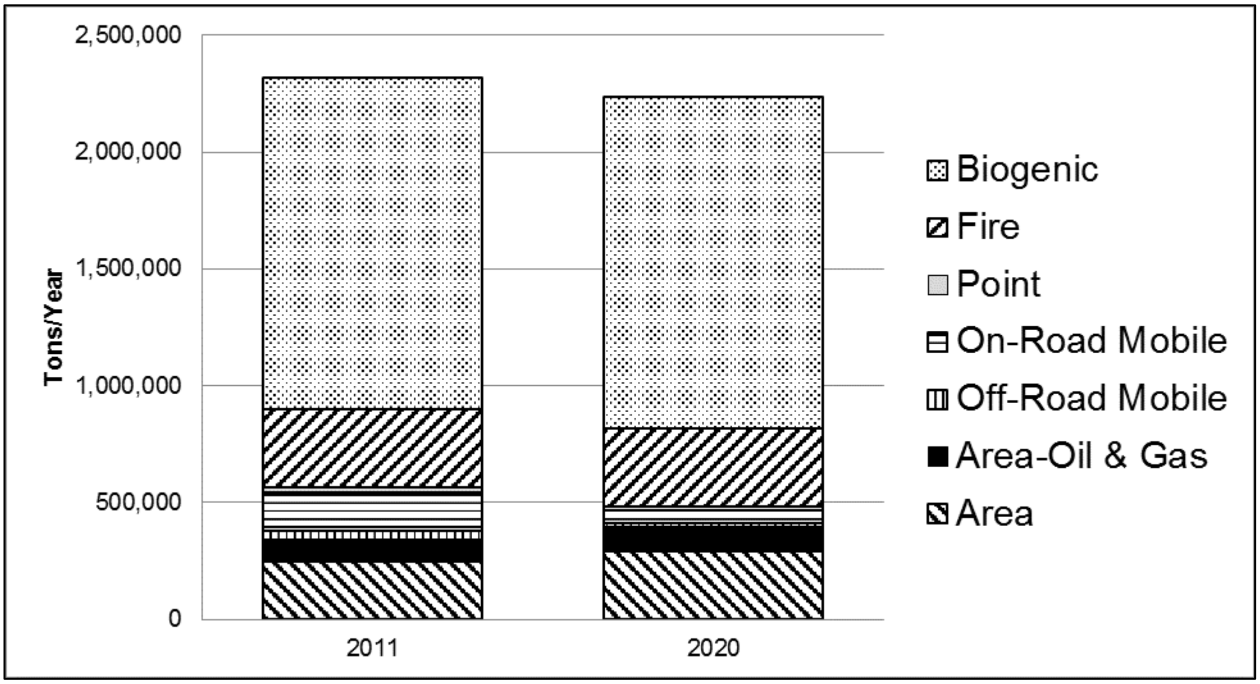

Figure 75. Baseline and projected VOC emissions

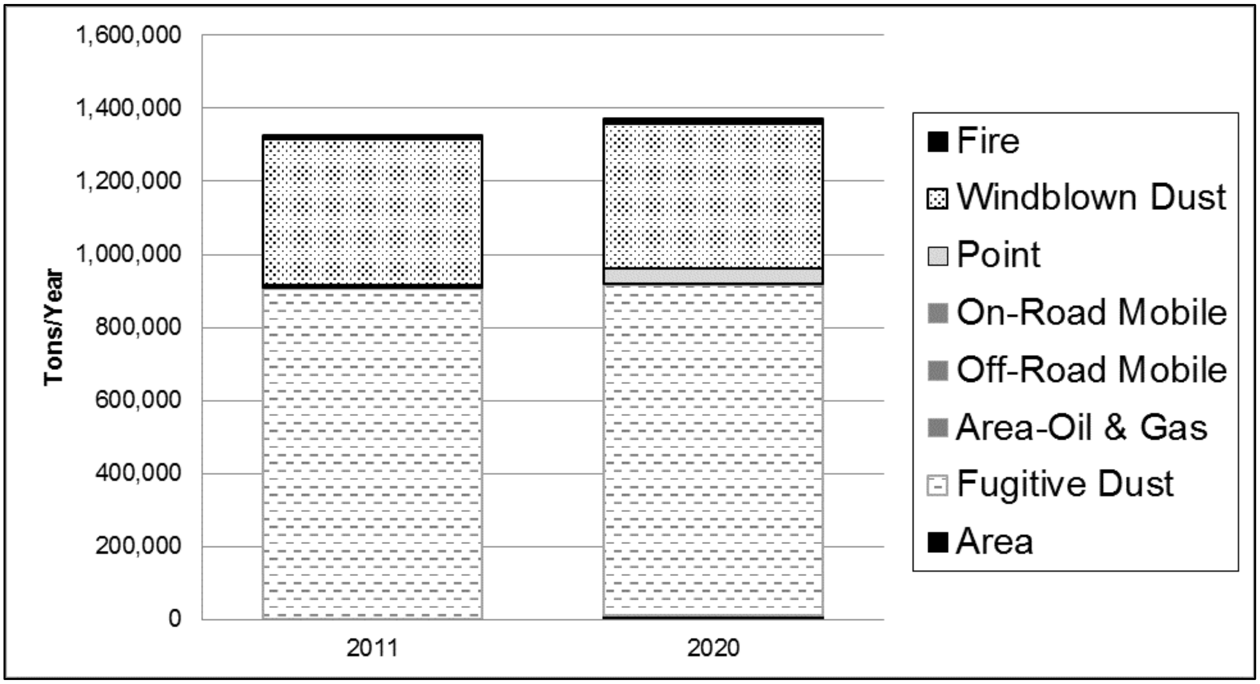

Figure 76. Baseline and projected coarse particulate matter emissions

Note: Fire is the black at the top of the column. Area is the black at the bottom of the column. On and off road mobile and area-oil and gas are combined with the same symbol because they make up a proportion of the total too small to differentiate between them.

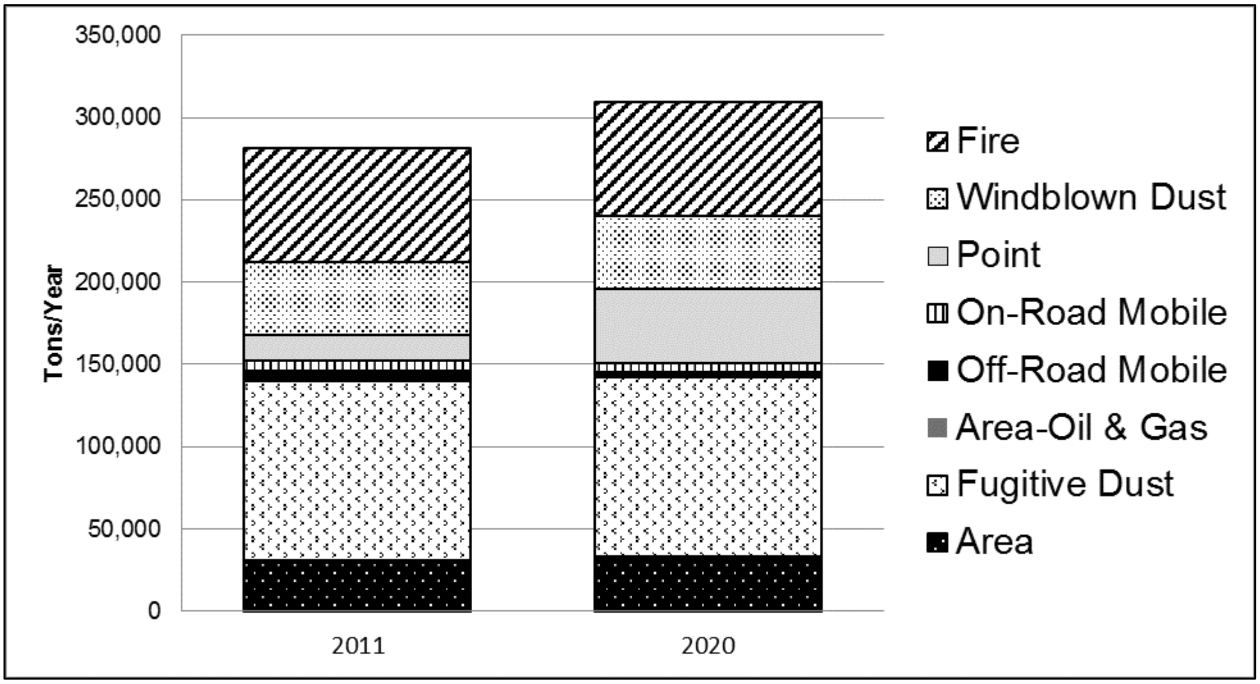

Figure 77. Baseline and projected fine particulate matter emissions

The data demonstrates that the majority of nitrogen oxides, sulfur dioxide and VOCs in the Gila airshed originate from the urban counties containing Phoenix, Tucson, Albuquerque, Las Cruces, El Paso and Ciudad Juarez, or industrial counties with significant oil and gas development or coal-fired power plants (i.e. San Juan County, NM). Particulate emissions are dominated by fire and dust across the entire Gila airshed. There is some uncertainty in the data from Mexico, in that it is only indicated for area, point and on-road mobile sources, while the U.S. data is more finely distinguished.

There is a projected decrease in carbon monoxide and nitrogen oxides emissions through 2020. Most of the reductions come from fewer mobile sources associated with the introduction of lower emissions vehicles over time, cleaner fuels and improved gas mileage. The overall decrease would be greater if it were not partially offset by increases in both point and area sources of emissions from Mexico.

Sulfur dioxide emissions are projected to increase in the Gila airshed, also due to increases in emissions from Mexico. In 2011, point source sulfur dioxide emissions from Mexico accounted for 60 percent of the total emissions and are expected to increase to 75 percent in 2020. Over this same time period, U.S. emissions of sulfur dioxide are expected to decrease by 10 percent.

VOC emissions in the Gila airshed are dominated by biogenic emission sources and are projected to remain fairly stable through 2020. Particulate emissions, both CPM and FPM, are expected to increase slightly. These emissions come from wildfires, prescribed fires, agricultural fires and dust. There is a degree of uncertainty associated with estimating these emissions from year to year, and therefore in the interpretation of any trend. Higher temperatures and persistent drought conditions, such as those predicted to accompany climate change, could lead to an increasing trend (Prospero and Lamb 2003).

Ambient Air Quality

While emissions, or volume of pollutants entering the atmosphere, play an important role in determining overall air quality for a given area, air quality evaluations also consider ambient concentrations of pollutants in the air. The Forest Service uses these concentrations to determine how pollutants, such as particulate matter, nitrogen and sulfur dioxides, and ozone impact Forest resources. The NAAQS and NMAAQs described previously form the basis for the regulatory reference condition used to assess air quality. Where regulatory standards are met, there is no significant departure in terms of air quality.

Ozone Concentrations

Ozone is one of the major components of smog. It is not emitted into the atmosphere, rather it is formed in reactions involving nitrogen oxides and VOCs. Elevated ozone levels can cause breathing problems, trigger asthma, reduce lung function and increase the occurrence of lung disease. It also has potentially harmful effects on vegetation, which is usually the principal threat to wilderness areas. Vegetation may demonstrate elevated ozone levels through yellowing, reduced growth or premature death, although these symptoms are not unique to elevated ozone and may also be responses to insect infestations or disease.

Ozone data have been collected at the Chino Copper Smelter in Hurley, NM near the Gila NF. While this is an industrial site, data likely represent conditions worse than would be expected on the Forest but was chosen because of its close proximity. There is no significant departure from the regulatory reference related to ozone as concentrations have been consistently below the non-attainment thresholds at this site. The smelter was demolished in 2007 and smelting operations are no longer occurring at Chino.

Particulate Matter

Particulate matter measurements in or near the Gila NF are very limited. No FPM data are available as the single monitor set up in Silver City, NM by the EPA was taken down because the values were so consistently low it did not warrant the cost of operating the equipment. CPM data are limited to the station at the Chino Copper Smelter in Hurley, NM with a period of record beginning in 2009. The data show concentrations comply with the NAAQS. There is no significant departure from the regulatory reference in terms of particulate matter.

Nitrogen and Sulfur

Nitrogen oxides and sulfur dioxides occur as the result of fuel combustion, either from industrial or commercial sources such as power generation facilities, aircraft and automobiles. Nitrogen dioxide is the regulated form of nitrogen oxide emissions. Health effects from exposure to elevated concentrations of nitrogen dioxide include inflammation of the airways, and chronic bronchitis in children and other sensitive individuals. No data has been collected on nitrogen dioxide in or near the Gila NF.

Sulfur dioxide emissions are linked to the quality of sulfur in the fuels that are combusted and may also result from smelting and refining of copper ores. Exposure to sulfur dioxide causes changes in pulmonary function, increases in respiratory infections and irritation of the eyes. Monitoring data from the Chino Copper Smelter exists for a period of record beginning in 2000. This monitoring site was influenced, at times, from the emissions of the copper smelter showing elevated levels of sulfur dioxide when the smelter was in operation. Since the smelter was demolished in 2007, concentrations have declined significantly. There is no significant departure from the regulatory reference in terms of nitrogen and sulfur compounds.

Nitrogen oxides and sulfur dioxide are linked to the formation of nitrate and sulfate aerosols, which can have adverse effects on visibility. They are also linked to increases in acid precipitation and acid deposition. Both of these subjects are discussed further following sections.

Visibility

Visibility refers to the conditions that allow the appreciation of the landscape in terms of form, contrast, detail and color of near and distant features. It has been valued going back to the 1977 Clean Air Act amendments, which recognized it as an important value for most wilderness areas by creating the Class I designation. Particulate and gaseous air pollutants may interfere with the observer's ability to see and distinguish these features.

The Interagency Monitoring of Protected Environments (IMPROVE) data for the Gila NF were summarized for the 20 percent haziest and 20 percent clearest days on an annual and monthly basis using a 1995-2014 period of record. The visibility condition that represents the "natural background" goal for Class I areas is based on the emissions summary data provided by the IWDW (2015). These results are displayed in Figure 78 and Figure 79.

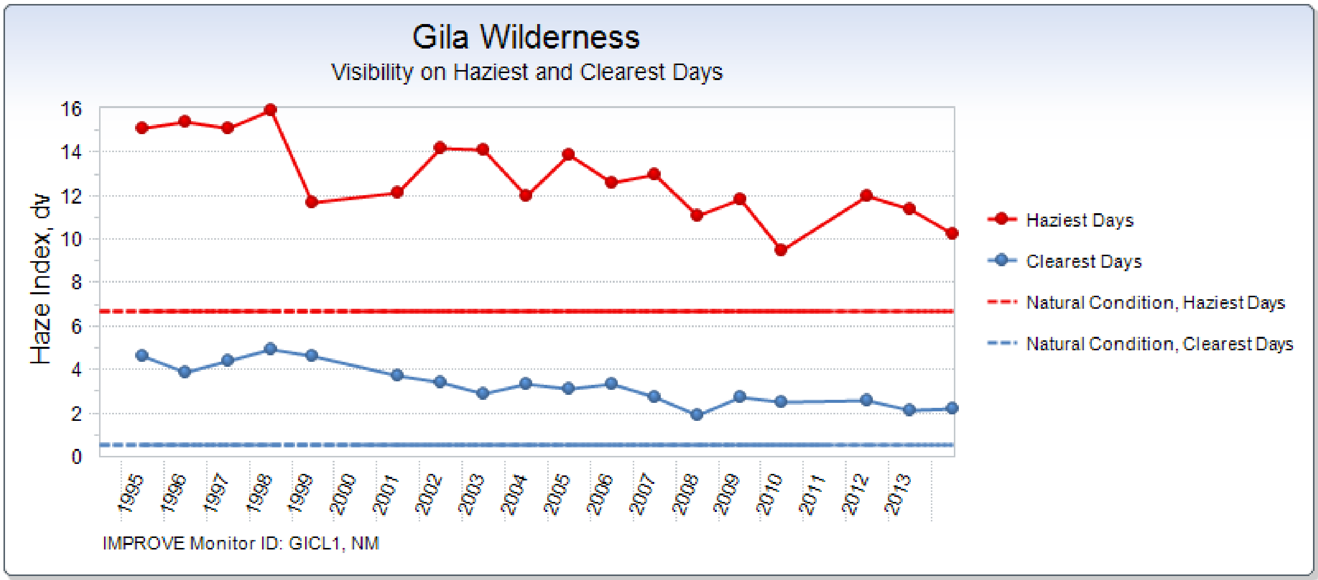

Figure 78. Summary of IMPROVE visibility monitoring data

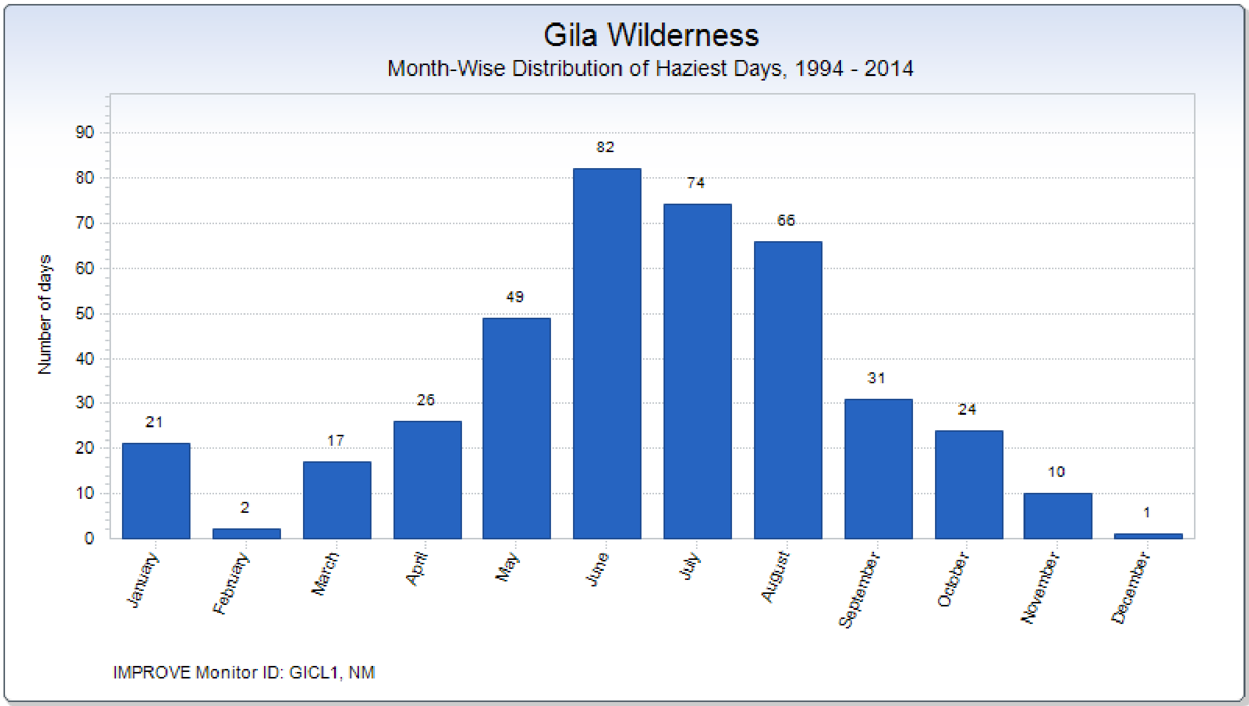

Figure 79. Distribution of haziest days by month

In general, the data show relatively good visibility conditions (13 dv or better), except on the haziest 20 percent of days; however, there is still significant departure in the Gila airshed in terms of visibility. The general trend has been toward moderate improvement. Analysis of the pollutant types and the monthly distribution of their concentrations indicate that the haziest days are the result of wildfire smoke impacting visibility on the Gila NF. There are ongoing discussions between federal land managers, the states, and the EPA regarding how visibility impairments related to wildfire are quantified in relation to human produced pollutants like sulfate and nitrate aerosols.

Atmospheric Deposition

Nitrogen and Sulfur

Air emissions of nitrogen oxides and sulfur dioxide can lead to atmospheric transformation of these pollutants into acidic compounds, such as nitric and sulfuric acids. These acids are deposited onto land and into waterbodies either wet or dry. Wet deposition occurs as acid rain, snow or fog. Dry deposition is a more complex process, but basically occurs as these acidic compounds become associated particulate matter and settle out of the air.

Nitrogen can also be deposited as nitrate or ammonium. These are the forms of nitrogen that are plant nutrients. Increases in nitrogen deposition can “over-fertilize” non-agricultural ecosystems, thereby artificially enhancing the productivity of native and non-native species, increasing system vulnerability to invasive species, and altering species composition and long term patterns of nutrient cycling. Excessive nitrogen deposition also brings with it the potential for nitrate leaching into surface and groundwater. In surface water, this can lead to eutrophication. Nitrate is also toxic to humans at certain concentrations and infants are most vulnerable. Nitrate contamination in groundwater causes “blue-baby syndrome.”

Deposition of nitrogen and sulfur can lead to acidification of lakes, streams and soils, injury to high elevation forests, and changes in terrestrial and aquatic species composition and abundance. High elevation forests are at greater risk because precipitation, and therefore wet deposition, increases with elevation.

Direct measurements of wet nitrogen and sulfur deposition in precipitation were collected between 1985 and 2012 at a monitoring station at the Gila Cliff Dwellings National Monument near the Gila Wilderness. Funding to operate this station was discontinued in 2012. Figure 80 and Figure 81 display the measurements collected at this station. Units are in kilograms per hectare, which is equivalent to approximately 0.9 pounds per acre.

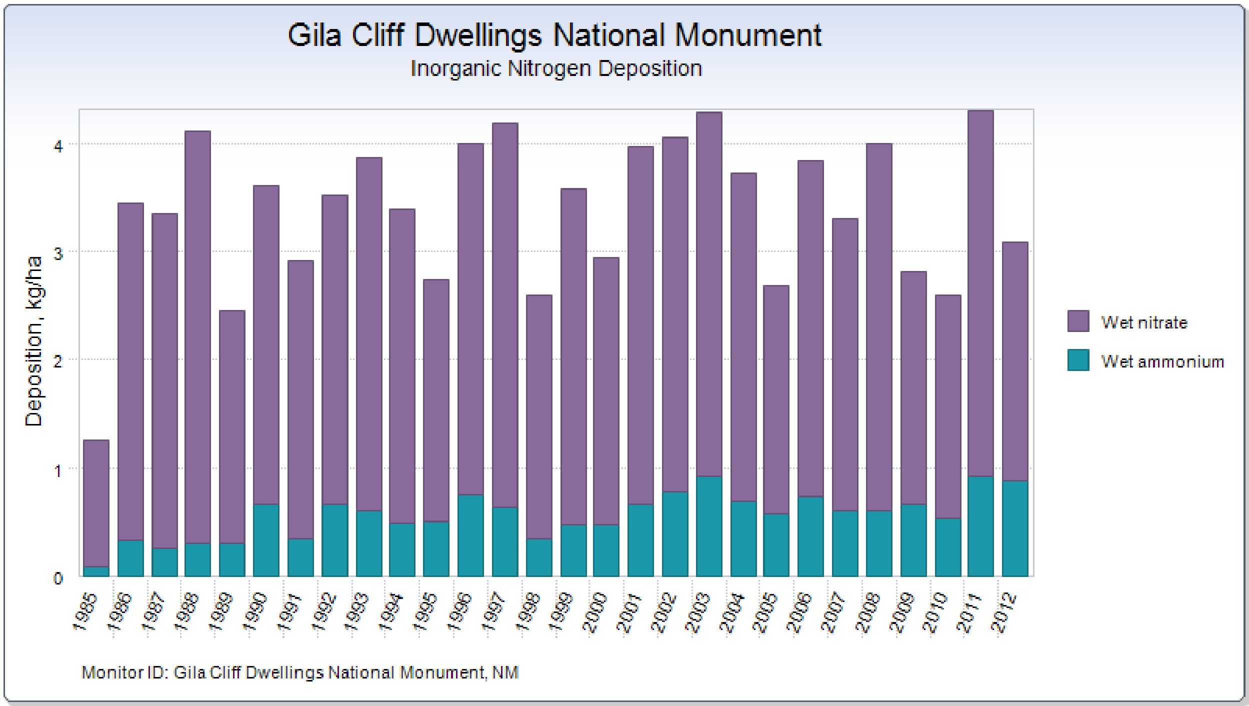

Figure 80. Inorganic nitrogen deposition (Gila Cliff Dwellings National Monument, 1985-2012)

(Data obtained from http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id=NM07&net=NTN)

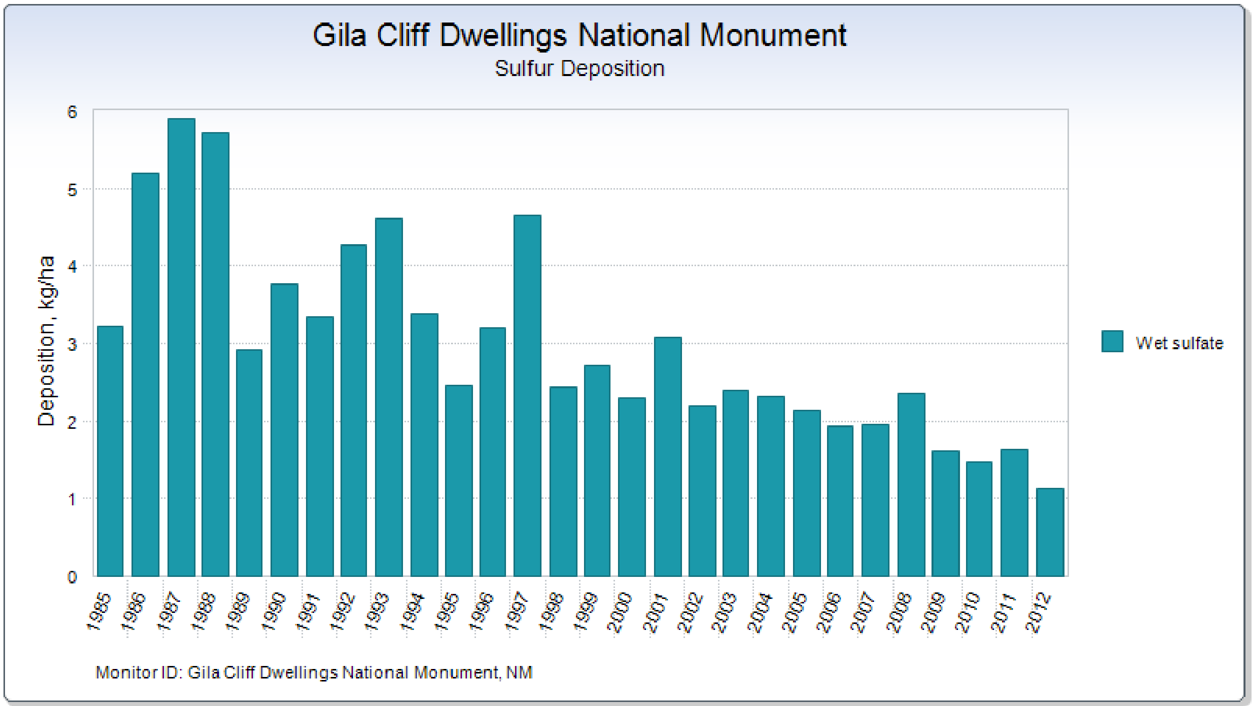

Figure 81. Sulfur deposition (Gila Cliff Dwellings National Monument, 1985-2012)

Over the period of record, wet deposition of nitrogen in the forms of nitrate and ammonium, has remained fairly constant. Sulfur deposition has declined significantly and corresponds with the closure of copper smelting operations at mines adjacent the Gila NF. However, wet deposition does not account for all deposition. While there are no monitoring stations on the Forest to measure dry deposition, such stations exist at the Chiricahua National Monument and Petrified Forest National Park. Data from these stations provide the ability to estimate the proportion of nitrogen and sulfur deposition attributable to dry deposition on the Forest. Figure 82 and Figure 83 display the five year average total wet and/or dry deposition at Oliver Knoll (wet only), Petrified Forest National Park, Chiricahua, and the Gila Cliff Dwelling National Monuments. The variability and range of potential deposition across the Forest is better illustrated by including multiple monitoring locations in and near the Gila National Forest.

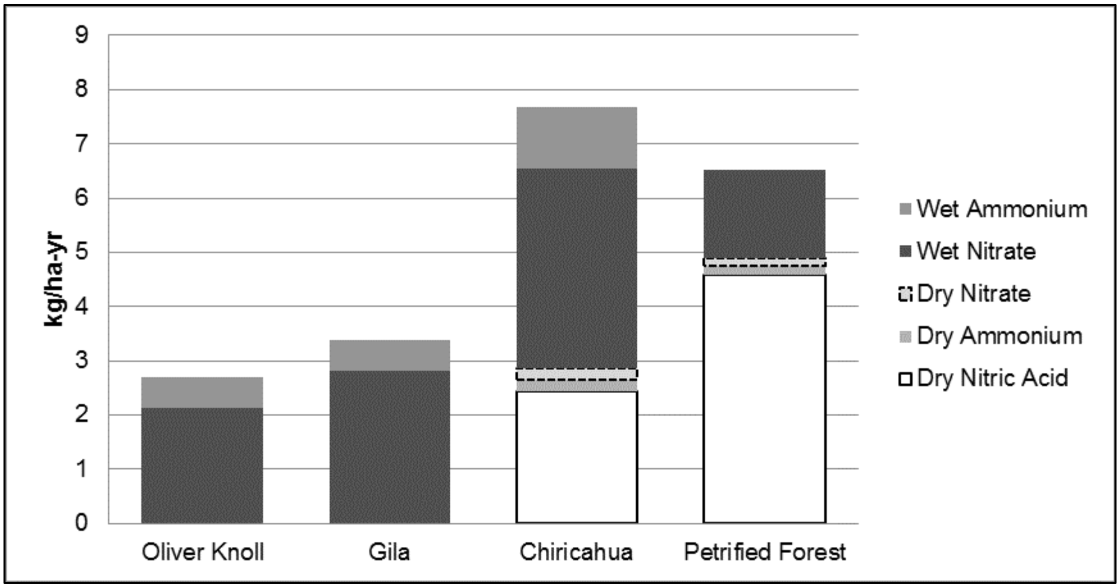

Figure 82. Five year average of total nitrogen deposition at selected sites

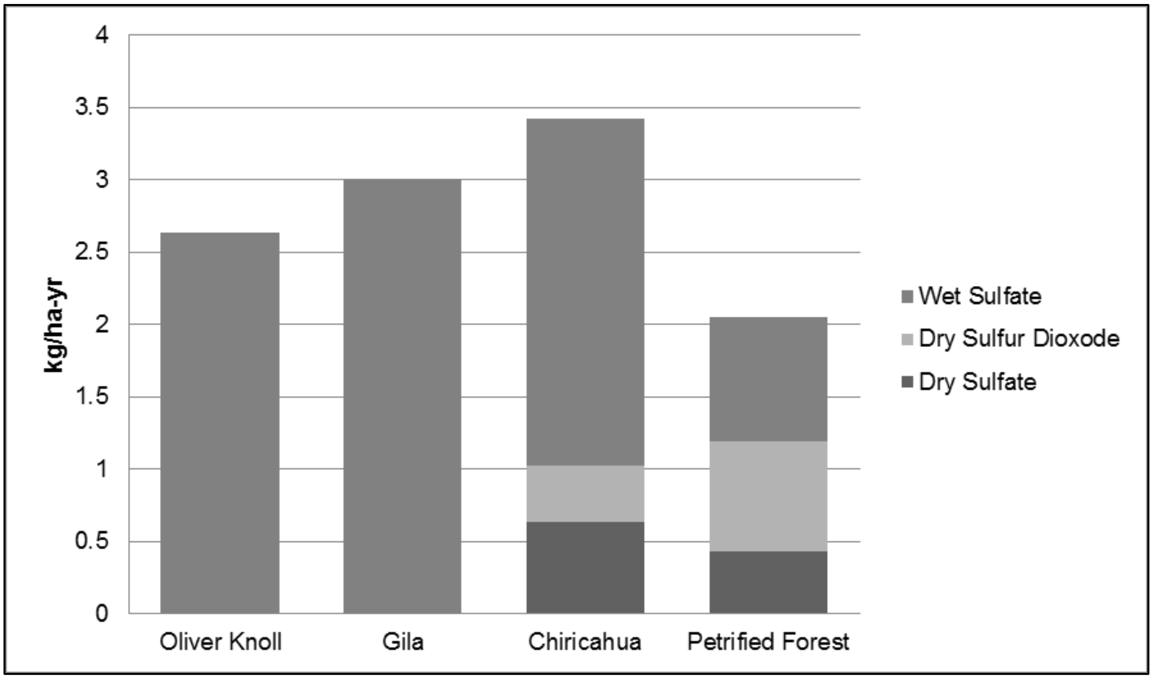

Figure 83. Five year average of total sulfur deposition at selected sites

Examination of the sum of dry and wet deposition at the Petrified National Forest Park and Chiricahua National Monument suggests that 40 to 75 percent of the nitrogen deposition and 30 to 60 percent of the sulfur deposition on the Gila NF likely comes from dry deposition. Considering nitrogen emissions are expected to decrease in the Gila airshed, it is reasonable to expect nitrogen deposition will decrease. Similarly, sulfur deposition can be expected in increase as increases in sulfur emissions from Mexico offset decreases in U.S. emissions.

Mercury

Mercury deposition is an additional concern as it is a persistent toxin which can stay in the environment for long periods of time, cycling between air, water and soil. It is emitted primarily by coal-fired power plants and may be carried thousands of miles before deposition occurs. Similar to nitrogen and sulfur, mercury deposition may be wet or dry. Mercury is transformed by bacteria in aquatic sediments into a neurotoxin that is found in fish. It has detrimental health effects to humans, and behavioral and reproductive impacts to wildlife. However, each person's exposure depends on the amount of this neurotoxin found in the fish they eat, how much fish they eat, and how often. Mercury is subject to bioaccumulation, which means predator fish tend to have higher concentrations than prey fish.

Almost every state, New Mexico included, has consumption advisories for lakes and streams with water quality impairments due to mercury concentrations in fish tissue. These impaired water bodies in and near the Gila NF are identified in Chapter 6: Water. As a result of coal-fired utilities in the Southwest and the limited mercury pollution controls at those sites, the total concentration of mercury in the air is fairly high relative to elsewhere in the U.S. However, wet deposition is relatively low, except at high elevation, because of lower precipitation (MDN 2013).

While it is difficult to assess the current effects that mercury deposition is having on the Gila, since there are no mercury deposition monitors currently operating in the area (the Caballo Mercury Deposition Network monitoring site has not been operational since 2005), there are conflicting trends that suggest overall mercury effects will be stable. New regulatory controls at a few regional coal-fired power plants should reduce the total mercury emissions over the next several years. However, as previously stated, sulfur emissions and deposition are projected to increase. Since the bacteria that transform mercury into a neurotoxin require sulfur, mercury related impacts could foreseeably increase.

Ozone

Ground-level ozone, while not atmospheric deposition in the strictest sense of the word, interferes with the ability of plants to produce and store food and makes them more susceptible to insects, disease, other pollutants, drought and high temperatures. Some plants have been identified as particularly sensitive to the effects of ozone and are reliable indicators of toxic ozone levels. Elevated levels of ozone have not been directly measured on the Gila NF, nor has an assessment of those species sensitive to ozone been conducted.

Critical Loads

Critical loads describe the threshold amount of a pollutant below which no significant harmful effects on specified ecosystem components, such as plants and plant communities, lichens, fungi, soils, etc. Above the critical load, harmful effects attributable to the deposition of pollutants begin to occur. They are based on scientific information about expected ecosystem responses to a given level of atmospheric deposition. For ecosystems damaged by air pollution, critical loads help determine how much improvement in air quality would be needed to provide for recovery. Where they have not been exceeded, critical loads can identify levels of air quality needed to maintain and protect ecosystems into the future.

U.S. scientists, air regulators, and natural resource managers have developed critical loads for areas across the United States. This development includes collaboration with scientists in Europe and Canada. Currently, there are no critical loads specific to the Gila NF. Critical load information is limited to research conducted by Pardo et al. (2011a, 2011b) within the Temperate Sierras and North American Desert ecoregions (CEC 1997). This information pertains to nitrogen and acid deposition.

Nitrogen

Lichens add significantly to the biodiversity of ecosystems and are some of the most sensitive species to nitrogen deposition. Critical loads nitrogen deposition have been developed for lichens in the Temperature Sierras ecoregion and are based on expert judgement (Pardo 2011; Pardo et al. 2011). In 2013 and 2014, The Forest Service and researchers have collected lichen tissue for laboratory analysis at five locations in the Gila Wilderness and six locations in the Aldo Leopold Wilderness. Seven of the nine species analyzed had elevated levels of nitrogen (St. Clair 2014). Based on the available critical load information and the Gila NF lichen analysis results, one percent exceeded the critical load. The minimum amount that the Gila NF exceeded the critical load was 0.03 kilograms per hectare and the maximum was 0.27 kilograms per hectare. Analysis is being conducted on additional samples collected after 2014, as well as on archived samples collected in 1996.

Herbaceous plants and shrubs comprise the majority of the vascular plants in North America (USDA NRCS 2016). They are less sensitive to nitrogen deposition than lichens, but more sensitive than trees due to relatively faster growth rates, shallower roots and shorter life span (Pardo et al. 2011a, 2011b). The shorter lifespan of these species can result in a rapid response to nitrogen deposition and rapid shifts (1-10 years) in community composition. Where invasive species are present, these shifts often favor those species over native species (Pardo et al. 2011a, 2011b). Critical loads from the Temperate Sierras ecoregion for herbaceous plants and shrubs are not available for the Gila NF. However, based on critical loads from the North American Deserts ecoregion, deposition in the range of three to 8.4 kilograms per hectare per year increased biomass of invasive grasses, decreased native forbs and change community composition.

Mycorrhizal fungi reside below the soil surface and have a symbiotic relationship with plants, which means that they occur within and/or closely associated with plant roots. This relationship benefits both the fungi and the plant. Atmospheric deposition of nitrogen in exceedance of the critical loads has been shown to alter community structure and composition, root colonization and decrease species richness (Pardo et al. 2011a, 2011b). There are no critical loads for mycorrhizal fungi and nitrogen deposition on the Gila NF, nor are there literature values to refer to. There is also no critical load for nitrogen deposition and nitrate leaching.

Acid

The potential for impacts related to acid deposition has been recognized in the United States for more than 30 years. Research has shown nitrogen and sulfur deposition can have acidifying effects on soil and water resulting in negative impacts to aquatic resources, forest sustainability, biodiversity and ecosystem health (Driscoll et al 2001; McNulty et al. 2007). The physical and chemical properties of soils that determine its capacity to resist changes in pH are the primary controls on whether or not critical loads are exceeded. Also important is the rate of acid deposition, which is related to the types and amounts of pollutants being emitted. Coniferous forests are generally at higher risk because needles are naturally acidic. Higher elevation also increases risk as more precipitation tends to occur in these areas. Critical loads for acid deposition and an analysis of exceedances have been developed for soils at a national level by McNulty et al. (2007). Critical loads have not been exceeded on the Gila NF (McNulty et al. 2007).

Surface water acidification reduces the abundance and diversity of aquatic species. Many of the same factors discussed in the previous paragraph related to soils influence the susceptibility of aquatic ecosystems to acid deposition. Acidification begins in adjacent terrestrial areas (Pidwirny 2006) and depends on the system's ability to neutralize the acid before it leaches into surface water. Water quality data from NMED indicates there are no waters impaired for pH on the Gila NF (NMED 2014a).

Stakeholder Input

Air quality is important to the Gila NF and the public. Smoke impacts to air quality were the primary topic about which the public raised concerns. The negative effects of smoke on human health were the focus for some who expressed their desire for no burning to occur on the Forest, whether as prescribed fire or wildfire. Others would like to see the Forest approach the state legislature to relax rules for prescribed burns as they tend to generate less smoke and have lower potential for overall ecological damage. In general, the perception of those who provided air quality related input is that air quality is good overall and is potentially improving, except during large, high severity wildfires. After the release of the draft assessment report, an additional comment was received questioning the chosen airshed determined as relevant to the plan area. Clarification regarding the airshed used in this assessment was incorporated into the airshed section of this chapter.

Risk

The ecosystem services provided by air are generally stable and not at risk. Air quality on the Gila NF is within national and state ambient air quality standards. Based on current and projected emissions inventories, the trend appears to be stable or improving for most pollutants with the exception of sulfur dioxide. This is also true regarding visibility conditions from a regulatory perspective because the State is operating under an approved SIP and is on an acceptable trajectory to the goals outlined in the Clean Air Act. The primary challenge could be with regard particulate matter, which can affect both ambient air quality and visibility on the Forest. Land-use, both on and off Forest, climate change and drought can contribute to particulate matter. Wildfires can also be a significant source of particulate matter for short periods of time, but can have significant public health impacts during these episodes.

There are many factors that contribute to the reliability and confidence of an assessment. Typically, a sufficient amount of direct measurements taken over time provide the greatest level of confidence regarding the current state and trends of forest health as it applies to air quality impacts. In the absence of direct measurements, modeled data can be used to assess relative risk of ecological systems to the impact of air pollution. However, this creates a greater degree of uncertainty in the interpretation. Understanding the assumptions in the modeled data and how well they perform on the ground determines the degree of confidence in the interpretation.

There are direct measurements, taken over time, for ambient air quality and visibility, therefore reliability of the assessment is high with regard to these characteristics. However, there is a fair amount of uncertainty associated with the risk that air quality might pose to ecosystem integrity and sustainability due to the very limited data on which to develop Gila NF specific critical loads. Research is weak with regards to assessing critical loads on the Forest and there is significant uncertainty in the assessment regarding the magnitude of impacts from nitrogen deposition. The primary results in the assessment were based on modeled critical loads and have not been verified on the Forest. Lichen studies represent the only direct measure of air pollution impacts. Additionally, the difficulty associated with quantifying dry deposition on complex mountainous terrain in arid climates with very little data (Pardo et al. 2011a, 2011b) contribute to the uncertainty of critical load estimates.

Modeled results also indicate that the levels of acid gases are not at levels significant enough to result in impacts to either soils or surface water. There are no direct measurements on the Forest that indicate otherwise. There is some indication that mercury deposition at higher elevations on the Forest may be significant, however, atmospheric mercury, based on regional emissions, is also expected to decrease. Table 117 provides a summary of air quality related conditions, trends and reliability of those determinations.

Table 117. Summary of conditions, trends, and reliability of assessment

Air Quality Measure	Current Conditions	Trend	Reliability
NAAQS[1]			
Carbon Monoxide	Good	Improving	High
Nitrogen Dioxide	Good	Improving	High
Sulfur Dioxide	Good	Declining	High
Lead	Good	Stable	High
Ozone	Good	Stable	High
FPM	Good	Stable to Declining	High
CPM	Good	Stable to Declining	High
Visibility			
Visibility[2]	Departed	Stable to Improving	High
	Critical Loads- Deposition[3]		
Nitrogen Eutrophication			
Lichens	Low risk	Improving	Low
Herbaceous Plants and Shrubs	Low risk	Improving	Low
Mycorrhizal Fungi	Unknown	Improving	Low
Forests	Unknown	Improving	Low
Nitrate Leaching	Unknown	Improving	Low
Acid Deposition			
Soils	Good	Improving	Low
Surface Water	Low risk	Stable to Improving	Moderate
Deposition (other)			
Mercury	Low risk	Improving	Low
Ozone	Unknown	Unknown	N/A

[1] Relative to NAAQS

[2] Relative to 2064 Regional Haze Goal

[3] Level of risk, is based on the extent of potential impact on the Forest. For example, if models indicate that 98% of the Forest area exceeds nitrogen critical loads for lichens, that would be high risk. While approximately 50% of the forest area exceeds nitrogen critical loads for Mycorrhizal fungi or Forests, this is moderate risk. Break points are 0-33%- Low risk; 34-66%- Moderate risk; and 67-100%- High risk. In some cases, where there is conflicting data, the data is sparse, or has considerable uncertainty, best professional judgement was used to assign risk level.

Summary

Air quality and the values dependent on air quality on the Gila NF are generally in good condition or are improving as most pollutants are decreasing; however, visibility and ambient air quality conditions associated with particulate matter are expected to continue to have episodic periods of very high levels —as a result of wildfires and increases in fugitive dust due to the effects of climate change. Also, impacts from emissions along the US-Mexico border are a significant concern and also an area of significant uncertainty in terms of the magnitude and subsequent impacts. Lastly, modeled critical loads from nitrogen deposition are insufficient to assess the full range of possible impacts to the ecosystems potentially affected.

Chapter 6. Water

Introduction

Water is necessary for the existence of all life. Water exists in soil and groundwater, streams, springs and seeps, wetlands and waterbodies, all of which occur in watersheds. This chapter describes reference and current conditions, and projects future conditions and trends related to key ecosystem characteristics of water within and surrounding the Gila NF. These characteristics include the dominant ecological characteristics that describe the composition, structure, function and connectivity of ecosystems as they relate to water resources. Table 118 lists the characteristics analyzed for this assessment and the metric, or standard of measurement by which it is analyzed.

Table 118. Key water resource characteristics for assessment

Water Resource Characteristic	Metric
Watersheds	Condition
Perennial and Intermittent Streams	Extent and Distribution
Streamflow	Mean and Median Annual Flow High and Low Flow Days Mean Monthly Flow
Surface Water Quality	Regulatory Water Quality Status
Aquatic Biota	Native and Non-Native Fish Species Richness Distribution of Native and Non-Native Fishes
Groundwater	Quantity Extent and Distribution of Springs, Seeps and Wetlands Quality

Each water resource feature is a main heading in this chapter. Under each main heading is a discussion of current and reference conditions, trends, system drivers and stressors, and risk related to each characteristic. Waterbodies are not analyzed as a key ecosystem characteristic because most are constructed features not naturally occurring features on the Forest. Regardless, this chapter does include a main heading and discussion regarding waterbodies because they do have ecological significance. Similarly, groundwater wells are not analyzed as a key ecosystem characteristic, but are briefly discussed because of their socioeconomic and ecological importance. The chapter concludes with stakeholder input received during the assessment concerning water resources, and a summary. This chapter does not include a full treatment of aquatic species (see portions of Chapter 8: At-Risk Species) or riparian resources (see Chapter 7: Riparian) but includes supporting information from those analyses.

Ecosystem Services of Water Resources

Water resources on the Gila NF provide many ecosystem services from which society derives enjoyment or benefit. It provides supporting ecosystem services as primary production, soil formation and nutrient cycling cannot happen without it. Water resource features contribute to provisioning and regulating services by contributing to erosion control, flood regulation, water purification, the production of forage, livestock, and game animals taken for meat, and other products. They also provide many cultural ecosystem services to society as they provide opportunities for recreation, personal enrichment, education and research.

Scales of Analysis

This analysis is based on three watershed scales. Watersheds are defined by the topographic extent of an area that drains to a single point in a stream or river system. Watersheds are cataloged using a uniform hierarchical system developed by the United States Geological Society (USGS). The United States is divided and subdivided into successively smaller hydrologic units. There are six levels of hydrologic units: region (1st level), subregion (2nd level), basin (3rd level), subbasin (4th level), watershed (5th level) and subwatershed (6th level) (USGS 1999). The word "watershed" is therefore both a general term, and a specific categorical term depending on the context it is used in.

Regions can encompass several states. Subwatersheds, the smallest unit, are typically 16,000 to 32,000 acres (25-50 square miles). This analysis uses subbasins for the broadest scale of assessment and watersheds and subwatersheds for the finest scale. The purpose of the broadest scale is to understand the environmental context beyond the Forest to determine the opportunities or limitations for the Gila NF may have to contribute to the sustainability of the larger ecological systems, as well as the impacts of the broader landscape on the sustainability of resources on the Forest. The broad scale is referred to as the context area. The context area includes all subbasins containing at least one subwatershed intersecting the Forest boundary. The fine scale is the referred to as the plan area. The plan area includes all watersheds with at least one subwatershed intersecting the Forest boundary.

Forty nine watersheds compose the plan area totaling approximately 8.4 million acres, of which the Gila NF constitutes 39 percent. Within the plan area watersheds, 202 subwatersheds intersect the Gila NF boundary. These subwatersheds are used to describe plan area watershed conditions on the Gila NF. The context area consists 11 subbasins totaling approximately 19.1 million acres, of which the Gila NF constitutes 17 percent. Table D1 in Appendix D displays subbasin, watershed and subwatershed names, hydrologic unit codes, total acres, Gila NF acres and percent within Forest boundaries. Figure 84 and Figure 85 display the context and plan area respectively relative to the Forest. The local units introduced in Chapter 1: Ecological Integrity and Sustainability are used to explore patterns of risk within the Forest, at a scale common to all ecological analyses.

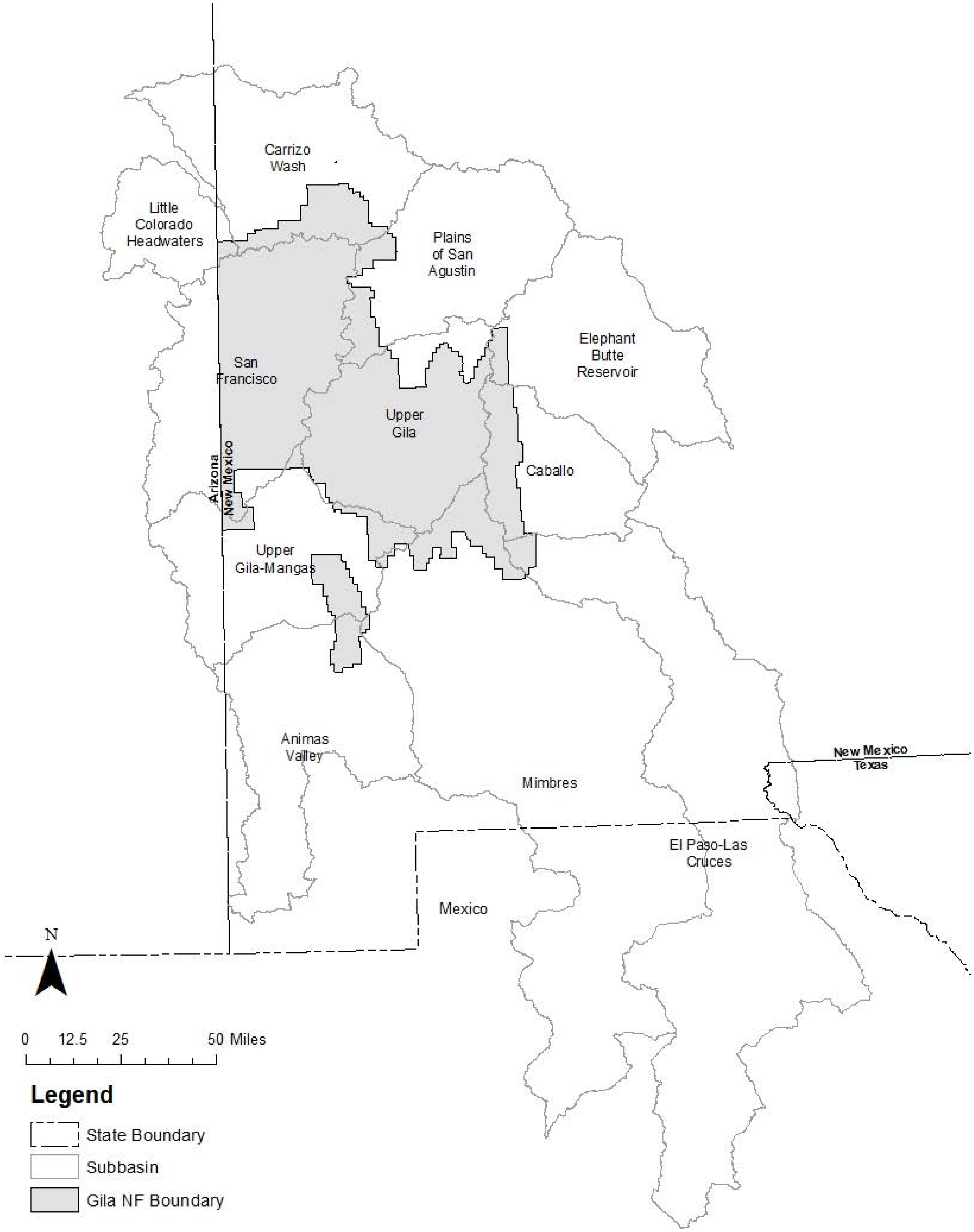

Figure 84. Context area subbasins

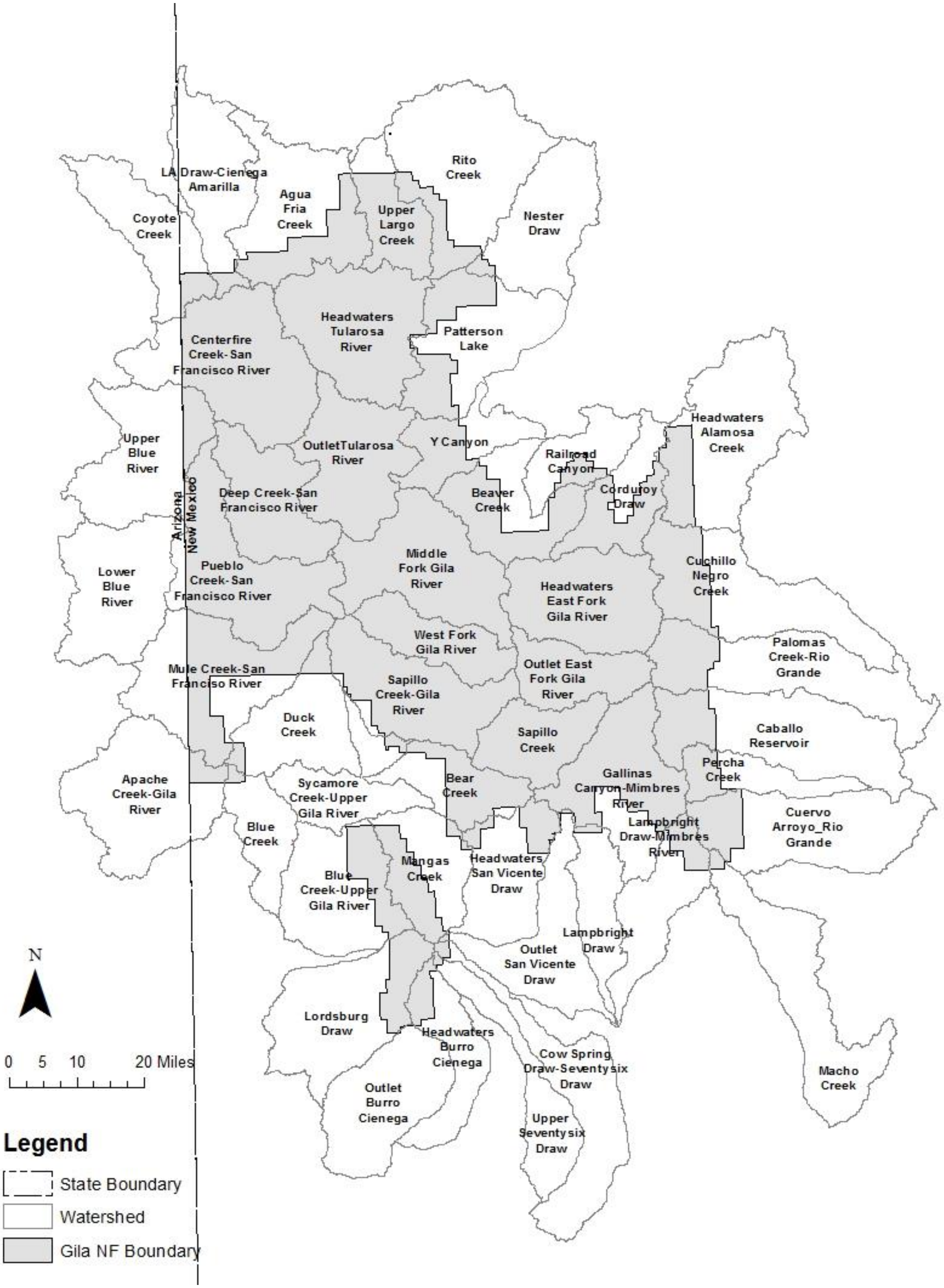

Figure 85. Plan area watersheds

Data

United States Geological Survey (USGS) Watershed Boundary Dataset (WBD) and National Hydrography Dataset (NHD) provide information about the location and extent of watersheds, streams, waterbodies and springs and seeps. USGS streamflow data is also used. Wetland data is provided by United States Fish and Wildlife Service's National Wetlands Inventory. Climate data is provided by the Western Regional Climate Center. The New Mexico Environment Department's Surface Water Quality Bureau (NMED SWQB) is the primary source of water quality information, with the equivalent agencies in Arizona and Texas providing information about water quality for the context scale. Similarly, information about wells was obtained from the New Mexico, Arizona and Texas Offices of the State Engineer. The Gila NF Fire History and Monitoring Trends in Burn Severity (MTBS) datasets provide data related to prescribed fire and wildfire. The watershed condition classification information for the Gila, Apache-Sitgreaves and Cibola National Forests are used throughout this assessment. Fish distribution data was compiled from a variety of sources including Gila NF survey records, NM Department of Game and Fish records, NM Natural Heritage Database, FISHNET database (a global database of fish collections from a multitude of universities, museums, and other organizations), and "The Fishes of New Mexico" (Sublette et al. 1990) which contained information on the historic distributions of New Mexico fish. Additional information was used as indicated by citations throughout this chapter.

Watersheds

Watershed condition describes the status of the physical and biological characteristics and processes within a watershed that affect hydrologic and soil functions supporting aquatic ecosystems. Watersheds that are functioning properly have the following characteristics (Potyondy and Geier 2011).

- They provide for high biotic integrity, which includes habitats that support adaptive animal and plant communities that reflect natural processes.
- They are resilient and recover rapidly from natural and human disturbances.
- They exhibit a high degree of connectivity longitudinally along the stream, laterally across the floodplain and valley bottom, and vertically between surface and subsurface flows.
- They provide important ecosystem services, such as high quality water, the recharge of streams and aquifers, the maintenance of riparian communities, and the moderation of climate variability and change.
- They maintain long-term soil productivity.

Analysis Methods

The Watershed Condition Classification is an interdisciplinary evaluation of watershed condition employed across all National Forest System lands. It offers a systematic, flexible means of classifying watersheds based on a core set of national watershed condition indicators. The classification system utilizes existing data, local knowledge, professional judgment, written rule sets and criteria. Each of the 12 indicators is composed of one or more attributes. The attributes are scored, summed, and averaged to produce indicator scores, which are averaged within four process categories. The overall watershed condition score is then computed as a weighted average of the process category scores. The final score for each subwatershed results in an overall rating of Functioning Properly, Functioning at Risk, or Impaired Function (Potyondy and Geier 2011). The classification is available to the public online at http://apps.fs.fed.us/nfs/nrm/wcatt/WCFMapviewer/; the hydrologic unit codes provided in Appendix D may be useful for navigating the map viewer. Table 119 provides a detailed outline of the model.

Table 119. Watershed Condition Classification model

Aquatic Physical Process Category: 30 percent of weighted average
Water Quality Indicator: addresses the alteration of the physical, chemical and biological components of water quality including 303(d) listings and other water quality issues not resulting in a 303(d) listing
Water Quantity Indicator: addresses changes to the natural streamflow regime with respect to magnitude, duration and timing
Aquatic Habitat Indicator: addresses aquatic habitat condition with respect to habitat fragmentation, large woody debris, and channel shape and function
Aquatic Biological Process Category: 30 percent of weighted average
Aquatic Biota Indicator: addresses distribution, structure and density of native and introduced aquatic fauna
Riparian/Wetland Vegetation Indicator: addresses function and condition of native riparian vegetation along streams, waterbodies and wetlands
Terrestrial Physical Process Category: 30 percent of weighted average
Roads and Trails Indicator: addresses changes to the hydrologic and sediment regimes due to density, location, distribution and maintenance of the road and trail network
Soil Condition Indicator: addresses alteration to natural soil condition, including productivity, erosion and chemical contamination
Terrestrial Biological Process Category: 10 percent of weighted average
Fire Regime/Wildfire Effects Indicator: addresses potential for altered hydrologic and sediment regimes because of departures from natural range of variability in vegetation, fuel composition, fire frequency, fire severity and fire pattern;
Forest Cover Indicator: addresses the potential for altered hydrologic and sediment regimes because of the loss of forest cover on Forest lands;
Forest Health Indicator: addresses forest mortality impacts to hydrologic and soil function due to major invasive and native forest pests, insect and disease outbreaks and air pollution;
Terrestrial Invasive Species Indicator: addresses potential impacts to soil, vegetation and water resources due to terrestrial invasive species including vertebrates, invertebrates, and plants;
Rangeland Vegetation Indicator: addresses impacts to soil and water relative to the vegetative health of rangelands.

There are 202 subwatersheds within the plan area. Watershed condition classifications are available for 189. These classifications describe 46 of the 49 plan area watersheds and more than 99 percent of the Forest. No condition classification data are available for Outlet San Vincente Draw, Upper Seventysix Draw, or Outlet Burro Cienega.[21] The initial watershed condition classification was conducted in 2011. This classification was updated in 2016 to reflect changed conditions as a result of the significant wildfires the plan area has experienced since that time. The 2016 classification is used for this assessment.[22]

It is assumed that most watersheds would have been within their functional limits prior to European settlement. Therefore, the reference condition for watershed condition is defined as Functioning Properly with Functioning at Risk and Impaired Function classifications representing a departure from the reference. Subwatershed condition classifications are area weighted to the watershed level to describe

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[21] A five percent area within the Gila NF threshold was used to determine which subwatersheds would be classified based on the assumption that below this percentage, the effects of Gila NF land management on overall condition were not significant. The Gila NF contains five percent or more of 181 of these subwatersheds and classified all but one. This subwatershed was classified by the Cibola National Forest (Cibola NF) because a larger percentage occurs within Cibola NF boundaries. The remaining eight subwatersheds were classified by the Apache-Sitgreaves National Forests (Apache-Sitgreaves NFs) for the same reason, and although less than five percent of those subwatersheds occurs on the Gila NF, collaborative management by both Forests does represent a significant contribution to overall watershed condition. The 13 subwatersheds with no condition classification represent less than one percent of the Forest.

[22] The Gila NF updated its initial classification in 2016. All subwatersheds that experienced fire of any severity across 1000 acres or more of its area were re-classified, including those impacted by the 2012 Whitewawter Baldy Complex, 2013 Silver Fire, and 2014 Signal Fire. The Apache-Sitgreaves NFs updated their classification following 2011 Wallow Fire. Those subwatersheds classified by the Cibola NF have not been updated, but have not experienced a large scale disturbance that might warrant re-classification.

the variability in conditions within plan area watersheds. The condition classification representing the largest proportion of the watershed area is then used to assign a single condition class to that watershed. This same procedure is repeated at the subbasin scale, using the subwatershed condition classification that represents the largest proportion of the subbasin area to describe the context area. Information suitable for assessing trend is not available. Risk is a direct interpretation of the watershed condition classification. Individual indicator and attribute scores are not assessed here in terms of departure, but are discussed in terms of explanatory value relative to overall watershed conditions, as they exist under current management.

Plan Area

The variability in current watershed conditions across the plan area is displayed below in Table 120 .

Table 120 . Current watershed conditions and departure across the plan area.

	Subwatershed Condition Class			
Watershed Name	**Functioning Properly (% of Watershed Area)**	**Functioning At Risk (% of Watershed Area)**	**Impaired Function (% of Watershed Area)**	**Overall Watershed Condition Class**
Plains of San Agustin Subbasin				
Nester Draw	100%	0%	0%	Functioning Properly
Patterson Lake	100%	0%	0%	Functioning Properly
Y Canyon	100%	0%	0%	Functioning Properly
Elephant Butte Reservoir Subbasin				
Headwaters Alamosa Creek	58%	42%	0%	Functioning Properly
Caballo Subbasin				
Caballo Reservoir	14%	27%	60%	Impaired Function
Cuchillo Negro Creek	29%	71%	0%	Functioning at Risk
Palomas Creek-Rio Grande	20%	80%	0%	Functioning at Risk
Percha Creek	0%	100%	0%	Functioning at Risk
El Paso-Las Cruces Subbasin				
Cuervo Arroyo-Rio Grande	42%	58%	0%	Functioning at Risk
Mimbres Subbasin				
Cow Spring Draw-Seventysix Draw	0%	100%	0%	Functioning at Risk
Gallinas Canyon-Mimbres River	8%	69%	23%	Functioning at Risk
Headwaters San Vicente Draw	0%	100%	0%	Functioning at Risk
Lampbright Draw	0%	100%	0%	Functioning at Risk
Lampbright Draw-Mimbres River	40%	60%	0%	Functioning at Risk
Macho Creek	100%	0%	0%	Functioning Properly

Watershed Name	Subwatershed Condition Class			Overall Watershed Condition Class
	Functioning Properly (% of Watershed Area)	Functioning At Risk (% of Watershed Area)	Impaired Function (% of Watershed Area)	
Little Colorado Headwaters Subbasin				
Coyote Creek	21%	79%	0%	Functioning at Risk
Carrizo Wash Subbasin				
Agua Fria Creek	100%	0%	0%	Functioning Properly
LA Draw-Cienega Amarilla	0%	100%	0%	Functioning at Risk
Rito Creek	100%	0%	0%	Functioning Properly
Upper Largo Creek	45%	55%	0%	Functioning at Risk
Upper Gila Subbasin				
Beaver Creek	100%	0%	0%	Functioning Properly
Corduroy Draw	100%	0%	0%	Functioning Properly
Headwaters East Fork Gila River	51%	49%	0%	Functioning at Risk
Middle Fork Gila River	10%	76%	14%	Functioning at Risk
Outlet East Fork Gila River	28%	72%	0%	Functioning at Risk
Railroad Canyon	100%	0%	0%	Functioning Properly
Sapillo Creek	65%	35%	0%	Functioning Properly
Sapillo Creek-Gila River	23%	58%	19%	Functioning at Risk
West Fork Gila River	0%	100%	0%	Functioning at Risk
Upper Gila-Mangas Subbasin				
Apache Creek-Gila River	0%	100%	0%	Functioning at Risk
Bear Creek	33%	67%	0%	Functioning at Risk
Blue Creek	100%	0%	0%	Functioning Properly
Blue Creek-Upper Gila River	18%	82%	0%	Functioning at Risk
Duck Creek	33%	67%	0%	Functioning at Risk
Mangas Creek	22%	78%	0%	Functioning at Risk
Sycamore Creek-Upper Gila River	0%	100%	0%	Functioning at Risk
Animas Valley Subbasin				
Headwaters Burro Cienega	0%	100%	0%	Functioning at Risk
Lordsburg Draw	0%	100%	0%	Functioning at Risk
San Francisco Subbasin				
Centerfire Creek-San Francisco River	0%	91%	9%	Functioning at Risk
Deep Creek-San Francisco River	17%	83%	0%	Functioning at Risk

Watershed Name	Subwatershed Condition Class Functioning Properly (% of Watershed Area)	Functioning At Risk (% of Watershed Area)	Impaired Function (% of Watershed Area)	Overall Watershed Condition Class
Headwaters Tularosa River	22%	78%	0%	Functioning at Risk
Lower Blue River	100%	0%	0%	Functioning Properly
Mule Creek-San Francisco River	35%	45%	20%	Functioning at Risk
Outlet Tularosa River	18%	65%	17%	Functioning at Risk
Pueblo Creek-San Francisco River	7%	35%	58%	Impaired Function
Upper Blue River	9%	89%	2%	Functioning at Risk

Recall that not all indicators are given the same weight, which means a subwatershed may be considered Functioning Properly overall, but may have indicators that are rated Functioning at Risk or even Impaired Function. Likewise, subwatersheds that are considered Functioning at Risk or Impaired Function overall, may have indicators that are considered Functioning Properly. Figure 86 through Figure 97 display the indicator ratings and percentage of subwatersheds in each category, followed by a discussion of these ratings and their contributions to departure at the Forest and watershed scale.

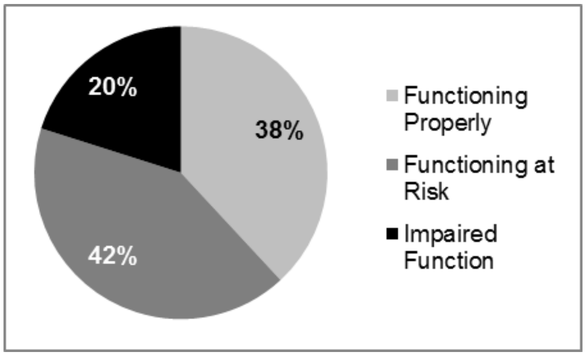


Figure 86. Aquatic Biota Indicator

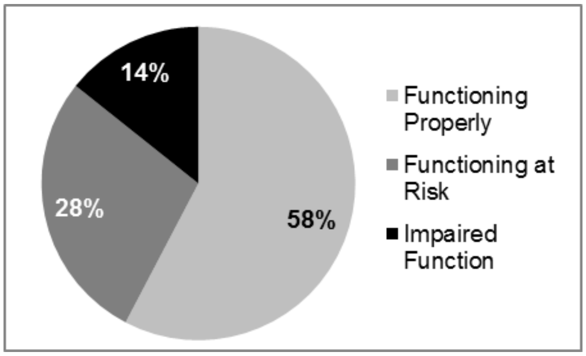


Figure 88. Water Quantity Indicator

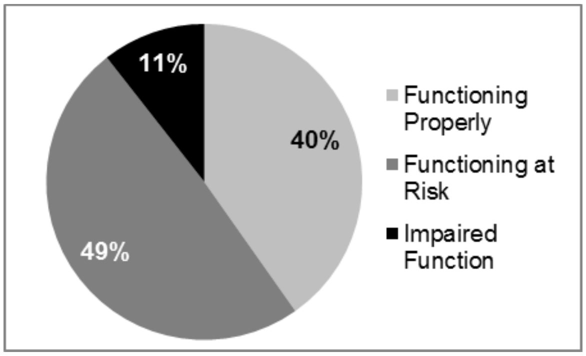


Figure 87. Riparian/Wetland Vegetation Indicator

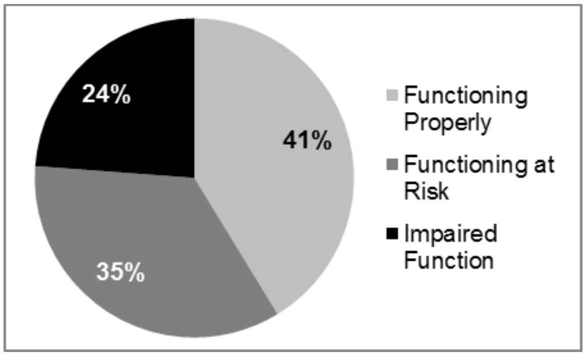


Figure 89. Aquatic Habitat Indicator

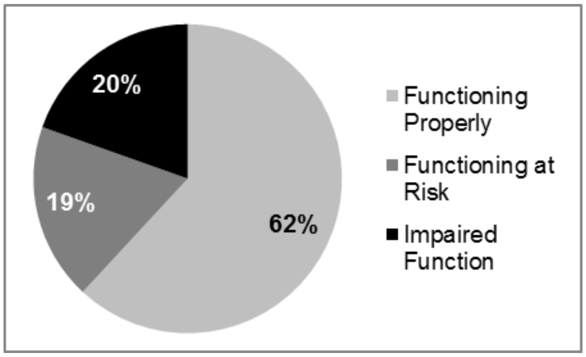


Figure 90. Water Quality Indicator

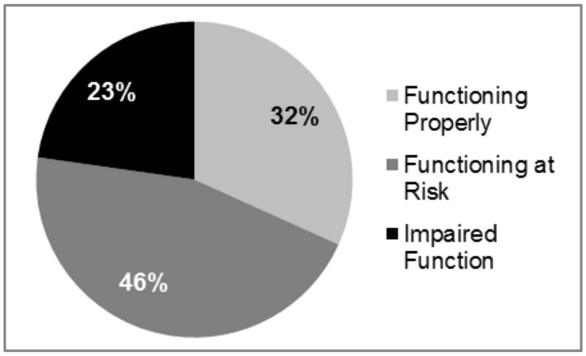


Figure 91. Soil Condition Indicator

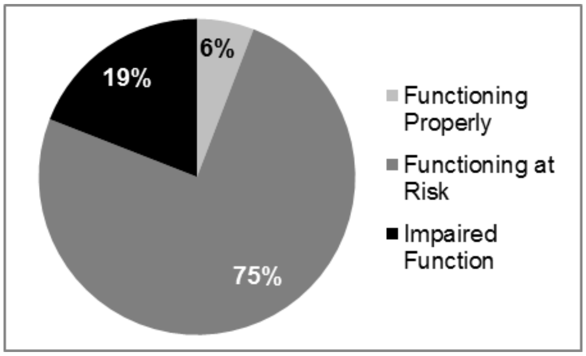


Figure 92. Fire Regime/Wildfire Effects Indicator

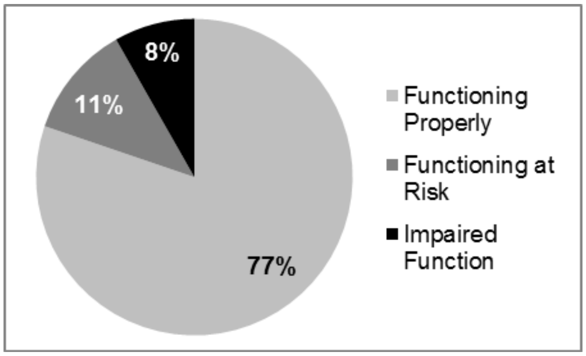


Figure 93. Forest Cover Indicator

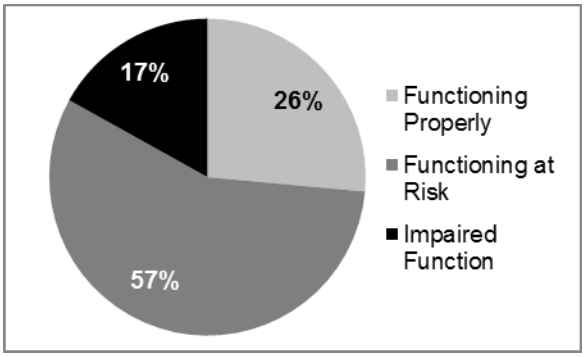


Figure 94. Roads and Trails Indicator

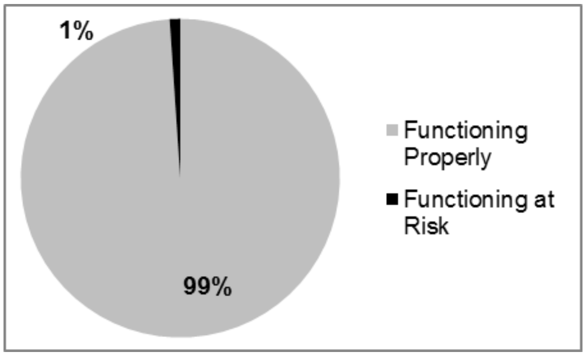


Figure 95. Forest Health Indicator

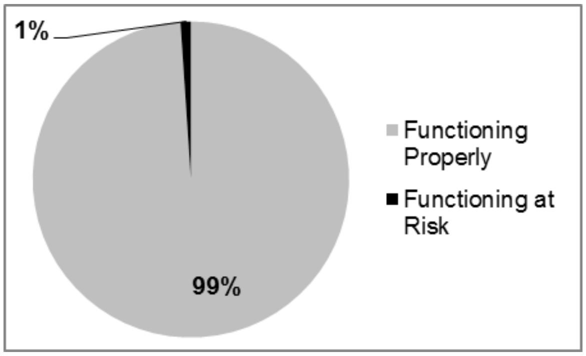


Figure 96. Terrestrial Invasive Species Indicator

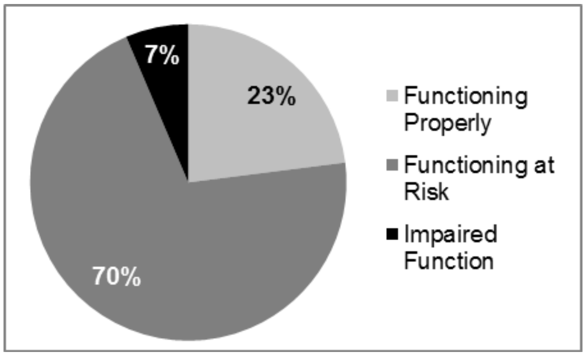


Figure 97. Rangeland Vegetation Indicator

Looking at the subwatershed indicator ratings and the rationales behind them allows for the interpretation of the causes behind departure in watershed condition at the Forest level. The rationale for these indicator ratings are documented at http://apps.fs.fed.us/nfs/nrm/wcatt/WCFMapviewer/. The indicators given the most weight in the 12 indicator model, and therefore largely responsible for the overall subwatershed classification are: aquatic biota, aquatic habitat, riparian/wetland vegetation, water quality, water quantity, soil condition and roads and trails. Less than half of the Forest's subwatersheds are Functioning Properly in terms of aquatic biota (Figure 86), aquatic habitat (Figure 89) and riparian/wetland vegetation (Figure 87).

The riparian/wetland vegetation indicator is considered Functioning Properly if "native mid to late seral vegetation appropriate to the site's potential dominates the plant communities and is vigorous, healthy, and diverse in age, structure, cover and composition on more than 80 percent of the riparian/wetland areas in the watershed…" and reproduction of native species is occurring such that sustainability is ensured and the vegetation is supported by the properly functioning hydrologic characteristics of the particular stream or wetland system (Potoyndy and Geier 2011). Functioning at Risk ratings reflect a moderate loss of these characteristics with limited areas displaying significant impacts. An indicator rating of Impaired Function indicates 25 percent or less of the riparian/wetland areas in the watershed display the characteristics described as Functioning Properly.

According to the rationale documented in the Gila NF classification, 23 of the 113 subwatersheds rated Functioning at Risk or Impaired Function in terms of riparian/wetland vegetation (Figure 87) are limited in their ability to support these vegetation communities due to the lack of perennial or intermittent surface or subsurface water. Approximately 67 of the 76 subwatersheds that are Functioning Properly (Figure 87) are also limited in their ability to support riparian/wetland vegetation, leaving approximately 98 subwatersheds across the Forest that were not considered as limited by water in their ability to support these vegetation communities. This indicator score was given a lower weight (less than two percent) in all subwatersheds limited by available water so that the overall classification is not significantly influenced. However, this means that just nine percent of the Forest's subwatersheds that currently have the water to support riparian/wetland communities are Functioning Properly, 29 percent are Functioning at Risk or Impaired Function due to fire and/or post-fire effects, and 10 percent are rated Functioning at Risk or Impaired Function due to the cumulative effects of relatively small irrigation diversions that lead to drying of the system. The remaining 52 percent are Functioning at Risk or Impaired Function due to the effects of drought, rising temperatures, roads and motorized trails, and/or herbivory by wildlife and livestock. More than 10,600 acres of riparian are currently excluded from livestock grazing (see Chapter 9: System Drivers and Stressors for more information).

Patterns in the aquatic habitat indicator closely mirror those found in the riparian/wetland vegetation indicator, as available water and its distribution affect habitat quality and connectivity. An aquatic habitat rating of Functioning Properly means that "the watershed supports large continuous blocks of high-quality aquatic habitat and high-quality stream channel conditions" (Potoyndy and Geier 2011). Ratings of Functioning at Risk indicate "the watershed supports medium to small blocks of contiguous habitat. Some high-quality aquatic habitat is available, but stream channel condition show signs of being degraded" (Potoyndy and Geier 2011). Impaired Function ratings meant that "the watershed supports small amounts of continuous high-quality habitat. Most stream channel conditions show evidence of being degraded by disturbance" (Potoyndy and Geier 2011). There is a higher percentage of subwatersheds that are Functioning at Risk or Impaired Function (Figure 87 and Figure 89) because the aquatic habitat indicator considers stream channel shape and function, which the watershed condition classification model does not directly consider for riparian/wetland vegetation (Table 119). Large woody debris remains important to aquatic habitat, but is less of a contributing factor to departure in most subwatersheds. This indicator was also given a lower weight where there is not enough water to support aquatic habitat.

Available water limits the potential for riparian/wetland vegetation and aquatic habitat, but represents an even greater limitation to the aquatic biota indicator. Approximately 30 percent of subwatersheds rated Functioning at Risk or Impaired Function lack sufficient water to support aquatic biota, as opposed to the 20 percent that are water limited with respect to riparian/wetland vegetation. An additional factor contributing to departure in the aquatic biota indicator is that non-native species are present in approximately 70 percent of subwatersheds that support aquatic biota and are out-competing natives in approximately 38 percent of these. Aquatic biota are analyzed as an ecosystem characteristic later in this chapter.

The water quantity indicator is intended to capture significant changes in streamflow due to water diversions, water controls or wildfire. Water controls (e.g. dams and berms in drainages), or cumulative effects of relatively small irrigation diversions or controls are responsible for just over a quarter of the 42 percent of all subwatersheds rated as Functioning at Risk or Impaired Function with respect to this indicator (Figure 88) with wildfire effects responsible for the remainder.

Of subwatersheds rated Functioning at Risk or Impaired Function with respect to the water quality indicator (Figure 90), 23 contain streams that are not meeting State water quality standards for one or more reasons (i.e. 303(d) listed). Other water quality issues not resulting in 303(d) listings are primarily sediment and temperature related. Wildfire effects resulted in negative changes to this indicator score in 42 subwatersheds between the Gila NF's initial 2011 classification and 2016 update.

The roads and trails indicator scores reflect the attributes of road density, maintenance and proximity to water of all motorized linear transportation features. All of these attributes were identified issues in subwatersheds rated Functioning at Risk or Impaired Function. Lack of road maintenance is the largest concern across the Forest in terms of these attributes, followed by proximity to water and road density. Of the 26 percent of subwatersheds that are rated Functioning Properly (Figure 94), most are located primarily or entirely within wilderness areas.

Of the 69 percent of subwatersheds with soil condition indicator ratings of Functioning at Risk or Impaired Function (Figure 91), all are experiencing some degree of accelerated erosion and decreased productivity. This is due to fire effects in 38 subwatersheds. Soil condition, soil loss and productivity are discussed in further detail in Chapter 4: Soil. Soil contamination risk has been identified as an issue in approximately 38 percent subwatersheds with the risk of atmospheric deposition of nutrient nitrogen and/or acidic compounds being cited as the reason in most cases. Atmospheric deposition and contamination are discussed in further detail in Chapter 4: Soil and Chapter 5: Air. The contamination risk due to atmospheric deposition was rated for the Gila NF by the USDA Forest Service Washington Office. Old mines are the second most common risk factor (8 percent), with leaky underground fuel tanks and old landfills account for one percent each.

The fire regime/wildfire effects indicator scores (Figure 92) are affected by the Fire Regime Condition Class (FRCC) and or wildfire effects, not both (Potyondy and Geier 2011). FRCC is a departure rating from the historic range of variability in fuel composition, fire frequency, severity and pattern with low, moderate and high categories. Subwatersheds that are Functioning Properly with respect to this indicator (Figure 92) have a predominantly low departure from the natural fire regime or wildfire effects such that they are expected to recover in one to two years. Subwatersheds that are rated Functioning at Risk (Figure 92) with respect to this indicator are considered moderately departed from the historic fire regime or wildfire effects such that some increase in erosion and runoff are a concern, but long-term watershed integrity is not at risk. Recovery from wildfire effects is expected in two to five years. Subwatersheds that are considered Impaired Function (Figure 92) are highly departed from the natural fire regime or post-fire effects persist longer than five years and are a threat to long-term watershed integrity. All Impaired

Function ratings are due to wildfire effects. Of the Functioning at Risk ratings, approximately half are due to wildfire effects with the remainder being due to departures in the historic fire regime.

The forest cover indicator scores are affected by stand replacement fire or any other management activity that reduces forest cover. The 19 percent of subwatersheds that are Functioning at Risk or Impaired Function with respect to this indicator correspond directly to those subwatersheds rated as Impaired Function for the fire regime/wildfire effects indicator (Figure 93).

Although 99 percent of subwatersheds are rated Functioning Properly with respect to the forest health indicator (Figure 95), instances of insects and disease do occur on the Forest (see Chapter 2: Upland Vegetation and Chapter 9: System Drivers and Stressors for more information). The indicator rating reflects the degree of tree mortality expected or occurring due to insects, disease or air pollution. The Functioning Properly rating was assigned if these issues were present in less than 20 percent of the subwatershed. A rating of Functioning at Risk indicates problems in 20 to 40 percent of the subwatershed and Impaired Function indicates problems in more than 40 percent. No subwatersheds are rated Impaired Function for forest health and only two were rated Functioning at Risk. Some known issues, such as dwarf mistletoe infestation were not reflected in the ratings due to insufficient data. While this watershed scale assessment of insects and disease is not directly comparable to the Ecological Response Unit (ERU) scale analysis in Chapter 2: Upland Vegetation, at the Forest scale, the results validate each other.

In general, terrestrial invasive species are not well established on the Gila NF as compared to other forests in the Southwest. However, formal survey data is limited. This indicator relied primarily on local knowledge of existing populations. Ninety nine percent of subwatersheds are currently considered Functioning Properly with respect to this indicator (Figure 96). In the one percent rated Functioning at Risk, populations of bull thistle are identified the cause. While other invasive species may exist across the Forest, their populations are not known to meet the criteria that would move a subwatershed into a Functioning at Risk or Impaired Function rating. Invasive species are discussed further in Chapter 2: Upland Vegetation, Chapter 7: Riparian, and Chapter 9: System Drivers and Stressors.

The rangeland vegetation indicator was scored by District range specialists referencing available data collected at permanent range monitoring sites, the national ruleset provided in the technical guide (Potyondy and Geier 2011) and professional judgement to rate this indicator. Range condition data scores sites into very poor, poor, fair, good and excellent condition categories as identified by the Parker 3-step protocol. For the watershed condition assessment, ratings were averaged to each subwatershed with very poor and poor range condition categories being equated with Impaired Function indicator ratings, fair with Functioning at Risk, and good and excellent being equated with Functioning Properly indicator ratings. While the range data includes trend analysis, the watershed condition classification does not provide a means to report trends; therefore trends were not assessed at the watershed scale. According to this data, 23 percent of subwatersheds are Functioning Properly, 70 percent are considered Functioning at Risk and 6 percent are Impaired Function (Figure 97). Range condition is discussed further in Chapter 11: Multiple Use.

Two watersheds are Impaired Function overall: Pueblo Creek-San Francisco River and Caballo Reservoir (Table 120). In Pueblo Creek-San Francisco River, part of this departure is due to changes in most indicator ratings in three subwatersheds as a result of the 2012 Whitewater Baldy Complex Fire. However, there are issues in this watershed that predate the Whitewater Baldy Complex Fire and analysis methods would still have shown a high departure in watershed condition. Pre-Whitewater Baldy, roads and trails, soil condition and rangeland vegetation indicator ratings were Functioning at Risk or Impaired Function in most subwatersheds and aquatic habitat fragmentation and nonnative aquatic species were identified issues as well. Pre-fire, all subwatersheds were associated with a moderate departure from the historic fire regime (Functioning at Risk). Post-fire, this remains the case where this indicator isn’t rated Impaired Function because of the Whitewater Baldy Complex Fire. The 2013 Silver Fire had similar effects to indicator ratings in Caballo Reservoir. Prior to the Silver Fire, analysis methods would have depicted low departure in this watershed.

Context Area

In terms of watershed condition, opportunities and limitations are determined by the percentage of subbasin area located within the Gila NF. Table 121 displays the subbasin extent and percentage occurring on Forest for the 11 context area subbasins.

Table 121. Context area subbasin extent and Gila NF percent

	Subbasin Area		
Subbasin Name	**Total (acres)**	**Gila NF (acres)**	**% On Gila NF**
Plains of San Agustin	1,275,453	135,981	11
Elephant Butte Reservoir	1,403,516	40,451	3
Caballo	795,153	211,635	27
El Paso-Las Cruces	3,542,482	37,572	1
Mimbres	4,283,488	210,291	5
Little Colorado Headwaters	515,246	13,510	3
Carrizo Wash	1,446,531	197,142	14
Upper Gila	1,269,561	1,069,298	84
Upper Gila-Mangas	1,311,302	198,660	15
Animas Valley	1,449,526	59,574	4
San Francisco	1,793,569	1,097,383	61
Totals	**19,085,827**	**3,271,497**	**17**

Continuing with the five percent area threshold to determine which subwatersheds were classified, the Gila NF's ability to contribute to sustainability is limited to those subbasins with five percent or more occurring on National Forest System lands. The Gila NF alone constitutes five percent or more of Plains of San Agustin, Caballo, Mimbres, Carrizo Wash, Upper Gila, Upper Gila-Mangas and San Francisco subbasins. When including Apache-Sitgreaves and Cibola NFs, National Forest System lands constitute more than five percent of the Little Colorado Headwaters and Elephant Butte Reservoir subbasins. Figure 98 summarizes current conditions at the subbasin scale.

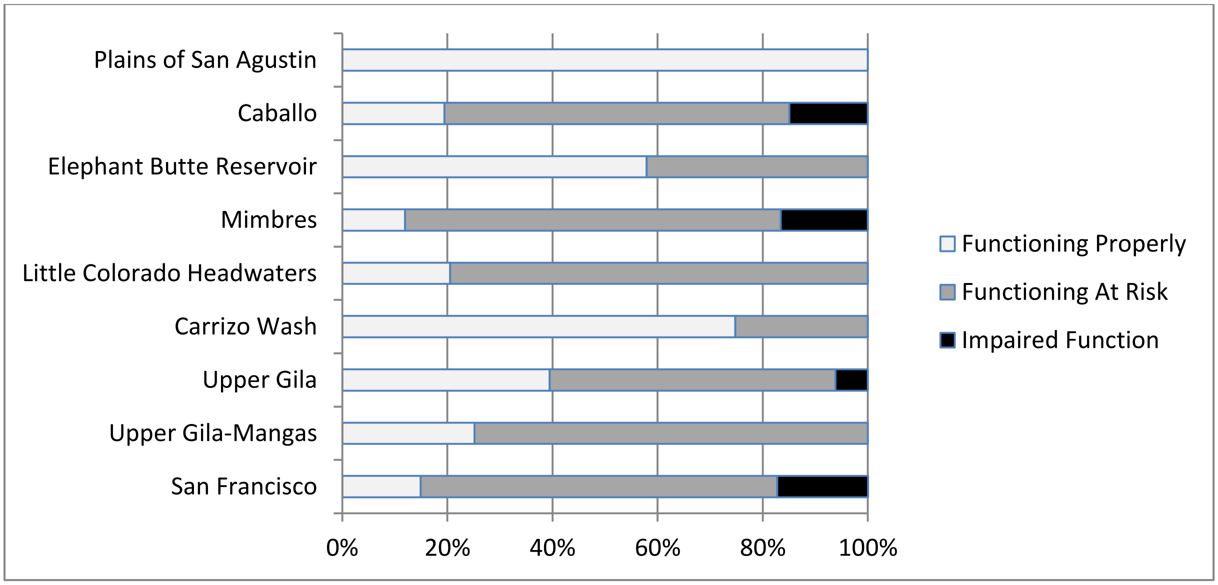


Figure 98. Subbasin watershed conditions on the Gila NF

In the Plains of San Agustin subbasin, all Gila NF acres are Functioning Properly, as are 75 percent of Forest acres in Carrizo Wash and 58 percent of Elephant Butte Reservoir. In other subbasins, watershed condition is Functioning at Risk overall with less than half of the area is Functioning Properly. Areas of Impaired Function occur in San Francisco, Upper Gila, Mimbres and Caballo subbasins.

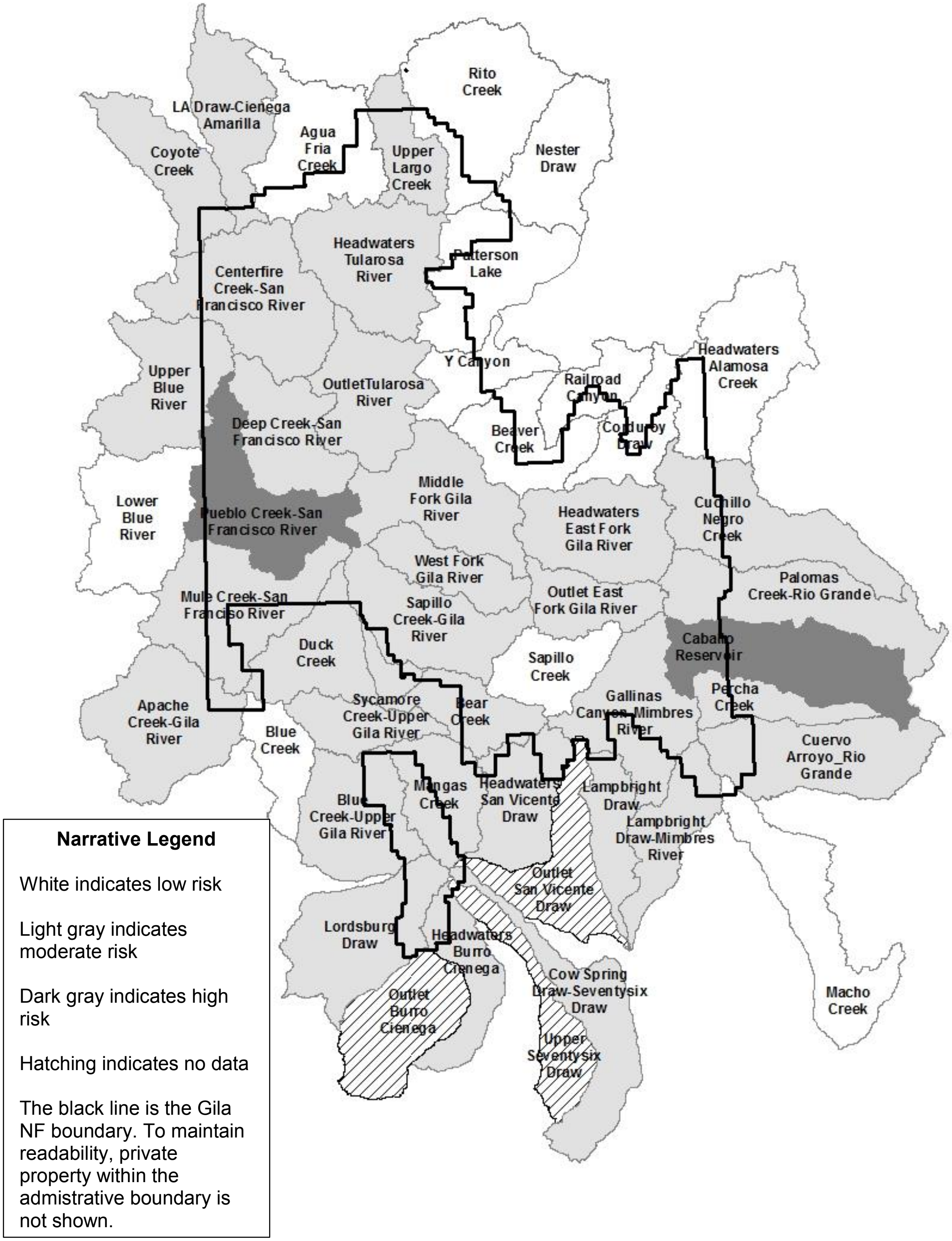
Opportunities to contribute to sustainability by maintaining or improving subbasin watershed conditions exist in all nine of these subbasins. These opportunities increase with the percentage of the total area located on the Forest. Off-forest watershed conditions currently have little direct impact on overall watershed conditions within most subbasins because the majority of off-Forest area is located downhill and downstream. Severe watershed degradation would have to occur in order for impacts to be realized uphill and upstream. This is true to a lesser extent in the San Francisco subbasin and Upper Gila-Mangas where off-forest watershed conditions could potential have greater impact on watershed condition within Gila NF. This is due to topographic factors, as well as patterns of landownership and use.

Risk

As stated in the discussion of analysis methods, risk is a direct interpretation of the watershed classification. Risk is assessed using the risk matrix below based on the departure classifications in Table 120. The results of the risk assessment for plan area watersheds follows Table 122 as Figure 99.

Table 122. Risk matrix for watershed condition

Departure Classification	Risk Assessment
Functioning Properly	Low Risk
Functioning at Risk	Moderate Risk
Impaired Function	High Risk



Narrative Legend

White indicates low risk

Light gray indicates moderate risk

Dark gray indicates high risk

Hatching indicates no data

The black line is the Gila NF boundary. To maintain readability, private property within the admistrative boundary is not shown.

Figure 99. Risk to watershed condition across the plan area

Fourteen of the 49 plan area watersheds are associated with a low risk to overall watershed condition under current management, 30 watersheds are associated with moderate risk and two watersheds with high risk. Recall that three watersheds do not have classifications because no subwatershed within those watersheds has one percent of its total area located on National Forest System lands. The largest percentage of the Forest is associated with a moderate risk to watershed condition based on the same approach as was used at the watershed level. Subwatershed indicator ratings identify factors contributing to risk. Table 123 displays the percent of indicator scores within the low, moderate and high risk categories that are not Functioning Properly.

Table 123. Subwatershed indicators contributing to watershed risk

	Percent of Subwatershed Indicator Ratings not Functioning Properly											
Watershed Risk Rating	Aquatic Biota	Riparian/Wetland Vegetation	Water Quality	Water Quantity	Aquatic Habitat	Roads and Trails	Soil Condition	Fire Regime or Wildfire Effects	Forest Cover	Forest Health	Terrestrial Invasive Species	Rangeland Vegetation Condition
Low	19	14	5	17	14	18	45	86	2	0	0	81
Moderate	73	72	48	49	70	79	74	97	23	<1	<1	75
High	85	85	46	54	77	69	92	92	30	8	0	69

Aquatic biota, aquatic habitat, riparian/wetland vegetation, soil condition, water quality, fire regime/or wildfire effects and rangeland vegetation indicators are significant contributors to risk in all risk categories. The contribution of the rangeland vegetation condition indicator decreases from low to high risk categories as a result of less area occupied by rangeland systems in watersheds at moderate and high risk. In low risk watersheds, the fire regime/wildfire effects indicator is not Functioning Properly due to departure from the natural fire regime, but not wildfire effects. This as opposed to most high risk watersheds being associated with wildfire effects. Both cases occur in moderate risk watersheds. The remaining indicators listed at the beginning of this paragraph increase with watershed risk categories. The casual factors of risk related to each indicator have been discussed previously in the description of each indicator and the discussion of current conditions presented in the analysis methods and plan area subsections.

Local unit risk was determined by calculating the percentage of the local unit area represented by each watershed risk rating. The risk rating representing the largest percentage was assigned to the local unit. All local units are associated with a moderate risk to watershed condition under current management except Little Colorado-San Agustin Fringe in which there is a low potential risk. The following table provides the same information for watersheds presented in Table 123 above for each local unit.

Table 124. Subwatershed indicators contributing to local unit risk

	Percent of Subwatershed Indicator Ratings not Functioning Properly											
Local Unit	Aquatic Biota	Riparian/Wetland Vegetation	Water Quality	Water Quantity	Aquatic Habitat	Roads and Trails	Soil Condition	Fire Regime or Wildfire Effects	Forest Cover	Forest Health	Terrestrial Invasive Species	Rangeland Vegetation Condition
Apache	85	81	44	67	78	89	63	96	11	0	0	100
Black Range	44	51	32	39	51	80	61	90	24	10	0	68
Little Colorado – San Agustin Fringe	36	40	23	30	36	62	62	94	2	0	2	89
Mogollon Front	68	71	32	38	74	79	88	94	24	0	3	82
Upper Gila	79	74	84	21	79	53	74	0	68	5	0	37
Lower Gila	91	67	45	39	27	82	70	97	6	0	0	76

Most low risk watersheds have relatively few perennial or intermittent stream miles on the Forest, with the exception of Sapillo Creek, therefore there is less risk associated with aquatic biota, aquatic habitat, and riparian/wetland vegetation. The risk in most low risk watersheds is the result of moderate departure in the historic fire regime and rangeland vegetation indicators that are Functioning at Risk. Low severity fire mitigates risk of large extents of high and moderate burn severity, and therefore risk to watershed condition. In most of these watersheds, restoration of the historic fire regime and herbivory by livestock and wildlife compete for the same resource; that is to say forage available to support wildlife and livestock is also the fine fuels necessary to carry fire. Almost half of these low risk watersheds also have soil conditions (i.e. productivity and erosion) that are Functioning at Risk, and in a few instances, Impaired Function. This risk is due in large part to reduction in soil functions related to historic livestock grazing practices that are no longer practiced. However it is also influenced by current livestock grazing management and in most of these low risk watersheds, herbivory by elk. While current livestock management has allowed for improvements in soil condition and range condition trends across the Forest are generally stable to slightly upward (Chapter 11: Multiple Uses), current management slows natural recovery of soil functions that were altered by historic practices.

These dynamics are also at work to varying degrees in moderate and high risk watersheds and all local units, as reflected in the percentages of indicator scores not Functioning Properly (Table 123 and Table 124). On the other hand, wildfire effects due to large areas of high and moderate burn severity contribute to risk in both high risk watersheds and some moderate risk watersheds. This is not a risk factor in low risk watersheds. Wildfire effects pose risk to aquatic habitat, riparian/wetland vegetation, water quantity, water quality, soil condition and forest cover indicators, but in some cases have favored native aquatic species (see Aquatic Biota subsection of this chapter).

Roads and trails are also a significant contributor to risk to soil condition, aquatic habitat, water quality and therefore aquatic biota. Roads and trails, herbivory and fire represent the primary system drivers and stressors to overall watershed condition on the Gila NF that are within the ability and authority of the Forest to manage. Chapter 9: System Drivers and Stressors also contains greater detail concerning all watershed condition drivers and stressors and their historic and current status on the Forest.

While not within the ability or authority of the Forest to control or influence, climate change is major stressor that elevates the risk to watershed condition. Climate change, its potential effects to watershed condition and watershed vulnerability to climate change are discussed in detail in Chapter 9: System Drivers and Stressors. On the basis of a moderate or greater vulnerability to climate change, which is the case for all Gila NF watersheds, local units and the Forest as a whole, all low risk ratings are elevated to moderate, and moderate is elevated to high risk. Although climate change is outside the ability or authority of the Forest to control or influence, Forest management has opportunities to mitigate associated risk by maintaining, improving or restoring watershed processes.

Perennial and Intermittent Streams

Streams can be classified as perennial, intermittent or ephemeral by seasonal variations of flow. Ephemeral streams experience relatively short duration flow only in direct response to surface runoff from precipitation or snow melt. Perennial streams typically flow year round as they receive contributions from both surface runoff and groundwater. Intermittent streams fall between perennial and ephemeral types as groundwater contributions are seasonal. Along the full length of any one stream, there may be stretches that could be classified differently. Elevation, bedrock type and topography; bank, floodplain and channel bed materials; channel geometry; and the valley size and shape are a few of the factors that can influence these flow regimes.

Streams, especially perennial and intermittent streams, are important water sources that support terrestrial, riparian and aquatic ecosystems, as well as human uses. This section is an assessment of where, and at what densities these streams exist across the landscape.

Analysis Methods

Limited information is available to describe a reference condition for the extent and distribution of these water resource features; therefore, an alternative methodology is required. Representativeness and redundancy analysis is used instead of departure and trend analysis to facilitate risk assessment.

Representativeness is descriptive of current conditions, and substitutes for a departure rating. It is based on three assumptions:

1) There is a “representative” range of specific water feature conditions associated with a characteristic across the landscape.
2) A wide range of hydrologic feature conditions will sustain the highest degree of biodiversity.
3) A higher representativeness, leading to a wider range of conditions, creates a more sustainable ecosystem.

Representativeness is evaluated by calculating the proportional occurrence of a characteristic on the Forest at a given scale (e.g. watershed) compared to that found at the next larger scale (e.g. subbasin). The resulting value is a stream density ratio. A rating of proportional, overrepresented, or underrepresented is assigned based on how close the resulting value is to one. A value of one indicates that the stream density on the Gila NF is similar to the stream density outside the Forest. Values between 0.9 and 1.1 are considered proportionally represented. The majority of subwatersheds have values in this range which was the basis for establishing these thresholds. Values below this range are underrepresented and indicate lower stream densities on the Forest as compared to lands off Forest. Values above this range are overrepresented and indicate higher stream densities on the Forest as compared to lands off Forest.

Redundancy describes the distribution of a characteristic across the landscape. It is based on the assumption that finding a characteristic in multiple, evenly distributed places increases the likelihood of maintaining representativeness and decreases the risk of losing that characteristic, or a specific condition of that characteristic, through a single disturbance event. Either a characteristic is redundant, or it is not. This is evaluated by answering the question: does the characteristic occur in every subunit on the Forest within the larger area? For example, the Outlet East Fork Gila River watershed contains five subwatersheds. Perennial streams are present in four of these watersheds, and are absent in one subwatershed; therefore, perennial streams are not considered redundant in the Outlet East Fork Gila River watershed.

What is known about the current and historic distribution of native fishes, analyzed as a key characteristic in the following subsection, also provides an important perspective relative to perennial streams. That information is used as a “stop-check” to validate or refine the assessment of risk to perennial streams.

Limitations of the representativeness and redundancy approach include the fact that the assumptions it is based on may or may not hold true in the environment. Additionally, it is a purely mathematical analysis approach and does not incorporate consideration of system drivers and stressors as do other methodologies used in the ecological assessment.

Plan Area

Table 125 lists each of the 49 plan area watersheds and displays total watershed area, watershed area located on Forest, total perennial and intermittent stream miles and percentage occurring on and off-Forest. Appendix D contains a table displaying similar information, but also includes subwatersheds with the addition of subwatersheds.

Table 125. Extent and distribution of perennial and intermittent stream miles for plan area watersheds and the Gila NF

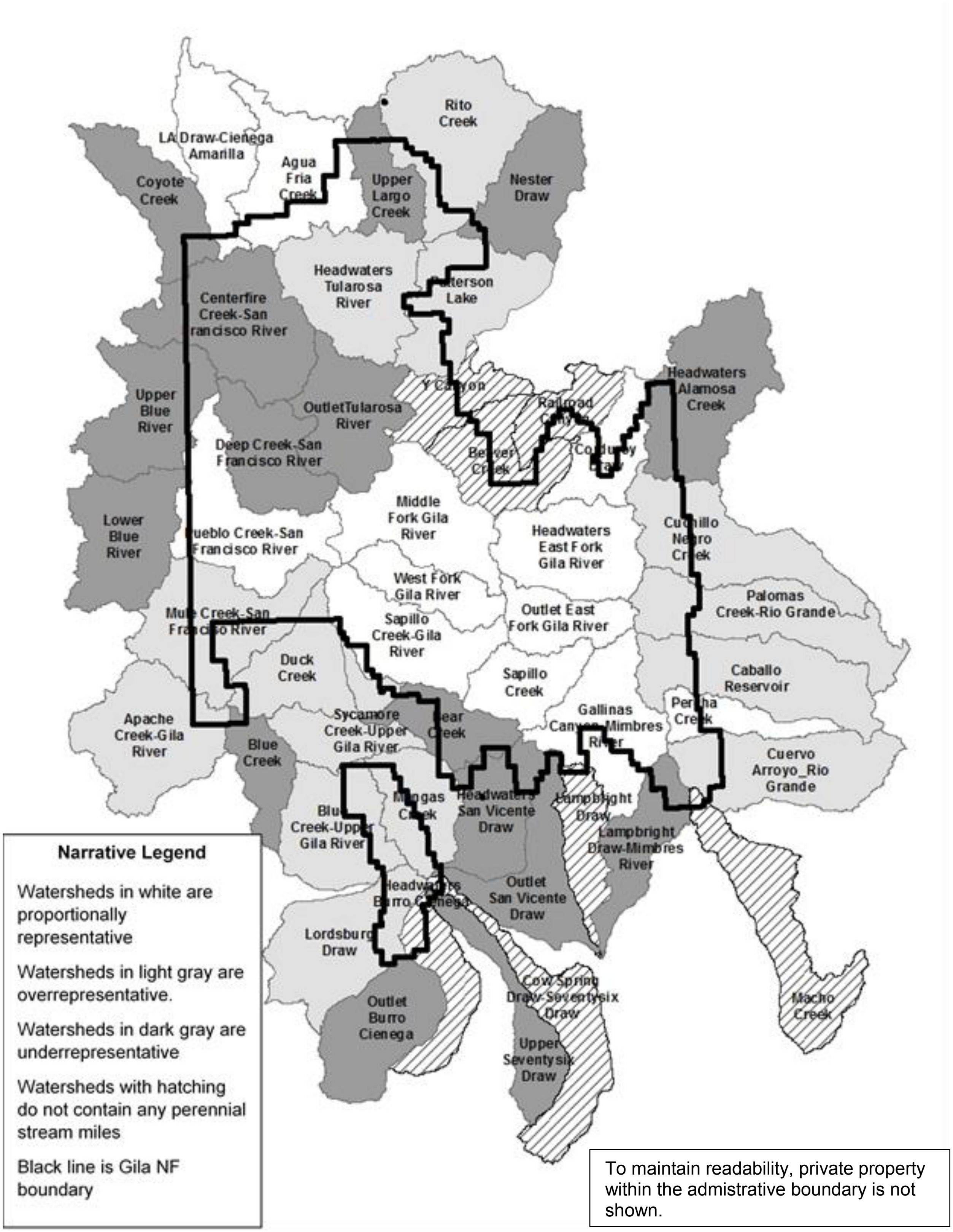
	Watershed Area			Perennial Stream Miles			Intermittent Stream Miles		
Watershed Name	**Total (acres)**	**Gila NF (acres)**	**% Gila NF**	**Total**	**On Gila NF**	**% On Gila NF**	**Total**	**On Gila NF**	**% on Gila NF**
Plains of San Agustin Subbasin									
Nester Draw	169,190	5,328	3	0.2	0	0	3.8	0.4	10
Patterson Lake	207,398	78,514	38	0.5	0.5	100	18.5	10.3	56
Y Canyon	97,476	52,140	38	0	0	--	0	0	--
Elephant Butte Reservoir Subbasin									
Headwaters Alamosa Creek	257,399	40,451	16	1.4	0	0	80.3	17.2	21
Caballo Subbasin									
Caballo Reservoir	247,026	52,993	21	47.8	26.1	55	58.6	21.0	36

	Watershed Area			Perennial Stream Miles			Intermittent Stream Miles		
Watershed Name	**Total (acres)**	**Gila NF (acres)**	**% Gila NF**	**Total**	**On Gila NF**	**% On Gila NF**	**Total**	**On Gila NF**	**% on Gila NF**
Cuchillo Negro Creek	236,142	76,046	32	29.7	18.3	62	86.2	44.6	52
Palomas Creek-Rio Grande	234,606	57,833	25	49.0	19.5	40	41.6	24.4	59
Percha Creek	77,379	24,763	32	34.3	9.9	29	16.5	9.1	55
El Paso-Las Cruces Subbasin									
Cuervo Arroyo-Rio Grande	226,938	37,572	17	21.2	6.6	31	52.2	6.1	12
Mimbres Subbasin									
Cow Spring Draw-Seventysix Draw	184,549	3,070	2	0	0	--	0	0	--
Gallinas Canyon-Mimbres River	205,881	151,448	74	83.1	74.3	89	73.0	23.2	32
Headwaters San Vicente Draw	144,197	26,072	18	4.1	3.6	89	46.5	7.3	16
Lampbright Draw	92,105	2,351	3	0	0	--	0	0	--
Lampbright Draw-Mimbres River	124,477	20,713	17	1.5	0.1	5	50.1	6.2	12
Macho Creek	213,735	3,641	2	0	0	--	0	0	--
Outlet San Vicente Draw	160,634	1,684	1	0	0	--	0	0	--
Upper Seventysix Draw	114,409	1,313	1	0	0	--	0.5	0.5	100
Little Colorado Headwaters Subbasin									
Coyote Creek	147,501	13,510	9	32.6	0.7	2	32.4	0.3	1
Carrizo Wash Subbasin									
Agua Fria Creek	218,968	76,850	35	19.3	6.7	35	2.2	2.0	89
LA Draw-Cienega Amarilla	160,256	7,918	5	7.4	0.4	6	0	0	--
Rito Creek	279,878	37,218	13	6.3	3.7	59	10.5	3.9	37
Upper Largo Creek	98,300	75,156	76	19.3	6.7	35	8.2	2.8	34
Upper Gila Subbasin									
Beaver Creek	147,638	79,799	54	0	0	--	5.0	5.0	100
Corduroy Draw	111,118	68,279	61	11.9	6.7	56	11.4	10.6	93
Headwaters East Fork Gila River	193,943	192,473	99	68.6	60.2	88	41.1	39.3	96
Middle Fork Gila River	218,844	218,128	>99	96.6	94.1	97	18.5	18.5	100
Outlet East Fork Gila River	104,412	103,887	99	56.4	53.3	94	11.5	11.5	100
Railroad Canyon	89,105	14,046	16	0	0	--	0	0	--
Sapillo Creek	110,693	108,907	98	45.3	40.5	89	15.8	14.4	91

	Watershed Area			Perennial Stream Miles			Intermittent Stream Miles		
Watershed Name	Total (acres)	Gila NF (acres)	% Gila NF	Total	On Gila NF	% On Gila NF	Total	On Gila NF	% on Gila NF
Sapillo Creek-Gila River	189,860	181,341	96	139.9	135.3	97	27.2	20.4	75
West Fork Gila River	103,948	102,439	99	86.3	81.0	94	11.9	11.9	100
Upper Gila-Mangas Subbasin									
Apache Creek-Gila River	237,306	12,270	5	1.4	0.7	49	125.0	4.9	4
Bear Creek	103,985	65,069	63	10.5	2.8	26	70.8	46.2	65
Blue Creek	88,931	3,428	4	20.6	0	0	0	0	--
Blue Creek-Upper Gila River	186,504	46,732	25	33.5	11.7	35	42.1	11.2	26
Duck Creek	144,993	16,862	12	12.4	5.7	46	30.7	0	0
Mangas Creek	130,597	50,698	39	0.4	0.4	100	31.6	6.0	19
Sycamore Creek-Upper Gila River	121,829	3,601	3	17.1	1.1	6	0.5	0.4	94
Animas Valley Subbasin									
Headwaters Burro Cienega	109,203	17,666	16	0	0	0	8.2	0.1	1
Lordsburg Draw	221,184	41,617	19	4.2	2.2	53	0	0	--
Outlet Burro Cienega	179,037	291	<1	<0.1	0	0	0	0	--
San Francisco Subbasin									
Centerfire Creek-San Francisco River	267,108	207,266	78	145.9	64.0	44	119.8	41.1	34
Deep Creek-San Francisco River	153,321	149,537	98	60.6	49.2	81	20.1	19.3	96
Headwaters Tularosa River	225,391	211,838	94	39.3	10.5	27	25.3	18.4	73
Lower Blue River	198,105	277	<1	90.0	0	0	410.0	0.5	<1
Mule Creek-San Francisco River	244,422	121,064	50	82.7	51.3	62	161.1	15.4	10
Outlet Tularosa River	184,206	180,493	98	54.6	39.4	72	8.2	8.2	100
Pueblo Creek-San Francisco River	226,379	198,993	88	81.7	63.5	78	76.5	52.9	69
Upper Blue River	198,049	27,915	14	172.3	9.68	6	363.6	8.7	2
Total	**8,388,553**	**3,271,497**	**39**	**1,688**	**956.7**	**57**	**2,227.4**	**545.9**	**25**

Perennial stream density is generally higher on Forest largely because it occupies upper watershed areas where many streams originate (i.e. headwaters), and where precipitation is higher and temperatures are cooler. Cooler temperatures reduce transpiration and evaporative demand which aids in keeping water in streams for longer periods. As intermittent streams tend to occur at lower elevation and/or lower positions in the watershed, precipitation is generally lower and temperatures warmer. This makes bedrock type and topography, bank, floodplain and channel bed materials, channel geometry, and the valley size and shape relatively stronger controls on flow regime. As these characteristics are highly variable from one watershed to another, intermittent stream density on the Gila NF is highly variable. The Forest's contribution to sustainability of perennial and intermittent stream miles increases with both percentage of miles and contributing watershed area on Forest.

The results of the representativeness and redundancy analysis for perennial stream miles, described under analysis methods, are displayed in Figure 100 and Figure 101 respectively, followed by the same information for intermittent stream miles in Figure 102 and Figure 103. Recall that watersheds that are proportionally representative have similar stream densities both on and off Forest. Those that are underrepresentative have lower stream densities on Forest compared to lands and those that are overrepresentative have higher stream densities on Forest as compared to other lands.



Narrative Legend

Watersheds in white are proportionally representative

Watersheds in light gray are overrepresentative.

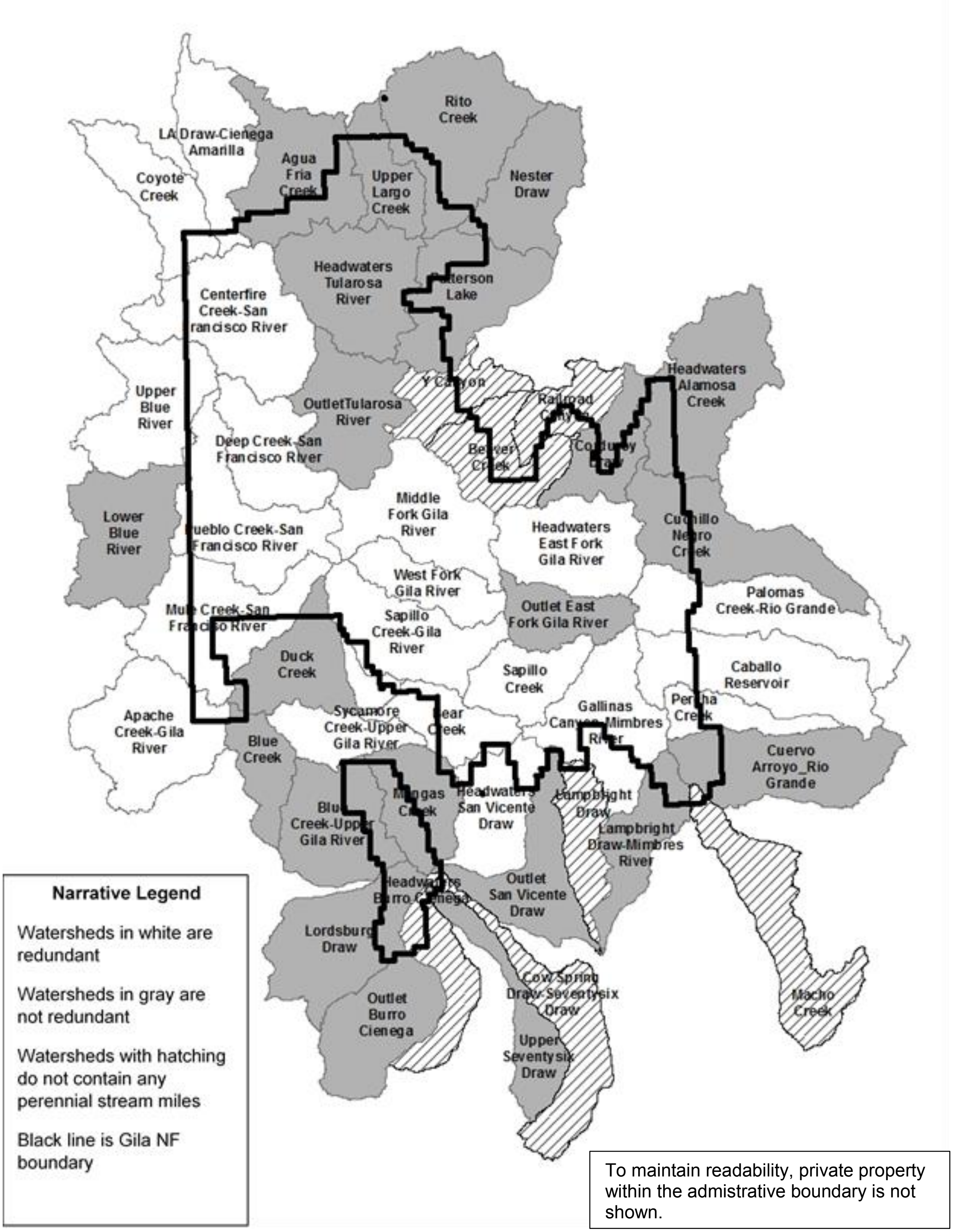
Watersheds in dark gray are underrepresentative

Watersheds with hatching do not contain any perennial stream miles

Black line is Gila NF boundary

To maintain readability, private property within the admistrative boundary is not shown.

Figure 100. Representativeness of perennial streams across the plan area



Narrative Legend

Watersheds in white are redundant

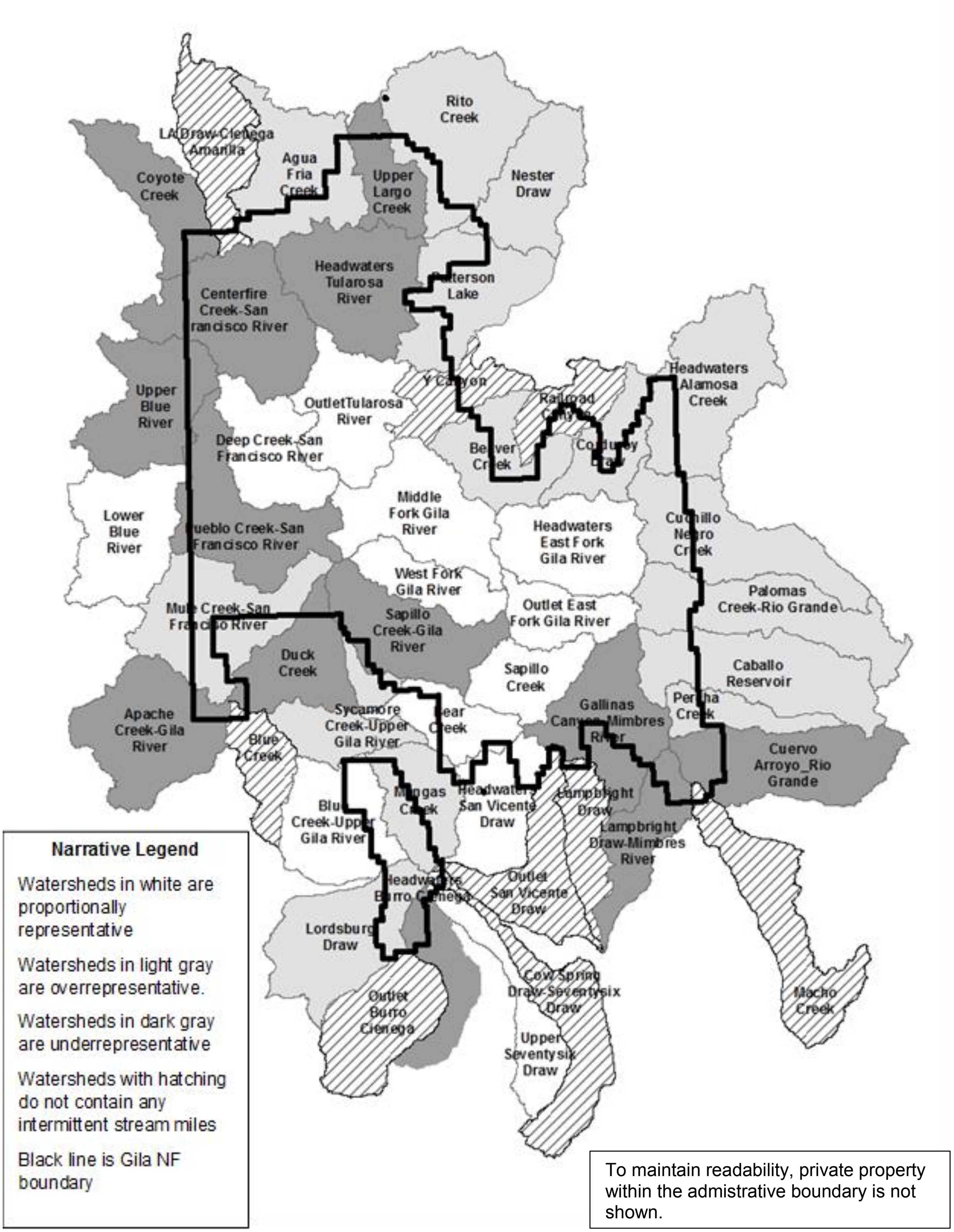
Watersheds in gray are not redundant

Watersheds with hatching do not contain any perennial stream miles

Black line is Gila NF boundary

To maintain readability, private property within the admistrative boundary is not shown.

Figure 101. Redundancy of perennial streams across the plan area



Narrative Legend

Watersheds in white are proportionally representative

Watersheds in light gray are overrepresentative.

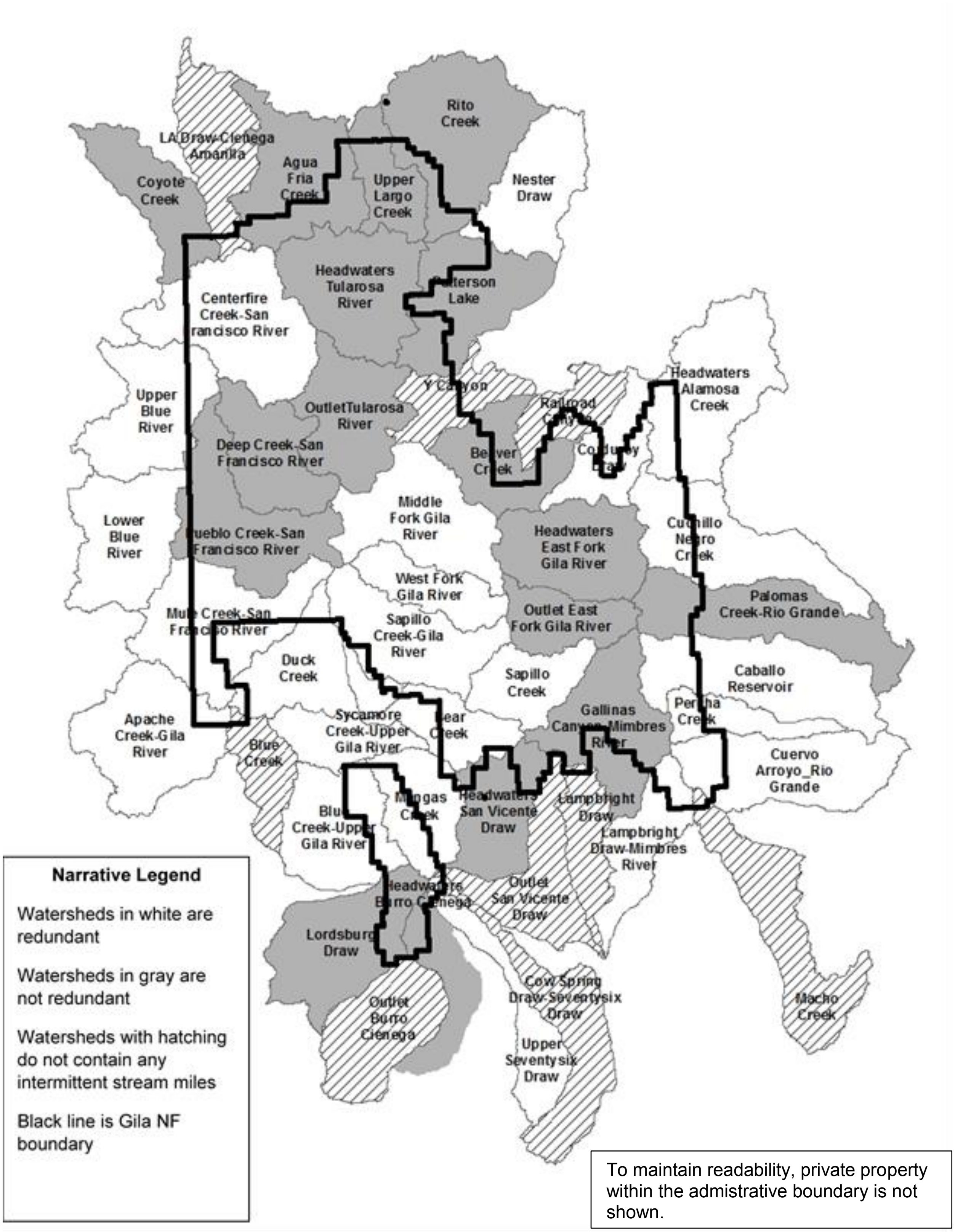
Watersheds in dark gray are underrepresentative

Watersheds with hatching do not contain any intermittent stream miles

Black line is Gila NF boundary

To maintain readability, private property within the admistrative boundary is not shown.

Figure 102. Representativeness of intermittent streams across the plan area



Narrative Legend

Watersheds in white are redundant

Watersheds in gray are not redundant

Watersheds with hatching do not contain any intermittent stream miles

Black line is Gila NF boundary

To maintain readability, private property within the admistrative boundary is not shown.

Figure 103. Redundancy of intermittent streams across the plan area

Context Area

Table 126 displays perennial stream miles by subbasin, and the portion located within Forest. The Forests have been working with the USGS to improve the NHD. As part of this, the Forests have distinguished the difference between intermittent and ephemeral streams at the watershed scale. However, this has not been done for the context area outside of National Forest System lands. Therefore, similar data for intermittent streams at the subbasin level were not available.

Table 126. Extent and distribution of perennial stream miles for subbasins within the context area and the Gila NF

	Subbasin Area			Perennial Stream Miles		
Subbasin Name	**Total (acres)**	**Gila NF (acres)**	**Gila NF (%)**	**Total**	**On Gila NF**	**% on Gila NF**
Plains of San Agustin	1,275,453	135,981	11	0.7	0.5	76
Elephant Butte Reservoir	1,403,516	40,451	3	74.3	0	--
Caballo	795,153	211,635	27	160.8	73.8	46
El Paso-Las Cruces	3,542,482	37,572	1	116.0	6.6	6
Mimbres	4,283,488	210,291	5	98.6	78.0	79
Little Colorado Headwaters	515,246	13,510	3	268.5	0.7	<1
Carrizo Wash	1,446,531	197,142	14	43.6	14.0	32
Upper Gila	1,269,561	1,069,298	84	504.9	471.0	93
Upper Gila-Mangas	1,311,302	198,660	15	100.9	22.3	22
Animas Valley	1,449,526	59,574	4	4.2	2.2	52
San Francisco	1,793,569	1,097,383	61	759.8	287.5	38
Totals	**19,085,827**	**3,271,497**	**17**	**2,132.1**	**956.7**	**45**

The Gila NF occupies 17 percent of the context area and contains 45 percent of perennial stream miles. The opportunities for the Forest to contribute to sustainability of perennial streams is proportional to the percentage of miles and contributing watershed area located on Forest. Opportunities are only indirect in the case of Elephant Butte, and relatively small in Little Colorado Headwaters and El Paso-Las Cruces subbasins. The Forest's contributions are greatest in Upper Gila because of the high proportion of both watershed area and perennial miles. The Forest is a significant contributor in San Francisco and in Upper Gila-Mangas, largely because the Upper Gila drains to it. Despite the relatively small percentage of subbasin area on Forest, it remains the primary contributor to sustainability of perennial streams in the Mimbres. Regardless of the low number of perennial miles in Animas Valley and Plains of San Agustin, these streams are no less important and the Forest is a significant contributor to sustainability. While equivalent data is not available to describe the Forest's opportunities and limitations for intermittent streams, they certainly exist in subbasin watersheds that contain intermittent streams on the Forest.

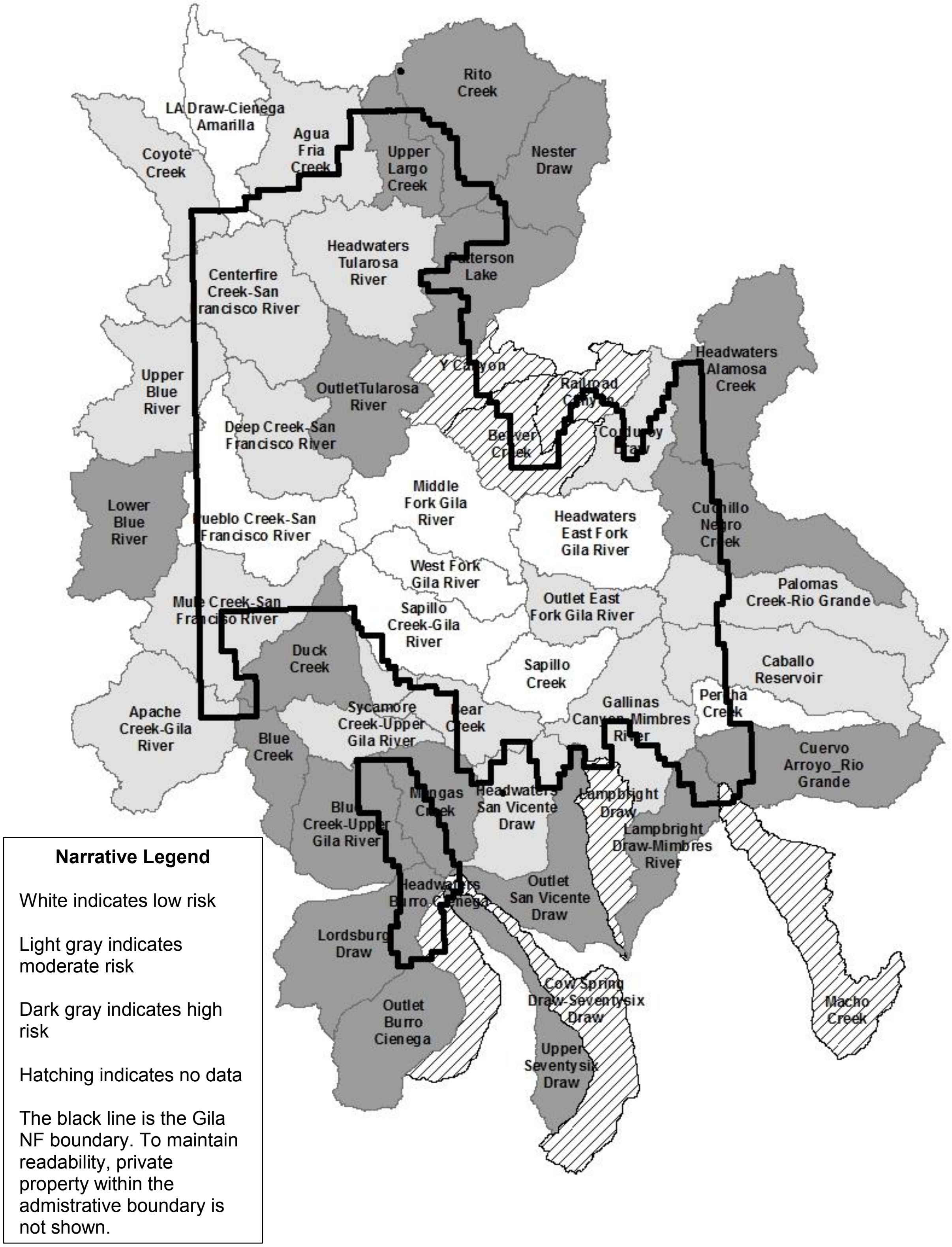
Risk

The results of the representativeness and redundancy analysis are applied to the assessment of risk to the extent and distribution of perennial and intermittent stream miles using the matrix displayed as Table 127. In watersheds that do not contain any perennial or intermittent stream miles within subwatersheds that intersect the Forest boundary, there is no risk.

Table 127. Risk matrix for representativeness and redundancy analysis results.

	Redundant	Not Redundant
Proportionally Represented	Low Risk	Moderate Risk
Not Proportionally Represented	Moderate Risk	High Risk

The results of the watershed scale risk assessment are presented in Figure 104 (perennial) and Figure 105 (intermittent).



Narrative Legend

White indicates low risk

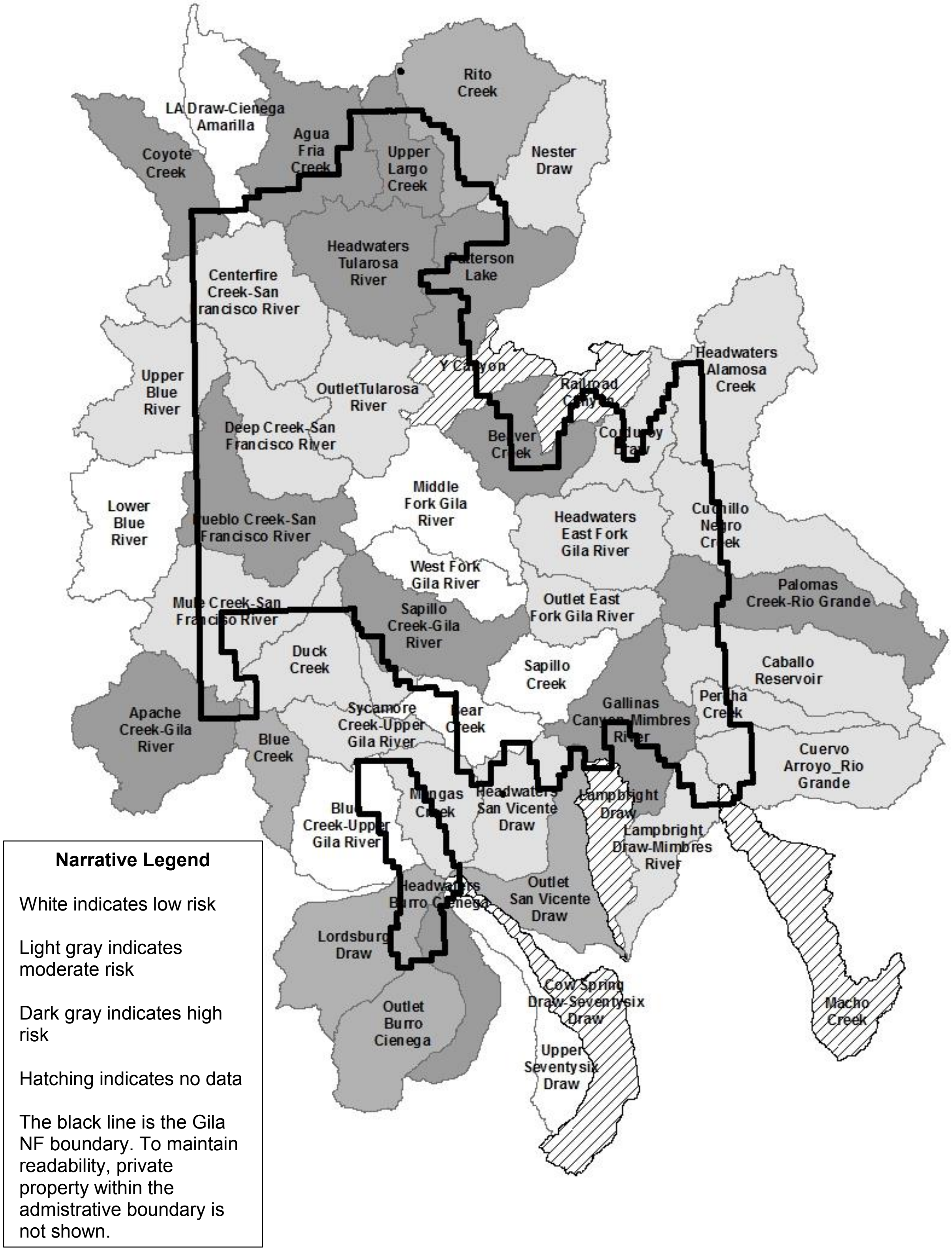
Light gray indicates moderate risk

Dark gray indicates high risk

Hatching indicates no data

The black line is the Gila NF boundary. To maintain readability, private property within the admistrative boundary is not shown.

Figure 104. Risk to perennial streams across the plan area.



Narrative Legend

White indicates low risk

Light gray indicates moderate risk

Dark gray indicates high risk

Hatching indicates no data

The black line is the Gila NF boundary. To maintain readability, private property within the admistrative boundary is not shown.

Figure 105. Risk to intermittent streams across the plan area.

There is no relationship between risk interpreted from the representativeness and redundancy analysis and the status of system drivers or stressors, including Gila NF management. Rather, it is mostly a reflection of climatic factors and patterns of land ownership. Private property within the Gila NF administrative boundary tends to be located near water sources, which leads to perennial and/or intermittent streams to be underrepresented on Forest in some cases where it might appear reasonable to expect proportional representation. While Forest management can contribute to the sustainability of water occurring as perennial an intermittent streams by maintaining and improving watershed condition, climate change and competition between ecological and socio-economic demands for water are the primary stressors contributing to risk as discussed in the Chapter 9: System Drivers and Stressors.

Forest and local unit risk is assessed by assigning each local unit the risk category associated with the majority of its area. Based on this approach, the Forest as a whole is associated with a moderate risk, Upper Gila local unit is associated with a low risk to perennial streams and all other local units with a moderate risk. With respect to intermittent streams, Forest-wide risk is moderate, Upper and Lower Gila local units are associated with a low risk and all other local units with a moderate risk. The difference between perennial and intermittent stream risk in Lower Gila is a reflection both stream density and distribution, not the value these features provide. In general, intermittent streams densities on Forest are similar to other lands in this local unit and their distribution is more even than perennial streams. Given the limitations associated with the analysis methodology, and water being essential for ecological sustainability in the Southwest, this risk assessment should not be used alone to inform management priorities.

Streamflow

In general, streamflow has two primary components: base flow and surface runoff. Base flow comes from groundwater that flows from springs or directly from the bed and banks of stream channels. Base flow maintains streamflow in perennial streams throughout the year and is particularly important during dry periods. Surface runoff is the result of rainfall and snowmelt. Surface runoff varies with the total amount of rainfall and the intensity, duration and extent of rainfall events. The influence of temperature, watershed condition, evapotranspiration rates, as well as soil depth, texture, structure and moisture content before the rainfall event are also important factors in determining runoff responses.

Analysis Methods

Streamflow can be characterized in terms of the timing, magnitude, frequency, duration, and the variability associated with each characteristic. This section focuses on data from the six USGS streamflow gages located within the plan area on Mogollon Creek and the San Francisco, Gila, and Mimbres rivers.[23] Figure 106 displays the location of the streamflow gages.

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[23] All streamflow gages used in this analysis lie within the plan area. One additional streamflow gage occurs within the context area on the Gila River near Virden, New Mexico. This gage was not analyzed as the difference in contributing watershed area between the Virden and Redrock gages is relatively small.

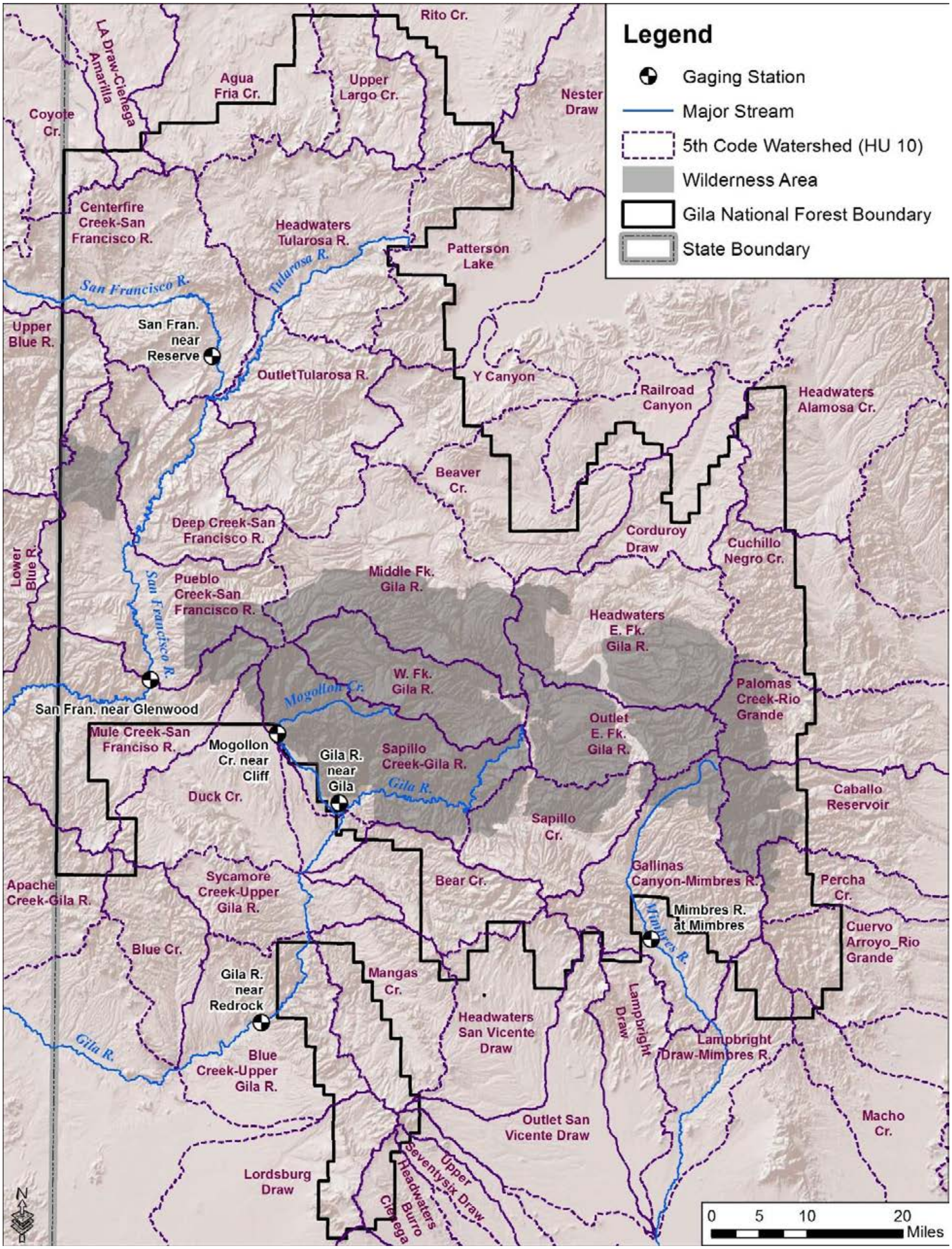

Figure 106. Location of USGS gages used for streamflow analysis

Quantitative streamflow records are not available for the time prior to European settlement, which necessitates establishing a reference period within the period of record. Since approximately 1990, a decreasing trend is observed in the precipitation record, accompanied by an increasing trend in temperature. As discussed under the climate change heading in Chapter 9: System Drivers and Stressors, mean annual temperature has not dipped below the period of record average since 1992. Based on these observations, the year 1990 was selected as the threshold year to define the reference time period for this assessment. This is also the threshold year used in developing the Climate Change Vulnerability Assessment (CCVA) for the Gila NF (Triepke 2015). The threshold is applied by using pre-1990 data to describe the reference period and post-1990 data to describe current conditions. Dividing the single period of record into reference and current time periods allows for a description of departure, but a third time period is needed to describe any trends. Trend is assessed using subset of the current time period beginning in the year 2000. The year 2000 has been used in other streamflow studies and was selected because it allows for the most direct comparison of these analysis results with the more rigorous Flood Frequency, Flow Duration, and Trends (England 2002) analysis in the Gila River Fluvial Geomorphology Study conducted by the Bureau of Reclamation (BOR). This study is discussed further later in this chapter.

However, using just six streamflow gages with relatively short periods of record to determine departure and trend in streamflow has limitations. A paleostreamflow reconstruction, extending back to the year 1663 and including the Gila and San Francisco Rivers gages, describes a high degree of natural variability in streamflow patterns as a defining characteristic and concluded that the reconstruction was best interpreted as a record of drought (Meko and Graybill 1995). Also, the instrumental record very likely represents higher than average precipitation period (Meko and Graybill 1995; Cook et al. 2011; Gori et al. 2014; also see the predominant climate regime discussion in Chapter 9: System Drivers and Stressors). The bottom line being that regardless of trends that may be interpreted in the gage data, area hydrology is the product of many natural and human caused changes over a much longer period of time than the instrumental record reflects. With such limited baseline data and high variability, change (i.e. departure) is very difficult to detect (McLean 1981).

Another consideration for all of gages except the San Francisco River near Reserve gage is that post-fire effects from recent uncharacteristic wildfires have altered watershed response and streamflow patterns. There is not yet a sufficient period of record to quantitatively describe the magnitude and duration of changes in flow, or to differentiate short and long term trends when considering annual and monthly values. In light of the limitations associated with the gage data analysis, the most accurate description of departure and trends in streamflow considers the gage data analysis, the BOR study (England 2002), historic and current distribution of native fishes, and the water quantity indicator from the watershed condition classification. Recall that the water quantity indicator provides qualitative documentation of altered streamflow resulting from water diversions, water controls and significant wildfire.

For watersheds with representation in the gage data, departure and trend is initially determined by the gage data and refined based on the water quantity indicator and aquatic biota data. If the water quantity indicator ratings capture wildfire effects or diversions that are not reflected in the gage data, departure is elevated to reflect the indicator rating that represents the largest percentage of the watershed if it is different from the gage data interpretation. Where native fish were present and are now completely absent, and there are no non-native fish, departure is elevated one category. For watersheds without representation in the gage data, the water quantity indicator and aquatic biota data are used to determine departure; again, with the departure category reflecting the indicator score that represents the largest percentage of the watershed. (i.e. Functioning Properly equates to low departure, Functioning at Risk equates to moderate departure and Impaired Function equates to high departure). The watershed condition classification is not suitable to assess trend. Therefore, trends are only defined where the gage data is applied.

Plan Area

Average, or mean streamflow values are useful for describing the range of variability in flow characteristics. Median values are better for understanding the central tendency; in this case, how much water is typically in the stream at a given time and over what period of time.

At the San Francisco River gage near Reserve, mean annual flow has varied between a minimum of 4.8 cubic feet per second (cfs) in 2003 to 86.7 cfs in 1983. Median annual flow has varied between a minimum of 3.9 cfs (2009) and a maximum of 21 cfs (1983). Flows generally increase along the San Francisco River as it travels south and west from Reserve to the gage near Glenwood where the mean annual flow has ranged between 12 cfs (1986) and 374.9 cfs (1983). Median annual flows at this gage have varied from 11 cfs (1956) to 107 cfs (1941).

At the Mogollon Creek gage near Cliff, mean annual flow has varied between a minimum of 4.3 cfs (2000) and 85.2 cfs (1978). Median annual flows have varied between a minimum of 1.3 cfs (2000) and 29 cfs (1983). Just above the confluence with Mogollon Creek, mean annual flow at the Gila River gage near Gila has varied between 43 cfs (1956) and 413.7 cfs (1993). Median annual flow has varied between 44 cfs (1956) and 209 cfs (1941). As the Gila River continues west and south through the Burro Mountains, streamflow and variability increase. At the gage near Redrock, mean annual flow has ranged between 50.4 cfs (1951) and 635.6 cfs (1993) and median annual flows have ranged between 52 cfs (1953) and 318 cfs (1941). At the Mimbres River gage near Mimbres, mean annual flows have varied between a minimum of 3.1 cfs in 2003 and 41.7 cfs in 1992. Median flows have ranged between 3.1 cfs (2003) and 22 cfs (1991). Figure 107 illustrates annual variability in mean and median flows at the Mimbres gage across the period of record. Appendix D contains equivalent figures for all gages.

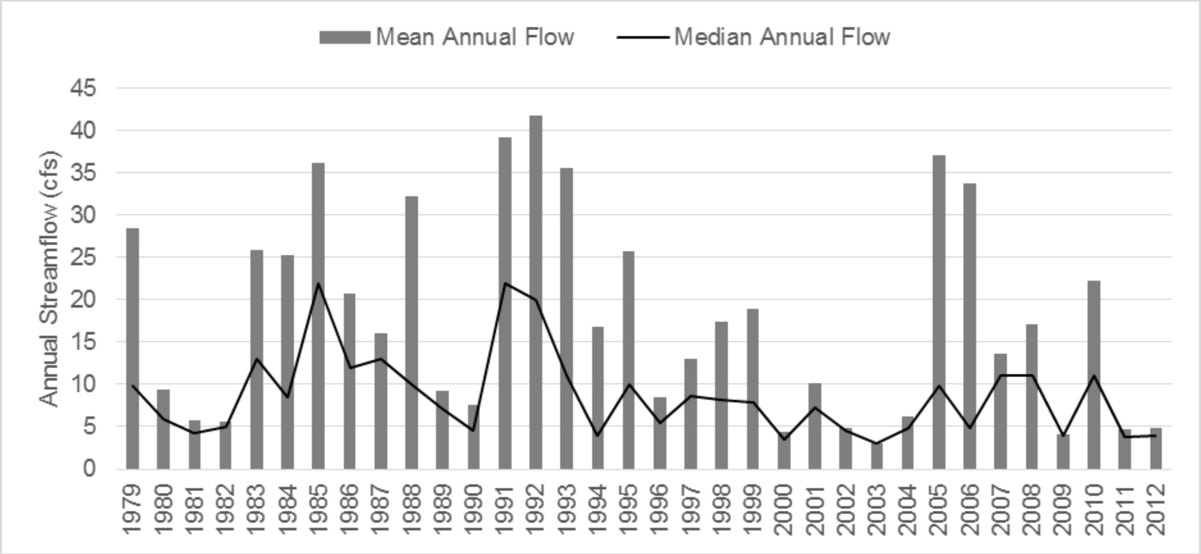

Figure 107. Annual mean and median streamflow at the Mimbres River gage near Mimbres, period of record 1979-2012[24]

Seasonal variability in mean monthly flow is important as an indicator of the relative importance of baseflow, snowmelt and rainfall runoff contributions. Snowmelt contributions to mean monthly streamflow are most important from February through April, with the highest flows of the year occurring in March at all gages except the Mimbres River gage where snowmelt runoff peaks in February and the

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[24] The Mimbres River gage near Mimbres has not consistently been in operation since 2012. There is not enough data in subsequent years to provide for analysis.

highest mean monthly flows occur in August (31.4 cfs) during the summer monsoon season. However, flows above 20 cfs are maintained at the Mimbres River gage between January and April, which demonstrates that snowmelt runoff remains an important streamflow component. Beginning in May, the importance of snowmelt runoff begins to be replaced by baseflow contributions, which are most important in June prior to the onset of the summer monsoons when mean monthly flows are at their lowest at all gages.

Rainfall runoff contributions are most important from July through October, with the highest mean monthly flow during this period occurring in August for the Mimbres River gage, September for the Mogollon Creek and Gila River gages near Gila and Redrock, and October at the San Francisco River gages. November and December mean flows are a combination of surface runoff and baseflow at all gages. Figure 108 illustrates the monthly variability in mean flow for the Gila near Gila gage across the period of record. Appendix D contains a table displaying this information for all gages.

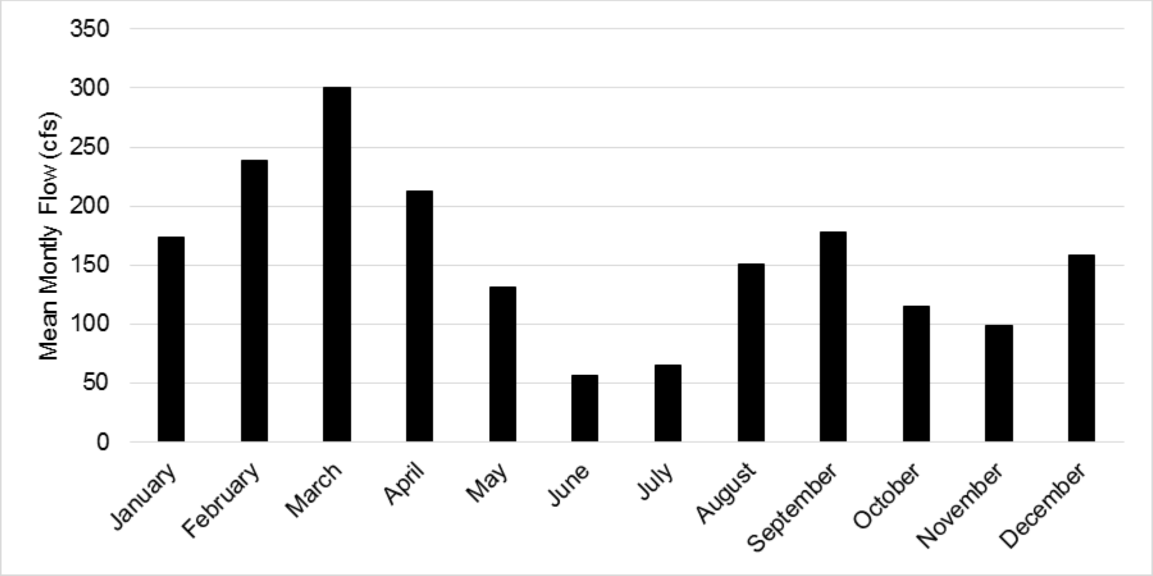

Figure 108. Monthly flow at the Gila River gage near Gila, period of record 1928-2014

High and low flows and the frequency at which they occur are important streamflow characteristics. For this assessment, high flow days are considered to be those days where mean flow is equal to or greater than the two-year flood return interval. Return intervals are discussed further in Chapter 7: Riparian where flood frequency is analyzed as a key characteristic.

Based on this definition of high flow days, less than one percent of days in the period of record for each gage have been high flow days. There have been 21 high flow days at the San Francisco River gage at Reserve, 51 at the gage near Glenwood, 3 at the Mogollon Creek gage, 135 at the Gila River gage near Gila, 44 at the gage near Redrock, and 15 at the Mimbres River gage.

Low flow days are defined as those days when mean flow is equal to or less than the fifth percentile of the period of record. Across the period of record, there have been 1,511 low flow days at the San Francisco River gage near Reserve (≤2.5 cfs), 2,035 days near Glenwood (≤13 cfs), 1,447 at the Mogollon Creek gage (0 cfs), 1,629 at the Gila River near Gila (≤30 cfs), 1,511 near Redrock (≤20 cfs), and 650 at the Mimbres River gage (≤1.7 cfs)

Table 128 summarizes the available data for mean and median annual flow, high and low flow days, and climatic variables for the Gila near Gila gage. Appendix D contains a table displaying the same information for all gages.

Table 128. A comparison of annual streamflow characteristics and climatic variables at Gila near Gila between the reference and current time periods

		Post-1990		Post-2000	
Variable	**Pre-1990**		**Change from pre-1990 (%)**		**Change from pre-1990 (%)**
Gila River near Gila, NM					
Mean Annual Flow (cfs)	149.6	172.5	+15%	144.7	-3%
Median Annual Flow(cfs)	72	77	+7%	68	-6%
High Flow Days (number of days/total days in period of record)	77/22,645	58/9,130	+87%	28/5,478	+50%
Low Flow Days (number of days/total days in period of record)	1,040/22,645	589/9,130	+40%	455/5,478	+81%
Southwestern Mountains Climate Division					
Mean Annual Precipitation (in)	15.1	15.4	+2%	14.3	-5%
Mean Annual Temperature (°F)	48.6	49.8	+1.2	50.1	+1.5

At the San Francisco River near Reserve, mean and median flow have decreased substantially, which is consistent with England (2002). This indicates a decreasing trend in streamflow, and variability of flow. This is further supported by the dramatic decrease in high flow days and the increase in low flow days. Near Glenwood, the San Francisco River gage demonstrates an overall increase in high flow days and mean and median flow between the reference and current time period, with a decrease in low flow days. This is also consistent with the BOR study (England 2002). However, in the post-2000 time period, high flow days and mean and median flow decreased and low flow days increased suggesting a drying trend and a reduced variability of flow.

On Mogollon Creek, mean flow has not changed significantly overall, but has decreased since 2000. However, median flow is down 18 percent between reference and current time periods and 33 percent since 2000. High and low flow days have both increased. This is indicative of a drying trend and increasing variability in flow. At the Gila near Gila gage, mean and median flow have increased between reference and current time periods, consistent with the BOR study (England 2002). High and low flow days have also increased overall. However, in the 2000-2014 time period, mean and median flows have decreased slightly as high and low flow days continued to increase. This may signal the beginning of a drying trend and increasing variability in flow. Similar trends and interpretations are associated with the Gila River gage near Redrock. The Mimbres River data clearly shows a dramatic drying trend and decreasing variability in flow, with low flow days, mean and median flow decreasing between the reference and current time period.

Periods of record, precipitation and temperature all influence this analysis and the conclusions that may be drawn from it. According to the BOR study, which included all of the gages analyzed here except the Mimbres gage, precipitation patterns explained streamflow patterns at all gages except the San Francisco near Reserve (England 2002). On the other hand, there is some explanatory value in the period of record at this gage (1968-2014) given that it includes the relatively wet 1980s but does not include the drought of the 1950s. This would inflate the reductions in streamflow and variability, but to what degree is uncertain. This is also a likely issue with the Mogollon Creek and Mimbres gage data. Regardless, general decreasing trends in precipitation and increasing trends in temperature over the last two decades have significantly impacted annual streamflow patterns.

Average monthly values are also be descriptive of departure and trends in streamflow. Figure 109 illustrates changes in average monthly streamflow for the San Francisco near Glenwood. Appendix D contains similar figures for all gages.

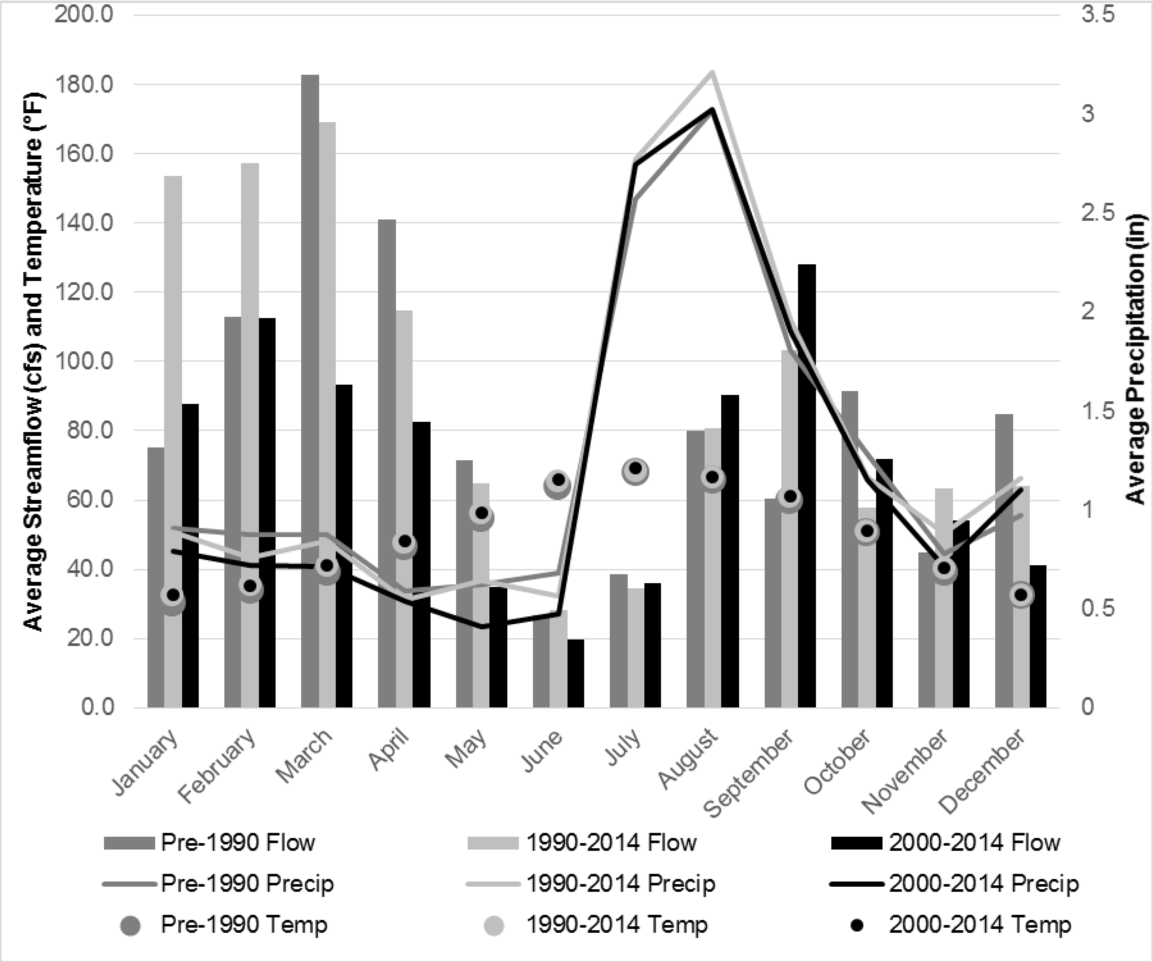

Figure 109. Mean monthly streamflow at the San Francisco gage near Glenwood (period of record 1928-2014) and mean monthly precipitation and temperature Southwestern Mountains climate division (period of record 1895-2014)

When comparing the post-2000 subset of the current time period to the reference period, several general trends are observed: average streamflow has decreased in the winter and spring months (December-May), peak snowmelt runoff is occurring earlier and the snowmelt runoff period is decreasing, and the duration of late spring-early summer low flow periods are increasing. These changes are consistent with climate change projections and have enormous ecological and socioeconomic implications. During monsoon months (July-September) streamflow variability reflects variability of monsoon patterns and may be increased, decreased or the same between all time periods.

As described under analysis methods, the gage data, the historic and current distribution of native fishes, and the water quantity indicator from the 2016 watershed condition classification are used describe departure and trend in streamflow. The results are discussed following Figure 110 which displays the results graphically.

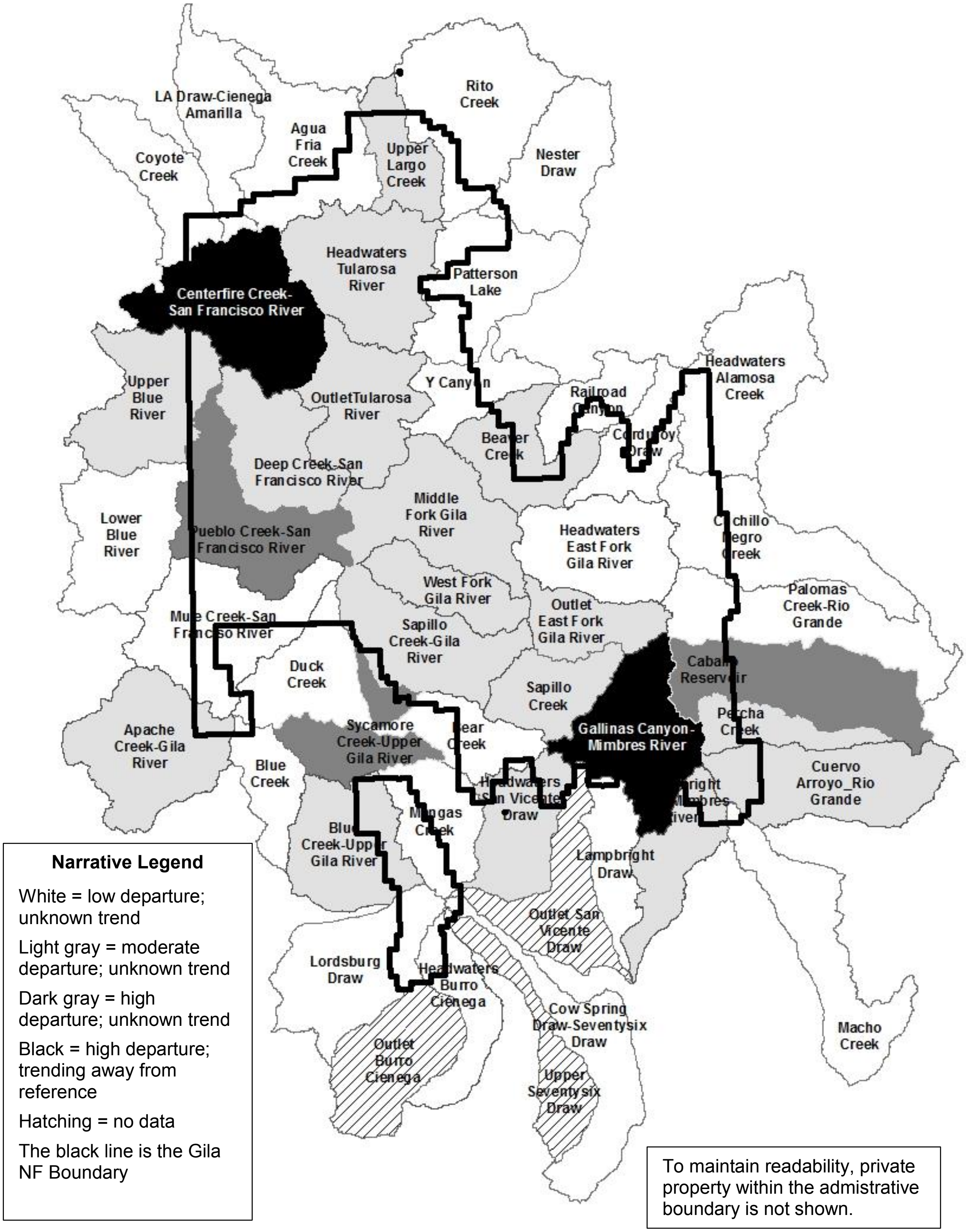

Figure 110. Departure and trend in streamflow for plan area watersheds

There is no gage data or watershed condition classification data to describe departure and trend in streamflow for Outlet Burro Cienega, Upper Seventysix Draw, or Outlet San Vincente Draw. Centerfire Creek-San Francisco River is the only watershed represented by the San Francisco River gage near Reserve. The Outlet Tularosa River watershed enters the San Francisco River just below the gage. Based on the gage data analysis and the conclusion drawn by England (2002) that this was the only gage in his study where trends could not be explained by precipitation patterns, Centerfire Creek-San Francisco River is in high departure and trending away from reference. This watershed contains water control structures in many of its drainages that alter streamflow, however, these structures were in place during the reference period. Therefore, like precipitation patterns, they cannot fully explain changes in streamflow. This watershed also experienced further alteration in some areas following the 2011 Wallow Fire. As mentioned previously under the Analysis Methods heading, not enough time has passed for changes due to recent wildfires to be reflected in annual and monthly values.

Departure and trend in the remaining watersheds in the San Francisco subbasin are based on the water quantity indicator. England concluded that the variability at the San Francisco River gage near Glenwood could be explained by precipitation patterns (2002), most or all of the water controls and diversions that occur, were already in place during the reference period and the only events that have happened in the current time period with the ability to create changes in streamflow at this scale are large extents of high and moderate burn severity, such as occurred in the 2012 Whitewater Baldy Complex Fire. While watersheds will regain function overtime, hydrologic response to precipitation may be never return to pre-fire conditions in some watersheds. This will depend on the extent and severity of soil erosion and changes to stream channel shape and function. Existing diversions in these watersheds are known to reduce flow and in some places, remove all of the surface flow in the San Francisco River during parts of the year. This usually occurs during low flow periods coinciding with the growing (irrigation) season.

A similar approach as was taken with watersheds represented by the San Francisco near Reserve gage was used for watersheds that had representation in the Gila River near Gila and Gila River near Redrock gage data for the same reasons. Of those watersheds represented by the Gila River near Gila gage, nearly all are in moderate departure due to post-fire effects of the Whitewater Baldy Complex Fire. In Beaver Creek, departure was elevated from low to moderate based on data previously documenting desert sucker, headwater chub, longfin dace and speckled dace. No native or non-native fish are currently known to occupy streams in this watershed. Of those watersheds represented by the Gila River near Redrock gage, Sycamore Creek-Gila River is the only watershed in high departure. This is due to water controls and diversions, the most significant of which is associated with Bill Evans Lake and ongoing mining activities at Tyrone, New Mexico. The dams constructed by the New Mexico Department of Game and Fish that create Quemado Lake, Snow Lake, Lake Roberts, and Bear Canyon Dam Reservoir also alter flow to varying extents in the Upper Largo, Middle Fork Gila River, Sapillo Creek and Gallinas Canyon-Mimbres River watersheds respectively.

Gallinas Canyon-Mimbres River is the only watershed represented by the Mimbres River gage. Since this gage was not part of the BOR study (England 2002), it is considered to be in high departure and trending away from reference based on this gage data analysis. There are small diversions in this watershed and the 2013 Silver Fire has contributed to alteration of streamflow in this watershed. The Silver Fire has also altered flow in Lampbright Draw-Mimbres River, Caballo Reservoir, Percha Creek and Cuervo Arroyo-Rio Grande watersheds. Tailings piles from historic mining activity in the Cold Springs drainage of Lampbright Draw-Mimbres River also contribute to departure in streamflow.

Context Area

Current streamflow conditions for the San Francisco, Upper Gila and Upper Gila-Mangas subbasins are represented by the gage data analysis. Based on the watershed departure rating representing the largest percentage of these subbasins, the San Francisco and Upper Gila are in moderate departure with an unknown trend and Upper Gila-Mangas is in low departure with an unknown trend. In the Little Colorado Headwaters, departure in streamflow is likely greater outside the Gila NF than within it (low departure) due to more stream miles, water controls and diversions and greater extents affected by the 2011 Wallow Fire. In Carrizo Wash, Plains of San Agustin, Elephant Butte Reservoir, Caballo, El Paso-Las Cruces Animas Valley subbasins, there is no stream gage data, watershed condition classification or aquatic biota information sufficient to describe current conditions. Some assumptions could be made regarding water controls and diversions, which are likely to occur at higher densities off Forest. Likewise, some assumptions could be made about large extents of high and moderate burn severity which are more likely to occur on Forest than on other lands. However, current conditions at the subbasin scale are not quantifiable based on existing information. Opportunities and limitations regarding the Gila NF's ability to contribute to ecological integrity and sustainability are the same factors discussed previously in the watershed condition and perennial and intermittent streams.

Risk

Risk to streamflow integrity and its ability to continue providing current levels of ecosystem services is assessed at the watershed scale using the matrix displayed as Table 129.

Table 129. Streamflow risk matrix.

Departure	Trend Toward Reference	Trend Unknown or Static	Trend Away from Reference
High	Risk Addressed	High Risk	Very High Risk
Moderate	Risk Addressed	Moderate Risk	High Risk
Low	Low Risk	Low Risk	Moderate Risk

The results of the risk assessment can be interpreted graphically from Figure 110 above, with the watersheds in white at low risk, light gray at moderate risk, dark gray at high risk and black at very high risk. This risk is can be attributed primarily to current climate, existing water controls and diversions. Changes to the distribution and length of time snow stays on the ground at the higher elevations resulting from large, contiguous extents of stand replacement fire (high and moderate burn severities) contributes to risk. Current management is also a risk factor in the sense that the large extents of high and moderate burn severity that occurred as the result of recent wildfires were due to the legacy of past fire suppression and drought conditions. Wildfire risk can be reduced through managed, low severity fire, whether prescribed or allowing wildfires to burn under favorable conditions, which reduces the risk of large extents of high and moderate burn severity. Risk to streamflow due to post-fire effects lessens with years, but recovery of stream channel shape and function may require decades. Departure in stream channel shape and function alters the connections between groundwater and surface water. Stream bed elevations raised by sediment deposition (aggradation) or lowered by erosion (degradation) have the potential to lead to drying of the system.

There is always a degree of risk associated with natural cycles of drought. However, this risk does not incorporate climate change which is predicted to increase the frequency, severity and duration of droughts (IPCC 2007; Seager et al. 2007), alter precipitation patterns, and thereby timing, quantity, duration and distribution of available water. A moderate or greater vulnerability to climate change at the watershed scale (see Chapter 9: System Drivers and Stressors) elevates risk one category. This is the case for all Gila NF watersheds. Table 130 displays the percentage of the Forest and each local unit in each risk category, without the consideration of climate change. Again, a moderate or greater vulnerability to climate change elevates risk one category which is the case for all local units and the Forest as a whole.

Table 130. Percentage of local unit and Forest area in each streamflow risk category.

Local Unit	Low Risk	Moderate Risk	High Risk	Very High Risk
Apache	35	36	0	29
Little Colorado-San Agustin Fringe	56	19	0	25
Mogollon Front	27	36	38	0
Black Range	49	11	14	26
Upper Gila	0	100	0	0
Lower Gila	44	55	1	0
Gila NF Total	34	50	8	11

Recall that high and very high risk are differentiated by whether or not there is a trend away from reference (Table 129). All watersheds in high departure that contribute area to the Apache and Little Colorado-San Agustin Fringe local units are trending away from reference.

Waterbodies

Waterbodies on the Gila NF are nearly all constructed features, although a few natural depressions do occur that may hold water seasonally. Because these are constructed features and did not exist prior to European settlement, waterbodies are not analyzed as a key characteristic; their very existence represents a departure from the reference period. However, they are important ecological features. Most waterbodies are earthen tanks built to provide livestock water (i.e. stock tanks), with a secondary benefit of providing water to wildlife. Not all stock tanks hold water year round. Some are poorly located or designed, and many are in need of maintenance. The most reliable livestock tanks are associated with areas of groundwater discharge, such as springs. A few have been stocked with non-native fish for recreational purposes by the New Mexico Department of Game and Fish (NMDGF). NMDGF also constructed, and has the management responsibility for dams that create the three lakes or reservoirs located, entirely or in part, on the Forest for recreational fisheries purposes. These lakes are Quemado Lake, Snow Lake and Lake Roberts.

While constructed waterbodies provide the benefit of storage, making surface water available to livestock, wildlife and for recreational purposes over a longer period of time, they alter natural patterns of water flow. Constructed waterbodies reduce the amount of water flowing downstream, which can be both positive and negative. These features may serve to attenuate floodwaters and potentially reduce negative flooding impacts to human life and property downstream. On the other hand, these features negatively impact natural streamflow patterns, hydrologic connectivity of stream systems, aquatic habitat connectivity, and tend to increase evaporative losses and reduce groundwater recharge. The most significant instances of these negative ecological impacts occurring on the Forest are captured by the water quantity indicator of the watershed condition classification.

The Forest does not have an inventory of storage capacity and condition related to all stock tanks located within its boundaries, but is currently conducting an inventory in the Gila-San Francisco River basin. According to NHD, 18 percent of context area waterbodies occur on the Gila NF which is roughly proportional to the 17 percent (Table 121) of the context area the Forest occupies. Appendix D contains tables displaying information from the NHD about the number of waterbodies within the context and plan areas, both on and off-Forest.

Surface Water Quality

The primary source of water pollution on National Forest System lands are nonpoint source pollutants. Nonpoint source pollutants are those which cannot be traced back to a single point, such as pipes or ditches from industrial or sewage treatment sources. Nonpoint source pollution is caused by water moving over and through the ground and carrying natural and human-made pollutants into streams and waterbodies, and remains the nation's largest source of water quality problems. Common nonpoint source pollutants include temperature (too warm), sediment, metals, bacteria and nutrients. Activities potentially generating nonpoint source pollutants on the Forest include: mining activities, fire, grazing, roads, timber and fuelwood harvesting, recreational uses and ground disturbance generated by off-highway vehicle use.

The Federal Clean Water Act is administered by the Environmental Protection Agency (EPA) although the EPA delegates many functions to the Army Corps of Engineers and State governments. The New Mexico Water Quality Control Commission sets standards which define water quality goals by designating uses (e.g. domestic water supply, irrigation, livestock watering, wildlife habitat, and aquatic life), setting criteria to protect those uses, and establishing provisions to preserve water quality. Use Attainability Studies are conducted on a three year rotating basis to examine water quality standards for changes to reflect new technology, data or scientific understanding. The current standards were established in 2013.

Every two years, the New Mexico Environment Department's Surface Water Quality Bureau prepares an assessment of the quality of the state's surface waters, which includes a list of impaired waters. Impaired waters are those waters determined to be in non-attainment of standards for one or more of their designated uses. Limitations associated with budget and personnel mean that not all waters are assessed in any given two year cycle. The state water quality assessment is released in a document called the State of New Mexico Clean Water Act 303(d)/305(b) Integrated List and Report. The most current 303(d)/305(b) Integrated List and Report (2014-2016) is available at https://www.env.nm.gov/swqb/303d-305b/2014-2016/index.html.

Analysis Methods

There is no information regarding surface water quality sufficient to describe a reference condition; therefore the regulatory standard is used to describe reference and current conditions. The same thresholds used in the vegetation analysis are applied here to define low, moderate and high departure for watersheds based on the percentage of subwatersheds that intersect the Forest boundary and contain impaired streams:

- 0-33% of subwatersheds contain impaired streams=low departure
- 34-66% of subwatersheds contain impaired streams=moderate departure
- >66% of subwatersheds contain impaired streams=high departure

While this analysis explores causes of impairment, cause is not used to determine departure (or risk). Departure is based solely on whether or not subwatersheds contain impaired stream miles, regardless of whether those miles are listed for a single cause or multiple causes. Causes are explored for informational value that may be considered when developing plan components.

Departure from the regulatory reference condition does not necessarily imply trend. Changes in the water quality standards and methods of measurement have resulted in streams being added and removed from the 303(d) list without any actual changes in biological, chemical, or physical water quality parameters (NMED 2014b). In fact, 67 percent of the roughly 168 miles of impairments in Upper Gila and San Francisco subbasins removed from the 303(d) in 2014 were de-listed due to changes in standards and measurement methods.

The watershed condition classification's water quality indicator allows Forests to document water quality concerns that have not resulted in a 303(d) listing (Potyondy and Geier 2011). In watersheds without any 303(d) listings, if more than 33 percent of subwatersheds intersecting the Forest boundary have water quality concerns documented by the Gila NF's water quality indicator, departure is considered moderate. Otherwise, departure in these watersheds without 303(d) listings is low as described above.

Plan Area

Of the nearly 1,546 total miles of assessed streams in plan area watersheds, 42 percent occur on the Gila NF. Of the assessed stream miles located on the Gila NF, approximately 286 miles, or 44 percent are meeting all water quality standards. Approximately 364 miles, or 56 percent are listed as impaired for one or more reasons. The Middle Fork Gila River, West Fork Gila River, Outlet East Fork Gila River and Sapillo Creek-Gila River watersheds account for nearly 59 percent of the total impaired miles on the Forest, most of which occur in the Gila and Aldo Leopold Wilderness areas. Water quality conditions for stream miles not assessed is unknown because no data has been collected on miles not assessed. Miles of assessed streams, those that are meeting all State water quality standards and impaired miles for plan area watersheds are displayed in Table 131. Appendix D contains a similar table that includes subwatersheds.

Table 131. Miles of assessed streams, those that are meeting all State water quality standards and impaired miles for plan area watersheds.

Watershed Name	Gila NF % of Watershed	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
		Total	Gila NF	Total	Gila NF	Total	Gila NF
Plains of San Agustin Subbasin							
Nester Draw	3	0	0	0	0	0	0
Y Canyon	0	0	0	0	0	0	0
Patterson Lake	0	0	0	0	0	0	0
Elephant Butte Reservoir Subbasin							
Headwaters Alamosa Creek	16	0.1	0	0.1	0	0	0
Caballo Subbasin							
Cuchillo Negro Creek	32	1.2	0	1.2	0	0	0
Palomas Creek-Rio Grande	25	38.5	0	23.8	0	14.7	0
Percha Creek	32	24.7	0	24.7	0	0	0
Caballo Reservoir	21	62.7	10.8	12.9	0	49.8	10.8
El Paso-Las Cruces Subbasin							
Cuervo Arroyo_Rio Grande	17	48.8	9.1	36.8	9.1	12.0	0
Mimbres Subbasin							
Gallinas Canyon-Mimbres River	74	93.4	60.6	45.8	43.0	47.6	17.6
Headwaters San Vicente Draw	18	5.4	0	3.5	0	1.9	0
Outlet San Vicente Draw	1	24.2	<0.1	24.2	<0.1	0	0
Lampbright Draw	3	0	0	0	0	0	0
Lampbright Draw-Mimbres River	17	31.4	6.5	10.5	4.8	20.9	1.7
Macho Creek	0	0	0	0	0	0	0

Watershed Name	Gila NF % of Watershed	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
		Total	Gila NF	Total	Gila NF	Total	Gila NF
Upper Seventysix Draw	1	0	0	0	0	0	0
Cow Spring Draw-Seventysix Draw	2	0	0	0	0	0	0
Little Colorado Headwaters Subbasin							
Coyote Creek	9	0	0	0	0	0	0
Carrizo Wash Subbasin							
Rito Creek	13	0	0	0	0	0	0
Upper Largo Creek	76	32.7	11.6	32.7	11.6	0	0
Agua Fria Creek	35	0	0	0	0	0	0
LA Draw-Cienega Amarilla	5	0	0	0	0	0	0
Upper Gila Subbasin							
Railroad Canyon	16	<0.1	0	0	0	<0.1	0
Corduroy Draw	61	0	0	0	0	0	0
Beaver Creek	54	24.6	2.4	0	0	24.6	2.4
Headwaters East Fork Gila River	99	88.8	79.3	45.6	43.4	43.2	35.9
Middle Fork Gila River	100	84.7	81.6	20.3	20.3	64.4	61.3
West Fork Gila River	99	61.8	57.2	25.4	25.2	36.4	32.0
Outlet East Fork Gila River	99	41.8	39.0	0	0	41.8	39.0
Sapillo Creek	98	11.8	7.6	11.8	7.6	0	0
Sapillo Creek-Gila River	96	75.2	72.2	<0.1	<0.1	75.2	72.2
Upper Gila-Mangas Subbasin	***15***	***200.8***	***20.6***	***93.9***	***9.3***	***106.9***	***11.3***
Bear Creek	63	30.4	8.3	30.4	8.3	0	0
Duck Creek	12	0	0	0	0	0	0

Watershed Name	Gila NF % of Watershed	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
		Total	Gila NF	Total	Gila NF	Total	Gila NF
Mangas Creek	39	24.9	1.0	18.5	0.9	6.4	0.1
Sycamore Creek-Upper Gila River	3	8.4	1.0	0.1	0	8.3	1.0
Blue Creek	4	28.7	0	28.7	0	<0.1	0
Blue Creek-Upper Gila River	25	28.8	10.2	0	0	28.8	10.2
Apache Creek-Gila River	5	28.2	0	0	0	28.2	0
Animas Valley Subbasin							
Headwaters Burro Cienega	16	5.6	1.2	5.6	1.2	0	0
Outlet Burro Cienega	<1	3.4	0	3.4	0	0	0
Lordsburg Draw	19	0	0	0	0	0	0
San Francisco Subbasin							
Headwaters Tularosa River	94	28.7	9.1	26.5	8.7	2.2	0.4
Outlet Tularosa River	98	55.0	41.1	8.3	7.9	46.7	33.2
Centerfire Creek-San Francisco River	78	133.3	53.2	83.2	25.6	50.1	27.6
Deep Creek-San Francisco River	98	27.6	20.6	21.0	17.6	6.6	3.0
Upper Blue River	14	176.1	9.1	167.0	9.1	0	0
Pueblo Creek-San Francisco River	88	70.3	47.6	50.2	37.4	20.1	10.2
Lower Blue River	<1	33.4	0	8.1	0	25.3	0
Mule Creek-San Francisco River	50	98.4	22.2	87.1	17.2	11.3	5.0

Table 132 displays watershed total and Gila NF impaired miles by cause of impairment. Stream miles do not include those through waterbodies. Water quality for waterbodies is discussed separately. Miles by cause do not always add up to the total impaired miles because some are impaired for more than one reason. For example, there are 19.5 miles of the East Fork Gila River in the (Headwaters East Fork Gila River watershed that are impaired for both temperature and nutrients/eutrophication. These same 19.5 miles are listed twice, once under temperature and once under nutrients/eutrophication. The purpose for counting miles by cause is not to inflate the overall picture of water quality concerns on the Forest. The purpose of examining the extent of different causes of impairment is to provide a picture of how each cause contributes to water quality issues. Different causes may require different management approaches to address. Of the nearly 185 total stream miles within the plan area listed for more than one cause of impairment, approximately 99 miles occur on Forest. Causes are described and discussed following the table.

Table 132. Plan area watershed total and Gila NF impaired stream miles by cause of impairment

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Plains of San Agustin Subbasin																					
Nester Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y Canyon	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Patterson Lake	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elephant Butte Reservoir Subbasin																					
Headwaters Alamosa Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caballo Subbasin																					
Cuchillo Negro Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palomas Creek-Rio Grande	14.7	-	-	-	-	-	-	-	-	14.7	0	-	-	-	-	-	-	-	-	-	-

Watershed Name	Total Impaired Stream Miles	Impaired Stream Miles by Cause of Impairment																			
		Aluminum		**Benthic Macroinvertebrate Community**		**Cadmium and Lead**		**Conductance**		**Dissolved Oxygen**		***E. coli* bacteria**		**Nutrients and Eutrophication**		**Temperature**		**Turbidity or Suspended Sediment Concentration**		**Sediment**	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Percha Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caballo Reservoir	33.6	-	-	16.2	10.8	-	-	-	-	6.6	0	-	-	-	-	-	-	-	-	-	-
El Paso-Las Cruces Subbasin																					
Cuervo Arroyo-Rio Grande	11.9	-	-	-	-	-	-	-	-	-	-	11.9	0	-	-	-	-	-	-	-	-
Mimbres Subbasin																					
Gallinas Canyon-Mimbres River	47.4	-	-	-	-	-	-	-	-	-	-	11.9	0	8.7	11.9	21.6	5.6	-	-	-	-
Headwaters San Vincente Draw	1.9	-	-	-	-	-	-	-	-	-	-	-	-	1.9	0	-	-	-	-	-	-

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Outlet San Vincente Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampbright Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampbright Draw-Mimbres River	20.9	-	-	-	-	5.9	1.7	-	-	-	-	13.3	0	-	-	13.3	0	-	-	-	-
Macho Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Seventysix Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cow Spring Draw-Seventysix Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Watershed Name	Total Impaired Stream Miles	Impaired Stream Miles by Cause of Impairment																			
		Aluminum		**Benthic Macroinvertebrate Community**		**Cadmium and Lead**		**Conductance**		**Dissolved Oxygen**		***E. coli* bacteria**		**Nutrients and Eutrophication**		**Temperature**		**Turbidity or Suspended Sediment Concentration**		**Sediment**	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Little Colorado Headwaters Subbasin																					
Coyote Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carrizo Wash Subbasin																					
Rito Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Largo Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agua Fria Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Draw-Cienega Amarilla	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Gila Subbasin																					
Railroad Canyon[1]	<0.1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1*	0	-	-	-	-

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Corduroy Canyon	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beaver Creek	24.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.2	2.4	-	-	-	-
Headwaters East Fork Gila River	43.2	-	-	3.0	6.4	-	-	-	-	-	-	-	-	2.9	19.5	4.3	29.5	-	-	-	-
Middle Fork Gila River	64.4	1.4	5.8	-	-	-	-	-	-	-	-	-	-	1.0	13.1	2.1	48.2	-	-	-	-
West Fork Gila River	36.4	-	-	0	<0.1	-	-	-	-	-	-	-	-	-	-	4.4	32.0	-	-	-	-
Outlet East Fork Gila River	41.8	-	-	2.7	14.0	-	-	-	-	-	-	-	-	-	-	0.1	25.0	-	-	-	-
Sapillo Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sapillo Creek-Gila River	75.2	1.1	15.6	-	-	-	-	-	-	-	-	-	-	-	-	1.9	56.6	-	-	-	-

Watershed Name	Total Impaired Stream Miles	Impaired Stream Miles by Cause of Impairment																			
		Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Upper Gila-Mangas Subbasin																					
Bear Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duck Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mangas Creek	6.4	-	-	-	-	-	-	-	-	-	-	-	-	6.3	0.1	6.3	0.1	-	-	-	-
Sycamore Creek-Upper Gila River	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.9	1.0	-	-	-	-
Blue Creek	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	0	-	-	-	-
Blue Creek-Upper Gila River	28.8	-	-	-	-	-	-	-	-	-	-	-	-	9.4	10.2	18.6	10.2	-	-	-	-
Apache Creek-Gila River	28.2	-	-	-	-	-	-	-	-	-	-	28.2	0	-	-	-	-	6.6	0	-	-
Animas Valley Subbasin																					

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Headwaters Burro Cienega	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outlet Burro Cienega	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lordsburg Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
San Francisco Subbasin																					
Headwaters Tularosa River	2.2	-	-	-	-	-	-	-	-	-	-	1.8	0.4	-	-	1.8	0.4	1.8	0.4	-	-
Outlet Tularosa River	46.7	-	-	-	-	-	-	-	-	-	-	11.6	22.7	-	-	13.5	33.2	10.9	8.9	-	-
Centerfire Creek-San Francisco River	50.6	-	-	5.4	9.3	-	-	8.1	8.0	-	-	17.6	18.3	8.1	8.0	19.2	30.6	13.8	18.3	8.1	8.0

		Impaired Stream Miles by Cause of Impairment																			
Watershed Name	**Total Impaired Stream Miles**	**Aluminum**		**Benthic Macroinvertebrate Community**		**Cadmium and Lead**		**Conductance**		**Dissolved Oxygen**		***E. coli* bacteria**		**Nutrients and Eutrophication**		**Temperature**		**Turbidity or Suspended Sediment Concentration**		**Sediment**	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Deep Creek-San Francisco River	6.6	-	-	-	-	-	-	-	-	-	-	3.6	3.0	-	-	-	-	-	-	-	-
Upper Blue River	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pueblo Creek-San Francisco River	20.1	-	-	4.3	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5	8.9
Lower Blue River	25.3	-	-	-	-	-	-	-	-	-	-	25.3	0	-	-	-	-	-	-	-	-
Mule Creek-San Francisco River	11.3	-	-	0.1	0.7	-	-	-	-	6.3	4.2	-	-	-	-	-	-	-	-	-	-
Total	**658.1**	**2.5**	**21.4**	**31.7**	**42.5**	**5.9**	**1.7**	**8.1**	**8.0**	**27.6**	**4.2**	**113.3**	**44.4**	**38.3**	**62.8**	**144.2**	**232.6**	**33.1**	**27.6**	**13.6**	**16.9**

[1] This impairment in the Railroad Canyon watershed measures (0.03 miles), which represents a discrepancy between the NHD database and the water quality geospatial data as the NHD does not show any perennial or intermittent miles in this watershed.

Temperature is the number one cause of impairment on and off the Forest in plan area watersheds. Sixty two percent of temperature impairments in plan area watersheds occur on Forest. Streams listed as impaired due to temperature in the context and plan area are too warm to support their designated aquatic life uses. Temperature is important to aquatic species as most cannot regulate their own body temperatures. It also serves as a cue for certain biological processes and influences water chemistry characteristics such as dissolved oxygen concentrations. It is the sole cause of impairment in Beaver Creek, West Fork Gila River, Railroad Canyon[25], Sycamore Creek- Upper Gila River, Blue Creek and Blue Creek-Upper Gila River watersheds. It is the most common cause of impairment in Gallinas Canyon-Mimbres River, Lambright Draw-Mimbres River, Headwaters East Fork Gila River, Outlet East Fork Gila River, Middle Fork Gila River, Sapillo Creek Gila River, Mangas Creek and Outlet Tularosa River watersheds. It contributes to multiple causes of impairment in Headwaters Tularosa River and Centerfire Creek-San Francisco River watersheds, which has the most impairment causes of any watershed.

Temperature impairments may be caused by reduction in riparian canopy cover and shade over water, or changes in stream channel shape and function. Relatively wide shallow streams absorb more heat energy from the sun than relatively deep, narrow streams. Stream temperatures can also be elevated during low flow periods associated with seasonal precipitation patterns. There are also factors associated with measuring stream temperature that can lead to exceedances of the State standards, particularly the location of the temperature recorder in the stream. Most of the temperature impairments on the Forest occur within designated wilderness areas where fire and recreation are the only human activities. Nearly all of these impairments were first documented between 1996 and 2010 (NMED 2014b), prior to large extents of high and moderate burn severities in the watersheds containing these streams. At the time of the first documented impairments, these streams very likely expressed potential natural temperature conditions. Temperature water quality standards for most listed streams on the Forest are under review (NMED 2014b). However, whether or not changes in water quality standards occur, it is quite possible that temperature impairments will still exist on the Forest as watersheds, riparian areas and stream systems impacted by post-fire effects stabilize.

Nutrients and eutrophication are the second leading cause of impairment on the Forest. Excessive concentrations of nutrients necessary for plant growth may lead to eutrophication. Eutrophication is the process by which streams and waterbodies accumulate high concentrations of plant nutrients leading to excessive growth of algae (algal blooms). Algal blooms eventually deplete dissolved oxygen which leads to the death of aquatic organisms. This process occurs naturally, but human activity can accelerate the process. Nutrients chemically bond to soil particles, and often enter streams attached to sediment. Pollutant concentrations, including nutrients, also increase during low flow periods. Human activities that could potentially contribute plant nutrients to streams through nonpoint source pathways include mining activities, fire, grazing, roads, timber and fuelwood harvesting, recreational uses, septic systems, and ground disturbance generated by off-highway vehicle use. However, as it is primarily a nonpoint source pollutant, it would take intensive studies to determine the exact source along any given stream.

Dissolved oxygen is essential to aquatic life. Nutrients and the process of eutrophication, as well as temperature influence dissolved oxygen concentrations. The more advanced the eutrophication process and the warmer the temperatures, the less dissolved oxygen. Groundwater and surface water interactions also influence dissolved oxygen concentrations. Only the Mule Creek-San Francisco watershed contains streams located on the Gila NF impaired for dissolved oxygen.

Conductance is a measure of water’s ability to carry an electrical current. The ability of water to carry an electrical current is directly related to the concentration and type of dissolved salts and inorganic

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[25] This impairment in the Railroad Canyon watershed measures (0.03 miles), which represents a discrepancy between the NHD database and the water quality geospatial data as the NHD does not show any perennial or intermittent miles in this watershed.

compounds (solutes) contained in the water. Most streams maintain a fairly constant conductivity and any changes may be one of the first indicators of water quality issues. Most aquatic organisms can only survive within specific ranges of solute concentrations. Potential sources of solutes include all human activities identified as potential sources of nutrients, as well as natural geologic sources. Centerfire Creek-San Francisco watershed is the only one containing streams that are impaired due to conductance, which is only one of seven reasons why impaired streams in this watershed are not meeting water quality standards for their designated uses.

E. coli is a bacteria used as an indicator of contamination and health risk. Streams within the context and plan area that contain concentrations of *E. coli* that exceed the state standards are not meeting their designated use of primary (e.g. swimming) or secondary (e.g., wading) contact. It is a much larger problem off Forest (72 percent of all impairments) than on Forest (28 percent of impairments). Fecal matter may introduce *E. coli* and pathogens making people, wildlife and livestock potential sources of pollution. While septic systems occurring off-Forest have been identified as a probable source of nutrients contributing to water quality issues in the Mangas Creek watershed (NMED 2014b), septic systems have not been identified as a probable source of *E. coli* within plan area watersheds (NMED 2014b).

Benthic macroinvertebrates are aquatic organisms without backbones that live on the bottom of waterbodies. They have many important ecological functions and are found in all but the harshest or severely polluted streams. The size and composition of the benthic macroinvertebrate community serve as an indicator of water quality. Within a stream, the composition of benthic macroinvertebrate community is directly related to the water quality characteristics. For example, some families of invertebrates are found in high abundance in streams that are cold with a cobble substrate that have high dissolved oxygen, while others do quite well in warm, muddy rivers. Furthermore, in cases of very poor water quality, only the most tolerant invertebrate species will persist. Generally, decreased water quality (e.g., increased fine sediment) reduces intolerant species diversity and abundance (Reynoldson et al. 1997; Kaller and Hartman 2004). The fourth leading cause of water quality impairments on the Gila National Forest (42.5 miles) is related to benthic macroinvertebrate communities.

Two biological assessment approaches utilizing benthic macroinvertebrate communities are currently used in New Mexico for determining the attainment of water quality standards for aquatic life designated uses, namely the reference site approach (i.e., comparing an individual stream or waterbody to an appropriate individual reference site), and the reference condition approach (i.e., comparing an individual stream or waterbody to a reference condition for class or group of streams or waterbodies to which that stream or waterbody belongs). Currently, New Mexico has only defined a reference condition for wadeable, perennial streams in the Mountain ecoregions (NMED SWQB 2015a)[26]. The Gila NF falls entirely within the AZ/NM Mountains Ecoregion 23.

The reference condition approach expands on the original Rapid Bioassessment Protocol (RBP) methods (Plafkin et al. 1989) to acknowledge the reality of a wide range of aquatic conditions that reflect more than minimal impacts, including historic and current land and water use activities (Barbour et al. 1999; Stoddard et al. 2006). This broader concept of reference condition allows for the definition of reasonable and attainable targets or goals by class or group in order to assess potential impairment to the aquatic community at a larger number of study sites (NMED SWQB 2015a).

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[26] Wadeable, perennial streams located outside of the Mountain ecoregions continue to be assessed using the reference site approach from the original Rapid Bioassessment Protocol (RBP) (Plafkin et al. 1989) as modified by Jacobi (2009) when a suitable reference site has be identified and sampled as well. The New Mexico Environment Department (NMED) does not apply either method to large non-wadeable rivers, lakes and reservoirs, or non-perennial streams at this time (NMED SWQB 2015a).

In order to determine reference condition, data from a continuum of reference to stressed sites in the ecoregion(s) of interest must be available. NMED has been collecting benthic macroinvertebrate data since 1979. The formal process of developing numeric biological translators began in 2002 with assistance from the EPA and Tetra Tech, Inc. In 2006, NMED, in collaboration with Drs. Jacobi and Tetra Tech, Inc., developed a regional Mountain Stream Condition Index (M-SCI) to determine aquatic life use attainment for the Mountain biological region which consists of Ecoregions 21 and 23 (Southern Rockies and AZ/NM Mountains, which includes the Gila NF) (Griffith et al. 2006; Jacobi et al. 2006).

The M-SCI is composed of twelve individual metrics (i.e. standard of measurement) from five metric categories, representing community and species attributes such as taxonomic composition, taxonomic richness, tolerance, habit, and functional feeding group. For additional descriptions of these twelve metrics, see Plafkin et al. 1989, Barbour et al. 1999, and Jacobi et al. 2006.

M-SCI scores are normalized[27] utilizing the 95th percentiles associated with each metric. Each metric is first calculated and normalized. All metrics are then summed and averaged to produce an M-SCI score between 0 and 100. The resulting score is then placed in a condition category of Very Good (100 – 78.36), Good (78.35 – 56.71), Fair (56.70 – 37.21), Poor (37.20 – 18.89), or Very Poor (18.90 – 0) based on the distribution of reference site scores. Sites with M-SCI ranking of poor or very poor are considered not meeting water quality standards for their designated aquatic life use. Sites falling in the fair range are considered “Not Assessed” until a second sample can be taken. These sites will be listed as impaired if a second sample within a 5-year period confirms a value in this range (NMED SWQB 2015a). Table 133 explains how to interpret macroinvertebrate data to assess aquatic life use support. Additional data are often needed to determine the specific pollutant or “pollution” of concern.

Table 133. Interpreting benthic macroinvertebrate data to water quality status with respect to designated aquatic life use in wadeable, perennial streams

Type of data	Meeting all water quality standards	“not Assessed”	Impaired
Macroinvertebrate assemblages in Ecoregions 21 and 23 using M-SCI[2]	Reliable data indicate functioning, sustainable macroinvertebrate assemblages not modified significantly beyond the natural range of reference condition[1] (> 56.7 score).	Reliable data indicate macroinvertebrate assemblages might be modified beyond the natural range of reference condition (a) (≤56.7 and >37.2 score).	Reliable data indicate macroinvertebrate assemblage with impairment when compared to reference condition (a) (≤37.2 score).

[1] Reference condition is defined as the best situation to be expected within an ecoregion. Reference sites have balanced trophic structure and optimum community structure (composition & dominance) for stream size and habitat quality.

[2] Percentages based on Jacobi et al. (2006).

The Gila NF falls entirely within the AZ/NM Mountains Ecoregion 23 and can be assessed using the M-SCI scores collected by NMED. There are 27 water quality monitoring stations within, or immediately adjacent to the Gila NF (NMED SWQB 2015b), where M-SCI scores were calculated with the most recent score represented in Table 134 below. Trend was calculated by taking all measurements from each individual site and developing a trend line. Sites that only have one year of data are identified as having “no trend”.

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[27] Normalization is a mathematical procedure that adjusts values measured on different scales to a common scale.

Table 134. M-SCI scores for stations on the Gila NF

Watershed Name	Subwatershed Name	Site Name	Collection Date	M-SCI Score	Condition/Trend
Caballo Subbasin					
Caballo Reservoir	Outlet Las Animas Creek*	Las Animas Creek above box*	11/14/2011	37.32	Fair/Stable
Mimbres Subbasin					
Gallinas Canyon-Mimbres River	Allie Canyon-Mimbres River	McKnight Canyon Creek (aka East Fork of Mimbres) above the Mimbres	10/10/2002	54.93	Fair/No trend
		Mimbres River at upper Nature Conservancy Property*	11/18/2009	61.59	Good/Improving
	Powderhorn Canyon-Mimbres River	Mimbres River at Cooney Campground Crossing 150A	9/28/2005	47.43	Fair/No trend
	Noonday Canyon-Mimbres River	Mimbres River at Mimbres near USGS gage*	10/10/2002	52.77	Fair/Improving
	Gallinas Canyon-Mimbres River*	Mimbres River below Dwyer*	11/19/2009	36.77	Poor/Declining
Upper Gila Subbasin					
Headwaters East Fork Gila River	Headwaters Diamond Creek	Diamond Creek at Trail 42	8/23/2011	67.54	Good/Improving
Middle Fork Gila River	Indian Creek Canyon	Iron Creek at Forest Trail 151	9/29/2005	48.09	Fair/No trend
	Indian Creek Canyon-Middle Fork Gila River	Middle Fork Gila River	8/12/2000	71.58	Good/No trend

Watershed Name	Subwatershed Name	Site Name	Collection Date	M-SCI Score	Condition/Trend
	Gilita Creek	Willow Creek above Gilita Creek	11/5/2001	75.63	Good/Improving
West Fork Gila River	Headwaters West Fork Gila River	Cub Creek 1 mile above Middle Fork Gila	8/8/2000	150.08[1]	Very Good[1]/No trend
		West Fork Gila River above White Creek	8/9/2000	61.02	Good/No trend
	Outlet West Fork Gila River	West Fork Gila above Cliff Dwelling Canyon	9/19/2007	59.93	Good/Stable
Outlet East Fork Gila River	Headwaters Black Canyon	Black Canyon Creek ~0.75 miles above Aspen Canyon	11/6/2001	69.33	Good/Improving
	Outlet Black Canyon	Bonner Creek 1.5 miles above Black Canyon	7/6/2000	39.19	Fair/No trend
	Black Canyon-East Fork Gila River	East Fork Gila above West Fork	9/22/2011	53.58	Fair/Stable
		East Fork Gila River 1 mile above Black Canyon	7/31/2000	36.94	Poor/No trend
		East Fork Gila River below Black Canyon	11/8/2001	72.23	Good/Improving
Sapillo Creek-Gila River	Mogollon Creek-Gila River	Gila River 300 meters above Turkey Creek	10/27/2011	59.89	Good/Stable
	Turkey Creek	Turkey Creek (at Wilderness Boundary Forest Trail 155)	10/27/2011	49.21	Fair/Improving

Watershed Name	Subwatershed Name	Site Name	Collection Date	M-SCI Score	Condition/Trend
Upper Gila-Mangas Subbasin					
Bear Creek	Middle Bear Creek	Bear Creek below Dorsey Springs*	11/14/2006	58.19	Good/Declining
Mangas Creek	Mangas Creek-Upper Gila River*	Gila River above Mangas Creek*	9/22/2000	51.16	Fair/No trend
Sycamore Creek-Upper Gila River	Bear Creek-Upper Gila River	Gila River at NM Hwy 211 Bridge*	10/16/2007	64.7	Good/No trend
Blue Creek-Upper Gila River	Bear Canyon-Upper Gila River	Gila River below Mangas Creek *	11/8/2007	67.86	Good/No trend
San Francisco Subbasin					
Centerfire Creek-San Francisco River	Stone Creek-San Francisco River	San Francisco River above Luna	10/18/2007	65.19	Good/Stable
Pueblo Creek-San Francisco River	Whitewater Creek	Whitewater Creek above campground	10/6/2004	61.62	Good/Stable
Mule Creek-San Francisco River	Big Pine Canyon-San Francisco River	San Francisco River below Glenwood at Hot Springs	11/9/2011	56.34	Fair/Improving

*Not within plan area but within context area; included because upstream water quality can affect downstream water quality

[1] Data may not have been normalized by NMED

The M-SCI scores listed in the table are the most recent year the scores were calculated for each station. Some of the stations have had M-SCI calculated over multiple years with scores fluctuating through time. Of the 27 stations that had M-SCI calculations, 15 (56%) were in "Good" to "Very Good" condition and fully supporting aquatic life designated uses, 10 (37%) were in "Fair" condition indicating macroinvertebrate assemblages might be modified beyond the natural range of reference conditions, while two (7%) were considered to be in "Poor" condition indicating macroinvertebrate assemblages are impaired when compared to reference conditions. The 10 stations in fair condition are considered "Not Assessed" by NMED for assessment purposes under the Clean Water Act (Table 134 above) and a second sample taken within a 5-year period is required to reliably determine condition.

While additional data are needed to determine the specific pollutant responsible for benthic macroinvertebrate community conditions, one of the likely causes is sediment. Excess sediment in streams and waterbodies can negatively affect the biological processes of aquatic species and macroinvertebrate populations (Reynoldson et al. 1997; Kaller and Hartman 2004). Sediment can also carry with it other pollutants such as bacteria and nutrients. Turbidity is a measure of water clarity, which is affected by suspended fine sediments and dissolved solids. Suspended Sediment Concentration is a measure of the quantity of solid material per volume of water. Turbidity and Suspended Sediment Concentration are the most visible indicators of excess sediment. Sediments eventually settle out of suspension and can negatively impact benthic macroinvertebrate habitat. There are 30.5 total miles of impairments due to sediment, and 60.7 miles impaired for turbidity or suspended sediment concentrations. Miles of these impairments are similar on and off the Forest (Table 132). All of the activities identified as potential sources of nutrients leading to eutrophication or solutes leading to conductance impairments are also potential sources of sediment.

The remaining causes of water quality impairments are metals: aluminum, cadmium and lead. Aluminum is the third most common element in the earth's crust. At certain concentrations, aluminum is toxic. Mogollon Creek (Sapillo Creek-Upper Gila River watershed) and Willow Creek (Middle Fork Gila River watershed) have miles listed as impaired due to aluminum with concentrations that exceed those required to support the aquatic life criteria. A study conducted to determine the source of the aluminum leading to impairment of Mogollon Creek in the Sapillo Creek-Upper Gila River watershed concluded the probable source was geologic (Stevens and Clothier 2015). No such study is known to have been conducted for Willow Creek. Aluminum can be a component in emissions generated by coal fired power plants, and atmospheric deposition not impossible, however, there is no data related to the atmospheric deposition of aluminum. However, if the source was atmospheric deposition, it would most likely affect water quality across more of the plan area. Abandoned mine lands do not occur at watershed positions that could contribute aluminum to the impaired miles. Other potential industry related sources of aluminum are not present in these watersheds. The source of the aluminum is most likely geologic. Volcanic rocks, such as those that dominate these watersheds and are common across the Forest, contain varying amounts of aluminum. Therefore, the soils that form from these rocks also have varying amount of aluminum. A mineralogy study of the rocks and soils in these watersheds could potentially confirm or deny the probable source as natural. Cadmium and lead are naturally occurring metals toxic to plants, animals and microorganisms. Streams listed as impaired due to concentrations of these metals within Lampbright Draw-Mimbres River watershed (Table 132) are believed to be associated with historic mining operations. Remediation of a historic mine is anticipated to begin in 2017.

The water quality indicator from the watershed condition classification considers both water quality issues resulting in 303(d) listings, as well as other water quality concerns that have not resulted in a 303(d) listing. There are four watersheds without listed streams that have subwatersheds with other water quality concerns: Cuchillo Negro Creek, Cuervo Arroyo-Rio Grande, Lordsburg Draw and Percha Creek. All of these concerns are sediment related. Lordsburg Draw contains a large percentage of highly erodible soils formed from granite. Improving and maintaining vegetative groundcover is critical to prevent accelerated erosion and sediment delivery in this watershed. Vegetative groundcover is also of concern in Cuchillo Negro Creek. In Percha Creek and Cuervo Arroyo-Rio Grande, accelerated erosion and sediment delivery resulting from large extents of high and moderate burn severity from the 2013 Silver Fire is the concern. Although much of these areas received emergency watershed stabilization treatments following the fire and monitoring data indicates the treatments were effective at reducing erosion (see discussion under fire heading in Chapter 9: System Drivers and Stressors), accelerated erosion and sedimentation cannot be eliminated completely.

There are four assessed water bodies within the plan area watersheds, three of which occur entirely or in part within the Gila NF. These are located in the Carrizo Wash (Quemado Lake) and Upper Gila (Lake Roberts and Snow Lake) subbasins and all are listed impaired for nutrients and eutrophication (NMED 2014b). Bear Canyon Reservoir in Mimbres, which is downstream of the Forest boundary, is listed for nutrients and eutrophication, temperature and mercury in fish tissue (NMED 2014b). Bill Evans Lake is located off Forest, but is filled by water pumped from the Gila River by the mining company, Freeport McMoRan, Inc. Its overflow drains to Mangas Creek, a tributary of the Gila River, approximately five stream miles above the Gila River Bird Area. Bill Evans Lake is listed impaired for mercury in fish tissue (NMED 2014b). Mercury is most often deposited in lakes atmospherically and is related to emissions from coal burning power plants. More information about atmospheric deposition of mercury is found in the Chapter 5: Air. Mercury negatively impacts the biological processes of fish and is toxic to humans and animals.

In 2010, the State of New Mexico’s Water Quality Control Commission designated all perennial rivers, streams and wetlands located within wilderness areas as Outstanding National Resource Waters (ONRWs). Only those perennial rivers, streams and wetlands within wilderness areas carry this designation. The criteria for ONRW designations in New Mexico are set forth in the Water Quality Standards at Section 20.6.4.9.B NMAC (State of New Mexico 2013). These waters are subject to the same water quality criteria as other waters with the same designated uses but receive a higher degree of protection from human activities that could negatively alter their water quality status. However, forty four percent of all impaired stream miles are ONRWs. A discussion of why these streams receive a higher degree of protection, but so many are impaired follows Table 135 which displays the ONRW stream miles and wetland acres on the Gila NF and their water quality status by watershed.

Table 135. Outstanding National Resource Waters and impairment status

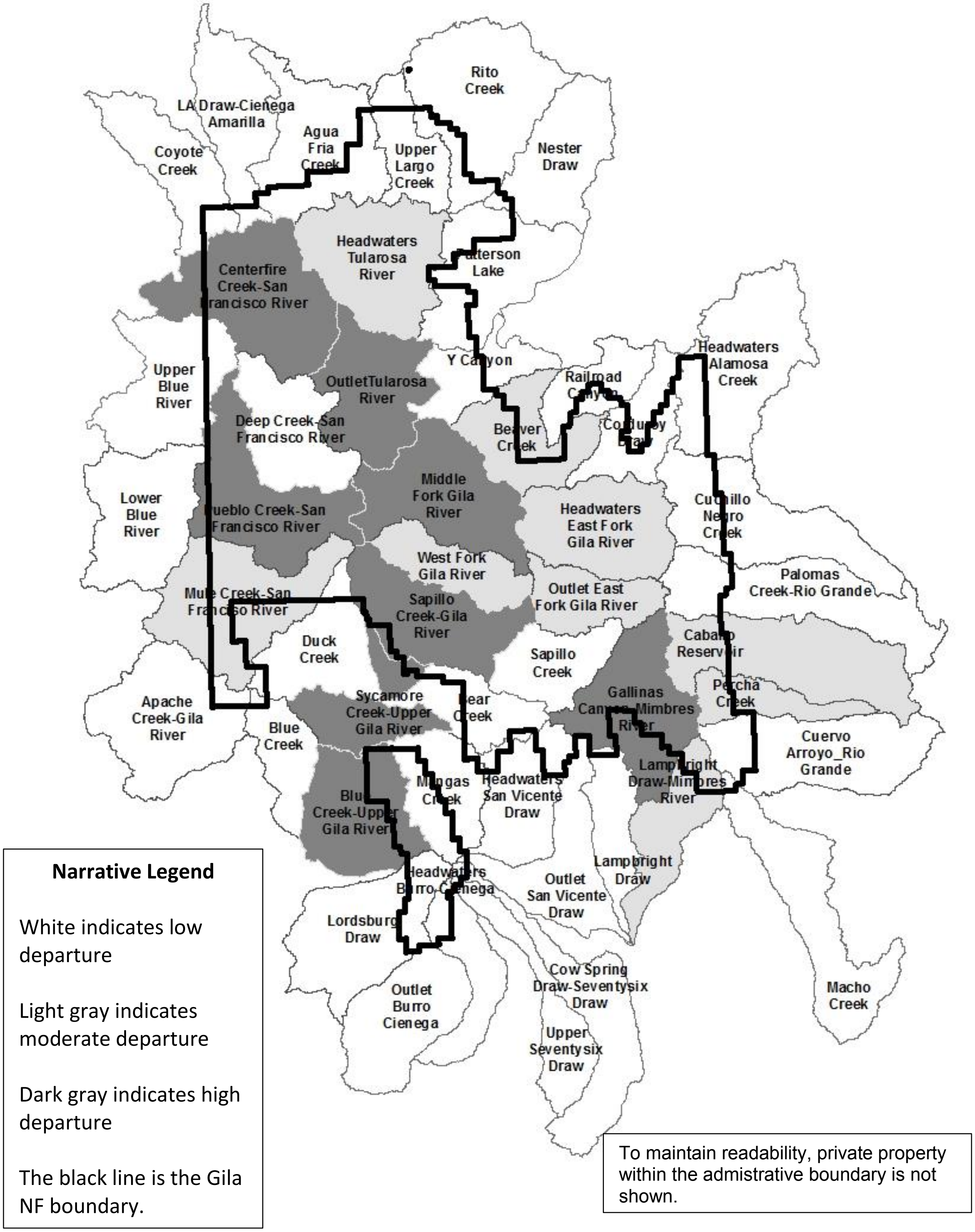
Subbasin Name	Watershed Name	ONRW Stream Miles	ONRW Impaired Stream Miles	Cause of Impairment	ONRW Wetland Acres	ONRW Wetland acres within 300 ft. of Impaired Stream
Caballo	Cuchillo Negro Creek	1.0	0	Not Applicable	0	Not Applicable
	Palomas Creek-Rio Grande	5.4	0	Not Applicable	6.1	0
	Percha Creek	0	0	Not Applicable	0.2	0
	Caballo Reservoir	25.2	3.6	BMiC	55.5	49.8
Elephant Butte Reservoir	Milligan Gulch	0	0	Not Applicable	0.2	0
Mimbres	Gallinas Canyon-Mimbres River	5.7	0	Not Applicable	31.9	0

Subbasin Name	Watershed Name	ONRW Stream Miles	ONRW Impaired Stream Miles	Cause of Impairment	ONRW Wetland Acres	ONRW Wetland acres within 300 ft. of Impaired Stream
Upper Gila	Headwaters East Fork Gila River	25.9	3.3	BMiC	135.7	92.5
	Middle Fork Gila River	74.6	47.2	81% Temp 8% each Nut/Eutro and Turbidity 4% Al	684.2	626.5
	West Fork Gila River	56.4	28.6	Temperature	281.96	233.5
	Outlet East Fork Gila River	42.4	29.4	68% Temp 32% BMiC	268.30	259.5
	Sapillo Creek	14.2	0	Not Applicable	12.37	1.7
	Sapillo Creek-Gila River	81.3	56.0	80 % Temp 20% Al	677.73	672.8
Upper Gila-Mangas	Duck Creek	1.7	0	Not Applicable	0.17	0
San Francisco	Deep Creek-San Francisco River	0	0	Not Applicable	0.39	0
	Pueblo Creek-San Francisco River	19.7	0	Not Applicable	160.08	0
	Mule Creek-San Francisco River	13.9	0	Not Applicable	0.52	0
Totals		**367.5**	**161.1**		**2,315.12**	**1,936.3**

Note: Al=Aluminum; BMiC = Benthic macroinvertebrate community; Nut/Eutro=Nutrients/Eutrophication; Temp=Temperature

Temperature is the leading cause of impairment for all ONRWs. This is directly related to the previous discussion on temperature impairments and NMED's review of the related water quality standards (NMED 2014b). More investigation is needed to determine appropriate temperature water quality standards for ONRWs as human activities in these wilderness areas are limited. The previous discussions regarding benthic macroinvertebrate and aluminum impairments also apply to ONRWs. Data used to determine whether or not the ONRWs in the Gila and Aldo Leopold wildernesses met their water quality standards for temperature were collected prior to the Whitewater Baldy Complex and Silver Fires. Post-fire effects to ONRWs could reasonably be expected to result in short-term higher stream temperatures as the riparian vegetation recovers. Long-term stream temperatures will depend on the recovery of channel shape and function which could take decades. In some areas, recovery of channel shape and function may impact the recovery of riparian vegetation, extending the length of time water quality impacts might occur. Sediment related impairments such as turbidity and the combined impacts of sediment and temperature to the benthic-macroinvertebrate community are also probable given altered post-fire hydrologic and sediment regimes. These statements regarding post-fire recovery of water quality apply to all watersheds and stream systems impacted by large extents of high and moderate burn severity, not just those containing ONRWs.

Figure 111 summarizes departure in water quality conditions as discussed previously under the analysis methods heading.



Narrative Legend

White indicates low departure

Light gray indicates moderate departure

Dark gray indicates high departure

The black line is the Gila NF boundary.

To maintain readability, private property within the admistrative boundary is not shown.

Figure 111. Water quality departure by plan area watershed

Context Area

Current water quality status within the context area is displayed in Table 136 in terms of total impaired miles. Table 137 displays subbasin impaired miles by cause, both on and off Forest. Values do not add up to the total impaired miles because some miles are impaired for more than one reason. Again, the purpose for counting miles by cause is not to inflate the overall picture of water quality concerns on the Forest. The purpose of examining the extent of different causes of impairment is to provide a picture of how each cause contributes to water quality issues. Different causes may require different management approaches to address. Of the 195 stream miles in the context area listed for more than one cause of impairment, approximately 99 miles occur on the Forest. Miles are counted for each reason. Miles through waterbodies are not included, but are discussed later in this subsection. Subbasins without impairments are not included.

Table 136. Impaired stream miles and Gila NF percent of impaired miles, subbasin area and stream miles.

Subbasin Name	Gila NF % of Subbasin	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
		Total	Gila NF	Total	Gila NF	Total	Gila NF
Plains of San Agustin	11	0	0	0	0	0	0
Elephant Butte Reservoir	3	37.0	0	37.0	0	0	0
Caballo	27	110.8	10.8	62.5	0	48.3	10.8
El Paso-Las Cruces	1	159.7	9.1	86.5	9.1	73.2	0
Mimbres	5	154.2	67.0	84.0	47.7	70.2	19.3
Little Colorado Headwaters	3	234.4	0	185.3	0	49.1	0
Carrizo Wash	14	88.6	11.6	77	11.6	0	0
Upper Gila	84	388.6	339.3	103.1	96.6	285.5	242.7
Upper Gila-Mangas	15	200.8	20.6	93.9	9.3	106.9	11.3
Animas Valley	4	52.0	1.2	9.0	1.2	0	0
San Francisco	61	654.4	202.6	460.5	123.4	193.9	79.2

Table 137. Context area miles of impairment by cause.

Miles of Impairment[1]

	Caballo		El Paso-Las Cruces		Mimbres		Little Colorado Headwaters		Upper Gila		Upper Gila-Mangas		San Francisco		Cause % Impaired Miles	
Cause of Impairment	Total Miles	On Gila NF	Total Miles	On Gila NF	Total Miles	On Gila NF	Total Miles	On Gila NF	Total Miles	On Gila NF	Total Miles	On Gila NF	Total Miles	On Gila NF	% of Total	% On Gila NF
Aluminum	0	0	0	0	0	0	0	0	23.9	21.4	0	0	0	0	2	4
Bacteria	0	0	11.7	0	0	0	0	0	0	0	0	0	0	0	1	0
Benthic Macroinvertabrate Community	27.0	10.8	0	0	0	0	0	0	26.1	20.4	0	0	21.1	11.3	7	8
Boron	0	0	6.0	0	0	0	0	0	0	0	0	0	0	0	1	0
Cadmium and Lead	0	0	0	0	7.6	1.7	0	0	0	0	0	0	0	0	1	<1
Conductance	0	0	0	0	0	0	0	0	0	0	0	0	16.1	8.0	1	2
Dissolved Oxygen	21.2	0	0	0	0	0	0	0	0	0	0	0	10.5	4.2	3	1
E. coli	0	0	61.6	0	25.2	0	0	0	0	0	38.8	0	135.5	44.3	23	9
Nutrients / Eutrophication	0	0	0	0	22.1	11.9	0	0	36.5	32.6	25.9	10.2	16.1	8.0	9	12
Temperature	0	0	0	0	40.5	5.6	0	0	228.5	193.6	68.2	11.3	95.6	61.1	38	53
Turbidity/Suspended Sediment Concentration	0	0	0	0	0	0	49.1	0	14.2	13.1	17.2	0	54.0	27.6	12	8
Sediment	0	0	0	0	0	0	0	0	0	0	0	0	30.5	16.9	3	3
Total All Causes (miles)	48.3	10.8	79.2	0	95.3	19.3	49.1	0	329.3	281.1	150.0	21.5	379.4	181.5		
All Causes (%)	29	22	7	0	8	20	4	0	29	85	13	14	34	48		

[1] *The number of miles of impairment are greater than impaired stream miles; where there are multiple causes listed for the same miles, those miles are counted for each cause.*

There are very few perennial or intermittent stream miles on Forest (Table 121) in subbasins where no impairments exist on Forest (Table 132). In general, water quality impairments are far less frequent on the Forest than off when considering the higher stream densities on Forest. However, this is clearly not the case in Upper Gila. The vast majority of the impaired miles are on Forest as most of the watershed area and stream miles are on Forest. As discussed in the plan area analysis, the reason for these impairments is almost all related to stream temperatures that exceed water quality standards for aquatic life designated uses. However, temperature standards for many Forest streams are being reviewed by NMED (2014b), which may or may not result in fewer impaired miles.

Opportunities and limitations associated with the Gila NF's ability to contribute to integrity and sustainability of water quality within the context area are related primarily to contributing watershed area on Forest and nonpoint source pollutant of concern. The discussion related to causes of impairment and possible sources of those pollutants presented in the plan area analysis apply here as well. Off-Forest water quality conditions currently have little direct impact on water quality conditions on-Forest within most subbasins because the majority of off-Forest area is located downhill and downstream. Where this is less the case, as in the San Francisco and Upper Gila-Mangas subbasins, off-Forest water quality conditions may impact water quality on-Forest. Table 137 displays subbasin impaired miles by cause, both on and off Forest. Values do not add up to the total impaired miles because some miles are impaired for more than one reason. Miles are counted for each reason. Subbasins without impairments are not included. In addition to the impaired waterbodies described in the plan area analysis, Caballo and Elephant Butte reservoirs, located in Caballo, Elephant Butte Reservoir and El Paso-Las Cruces subbasins are also impaired. One is listed for mercury in fish tissue. The other is listed for both mercury and PCB in fish tissue. As discussed previously, the most likely source of mercury is atmospheric deposition. PCB is compound that was used for a variety of industrial purposes. Even though it was effectively banned in the 1970s, it does not break down easily in the environment and remains a problem to this day. The most likely origins of PCB are the communities along the Rio Grande River. The Gila NF is not contributing to these impairments and Forest management has no opportunity to contribute to solutions.

Risk

Risk to water quality and its ability to continue providing current levels of ecosystem services is assessed at the watershed scale using the matrix displayed as Table 138.

Table 138. Water quality risk matrix.

Departure	Trend Toward Reference	Trend Unknown or Static	Trend Away from Reference
Significant (High and Moderate)	Risk Addressed	Moderate Risk	High Risk
Not Significant (Low)	Low Risk	Low Risk	Moderate Risk

Risk due to current management and under current water quality standards can be interpreted from Figure 111 above, with the watersheds in white being low risk (low departure; unknown or static trend), and both light gray (moderate departure; unknown or static trend) and dark gray (high departure; unknown or static trend) at moderate risk. The origins of this risk include all human activities and disturbance regimes discussed in Chapter 9: System Drivers and Stressors that can impact watershed and riparian condition including: fire, herbivory, non-fire vegetation treatments including timber and fuelwood harvest, insects and disease as they increase the risk of high severity fire, roads and trails, mining, recreation, invasive species and pesticide use. Watersheds and riparian areas that are Functioning Properly support water quality integrity. Therefore, the discussion of risk factors in the watershed subsection of this chapter, and Chapter 7: Riparian apply to water quality.

With 67 percent of its area represented by moderate risk ratings, risk to water quality at the Forest scale is also moderate. At the local unit scale, Lower Gila is represented by low risk ratings across 59 percent of its area, therefore risk to water quality in that local unit is low. All other local units are represented by risk ratings of moderate across 56 to 100 percent of their area, giving them a moderate risk rating overall.

Because of the nonpoint nature of most of the pollutants that can be produced as a result of these disturbances, it is difficult or impossible in most cases to determine the specific activity that is the source of the pollutant. The contributions of management activities that may generate non-point source pollutants have been discussed briefly throughout this chapter and are discussed in detail in Chapter 9: System Drivers and Stressors. Best Management Practices (BMPs) are methods or measures that are designed and implemented for site and project specific characteristics to mitigate risk to water quality associated with all activities. As in previous risk assessments, a moderate or greater watershed vulnerability to climate change is a stressor that elevates risk one category. Again, climate change is discussed in detail in Chapter 9: System Drivers and Stressors.

Aquatic Biota

The status of watersheds and water resources across the larger landscape influences conditions on the Forest, and in turn the Forest contributes to the overall sustainability of areas far from the Forest Service boundary. Aquatic biota are an important component of aquatic ecosystems, and as such, are influenced by the conditions of watersheds and water resources on the Forest. This section focuses on current and historic native and non-native species richness and distribution.

Analysis Methods

Prior to European settlement, only native fish species were present in the watersheds of the Gila NF. Their populations were more widespread, interconnected, and the aquatic habitat had all necessary components needed to persist. This pre-European settlement status of aquatic biota is used as the reference condition for this assessment. Although it is likely that aquatic habitat conditions have changed over time, this analysis assumes current perennial stream miles were only inhabited by native species; therefore, the current extent of perennial stream miles is used as a reference. Based on the available data concerning the current and historic distribution of native and non-native fishes, departure was calculated by dividing the number of native species currently present in each watershed by the number of native species that historically occurred within each watershed. This number represents departure in the watershed by the number of native species no longer present in the watershed. Number of non-native species present is also a measure of departure, but is not calculated into the overall measure of departure and is a stand alone measure. Departure categories of low, moderate and high are assigned as follows:

- 0-33% Departure = Low
- 34-66% Departure = Moderate
- 67-100% Departure = High

Due to the differences between the available datasets, trend is not analyzed for individual species. Some data had numbers of individuals that were caught, while other data just recorded presence/absence in a stream with no indication of abundance. Also, some data recorded was only for rare fish and other fish information was not taken. However, what is known about current trends is discussed.

Plan Area

Historically, 17 native fish occurred in plan area watersheds (Sublette et al. 1990). Currently, 15 of these native species still occur, while two of these native species, Beautiful shiner and Gila topminnow, are now considered extirpated (i.e. completely absent). Of the 15 native fish species still present within the Gila NF, five have decreased in their distribution, two have increased, and eight have remained relatively unchanged as displayed in Table 139.

Table 139. Native fish species changes in distribution.

Increased	Decreased	Unchanged
Gila chub *(Gila intermedia)*	Spikedace *(Meda fulgida)*	Longfin dace *(Agosia chrysogaster)*
Gila trout *(Oncorhynchus gilae)*	Roundtail chub (*Gila robusta*)	Speckled dace *(Rhinichthys osculus)*
	Loach minnow *(Tiaroga cobitis)*	Desert sucker *(Catostomus (Pantosteus) clarkii)*
	Rio Grande sucker (*Catostomus plebeius)*	Sonora sucker *(Catostomus insignis)*
	Rio Grande chub *(Gila pandora)*	Rio Grande Cutthroat trout (*O. clarki virginalis)*
		Chihuahua chub (*Gila nigrescens)*
		Fathead minnow (*Pimephales promelas*)
		Headwater chub (*Gila nigra)*

Table 140 displays the reference and current fish species richness, including natives and non-natives, by subwatershed. Departure percentages and categories are included.

Table 140. Reference (R) and current (C) occurrences of native fish species for plan area watersheds and subwatersheds

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Beautiful shiner*	Chihuahua chub	Desert sucker	Gila chub	Gila topminnow *	Gila trout	Headwater chub	Loach minnow	Longfin dace	Rio Grande chub	Rio Grande cutthroat	Rio Grande sucker	Roundtail chub	Sonora sucker	Speckled dace	Spikedace	Current/Historic species present	# of Non-Native fish species	Percent departure of current from historic	Departure Category
Plains of San Agustin																				
Patterson Lake									C[1]								1/1	1	0	L
Patterson Canyon									C[1]								1/1	1	0	L
Elephant Butte Reservoir																				
Headwaters Alamosa Creek										C[1]							1/1	0	0	L
Sim Yaten Canyon- Alamosa Creek										C[1]							1/1	0	0	L
Caballo																				
Palomas Creek-Rio Grande										C		C					2/2	1	0	L
South Fork Palomas Creek										C		C					2/2	1	0	L
Caballo Reservoir										C	R	C					2/3	1	33	L
North Seco Canyon										C[1]		R					1/2	0	50	M

The letter "C" is used to indicate where native fish species occurred historically and still occur. The letter "R" is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number "1" indicates that the fish found in the subwatershed were not collected on the Gila NF. The number "2" indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Beautiful shiner*	Chihuahua chub	Desert sucker	Gila chub	Gila topminnow *	Gila trout	Headwater chub	Loach minnow	Longfin dace	Rio Grande chub	Rio Grande cutthroat	Rio Grande sucker	Roundtail chub	Sonora sucker	Speckled dace	Spikedace	Current/Historic species present	# of Non-Native fish species	Percent departure of current from historic	Departure Category
Seco Creek										C[1]		C					2/2	0	0	L
Holden Prong[2]										R	R	R					0/3	0	100	H
Headwaters Los Animas Creek[2]										R	R	R					0/3	1	100	H
El Paso-Las Cruces																				
Cuervo Arroyo_Rio Grande										R		R					0/2	0	100	H
Headwaters Berenda Creek										R[1]		R[1]					0/2	0	100	H
Mimbres																				
Gallinas Canyon-Mimbres River	R	C	C									C			C		4/5	11	20	L
Powderhorn Canyon-Mimbres River	R	R	R									R			R		0/5	5	100	H
Allie Canyon-Mimbres River	R	C	C									C			C		4/5	5	20	L
Sheppard Canyon-Mimbres River	R	C	R									C			R		2/5	10	60	M
Noonday Canyon-Mimbres River	R	C	R									C			R		2/5	4	60	M
Gallinas Canyon	R	R	R									R			R		0/5	3	100	H
Headwaters San Vicente Draw																	0/0	2[1]	100	H

The letter "C" is used to indicate where native fish species occurred historically and still occur. The letter "R" is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number "1" indicates that the fish found in the subwatershed were not collected on the Gila NF. The number "2" indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Beautiful shiner***	**Chihuahua chub**	**Desert sucker**	**Gila chub**	**Gila topminnow ***	**Gila trout**	**Headwater chub**	**Loach minnow**	**Longfin dace**	**Rio Grande chub**	**Rio Grande cutthroat**	**Rio Grande sucker**	**Roundtail chub**	**Sonora sucker**	**Speckled dace**	**Spikedace**	**Current/Historic species present**	**# of Non-Native fish species**	**Percent departure of current from historic**	**Departure Category**
Pipeline Draw-San Vicente Draw																	0/0	2[1]	100	H
Lampbright Draw-Mimbres River	R	R										R					0/3	4	100	H
Gavilan Arroyo-Mimbres River	R	R										R					0/3	4	100	H
Carrizo Wash																				
Upper Largo Creek			C												C		2/2	5	0	L
Sawmill Canyon-Largo Creek			R												R		0/2	5	100	H
Paradise Canyon-Largo Creek			R												C		1/2	0	50	M
Rito Creek-Largo Creek			C[1]												R		1/2	0	50	M
Beaver Creek			R				R		R						R		0/4	0	100	H
Houghton Canyon-Beaver Creek			R				R		R						R		0/4	0	100	H
Headwaters East Fork Gila River			C			C	C	R	C					C	C	R	6/8	11	25	L
Hoyt Creek			C						C					R	C		3/4	1	25	L
Taylor Creek			C				R	R	C					C	C	R	4/7	9	43	M
Taylor Creek-Beaver Creek			C				R	R	C					C	C	R	4/7	4	43	M

The letter “C” is used to indicate where native fish species occurred historically and still occur. The letter “R” is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number “1” indicates that the fish found in the subwatershed were not collected on the Gila NF. The number “2” indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Beautiful shiner***	**Chihuahua chub**	**Desert sucker**	**Gila chub**	**Gila topminnow ***	**Gila trout**	**Headwater chub**	**Loach minnow**	**Longfin dace**	**Rio Grande chub**	**Rio Grande cutthroat**	**Rio Grande sucker**	**Roundtail chub**	**Sonora sucker**	**Speckled dace**	**Spikedace**	**Current/Historic species present**	**# of Non-Native fish species**	**Percent departure of current from historic**	**Departure Category**
Headwaters Diamond Creek						C									R		1/2	0	50	M
South Diamond Creek						C									R		1/2	0	50	M
Outlet Diamond Creek			C			R	C	R	C					C	C	R	5/8	2	37	M
Diamond Creek-East Fork Gila River			C			R	C	R	C					C	C	R	5/8	9	37	M
Middle Fork Gila River			C			C	C	C	C					C	C	C	8/8	13	0	L
Gilita Creek			C			C			C					C	C		5/5	4	0	L
Snow Canyon									R						C		1/2	4	50	M
Canyon Creek-Middle Fork Gila River			C			C	C		C					C	C		6/6	4	0	L
Indian Creek Canyon			C			R	R		C					R	C		3/6	1	50	M
Indian Creek Canyon-Middle Fork Gila River			C			R	C		C					C	C		5/6	4	17	L
Big Bear Canyon-Middle Fork Gila River			C				C	C	C					C	C	C	7/7	12	0	L
West Fork Gila River			C			C	C	C	C					C	C	C	8/8	12	0	L
White Creek						C	R								R		1/3	2	67	H
Headwaters West Fork Gila River			C			C	R								C		3/4	2	25	L

The letter “C” is used to indicate where native fish species occurred historically and still occur. The letter “R” is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number “1” indicates that the fish found in the subwatershed were not collected on the Gila NF. The number “2” indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Beautiful shiner***	**Chihuahua chub**	**Desert sucker**	**Gila chub**	**Gila topminnow ***	**Gila trout**	**Headwater chub**	**Loach minnow**	**Longfin dace**	**Rio Grande chub**	**Rio Grande cutthroat**	**Rio Grande sucker**	**Roundtail chub**	**Sonora sucker**	**Speckled dace**	**Spikedace**	**Current/Historic species present**	**# of Non-Native fish species**	**Percent departure of current from historic**	**Departure Category**
Little Creek			C			C	R	C	C					C	C	R	6/8	7	25	L
Outlet West Fork Gila River			C			R	C	C	C					C	C	C	7/8	12	13	L
Outlet East Fork Gila River			C			C	C	R	C					C	C	R	6/8	12	25	L
Headwaters Black Canyon			R			C								R	C		2/4	2	50	M
Apache Creek									C						C		2/2	1	0	L
Outlet Black Canyon			C			C	R	R	C					C	C	R	5/8	2	38	M
Black Canyon-East Fork Gila River			C			R	C	R	C					C	C	R	5/8	11	38	M
Sapillo Creek			C			C			C			C	R	C	C		6/7	10	14	L
Rocky Canyon-Sapillo Creek									C			C			C		3/3	0	0	L
Lake Roberts-Sapillo Creek			C			R			C			C		C	C		5/6	10	17	L
Copperas Creek-Sapillo Creek			C			R			C			C		C	C		5/6	7	17	L
Sheep Corral Canyon-Sapillo Creek			C			C			C			C	R	C	C		6/7	4	14	L
Sapillo Creek-Gila River			C	C		C		C	C				R	C	C	C	8/9	14	11	L
Sapillo Creek-Gila River			C			R		C	C				R	C	C	C	6/8	8	25	L
Hells Canyon-Gila River			C					R	C				R	C	C	R	4/7	7	43	M

The letter “C” is used to indicate where native fish species occurred historically and still occur. The letter “R” is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number “1” indicates that the fish found in the subwatershed were not collected on the Gila NF. The number “2” indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Beautiful shiner*	Chihuahua chub	Desert sucker	Gila chub	Gila topminnow *	Gila trout	Headwater chub	Loach minnow	Longfin dace	Rio Grande chub	Rio Grande cutthroat	Rio Grande sucker	Roundtail chub	Sonora sucker	Speckled dace	Spikedace	Current/Historic species present	# of Non-Native fish species	Percent departure of current from historic	Departure Category
Turkey Creek			C	C		R			C					C	C		5/6	3	17	L
Upper Mogollon Creek						C											1/1	2	0	L
Middle Mogollon Creek			C			R			C					C	C		4/5	2	20	L
Lower Mogollon Creek			C						C					C	C		4/4	3	0	L
Mogollon Creek-Gila River			C			R		C	C				R	C	C	C	6/8	12	25	L
Upper Gila-Mangas																				
Bear Creek			C					C	C					C			4/4	1	0	L
Middle Bear Creek			C					C	C					C			4/4	1	0	L
Duck Creek																	0/0	1	0	L
Headwaters Duck Creek																	0/0	1	0	L
Mangas Creek			C					C	C					C		C	5/5	6	0	L
Schoolhouse Canyon-Mangas Creek			C					C	C					C		C	5/5	6	0	L
Sycamore Creek-Upper Gila River			C					C	C				R	C	C	C	6/7	12	14	L
Bear Creek-Upper Gila River			C					C	C				R	C	C	C	6/7	12	14	L
Blue Creek			C					R	C					C	C		4/5	0	20	L

The letter “C” is used to indicate where native fish species occurred historically and still occur. The letter “R” is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number “1” indicates that the fish found in the subwatershed were not collected on the Gila NF. The number “2” indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Beautiful shiner*	Chihuahua chub	Desert sucker	Gila chub	Gila topminnow *	Gila trout	Headwater chub	Loach minnow	Longfin dace	Rio Grande chub	Rio Grande cutthroat	Rio Grande sucker	Roundtail chub	Sonora sucker	Speckled dace	Spikedace	Current/Historic species present	# of Non-Native fish species	Percent departure of current from historic	Departure Category
Cherry Creek-Blue Creek			C					R	C					C	C		4/5	0	20	L
Blue Creek-Upper Gila River			C					C	C				C	C	R	C	6/7	13	14	L
Bear Canyon-Upper Gila River			C					C	C				R	C	R	C	5/7	13	29	M
Swan Canyon-Upper Gila River			C					C	C				C	C		C	6/6	6	0	L
Apache Creek-Gila River																	0/0	1[1]	0	L
Apache Creek																	0/0	1[1]	0	L
San Francisco																				
Headwaters Tularosa River			C						C					C	C		4/4	8	0	L
Negro Canyon-Tularosa River			C						C					C	C		4/4	3	0	L
Apache Creek			C						C					C	C		4/4	0	0	L
Apache Creek-Tularosa River			C						C					C	C		4/4	2	0	L
Cold Springs Canyon-Tularosa River			C						C					C	C		4/4	7	0	L
Outlet Tularosa River			C			R		C	C					C	C		5/6	6	17	L
Long Canyon-Tularosa River			C					C	C					C	C		5/5	0	0	L
Headwaters North Fork Negrito Creek															C		1/1	0	0	L

The letter “C” is used to indicate where native fish species occurred historically and still occur. The letter “R” is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number “1” indicates that the fish found in the subwatershed were not collected on the Gila NF. The number “2” indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Beautiful shiner***	**Chihuahua chub**	**Desert sucker**	**Gila chub**	**Gila topminnow ***	**Gila trout**	**Headwater chub**	**Loach minnow**	**Longfin dace**	**Rio Grande chub**	**Rio Grande cutthroat**	**Rio Grande sucker**	**Roundtail chub**	**Sonora sucker**	**Speckled dace**	**Spikedace**	**Current/Historic species present**	**# of Non-Native fish species**	**Percent departure of current from historic**	**Departure Category**
South Fork Negrito Creek			C			R			C					C	C		4/5	3	20	L
Outlet North Fork Negrito Creek			R			R			C						C		2/4	0	50	M
Negrito Creek			C			R		C	C					C	C		5/6	2	17	L
Negrito Creek-Tularosa River			C			R		C	C					C	C		5/6	5	17	L
Centerfire Creek-San Francisco River			C					C	C			C	R	C	C	R	6/8	6	25	L
Trout Creek			C						R			C			C		3/4	5	25	L
Stone Creek-San Francisco River			C						C			C			C		4/4	3	0	L
SA Creek									C			C			C		3/3	1	0	L
Headwaters Centerfire Creek									C			C			C		3/3	0	0	L
Outlet Centerfire Creek			C						C			C		R	C		4/5	0	20	L
Big Canyon-San Francisco River			C						C			C		R	C		4/5	0	20	L
Starkweather Canyon									C						C		2/2	0	0	L
Cienega Canyon-San Francisco River			C					C	C			R	R	C	C	R	5/8	2	38	M
Deep Creek-San Francisco River			C					C	C				R	C	C	R	5/7	4	29	L
Headwaters Saliz Canyon			C						C					C	C		4/4	1	0	L

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Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Beautiful shiner***	**Chihuahua chub**	**Desert sucker**	**Gila chub**	**Gila topminnow ***	**Gila trout**	**Headwater chub**	**Loach minnow**	**Longfin dace**	**Rio Grande chub**	**Rio Grande cutthroat**	**Rio Grande sucker**	**Roundtail chub**	**Sonora sucker**	**Speckled dace**	**Spikedace**	**Current/Historic species present**	**# of Non-Native fish species**	**Percent departure of current from historic**	**Departure Category**
Outlet Saliz Canyon			C						C					C	C		4/4	1	0	L
Saliz Canyon-San Francisco River			C					C	C				R	C	C		5/6	2	17	L
Deep Creek									R						C		1/2	1	50	M
Devils Creek-San Francisco River			C					C	C				R	C	C	R	5/7	2	29	L
Upper Blue River			C					C	C					C	C	R	5/6	6	17	L
Dry Blue Creek			R					R	C					R	C	R	2/6	5	67	H
Campbell Blue Creek			C					R	C					C	C		4/5	4	20	L
Centerfire Creek-Blue River			C					C	C					C	C	R	5/6	2	17	L
Pueblo Creek-San Francisco River			C		R	R		C	C				R	C	C	R	5/9	8	44	M
Lower Pueblo Creek			C						C					C	C		4/4	1	0	L
Mineral Creek			C			R			C					C	C		4/5	1	20	L
Wendy Flat-San Francisco River			C					C	C				R	C	C	R	5/7	1	29	L
Whitewater Creek			C			R		C	C					C	C		5/6	4	17	L
South Dugway Creek-San Francisco River			C		R			C	C				R	C	C	R	5/8	7	38	M
Mule Creek-San Francisco River			C	C	R	C		C	C				R	C	C	R	7/10	11	30	L

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Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Beautiful shiner*	Chihuahua chub	Desert sucker	Gila chub	Gila topminnow *	Gila trout	Headwater chub	Loach minnow	Longfin dace	Rio Grande chub	Rio Grande cutthroat	Rio Grande sucker	Roundtail chub	Sonora sucker	Speckled dace	Spikedace	Current/Historic species present	# of Non-Native fish species	Percent departure of current from historic	Departure Category
Big Dry Creek			R			C			C						C		3/4	3	25	L
Upper Mule Creek									C						C		2/2	0	0	L
Lower Mule Creek			C	C					C					C	C		5/5	4	0	L
Big Pine Canyon-San Francisco River			C	R	R			R	C				R	C	C	R	4/9	10	56	M

The letter “C” is used to indicate where native fish species occurred historically and still occur. The letter “R” is used to indicate where native fish species occurred historically, but are now extirpated from those watersheds. Blank cells within the table indicate native fish species were not present historically within that subwatershed. An asterix (*) indicates the two native fish species are extirpated from the entire Forest. The number “1” indicates that the fish found in the subwatershed were not collected on the Gila NF. The number “2” indicates subwatersheds that do not currently contain any native or non-native fish, but where native fish are expected to be re-introduced (repatriated).

Table 141 displays native and non-native fish distribution within perennial stream miles by subwatershed. Departure percentages and categories are included. As an example of how to interpret this table, Patterson Canyon subwatershed contains 0.5 miles of perennial streams that currently do not contain any native fish, but do contain non-native fish. With only non-native fish present, departure is 100 percent and departure is categorized as high.

Table 141. Native and non-native fish distribution within perennial stream miles by subwatershed.

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Total HU Perennial Miles	Current Native Fish Only Stream Miles	Current Native/Non-native Fish Stream Miles	% Departure of Current Native Only from Stream Miles	Departure Category
Plains of San Agustin	**0.7**				
Patterson Lake	**0.5**	**0.0**	**0.5**	**100**	High
Patterson Canyon	0.5	0.0	0.5	100	High
Elephant Butte Reservoir	**74.3**				
Headwaters Alamosa Creek	**1.4**	**1.4**	**0.0**	**0**	Low
Caballo	**160.8**				
Palomas Creek-Rio Grande	**49.0**	**0.00**	**6.6**	**100**	High
South Fork Palomas Creek	6.6	0.0	3.4	100	High
Caballo Reservoir	**47.8**	**31.0**	**0.00**	**0**	Low
North Seco Canyon	9.9	9.4	0.0	0	Low
Holden Prong	9.2	0.0	0.0	100	High
Headwaters Los Animas Creek	11.8	0.0	0.0	100	High
El Paso-Las Cruces	**116.0**				
Cuervo Arroyo_Rio Grande	**21.2**	**2.2**	**0.0**	**0**	Low
Headwaters Berenda Creek	2.2	2.2	0	0	Low
Mimbres	**98.6**				
Gallinas Canyon-Mimbres River	**83.1**	**0.0**	**70.0**	**100**	High

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Total HU Perennial Miles**	**Current Native Fish Only Stream Miles**	**Current Native/Non-native Fish Stream Miles**	**% Departure of Current Native Only from Stream Miles**	**Departure Category**
Powderhorn Canyon-Mimbres River	15.3	0.0	13.9	100	High
Allie Canyon-Mimbres River	18.1	0.0	17.0	100	High
Sheppard Canyon-Mimbres River	17.8	0.0	13.4	100	High
Noonday Canyon-Mimbres River	5.0	0.0	4.0	100	High
Gallinas Canyon	13.8	0.0	13.5	100	High
Headwaters San Vicente Draw	**4.1**	**0.0**	**0.0**	**0**	Low
Lampbright Draw-Mimbres River	**1.5**	**0.0**	**1.5**	**100**	High
Gavilan Arroyo-Mimbres River	1.5	0.0	0.1	100	High
Carrizo Wash	**43.6**				
Upper Largo Creek	**19.3**	**10.3**	**9.0**	**47**	Moderate
Sawmill Canyon-Largo Creek	9.0	0.0	3.5	100	High
Paradise Canyon-Largo Creek	10.3	3.1	0.0	0.0	Low
1504000104 Headwaters East Fork Gila River	**68.6**	**21.0**	**47.5**	**69**	Moderate
Hoyt Creek	8.2	0.0	7.4	100	High
Taylor Creek	17.0	0.0	14.1	100	High
Taylor Creek-Beaver Creek	6.2	0.0	4.7	100	High
Headwaters Diamond Creek	9.9	9.9	0.0	0	Low
South Diamond Creek	11.1	11.1	0.0	0	Low
Outlet Diamond Creek	5.7	0.0	5.7	100	High
Diamond Creek-East Fork Gila River	10.5	0.0	7.3	100	High
Middle Fork Gila River	**96.6**	**0.0**	**91.0**	**100**	High
Gilita Creek	20.1	0.0	18.7	100	High
Snow Canyon	0.8	0.0	0.8	100	High

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Total HU Perennial Miles	Current Native Fish Only Stream Miles	Current Native/Non-native Fish Stream Miles	% Departure of Current Native Only from Stream Miles	Departure Category
Canyon Creek-Middle Fork Gila River	29.3	0.0	29.3	100	High
Indian Creek Canyon	6.3	0.0	6.3	100	High
Indian Creek Canyon-Middle Fork Gila River	17.9	0.0	17.9	100	High
Big Bear Canyon-Middle Fork Gila River	16.7	0.0	16.0	100	High
West Fork Gila River	**86.3**	**0.0**	**86.3**	**100**	High
White Creek	19.9	0.0	19.9	100	High
Headwaters West Fork Gila River	23.4	0.0	23.4	100	High
Little Creek	11.9	0.0	11.7	100	High
Outlet West Fork Gila River	31.1	0.0	26.1	100	High
Outlet East Fork Gila River	**56.4**	**0.0**	**56.4**	**100**	High
Headwaters Black Canyon	11.0	0.0	11.0	100	High
Apache Creek	5.9	0.0	5.9	100	High
Outlet Black Canyon	21.8	0.0	21.7	100	High
Black Canyon-East Fork Gila River	17.7	0.0	14.7	100	High
Sapillo Creek	**45.3**	**8.7**	**29.6**	**65**	Moderate
Rocky Canyon-Sapillo Creek	8.7	8.7	0.0	0	Low
Lake Roberts-Sapillo Creek	7.9	0.0	6.3	100	High
Copperas Creek-Sapillo Creek	3.2	0.0	0.01	100	High
Sheep Corral Canyon-Sapillo Creek	18.5	0.0	18.5	100	High
Sapillo Creek-Gila River	**139.9**	**0.0**	**139.9**	**100**	High
Sapillo Creek-Gila River	17.9	0.0	17.87	100	High
Hells Canyon-Gila River	22.6	0.0	22.58	100	High
Turkey Creek	25.2	0.0	24.85	100	High

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Total HU Perennial Miles**	**Current Native Fish Only Stream Miles**	**Current Native/Non-native Fish Stream Miles**	**% Departure of Current Native Only from Stream Miles**	**Departure Category**
Upper Mogollon Creek	34.5	0.0	34.53	100	High
Middle Mogollon Creek	12.7	0.0	10.02	100	High
Lower Mogollon Creek	5.3	0.0	5.27	100	High
Mogollon Creek-Gila River	21.8	0.0	20.21	100	High
Upper Gila-Mangas	**100.9**				
Bear Creek	**10.5**	**0.0**	**1.5**	**100**	High
Middle Bear Creek	1.5	0.0	0.4	100	High
Mangas Creek	**0.4**	**0.0**	**0.4**	**100**	High
Schoolhouse Canyon-Mangas Creek	0.4	0.0	0.4	100	High
Sycamore Creek-Upper Gila River	**17.1**	**0.0**	**8.7**	**100**	High
150400020401 Bear Creek-Upper Gila River	8.7	0.0	1.05	100	High
Blue Creek-Upper Gila River	**33.5**	**0.0**	**19.0**	**100**	High
Bear Canyon-Upper Gila River	10.3	0.0	8.9	100	High
150400020603 Swan Canyon-Upper Gila River	8.7	0.0	2.8	100	High
Apache Creek-Gila River	**1.4**	**0.0**	**1.4**	**100**	High
Apache Creek	1.4	0.0	0.7	100	High
San Francisco	**759.8**				
Headwaters Tularosa River	**39.3**	**16.7**	**15.1**	**38**	Low
Negro Canyon-Tularosa River	5.9	0.0	1.3	100	High
Apache Creek	16.7	5.2	0	0	Low
Apache Creek-Tularosa River	6.7	0.0	0.4	100	High
Cold Springs Canyon-Tularosa River	2.5	0.0	0.5	100	High

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	Total HU Perennial Miles	Current Native Fish Only Stream Miles	Current Native/Non-native Fish Stream Miles	% Departure of Current Native Only from Stream Miles	Departure Category
Outlet Tularosa River	**54.6**	**14.5**	**40.1**	**73**	High
Long Canyon-Tularosa River	6.7	4.0	0.0	0	Low
South Fork Negrito Creek	12.7	0.0	11.9	100	High
Outlet North Fork Negrito Creek	7.8	7.3	0.0	0	Low
Negrito Creek	13.0	0.0	11.0	100	High
Negrito Creek-Tularosa River	14.4	0.0	5.3	100	High
Centerfire Creek-San Francisco River	**145.9**	**23.5**	**84.4**	**58**	Moderate
Trout Creek	24.6	0.0	14.7	100	High
Stone Creek-San Francisco River	28.8	0.0	11.4	100	High
SA Creek	7.0	0.0	6.6	100	High
Headwaters Centerfire Creek	6.2	3.1	0.0	0	Low
Outlet Centerfire Creek	7.6	0.5	0.0	0	Low
Big Canyon-San Francisco River	7.6	5.7	0.0	0	Low
Starkweather Canyon	2.2	1.5	0.0	0	Low
Cienega Canyon-San Francisco River	24.1	0.0	12.8	100	High
Deep Creek-San Francisco River	**60.6**	**0.0**	**58.5**	**100**	High
Headwaters Saliz Canyon	3.8	0.0	3.8	100	High
Outlet Saliz Canyon	7.3	0.0	5.1	100	High
Saliz Canyon-San Francisco River	15.4	0.0	11.3	100	High
Deep Creek	18.4	0.0	16.9	100	High
Devils Creek-San Francisco River	13.6	0.0	10.0	100	High
Upper Blue River	**172.3**	**0.0**	**64.5**	**100**	High
Dry Blue Creek	16.3	0.0	8.5	100	High

Subbasin (4th Level), Watershed (5th Level) & Subwatershed (6th level)	**Total HU Perennial Miles**	**Current Native Fish Only Stream Miles**	**Current Native/Non-native Fish Stream Miles**	**% Departure of Current Native Only from Stream Miles**	**Departure Category**
Campbell Blue Creek	32.1	0.0	0.4	100	High
Centerfire Creek-Blue River	16.1	0.0	0.4	100	High
Pueblo Creek-San Francisco River	**81.7**	**0.0**	**72.6**	**100**	High
Lower Pueblo Creek	2.6	0.0	2.5	100	High
Mineral Creek	18.9	0.0	16.7	100	High
Wendy Flat-San Francisco River	11.1	0.0	1.9	100	High
Whitewater Creek	26.2	0.0	26.2	100	High
South Dugway Creek-San Francisco River	13.8	0.0	8.4	100	High
Mule Creek-San Francisco River	**82.7**	**29.2**	**46.5**	**56**	Moderate
Big Dry Creek	18.9	0.0	18.8	100	High
Upper Mule Creek	13.9	7.1	0.0	0	Low
Lower Mule Creek	8.8	0.0	4.3	100	High
Big Pine Canyon-San Francisco River	18.8	0.0	18.3	100	High
TOTALS					
Watershed level (5th level)	**1,421***	**158.5***	**955.1***	**67**	High
Sub-watershed level (6th level)	1,094.7*	80.5*	734.99*	67	High

*-There are differences of 307 and 279 stream miles in the 5th and 6th levels for current native only and current native/non-native stream miles, respectively, from the total hydrologic unit perennial miles, that likely have fish but may not have been surveyed because of difficult access areas, or a portion of the stream traverses private land.

Native-only streams are generally found in headwaters, where there are generally assemblages of native suckers, chubs, and dace. Historic land uses and introduction of nonnative species that occurred within the last hundred years or more have resulted in substantial negative impacts to aquatic communities and their watersheds. Although native fish may still inhabit these streams, their population and condition are likely in a diminished state. As a result, native fish populations have been reduced from a large interconnected population to isolated populations within altered and degraded habitats (Alves et al. 2008). Because of the altered habitat and isolated populations, all native fish species have lost much of their population redundancy within and outside the Gila NF.

Departure from the historical range of variability in streamflow characteristics, water chemistry, riparian vegetation, water temperature, nutrient supply, stream channel shape and function, large (coarse) woody debris and upland watershed condition can negatively impact aquatic habitat and affect native fish diversity and distribution. The severity and extent of recent wildfire has resulted in many of these changes (see Chapter 7: Riparian and Chapter 9: System Drivers and Stressors). Drought and the legacy of past fire suppression has increased both the possibility and the actual occurrence of large, high severity wildfires (see Chapter 9: System Drivers and Stressors). The degree to which native fishes are affected depends largely on the location and extent of the fire within the watershed, severity and post-fire precipitation events (Myers pers. comm. 2016).

Post-fire effects on cold and warm-water aquatic communities including oligochaetes (segmented worms resembling earthworms), insects, crayfish, fishes, and tadpoles have been studied following these large-scale fires in the upper Gila watershed (Whitney 2015). Several insect taxa responded to these fires with reduced biomass, whereas oligochaete biomass was unaffected. Biomass of six native fish species decreased after the fires, primarily attributed to site proximity to fire. Native and nonnative fish decreases after fire were most pronounced for cold-water salmonids (e.g. trout), while warm-water nonnative fishes exhibited limited responses. Nonnative crayfish and tadpoles collected were unresponsive to fire disturbance. In Rain, West Fork Mogollon, Whitewater, South Fork Whitewater and Turkey Creeks, non-native trout were greatly reduced and eliminated from most of the streams; however, a few individuals persisted in short stream reaches where impacts were less severe. In Mineral and Willow Creeks, non-native species were eliminated post-fire, while native dace and suckers were reduced. However, these native populations have since increased. In Turkey Creek, hybrid Gila x rainbow trout were almost eliminated, while Gila chub populations remained relatively stable. Also, in the Mimbres River, rainbow and brown trout have been eliminated post-fire, but Chihuahua chub and Rio Grande sucker have survived in several places (Myers pers. comm. 2016).

Motorized roads and trails and grazing by wildlife and livestock, both within the riparian zone and in the upland watershed, have the potential to influence sediment and nutrient delivery to streams, degrade water quality, alter peak run-off flows, and lead to greater habitat fragmentation (see Chapter 9: System Drivers and Stressors). Roads can act as barriers to fish movement (Furniss et al. 1991), reducing distribution and diversity of species. Many roads located in stream bottoms have likely contributed to habitat fragmentation if they were not designed with appropriate fish crossings where roads cross the creeks.

Hybridization, depredation, and competition from non-native fish have likely contributed to diversity and distribution declines in native fish species as well. For example, the Rio Grande cutthroat trout that occurred in Las Animas Creek were found through genetic testing to have been hybridized with rainbow trout. There are 21 non-native species that currently inhabit the streams within plan area watersheds. Moreover, long-fin dace (*Agosia chrysogaster*), is native to certain watersheds, but have been introduced into watersheds they historically did not occupy. Non-native fish species were introduced into these watersheds for sport fishing or by accident (see Chapter 11: Multiple Uses for the economic and social values of recreational fishing on the Gila NF). In 2008, New Mexico State Fish Hatcheries converted to raising triploid Rainbow trout, which are sterile and cannot reproduce, to be stocked in waters to minimize hybridization concerns with native trout species (NMDGF 2016a). The New Mexico Department of Game and Fish (NMDGF) only stocks lakes within the Gila NF with triploid Rainbow trout or channel catfish, and only stocks certain streams with native Gila trout or Chihuahua chub to promote native fish (NMDGF 2016a). While non-native warm water fish occur and successfully reproduce in rivers and streams on the Gila NF, NMDGF provides fishing opportunities through regulations on those but does not actively stock any fish (NMDGF 2016a).

Context Area

Data to assess aquatic biota at the subbasin scale is not available.

Risk

Risk is a direct interpretation of departure (low departure equals low risk, etc.) For many 6th code sub-watersheds, risk is low to moderate mostly due to many native fish species present with few non-native fish in the system. The highly departed, high risk 6th codes typically have most or all native species absent and/or a high number of non-native species present in the sub-watershed. The highly departed 5th codes were absent any native fish. Where post-fire responses of native insects and fishes are pronounced, it may indicate that the extent and frequency of fire threatens the persistence of native fauna and suggest that management activities promoting ecosystem resilience might help ameliorate wildfire effects (Whitney et al. 2015).

Native fish populations may continue to diminish in the presence of non-natives without active management to remove non-natives. However, with the high number of projects on-going to repatriate streams with native fish, fish barriers to prevent non-native species mixing with native species in certain streams, and the commitment from NMDGF to not actively stock non-native species in streams, native fish should have a higher likelihood of persistence. With the popularity of sport fishing and NMDGF managing certain water bodies for sportfishing, it is unlikely the Gila NF will ever be comprised of 100 percent native fishes.

Groundwater Resources

Quantity

The majority of groundwater resources within the Forest occur in fractured volcanic and sedimentary rock and are not considered important sources of groundwater by the State. Portions of important basin fill aquifers[28] do occur to a limited extent on Forest, but largely occur in the surrounding context area (NMED 2001). While the Forest may not be considered an important reservoir of groundwater overall, it is a very important source of recharge in the basin fill aquifers surrounding the Forest. The Forest contributes to groundwater recharge in the Gila-San Francisco, Mimbres, Middle and Lower Rio Grande, Las Animas, Hot Springs Artesian, and Lordsburg Underground Water Basins declared by the New Mexico Office of the State Engineer.

Data provided by the State Engineer's Office indicates that approximately one percent of context area groundwater wells occur on Forest. Appendix D contains a table based on information from the New Mexico, Arizona, and Texas Offices of the State Engineers about the number of wells within the context and plan areas, both on and off-Forest. Wells constructed on the Gila NF are able to be used for domestic, livestock, irrigation, municipal, industrial, and commercial purposes, although not all wells can be used for all purposes. Most are currently used to provide livestock water, providing a secondary benefit as water

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[28] Basin fill aquifers are thick deposits of sediment that accumulated in valley bottoms.

for wildlife. Wells on the Gila NF also provide water for 15 drinking water systems associated with recreation and administrative sites (see Chapter 14: Infrastructure).

Groundwater recharge occurs as a result of mountain-front or alluvial mechanisms. Mountain-front recharge is very important in arid and semiarid regions like the Southwest. It occurs as the result of higher precipitation and lower temperatures in the mountainous areas, the relatively shallow nature of mountain soils compared to lower lying area and fractured nature of the bedrock. Alluvial recharge occurs as a result of high flow events, originating from Forest streams. The importance of alluvial recharge has been emphasized in the Mimbres subbasin (Conover and Akin 1942). Recharge rates are very slow.

Locally important, but relatively small, shallow alluvial aquifers are found in valley bottoms across the plan area. Groundwater is both recharged and discharged in these aquifers. Zones of recharge and discharge may change over time along any particular stream in response to surface runoff contributions and changes in channel and floodplain location and materials. Also of local importance are perched aquifers. Although information describing their extent and distribution is not available, these aquifers support springs, seeps and wetlands on the Forest.

Anything that impacts any element of the hydrological cycle, has the potential to impact groundwater quantity through alteration of recharge and discharge patterns. Climate change and associated declines in snowpack and alterations to streamflow are of particular relevance, as is balance between water supply and demand.

There is limited scientific information available related specifically to groundwater, climate and climate change. However, the information that is available has largely been the result of studies conducted in arid and semiarid regions, such as the Gila NF is located in. The evidence suggests that groundwater flowing in these regional aquifers accumulated thousands of years ago, before and during the last ice age, and that very little has accumulated since, rendering groundwater a non-renewable resource (Taylor et al. 2012).

The primary impact of climate change on groundwater resources is indirect, such as the increased demand for groundwater by human populations during times of drought. Prior to European settlement, groundwater use was probably limited to natural discharge from springs and baseflow provided during low streamflow periods. The reference condition for groundwater is that the rate of discharge did not exceed the recharge rate. However, as discussed in the Chapter 9: System Drivers and Stressors, this is not currently the case. This characteristic is considered to be in high departure and trending away from reference at context and plan scales.

Risk

Risk to groundwater quantity is driven by climate and water use. The Gila NF does not have the ability or authority to control or influence either of these things. Regardless, risk is assessed here, and is a direct reflection of departure. There is a high risk at both the context and plan scales. As droughts are expected to become more frequent and severe with climate change (IPCC 2007; Seager et al. 2007), and since most of the groundwater pumped is used for irrigation purposes, demand may be expected to increase independent of population trends. Groundwater supply, on the other hand, is expected to decline. It has been estimated that over the next several decades, the western United States could experience a 10 to 30 percent reduction in groundwater recharge (Taylor et al. 2012), elevating the risk to groundwater sustainability. The Gila NF has observed a large increase over the last three years in the number of wells on the Forest that need to be deepened because they are no longer producing enough water. There has also been an observed increase in the number of new wells needed to supplement livestock grazing allotments with unreliable surface water.

Springs, Seeps and Non-Riverine Wetlands

The following analysis concerns the occurrence, extent and distribution of springs, seeps and non-riverine wetlands. It does not analyze any riparian vegetation communities that may be associated with these resource features. That is done in Chapter 7: Riparian of the assessment report. The water associated with riverine wetlands is accounted for in the perennial and intermittent streams, and streamflow analyses. These streamside wetlands cannot be separated from the streams themselves.

Groundwater is discharged to springs, seeps and wetlands in a variety of ways. The perched aquifers previously mentioned, are zone of saturated soils that form above a layer of low-permeability and the main water table. Depression springs are located in low lying areas where the surface topography corresponds with a near surface groundwater table. These types of springs typically receive some contribution from surface runoff as well. Contact springs are associated with abrupt changes in rock type. Springs also occur along fault lines, or where there are joints or fractures in the rock. Springs or seeps may or may not be associated with wetlands or riparian vegetation and some wetlands are not supported by groundwater. Nor do all wetlands support riparian or wetland species; playa lakes, as described subsequently, are an example.

Because of data limitations that prevent separation of wetlands that are supported by groundwater and those that are not, all wetlands, except riverine wetlands, are considered here. Riverine wetlands are considered in Chapter 7: Riparian. The US Fish and Wildlife Service (USFWS) National Wetlands Inventory describes plan and context area wetlands in terms of riverine, freshwater emergent and freshwater forested/shrub. Wetlands that do not rely on groundwater are typically seasonal and occur in low lying areas where the surface topography does not correspond with a high in the water table, such as playa lakes. While they may support upland vegetation that are adapted to periods of inundation and the salt accumulations that can occur in these systems, obligate wetland or riparian species are typically not present. Very few of these types of wetlands are known to occur on the Forest. They do exist to a larger extent within the context area.

Analysis Methods

The representativeness and redundancy approach utilized to assess the extent and distribution of perennial and intermittent streams, and associated limitations are also applied to the analysis of springs, seeps and wetlands.

Plan Area

The Forest does not have a detailed inventory of springs and seeps or non-riverine wetlands. Information about the extent and distribution of these features is limited to the NHD and the USFWS National Wetlands Inventory. The NHD documents what is known about the location and number of springs and seeps in the plan and context area, but does not provide any information as to whether they produce water seasonally, all year long, or if they no longer produce water at all. The USFWS wetlands dataset provides national coverage, but has not been entirely verified on the ground. Table 142 lists each of the 49 plan area watersheds and displays total watershed area, watershed area located on Forest, total number of springs and seeps, and acres of non-riverine wetlands, as well as the percentage occurring on and off-Forest. Appendix D contains a table with the same information but including the subwatersheds.

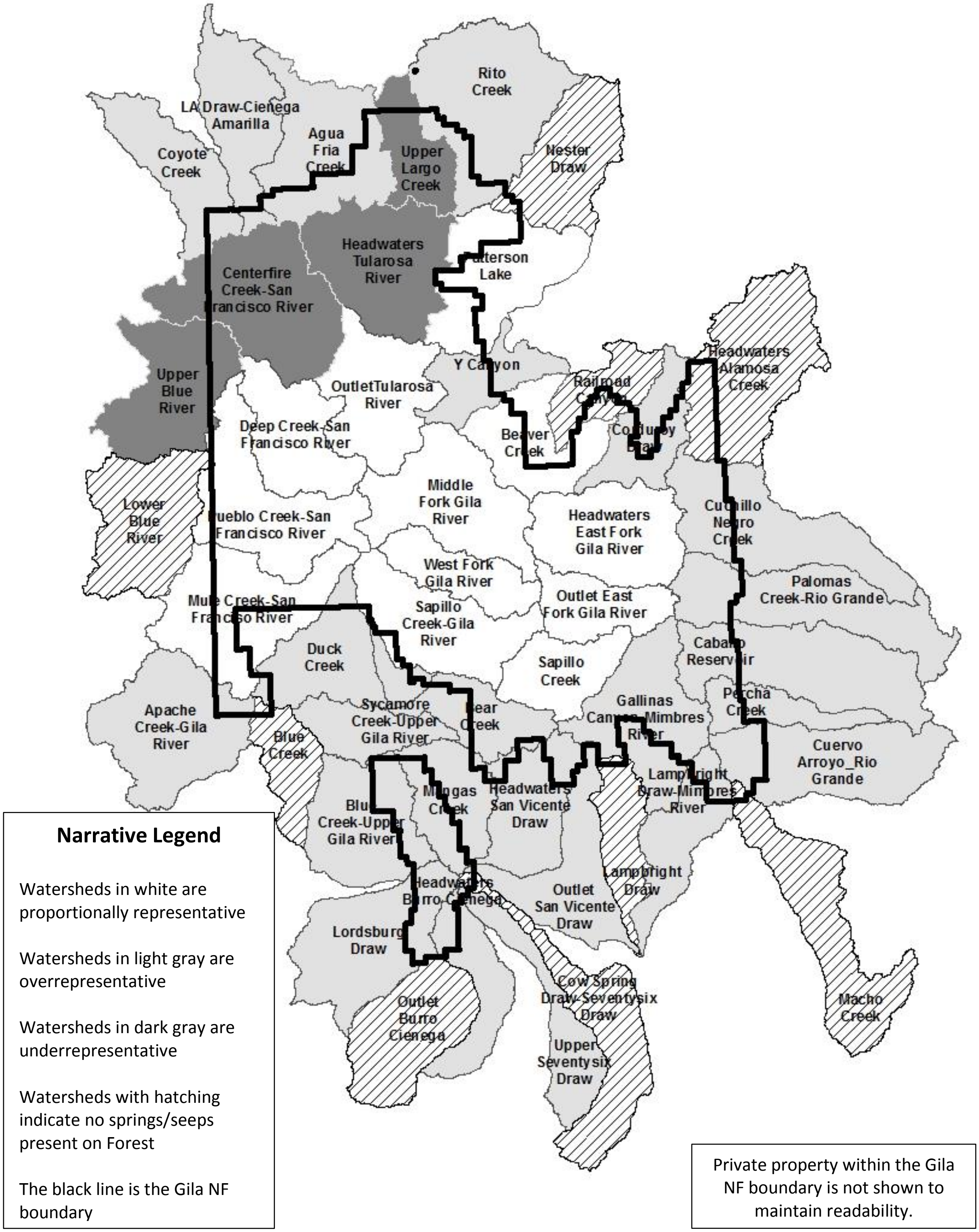
Table 142. Plan area extent and distribution of springs, seeps and non-riverine wetlands

Watershed Name	Watershed Area			Springs/Seeps (number)			Non-Riverine Wetlands (acres)		
	Total (acres)	Gila NF (acres)	% Gila NF	Total	On Gila NF	% On Gila NF	Total	On Gila NF	% on Gila NF
Plains of San Agustin Subbasin									
Nester Draw	169,190	5,328	3	32	0	0	0	0	--
Patterson Lake	207,398	78,514	38	30	12	40	18	0	0
Y Canyon	97,476	52,140	38	3	2	67	0	0	--
Elephant Butte Reservoir Subbasin									
Headwaters Alamosa Creek	257,399	40,451	16	19	0	0	0	0	--
Caballo Subbasin									
Caballo Reservoir	247,026	52,993	21	35	21	60	2,423	68	3
Cuchillo Negro Creek	236,142	76,046	32	33	21	64	7	0	0
Palomas Creek-Rio Grande	234,606	57,833	25	40	22	55	1,548	21	1
Percha Creek	77,379	24,763	32	25	18	72	85	0	0
El Paso-Las Cruces Subbasin									
Cuervo Arroyo-Rio Grande	226,938	37,572	17	39	25	64	195	0	0
Mimbres Subbasin									
Cow Spring Draw-Seventysix Draw	184,549	3,070	2	1	0	0	0	0	--
Gallinas Canyon-Mimbres River	205,881	151,448	74	67	64	96	468	39	8
Headwaters San Vicente Draw	144,197	26,072	18	29	23	6	0	0	--
Lampbright Draw	92,105	2,351	3	5	0	0	0	0	--
Lampbright Draw-Mimbres River	124,477	20,713	17	19	12	7	896	0	0
Macho Creek	213,735	3,641	2	13	0	0	37	0	0
Outlet San Vicente Draw	160,634	1,684	1	9	1	11	0	0	--
Upper Seventysix Draw	114,409	1,313	1	3	2	67	0	0	--
Little Colorado Headwaters Subbasin									
Coyote Creek	147,501	13,510	9	16	5	31	52	0	0

Watershed Name	Watershed Area			Springs/Seeps (number)			Non-Riverine Wetlands (acres)		
	Total (acres)	Gila NF (acres)	% Gila NF	Total	On Gila NF	% On Gila NF	Total	On Gila NF	% on Gila NF
Carrizo Wash Subbasin									
Agua Fria Creek	218,968	76,850	35	29	21	72	5	0	0
LA Draw-Cienega Amarilla	160,256	7,918	5	16	3	19	34	0	0
Rito Creek	279,878	37,218	13	35	21	60	107	0	0
Upper Largo Creek	98,300	75,156	76	16	9	56	7	0	0
Upper Gila Subbasin									
Beaver Creek	147,638	79,799	54	5	3	60	0	0	--
Corduroy Draw	111,118	68,279	61	10	8	80	0	0	--
Headwaters East Fork Gila River	193,943	192,473	99	32	30	94	153	140	91
Middle Fork Gila River	218,844	218,128	>99	26	24	92	716	705	98
Outlet East Fork Gila River	104,412	103,887	99	19	18	95	413	384	93
Railroad Canyon	89,105	14,046	16	0	0	--	0	0	--
Sapillo Creek	110,693	108,907	98	25	24	96	19	19	0
Sapillo Creek-Gila River	189,860	181,341	96	56	56	100	301	269	89
West Fork Gila River	103,948	102,439	99	23	21	91	312	275	88
Upper Gila-Mangas Subbasin									
Apache Creek-Gila River	237,306	12,270	5	62	14	23	252	0	0
Bear Creek	103,985	65,069	63	56	46	82	1	0	0
Blue Creek	88,931	3,428	4	7	0	0	3	0	0
Blue Creek-Upper Gila River	186,504	46,732	25	56	26	46	742	267	36
Duck Creek	144,993	16,862	12	4	4	100	3	<1	<1
Mangas Creek	130,597	50,698	39	32	21	66	5	0	0
Sycamore Creek-Upper Gila River	121,829	3,601	3	8	3	5	709	41	6
Animas Valley Subbasin									
Headwaters Burro Cienega	109,203	17,666	16	2	1	50	0	0	--

Watershed Name	Watershed Area			Springs/Seeps (number)			Non-Riverine Wetlands (acres)		
	Total (acres)	Gila NF (acres)	% Gila NF	Total	On Gila NF	% On Gila NF	Total	On Gila NF	% on Gila NF
Lordsburg Draw	221,184	41,617	19	20	18	90	0	0	--
Outlet Burro Cienega	179,037	291	<1	1	0	0	0	0	--
San Francisco Subbasin									
Centerfire Creek-San Francisco River	267,108	207,266	78	185	84	45	537	91	17
Deep Creek-San Francisco River	153,321	149,537	98	39	38	97	120	86	72
Headwaters Tularosa River	225,391	211,838	94	68	51	75	351	29	8
Lower Blue River	198,105	277	<1	215	0	0	240	0	0
Mule Creek-San Francisco River	244,422	121,064	50	118	56	47	402	71	18
Outlet Tularosa River	184,206	180,493	98	44	42	95	133	37	72
Pueblo Creek-San Francisco River	226,379	198,993	88	52	44	85	245	175	71
Upper Blue River	198,049	27,915	14	128	4	3	607	0	0
Total	**8,388,553**	**3,271,497**	**39**	**1807**	**918**	**51**	**12,146**	**2,718**	**22**

The results of the representativeness and redundancy analyses for springs and seeps are presented in Figure 112 and Figure 113, followed by Figure 114 and Figure 115 displaying the same information for non-riverine wetlands.



Narrative Legend

Watersheds in white are proportionally representative

Watersheds in light gray are overrepresentative

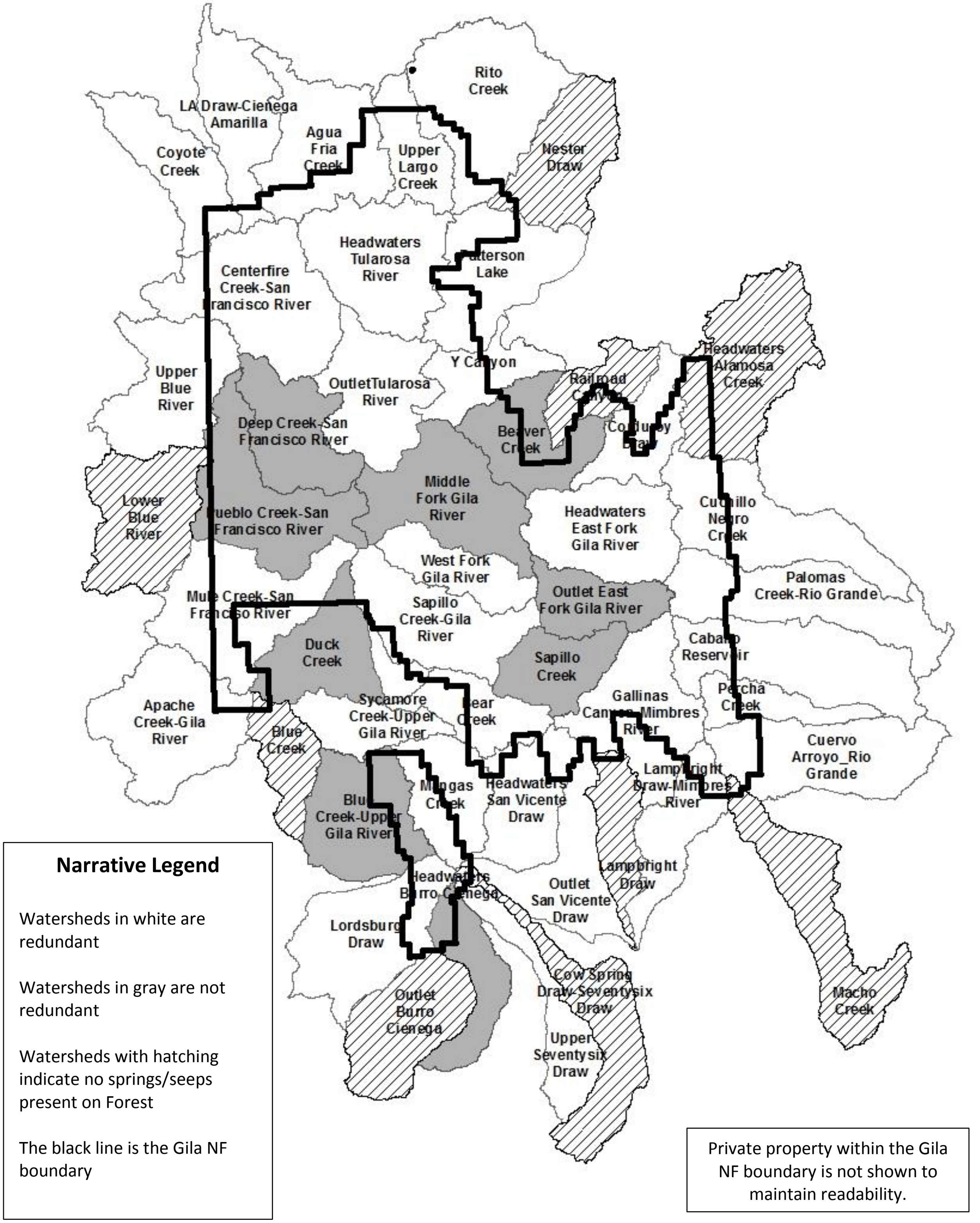
Watersheds in dark gray are underrepresentative

Watersheds with hatching indicate no springs/seeps present on Forest

The black line is the Gila NF boundary

Private property within the Gila NF boundary is not shown to maintain readability.

Figure 112. Representativeness of springs and seeps in plan area watersheds



Narrative Legend

Watersheds in white are redundant

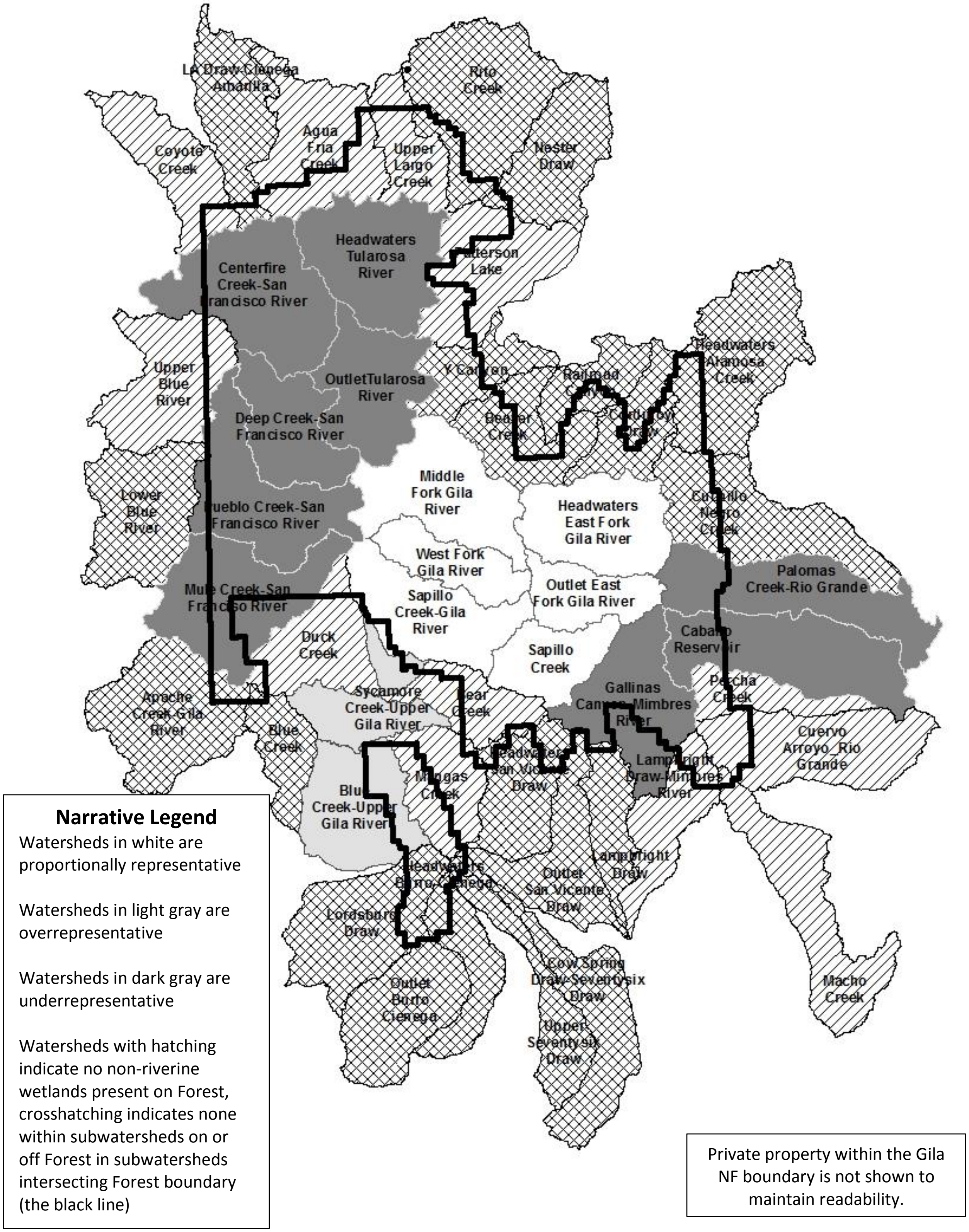
Watersheds in gray are not redundant

Watersheds with hatching indicate no springs/seeps present on Forest

The black line is the Gila NF boundary

Private property within the Gila NF boundary is not shown to maintain readability.

Figure 113. Redundancy of springs and seeps in plan area watersheds



Narrative Legend

Watersheds in white are proportionally representative

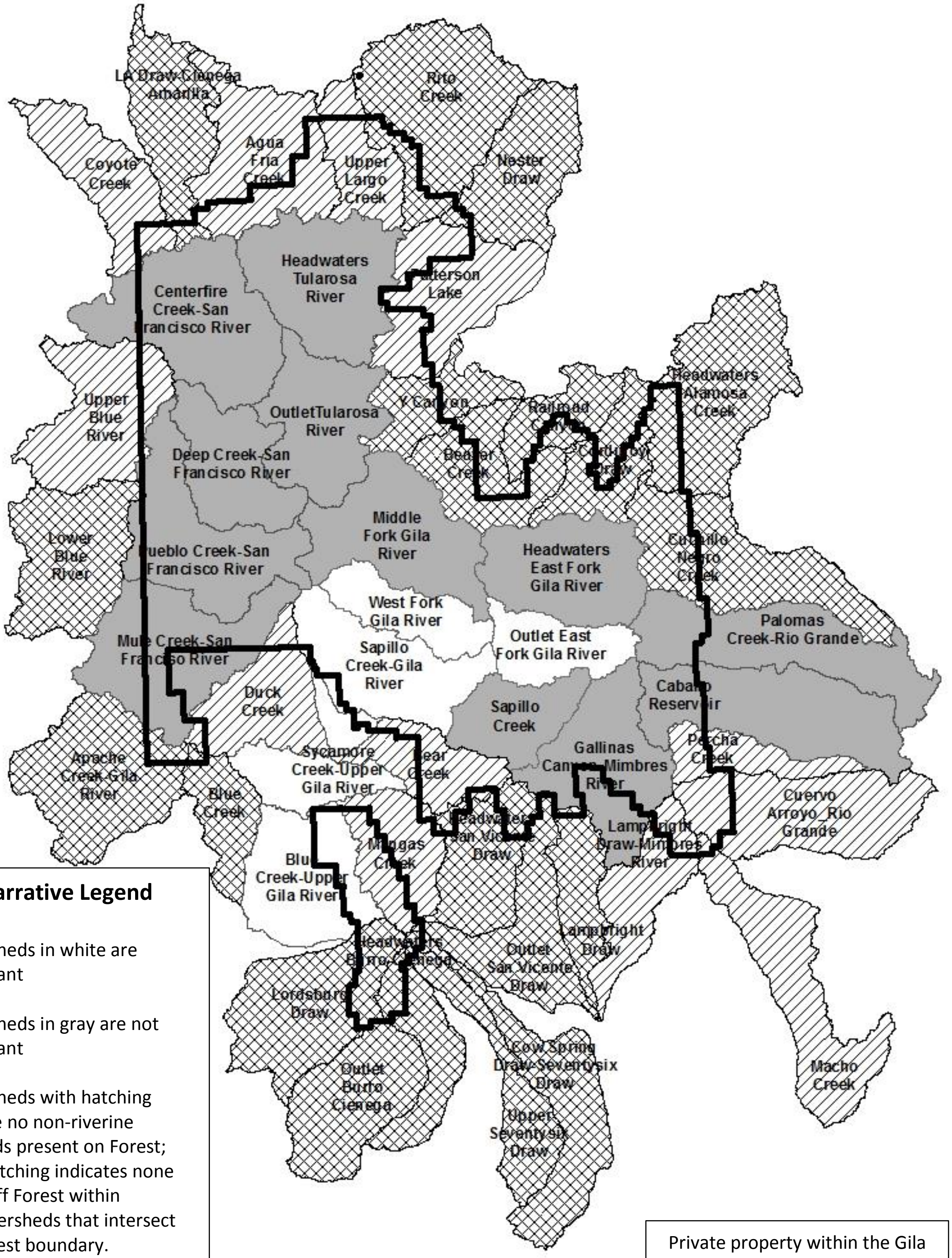
Watersheds in light gray are overrepresentative

Watersheds in dark gray are underrepresentative

Watersheds with hatching indicate no non-riverine wetlands present on Forest, crosshatching indicates none within subwatersheds on or off Forest in subwatersheds intersecting Forest boundary (the black line)

Private property within the Gila NF boundary is not shown to maintain readability.

Figure 114. Representativeness of non-riverine wetlands in plan area watersheds



Narrative Legend

Watersheds in white are redundant

Watersheds in gray are not redundant

Watersheds with hatching indicate no non-riverine wetlands present on Forest; crosshatching indicates none on or off Forest within subwatersheds that intersect the Forest boundary.

The black line is the Gila NF boundary

Private property within the Gila NF boundary is not shown to maintain readability.

Figure 115. Redundancy of non-riverine wetlands in plan area watersheds

Context Area

Table 143 displays the number of springs and seeps and acres of non-riverine wetlands by subbasin, and the portion located within the Forest.

Table 143. Extent and distribution of springs and seeps, and non-riverine wetlands within the context area.

Subbasin Name	Number of Springs and Seeps		Acres of Non-Riverine Wetlands	
	Total	On Gila NF	Total	On Gila NF
Plains of San Agustin	83	14	18	0
Elephant Butte Reservoir	115	0	11,787	0
Caballo	133	82	4,062	90
El Paso-Las Cruces	58	25	1,310	0
Mimbres	164	102	1,408	39
Little Colorado Headwaters	168	5	1,016	0
Carrizo Wash	118	54	285	0
Upper Gila	196	184	1,914	1,791
Upper Gila-Mangas	235	114	1,941	308
Animas Valley	29	19	2	0
San Francisco	912	319	2,836	490
Total	**2,211**	**918**	**26,579**	**2,718**

The Gila NF occupies 17 percent of the context area (Table 121) and contains 42 percent of the total number of springs and seeps and 10 percent of the non-riverine wetland acres. The opportunities for the Forest to contribute to sustainability of springs and seeps is directly related to their occurrence on Forest. In regard to non-riverine wetlands, this is also the case except where those wetlands are contiguous across jurisdictions. The Forest's contributions to integrity and sustainability and opportunities are greatest for both springs and seeps, and non-riverine wetlands in Upper Gila, San Francisco, Upper Gila-Mangas, Mimbres and Caballo. Other jurisdictions and their contributions and opportunities to integrity and sustainability are important in all subbasins.

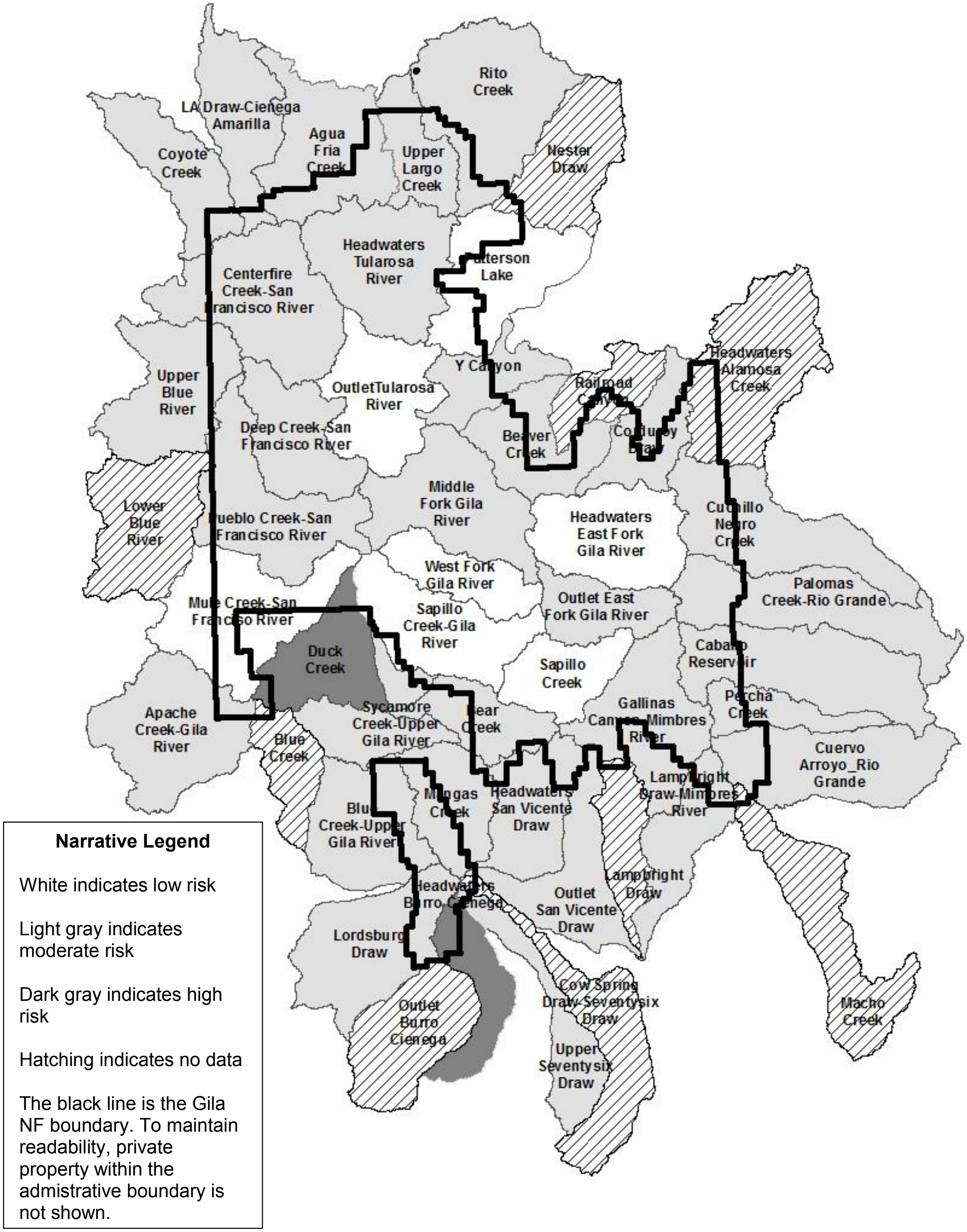
Risk

The results of the representativeness and redundancy analysis are applied to the assessment of risk to the extent and distribution of springs and seeps, and non-riverine wetlands using the matrix displayed as Table 144. In watersheds that do not contain any springs and seeps, or non-riverine wetlands in subwatersheds that intersect the Forest boundary, there is no risk.

Table 144. Risk matrix for representativeness and redundancy analysis results.

	Redundant	Not Redundant
Proportionally Represented	Low Risk	Moderate Risk
Not Proportionally Represented	Moderate Risk	High Risk

The results of the watershed scale risk assessment are displayed in Figure 116 (springs and seeps) and Figure 117 (non-riverine wetlands).



Narrative Legend

White indicates low risk

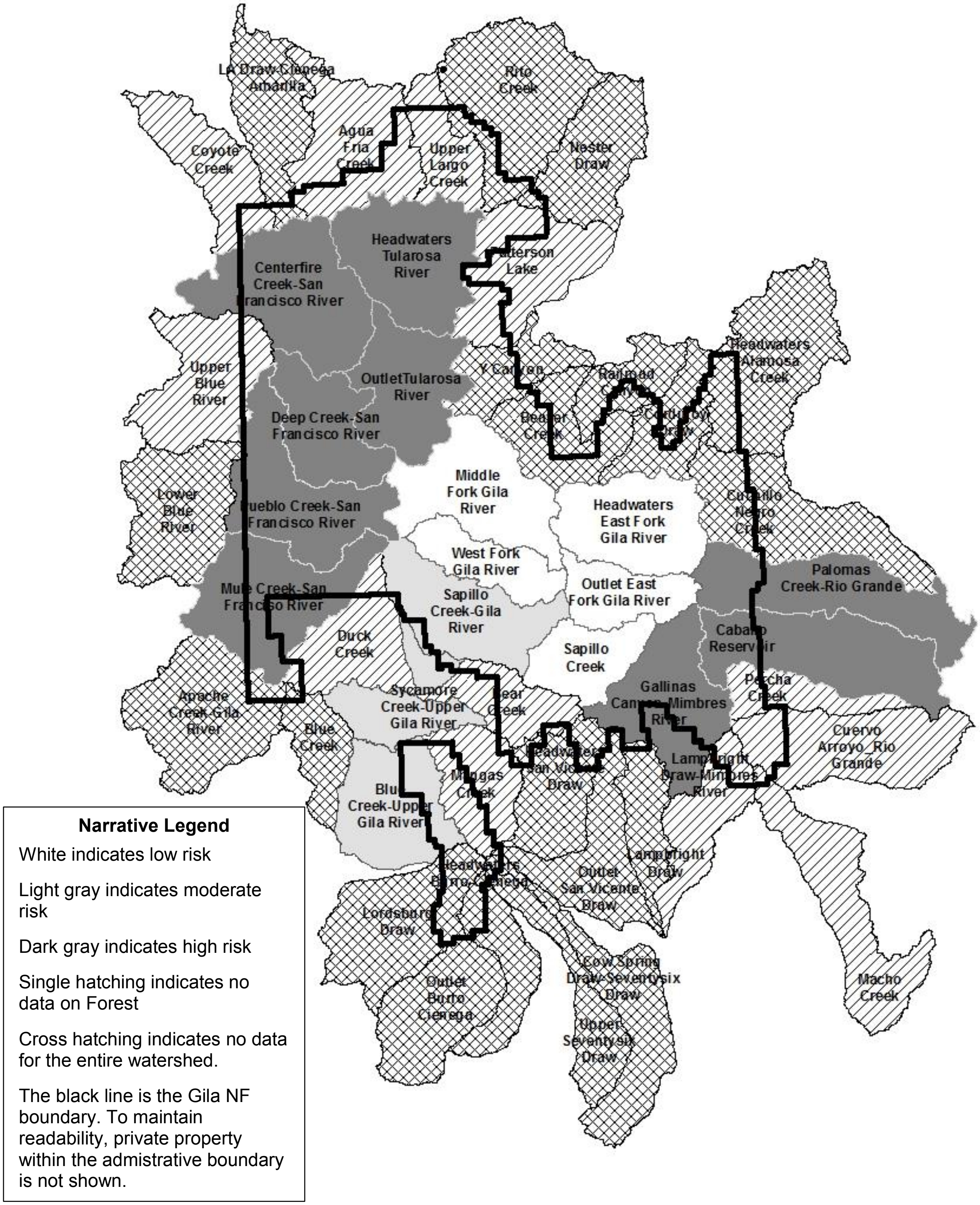
Light gray indicates moderate risk

Dark gray indicates high risk

Hatching indicates no data

The black line is the Gila NF boundary. To maintain readability, private property within the admistrative boundary is not shown.

Figure 116. Risk to springs and seeps across the plan area.



Narrative Legend

White indicates low risk

Light gray indicates moderate risk

Dark gray indicates high risk

Single hatching indicates no data on Forest

Cross hatching indicates no data for the entire watershed.

The black line is the Gila NF boundary. To maintain readability, private property within the admistrative boundary is not shown.

Figure 117. Risk to non-riverine wetlands across the plan area.

There is no relationship between risk interpreted from the representativeness and redundancy analysis and the status of system drivers or stressors, including Gila NF management. Rather, it is mostly a reflection of climate, site specific topography and patterns of land ownership. Private property within the Gila NF administrative boundary tends to be located near water sources, which causes these features to be underrepresented on Forest in some cases where it might appear reasonable to expect proportional representation. Because these features are relatively small, they are more susceptible to impacts related to management activities. In particular, those springs and seeps, and non-riverine wetlands that are seasonal or produce relatively small quantities of water are more likely to be dry up when fire or herbivory reduces the vegetative canopy that shades them, reduces site temperatures and therefore evaporation; while transpiration losses are reduced, evaporative losses are increased. The most significant risk to springs and seeps from management activity is development. Spring development involves any method or practice that diverts water produced by the spring and/or alters natural water flow paths. Based on the Gila NF's range improvements database 49 percent of the springs occurring on Forest have been developed to provide livestock water. As with the stock tanks discussed under the Waterbodies heading, there is no information on the reliability of the water produced from these springs. The relationship between how much water the spring produces, and how much is diverted is important to understand the magnitude of the ecological risk. While the water that is left is still available to support ecological values, its potential to do so is reduced. This competition between ecological and socio-economic demands for water, as well as climate change are the primary stressors contributing to risk.

Forest and local unit risk is assessed by assigning each local unit the risk category associated with the majority of its area. Based on this approach, the Forest and all local units are associated with a moderate risk to springs and seeps, except the Upper Gila local unit which is associated with a low risk. With respect to non-riverine wetlands, there is a high risk Forest-wide. Risk in all local units except Lower Gila is also high. Risk is low in Lower Gila because most of this local unit's area does not contain non-riverine wetlands across much of its area. This should not be taken to mean the wetlands in this local unit are of lesser value. All wetlands are ecologically important.

Groundwater Quality

There is not a lot of information about groundwater quality in the context or plan area. The State of New Mexico, through the Water Quality Control Commission, has developed regulations (20.6.2 NMAC) to protect groundwater resources. The State of New Mexico also relies on its State Drinking Water Rules that incorporate regulations in the federal Safe Drinking Water Act and establish additional requirements. The Safe Drinking Water Act and State Drinking Water Rules only apply to public water systems. Groundwater quality monitoring is typically only conducted at facilities with a permit to discharge pollutants or when individuals test their own domestic well water (NMED 2014b).

However, there is some departure from historic groundwater quality conditions in and around the Forest associated old landfills, historic mining activity and leaky underground storage tanks. These are documented by the soil contamination attribute of the watershed condition classification's soil condition indicator and would not have existed prior to European settlement. Historic mines are documented as a concern in five subwatersheds: Gavilon Arroyo-Mimbres River in Lampbright Draw-Mimbres River watershed and Headwaters Cow Spring Draw in Cow Spring Draw-Upper Seventysix Draw watershed, both in the Mimbres subbasin; Willow Creek-Mangas Creek in Mangas Creek watershed of Upper Gila-Mangas subbasin; and Hoodoo Canyon-Lordsburg Draw and Outlet Thompson Canyon in Lordsburg Draw watershed of the Animas subbasin.

In Cold Springs-Tularosa River of Headwaters Tularosa River watershed (San Francisco subbasin) there is a leaky underground fuel tank of concern to soil, groundwater and surface water quality as fuel is moving toward the Tularosa wetlands near Apache Creek, NM. There is also an old landfill in Starkweather Canyon of Centerfire Creek-San Francisco River watershed (San Francisco subbasin). There are some documented cases of groundwater contamination due to septic tanks within the context area on private property, but none are known to have impacted Forest groundwater resources. While there are localized groundwater quality concerns, the departure from pre-European groundwater quality is low overall. There is no information available to assess trend.

Risk

Based on low departure, there is a low risk to groundwater quality at all scales considered in this assessment.

Stakeholder Input

Watersheds and water resources are of great concern to the Gila NF and stakeholders. From stakeholder input received during the assessment, the importance of water to the overall health of the Forest, aquatic and riparian species, and recreational and economic value of the Forest were frequently visited topics. Observations concerning poor watershed conditions and water quality, altered streamflow, reduced streamflow and water availability in uplands springs and earthen tanks were common to all communities. Some are also concerned about groundwater supplies and declining recharge.

Some appreciate the challenges of balancing competing demands on water resources provided by the Forest and recognize that water has and will always be a limited and limiting ecological and economic resource. Others just want the Forest to provide more of it. While all desire clean and abundant water resources from watersheds that are functioning properly, there is disagreement of what that means and how to move toward those conditions.

There is broad recognition of altered ecological processes (stressors) due to Forest management but conflict regarding the causes and possible solutions. Poor watershed conditions are associated with fire suppression, altered fire regimes and post-fire effects, as well as increased densities of upland woody vegetation, reductions in timber harvesting and grazing, overgrazing by both livestock and elk, roads and trails, recreation, drought, and climate change. Increased timber and fuelwood harvesting, more grazing and less grazing, and construction of erosion control structures are proposed management solutions.

Roads, trails and recreation are also viewed as contributing to poor watershed conditions and water quality, but are valued for providing recreational and livestock management access to water resources. Timber harvesting and associated road maintenance, more frequent road maintenance, improved drainage features, and decommissioning of roads are proposed management solutions. Monitoring and maintenance of recreational facilities in drainage bottoms for water quality and stream health is recommended. Monitoring and managing upland recreational facilities and dispersed camping sites to improve watershed condition and protect water quality are also suggested.

Livestock access to perennial and intermittent streams is perceived both as something to be restricted and something that should not be restricted. Management recommendations include maintenance of existing livestock exclosures, construction of new exclosures and removal of all exclosures. These recommendations also apply to upland springs and wetlands. The construction of wetlands was also suggested.

The availability, reliability and quality of upland water resources are a concern. Many livestock tanks and wildlife waters are no longer functioning and in need of maintenance. Eutrophication and poor water quality associated with these developments could be improved with maintenance as well. There are springs that used to produce water are no longer doing so and many spring developments require maintenance. Partnerships are a suggested method to accomplish this work.

The importance of the ecosystem services provided by groundwater, in terms of livestock management and contributions to stream flow are recognized and declining groundwater tables are a concern. These concerns are largely attributed to climate change and declining snowpack.

Altered streamflow and associated reduction in water quantity are attributed to climate change, drought, changes in channel shape and function related to post-fire and livestock grazing, increased densities of upland woody vegetation, as well as native and non-native riparian vegetation.

There is great concern about interstate water compacts, future impacts to water resources, and therefore riparian and aquatic ecosystems on the Forest. There are also concerns about possible implications any Forest management decisions, or lack thereof, might influence the ability of streamflow to continue to support ecological values or interfere with the State's administration of water rights and local economies dependent on water use. These concerns are mostly specific to the Arizona Water Settlement Act and the proposed diversion of the Gila River and San Francisco rivers. The public holds conflicting viewpoints.

On one hand, many value the free flowing nature of the rivers for their ecological and recreational value and are concerned about negative impacts to those values resulting from a diversion. Their interest in plan revision includes a full consideration of ecological flow needs, climate change and the supporting science. A substantial body of scientific literature supporting their concerns, including but not limited to the Gila River Flow Needs Assessment, was provided during the assessment.

On the other hand, there are those that point to the historic and current water diversions for irrigation in along the rivers and feel the Gila River can remain free flowing in designated wilderness, but that downstream water users should continue to decide what do with the water. The concern being that changes in the Forest's land management plan could negatively affect downstream water rights holders or impinge on the State's ability to exercise its legal rights to administer water use.

After release of the draft assessment report, additional comments regarding water and watersheds were received. Many expressed concerns and ideas similar to those received earlier in the assessment phase. Others brought new perspectives on Forest issues and some offered concerns and opinions regarding this chapter of the draft assessment report. New perspectives included: the idea that livestock grazing permit holders could be cooperators in completing a Forest inventory of stock tanks; beavers should be provided greater protection; and reintroduction of the river otter.

With respect to input and feedback received on the draft assessment report, some believe the watershed condition classification provides an accurate assessment of conditions on the ground and assert that placing high priority on watershed and soil management is the key to ecological sustainability. Many perceived contradictions between conditions described in this chapter and the assessment of range conditions provided in Chapter 11: Multiple Uses. Others were alarmed at the watershed condition classification indicator scores for riparian vegetation condition and function and pointed to those scores as a clear need for change in management. Some questioned why certain uses (e.g. motorized travel and livestock grazing) were permitted in riparian areas that were classified as Functioning at Risk and identified specific areas where exclosures are in need of maintenance. Some felt the analysis of wetlands presented in this chapter should have included completed studies of riverine wetlands. A single comment pointed at the lack of current data regarding macroinvertebrates and concern for aquatic passage where roads cross streams. Some disagreed with the approach of counting miles of impaired streams by cause paints a poorer picture of water quality on the Forest than exists. Others were concerned about the purpose of the representativeness and redundancy analyses, fearing that those results would be used to justify lesser degrees of water resource protection in watersheds that were overrepresentative and/or redundant when all water resources are at risk under climate change predictions.

Summary

This assessment reviews the best available information at the subbasin, watershed and subwatershed level to explore the ability of the Forest's water resources to sustain the key ecosystem services they provide under current climate, existing budgets and Forest Plan direction. These ecosystem services are associated with watershed condition, streamflow, the extent and distribution of perennial and intermittent streams, springs, seeps and wetlands, surface water quality, aquatic biota and groundwater quantity and quality. Table 145 summarizes risk for these characteristics at the watershed scale (only for subwatersheds that intersect the Forest boundary), Forest and local unit scales. An entry of "L" represents low risk, "M" represents moderate risk, "H" high risk, and "VH" very high. No risk is assigned only where the characteristic analyzed is not present at a particular scale ("N") or there is no information ("ND"). Factors contributing to risk have been discussed throughout this chapter and Chapter 9: System Drivers and Stressors.

Table 145. Water resources risk summary by characteristic at the watershed, Forest and local unit scales.

Watershed Name	Key Ecosystem Characteristic										
	Watershed Condition	Perennial Streams	Intermittent Streams	Streamflow	Surface Water Quality	Aquatic Biota Species Richness	Aquatic Biota Extent and Distribution	Springs and Seeps	Non-Riverine Wetlands	Groundwater Quantity	Groundwater Quality
Plains of San Agustin Subbasin											
Nester Draw	L	H	M	L	L	N	N	N	N	H	L
Y Canyon	L	N	N	L	L	N	N	M	N	H	L
Patterson Lake	L	H	H	L	L	L	H	L	N	H	L
Elephant Butte Reservoir Subbasin											
Headwaters Alamosa Creek	L	H	M	L	L	L	L	N	N	H	L
Caballo Subbasin											
Cuchillo Negro Creek	M	H	M	L	L	N	N	M	N	H	L
Palomas Creek-Rio Grande	M	M	H	L	L	L	H	M	H	H	L
Percha Creek	M	L	M	M	M	N	N	M	H	H	L
Caballo Reservoir	H	M	M	H	M	L	L	M	N	H	L
El Paso-Las Cruces Subbasin											
Cuervo Arroyo-Rio Grande	M	H	M	M	M	H	L	M	N	H	L
Mimbres Subbasin											
Gallinas Canyon-Mimbres River	M	M	H	H	H	M	H	M	H	H	L
Headwaters San Vincente Draw	M	M	M	N	L	H	L	M	N	H	L

Watershed Name	**Key Ecosystem Characteristic**										
	Watershed Condition	**Perennial Streams**	**Intermittent Streams**	**Streamflow**	**Surface Water Quality**	**Aquatic Biota Species Richness**	**Aquatic Biota Extent and Distribution**	**Springs and Seeps**	**Non-Riverine Wetlands**	**Groundwater Quantity**	**Groundwater Quality**
Outlet San Vincente Draw	ND	M	H	N	L	N	N	M	N	H	L
Lampbright Draw	M	N	N	L	L	N	N	N	N	H	L
Lampbright Draw-Mimbres River	M	H	M	M	M	H	H	M	N	H	L
Macho Creek	L	N	N	L	L	N	N	N	N	H	L
Upper Seventysix Draw	ND	H	L	ND	L	N	N	M	N	H	L
Cow Spring Draw-Seventysix Draw	M	N	N	N	L	N	N	N	N	H	L
Little Colorado Headwaters Subbasin											
Coyote Creek	M	M	H	L	L	N	N	M	N	H	L
Carrizo Wash Subbasin											
Rito Creek	L	H	H	L	L	N	N	M	N	H	L
Upper Largo Creek	M	H	H	M	L	M	M	M	N	H	L
Agua Fria Creek	L	M	H	L	L	N	N	M	N	H	L
LA Draw-Cienega Amarilla	M	L	L	L	L	N	N	M	N	H	L
Upper Gila Subbasin											

Watershed Name	Key Ecosystem Characteristic										
	Watershed Condition	Perennial Streams	Intermittent Streams	Streamflow	Surface Water Quality	Aquatic Biota Species Richness	Aquatic Biota Extent and Distribution	Springs and Seeps	Non-Riverine Wetlands	Groundwater Quantity	Groundwater Quality
Railroad Canyon	L	N	N	L	L	N	N	N	N	H	L
Corduroy Canyon	L	N	M	L	L	N	N	M	N	H	L
Beaver Creek	L	M	H	M	M	H	H	M	N	H	L
Headwaters East Fork Gila River	M	L	M	L	M	M	M	L	L	H	L
Middle Fork Gila River	M	L	L	M	M	M	H	M	L	H	L
West Fork Gila River	M	L	L	M	M	M	H	L	L	H	L
Outlet East Fork Gila River	M	M	M	M	M	M	H	M	L	H	L
Sapillo Creek	L	L	L	M	L	M	M	L	L	H	L
Sapillo Creek-Gila River	M	L	H	M	M	M	H	L	M	H	L
Upper Gila-Mangas Subbasin											
Bear Creek	M	H	L	L	L	L	H	M	N	H	L
Duck Creek	M	M	M	L	L	H	H	H	N	H	L
Mangas Creek	M	H	M	L	L	M	H	M	N	H	L
Sycamore Creek-Upper Gila River	M	M	M	H	M	M	H	M	M	H	L
Blue Creek	L	H	H	L	L	L	N	N	N	H	L

Watershed Name	Key Ecosystem Characteristic										
	Watershed Condition	Perennial Streams	Intermittent Streams	Streamflow	Surface Water Quality	Aquatic Biota Species Richness	Aquatic Biota Extent and Distribution	Springs and Seeps	Non-Riverine Wetlands	Groundwater Quantity	Groundwater Quality
Blue Creek-Upper Gila River	M	H	L	M	M	M	H	M	M	H	L
Apache Creek-Gila River	M	M	H	M	L	H	H	M	N	H	L
Animas Valley Subbasin											
Headwaters Burro Cienega	M	N	N	H	L	N	N	H	N	H	L
Outlet Burro Cienega	ND	H	H	H	L	N	N	N	N	H	L
Lordsburg Draw	M	H	H	H	M	N	N	M	N	H	L
San Francisco Subbasin											
Headwaters Tularosa River	M	M	H	M	M	M	L	M	H	H	L
Outlet Tularosa River	M	H	M	M	M	M	H	L	H	H	L
Centerfire Creek-San Francisco River	M	M	M	VH	M	M	M	M	H	H	L
Deep Creek-San Francisco River	M	M	M	M	L	M	H	M	H	H	L
Pueblo Creek-San Francisco River	H	L	H	H	M	M	H	M	H	H	L
Upper Blue River	M	M	M	M	L	M	H	M	N	H	L

Watershed Name	**Key Ecosystem Characteristic**										
	Watershed Condition	**Perennial Streams**	**Intermittent Streams**	**Streamflow**	**Surface Water Quality**	**Aquatic Biota Species Richness**	**Aquatic Biota Extent and Distribution**	**Springs and Seeps**	**Non-Riverine Wetlands**	**Groundwater Quantity**	**Groundwater Quality**
Lower Blue River	L	L	L	L	L	N	N	M	N	H	L
Mule Creek-San Francisco River	M	M	M	L	M	M	M	L	H	H	L
Forest	M	M	M	L-VH	M	M	M-H	M	H	H	L
Local Unit											
Little Colorado-San Agustin Fringe	M	M	M	L-VH	M	M	H	M	H	H	L
Apache	M	M	M	L-VH	M	M	M	M	H	H	L
Mogollon Front	M	M	M	L-H	M	M	H	M	H	H	L
Black Range	M	M	M	L-VH	M	L-M	M	M	H	H	L
Upper Gila	M	L	L	M	M	M	H	L	H	H	L
Lower Gila	M	M	L	L-H	L	M	H	M	L	H	L

Most watersheds are associated with a moderate risk to sustainability primarily due to issues identified by the aquatic biota, aquatic habitat, riparian/wetland vegetation, water quality, water quantity, soil condition, roads and trails, fire regime/wildfire effects and rangeland vegetation condition indicators of watershed function. Two watersheds are associated with a high risk to sustainability. Caballo Reservoir is at high risk, primarily due to the effects of the 2013 Silver Fire. Pueblo Creek-San Francisco River is at high risk due to issues identified by the indicators listed above and effects of the 2012 Whitewater Baldy Complex Fire, although this watershed would have been placed in the high risk category even if the Whitewater Baldy Complex Fire had not occurred. Overall, most risk is associated with drought, legacy issues of past management and current management that is insufficient to mitigate these risks. Risk associated with the water quantity indicator (i.e. alterations to the natural streamflow hydrograph) is due to existing water diversions or controls and/or significant wildfire effects. Climate change and future development of water resources pose additional risk to water quantity.

With respect to the aquatic biota ecosystem characteristics (i.e. species richness and extent and distribution of native and non-native species), most risk is due to non-native species that are out-competing natives to varying degrees; the higher the risk rating, the larger the problem. In some cases, alterations of the natural streamflow hydrograph, due either to post-fire effects or water diversions or controls are negatively impacting aquatic species. Current management has met with some success, but much more work is necessary to maintain sustainability of native aquatic species.

Risk associated with water quality is moderate at the Forest and local unit scales, except in the Lower Gila local unit where risk is low. This may be associated with the number of watersheds containing very little water. This is also a factor in many watersheds with low risk to water quality. There is high risk associated with water quality in eight watersheds, including three that drain to the Gila River, four that drain to the San Francisco River above its confluence with the Gila River and one that drains to the Mimbres River. Causes vary but are primarily associated with stream temperatures that are too warm to meet their designated uses for aquatic habitat. Other contributing causes in these watersheds include excessive plant nutrients/eutrophication, *E. coli* and sediment related issues, although not all causes are present in each of these eight watersheds. NMED has and is conducting Use Attainability Studies to determine if designated uses and associated standards are appropriate for many of the Forest's streams. Regardless, management that moves watersheds toward Functioning Properly ratings and supports healthy riparian ecosystems can mitigate risks to water quality. Where non-riverine wetlands exist, there is generally a high risk in watersheds where they are few in number and unevenly distributed and low risk where there are more and distribution is more even. The same is true of perennial and intermittent streams, springs and seeps. However, limitations of the analysis approach include the fact that the assumptions it is based on may or may not hold true in the environment. It is a purely mathematical analysis approach and provides no consideration of the status of system drivers or stressors, including Gila NF management. Rather, it is mostly a reflection of climatic factors and patterns of land ownership.

The assessment of streamflow risk is tied to the water quantity indicator. It is also associated with the greatest degree of uncertainty due to the limited number of streamflow gages and the time scales over which data are available. However, drying trends are apparent in some systems and average streamflow has decreased in the winter and spring months (December-May), peak snowmelt runoff is occurring earlier and the snowmelt runoff period is decreasing, and the duration of late spring-early summer low flow periods are increasing. These changes are consistent with climate change projections and have enormous ecological and socioeconomic implications.

There is a high risk associated with groundwater quantity and low risk associated with groundwater quality at all scales. The risk to groundwater quantity arises from current and future demand for groundwater resources that exceed the rate of groundwater recharge. Risk to groundwater quality is localized and primarily associated with septic systems and old mining operations or landfills on or adjacent the Forest.

Given climate change predictions, current and future demand for water, and future water developments, all water features and water dependent resources are undoubtedly at risk. While management does not have the ability or authority to control or influence climate change or water use, emphasis on management approaches that increase water conservation, and anticipate reductions in water supply and increased frequency and severity of damaging storms will become increasingly important to ecological sustainability and the sustainability of multiple uses across the Forest in the future.

Chapter 7. Riparian

Introduction

Riparian areas are affected by the presence of surface and subsurface, perennial or intermittent, flowing or standing bodies of water. They are composed of distinctively different vegetative species than adjacent areas where water is more limited. In these systems, terrestrial and aquatic ecological processes are integrated. Riparian areas are defined by change and are adapted to disturbance. Because of variability in the amount, timing, distribution and duration of water availability in the Southwest, shifts in runoff, erosion, sedimentation, vegetation resistance to disturbance and resilience are site specific and episodic. This chapter includes a general description of riparian ecological response units (ERUs) occurring on the Gila NF, an analysis of key characteristics, a discussion of system drivers and stressors, an evaluation of risk, and summary of stakeholder input received during the assessment. Riparian ERUs are grouped based on similar dominant vegetative species which are:

- Cottonwood Group ERUs
    - Narrowleaf Cottonwood/Shrub
    - Sycamore-Fremont Cottonwood
    - Fremont Cottonwood/Shrub
    - Fremont Cottonwood-Oak
- Montane-Conifer Willow Group ERUs
    - Arizona Alder-Willow
    - Willow-Thinleaf Alder
    - Ponderosa Pine/Willow
    - Upper Montane Conifer/Willow
- Wetland (ciénega) ERU
    - Herbaceous Riparian
- Walnut-Evergreen Tree Group ERUs
    - Arizona Walnut
    - Walnut/Ponderosa Pine[29]
- Desert Willow Group ERU
    - Desert Willow

These groupings provide a framework for the analysis of most key characteristics, which include:

- Seral state proportion (structure)
- Ecological status (composition)
- Vegetative groundcover (function)
- Vegetation condition (function)
- Channel shape and function (function)
- Large woody debris (function)
- Flood frequency (process)[30]

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[29] The official ERU name is Little Walnut/Ponderosa Pine. However, the species of walnut present on the Gila NF is Arizona walnut (*Juglans major* (Torr.) A. Heller) not little walnut (*Juglans microcarpa* Berl.).

[30] Soil loss was not modeled for riparian soils as it is for upland soils. Soil loss models are not capable reflecting the complexity of the sediment transport processes involved in streamside environments. While there are certainly some capable watershed models that could model sediment transport within riparian areas, assessment time frames do not allow for their use. Even if assessment time frames did allow for their use, the available data would likely restrict their use in some or all riparian ERUs and/or groups of ERUs.

Due to the available data and the methods employed to utilize that data, large woody debris is analyzed outside of the group concepts. Flood frequency is first discussed outside of the group concepts, but is ultimately related back to the individual ERUs and group concepts. In the next few sections, ecosystem services, data, and analysis approach are described relative to each characteristic. Subsequently, each group is described and analyzed in terms of the characteristics identified in the preceding paragraph, followed by the large woody debris and flood frequency analyses. Riverine wetlands occur within several riparian ERUs and groups. Gila NF specific information is available regarding these wetlands, but that information is structured to major stream systems rather than ERUs. A discussion of this information follows the analysis of key characteristics. The risk assessment, stakeholder input, data gaps and summary sections conclude the chapter.

Ecosystem Services of Riparian Resources

Humans derive many benefits and enjoyment from the ecosystem services provided by the riparian resources on the Gila NF. Riparian zones contribute to provisioning and regulating services as they influence patterns of available water and nutrients, slow floodwaters, regulate stream temperatures, purify water, and contribute to the regulation of greenhouse gases and carbon storage. They provide a variety of supporting services as some of the greatest biodiversity occurs in riparian zones. One third of the Southwest's vascular plant species occur in riparian areas (Webb et al. 2007) and approximately 75 to 80 percent of all vertebrate species rely on riparian habitats despite the fact that they occupy a very small percentage of the landscape (Chaney et al. 1990; Riley 2005). The Gila River supports some of the highest numbers of bird species in the lower 48 states of the US, including important breeding habitat (Gori et al. 2014). Aquatic habitats and fish productivity are directly related to the health and function of riparian systems (Knutson and Naef 1997). They provide essential habitat for wildlife and aquatic species, including federally recognized and proposed threatened or endangered as well as sensitive wildlife and plant species. They also provide many cultural ecosystem services to society as they provide opportunities for recreation, personal enrichment, education and research.

Data

To assess seral state proportion, the same datasets identified in Chapter 2: Upland Vegetation were used with the exception of the dataset describing existing conditions. Instead of using the Midscale Existing Vegetation Mapping Project to describe current conditions, the 2016 Gila Riparian Existing Vegetation pilot project dataset is used. A field-based accuracy assessment has not been conducted on this pilot project. The watershed condition classification is used to assess vegetation condition and function, channel shape and function and large woody debris. With regard to riparian ecosystem characteristics, most of the information the watershed condition classification is based on the qualitative, field-based observations of the interdisciplinary team members, rather than quantitative data. The watershed condition classification is described in detail in Chapter 6: Water. The USGS streamflow gage data used in the streamflow analysis within Chapter 6: Water are also used to assess flood frequency as an ecological process and key characteristic for riparian.

A riparian Terrestrial Ecological Unit Inventory (TEUI) was completed for the Forest in the 1990s. Some riparian ecological units were also documented as part of TEUI mapping completed for landscape scale project planning during that time period. These completed inventories are part of the Gila NF's draft TEUI dataset which is described in greater detail in the Data section of Chapter 4: Soil. Riparian data collection and refinement of riparian ecological unit concepts are ongoing, but nearing completion. At present, there is no TEUI data documenting the Fremont Cottonwood/Shrub, Ponderosa Pine/Willow or Walnut/Ponderosa Pine ERUs. Completed surveys provide data summaries which are the primary information used to assess vegetative groundcover and ecological status. There are no TEUI data for lands that do not occur on National Forest System lands, therefore, these characteristics cannot be analyzed at the context scale. Admittedly, this is not an ideal dataset upon which to conduct analyses because riparian areas can change much quicker than upland ecosystems, and such analyses are therefore associated with a greater degree of uncertainty; however, no other quantitative data exists to analyze these two characteristics for riparian at the scales used in the assessment.

To account for significant changes in conditions due to recent post-fire flood events that have occurred since the TEUI data were collected, pre and post-2011 satellite imagery was used to detect observable change in riparian canopy cover, erosion and/or sedimentation. While changes can be seen in the satellite imagery, there is no way to differentiate between erosion and sedimentation (hence "erosion and/or sedimentation"). It is however, very clear where there has been a reduction in riparian canopy cover, vegetative groundcover and changes in channel shape and function because of how significant these events were. The year 2011 was chosen as a threshold because prior to that year, post-fire flood related impacts were localized, and not as widespread as they are now. Fires that occurred after the 2011 imagery was taken include the Wallow, Miller, Whitewater Baldy Complex and Silver Fires. An example illustrating changes observed via satellite imagery is provided in Figure 118 (pre-2011) and Figure 119 (post-2011). Reductions in riparian canopy cover and increases in unvegetated floodplain, indicative of either erosion or sedimentation are readily observed between the pre-2011 and post-2011 images. The results of the change detection are displayed in within each riparian group Table 146. Post-2011 imagery is from 2013; more recent satellite imagery for the Forest is not yet available.

Figure 118. The Meadows on the Middle Fork of the Gila River, 2011

Figure 119. The Meadows on the Middle Fork of the Gila River, post-2011

Table 146. Observable change in riparian canopy cover, erosion and/or sedimentation since 2011

Ecological Response Unit	Observable Change (% of Group or ERU)
Cottonwood Group ERUs	22
Narrowleaf Cottonwood/Shrub	24
Sycamore-Fremont Cottonwood	24
Fremont Cottonwood/Shrub	3
Fremont Cottonwood-Oak	0
Montane-Conifer Willow Group ERUs	63
Arizona Alder-Willow	66
Willow-Thinleaf Alder	77
Ponderosa Pine/Willow	1
Upper Montane Conifer/Willow	30
Wetland (cienega) ERU	5
Herbaceous Riparian	5
Walnut-Evergreen Tree Group ERU	3
Arizona Walnut	3
Walnut/Ponderosa Pine	0
Desert Willow Group ERU	6
Desert Willow	6
Area Weighted Gila NF Riparian ERU Total	**25**

Analysis Methods

Seral State Proportion

Analysis methods for this characteristic are the same as for upland vegetation. However, trend is not assessed because no Vegetation Dynamics Development Tool (VDDT) models, as used in the Upland Vegetation analysis, have been developed for riparian ERUs.

Ecological Status and Vegetative Groundcover

The analysis approach to the TEUI data, including how the reference and current condition are defined by the TEUI, is described in Chapter 4: Soil. Departure categories are elevated to moderate where the change detection describes post-fire flooding impacts across 33 to 66 percent of the ERU or group's area. Departure is elevated to high where these changes have occurred over more than 66 percent of the ERU or group's area. Trend cannot be assessed as no quantitative monitoring data comparable to the TEUI currently exists.

The limitations associated with the analysis approach to ecological status, as discussed in Chapter 4: Soil, remain true here, although to a lesser extent. If species diversity is high, but the same species are not present at each TEUI sample point location, this analysis methodology interprets that diversity as departure. Another factor that can contribute to site specific variability that may be contributing to departure is riparian soils. Riparian soils are highly diverse across both time and space. Not all soils have the same capacity to support riparian/wetland herbaceous species. Coarse textured soils that drain quickly are typically associated with lower ability to support herbaceous riparian species, while fine textured soils have a higher ability to do so. However, these soils may or may not support the same tree species, as tree roots access deeper soil layers than herbaceous species do.

However, the riparian analysis uses data summaries prepared for the completed surveys as previously described, which provide a more robust statistical basis than what time allows for the raw data used in the upland soils analysis; thus, departure ratings for ecological status in riparian ecosystems are associated with less uncertainty than upland systems. The greatest factor contributing to uncertainty is the size of the dataset. Smaller datasets are generally associated with greater uncertainty. All riparian ERUs have smaller datasets as compared to most of the upland ERUs. Another factor contributing to uncertainty is the quick response to changes in management or disturbance that occurs in riparian ecosystems, because of the higher plant available water in these systems as opposed to upland systems. Because changes can occur periodically and relatively rapidly, riparian datasets can become less accurate as time passes. The more recent the data, the less uncertainty.

Vegetation Condition, Channel Shape and Function, and Large Woody Debris

Riparian/wetland vegetation condition, channel shape and function, and large (aka coarse) woody debris characteristics are assessed using those indicators or attributes from the Gila NF's watershed condition classification as described in Chapter 6: Water. While this classification information is directly applicable to subwatersheds (6th level HUC) and cannot be correlated precisely at the ERU scale, watersheds and their riparian ecosystems respond to large scale disturbances as a single unit. The classification information does provide a general sense of riparian conditions with regard to these indicators and attributes. As described in the next paragraph, the riparian/wetland vegetation condition indicator, is a qualitative measure of the more quantitative seral state proportion characteristic. The similarities and differences between these two analyses will be used as a point of comparison.

Indicator and attribute ratings of Functioning Properly serve as the reference condition, with Functioning at Risk and Impaired Function representing a moderate and high departure respectively. Riparian vegetation conditions that are Functioning Properly are defined as "native mid to late seral vegetation appropriate to the site's potential dominates the plant communities and is vigorous, healthy and diverse in age, structure, cover and composition on more than 80 percent of the riparian/wetland areas in the watershed. Sufficient reproduction of native species appropriate to the site is occurring to ensure sustainability. Mesic (i.e. riparian) herbaceous plant communities occupy most of their site potential. Vegetation is in dynamic equilibrium appropriate to the stream or wetland system" (Potyondy and Geier 2011). Ratings of Functioning at Risk are defined as "native vegetation demonstrates a moderate loss of vigor, reproduction or growth, or it changes in composition, especially in areas most susceptible to human impact. Areas displaying light to moderate impact to structure, reproduction, composition and cover may occupy 25 to 80 percent of the overall riparian area with only a few areas displaying significant impacts. Up to 25 percent of the species cover or composition occurs from early seral species and/or there exist some localized but relatively small areas where early seral species dominates, but the communities across the watershed are still dominated by mid to late seral vegetation. Xeric (i.e. upland) herbaceous communities exist where water relationships have been altered but they are relatively small and localized, generally are not contiguous across large areas and do not dominate across the watershed" (Potyondy and Geier 2011). Impaired Function ratings are defined by conditions described as Functioning Properly occurring on less than 25 percent of the riparian/wetland areas in the watershed, with shifts to upland species because of altered water relationships and limited reproduction of mid to late seral riparian species (Potyondy and Geier 2011).

Channel shape and function ratings of Functioning Properly indicate "channel width-to-depth ratios exhibit the range of conditions expected in the absence of human influence. Less than 5 percent of the stream channels show signs of widening. Channels are vertically stable, with isolated locations of aggradation (i.e. sedimentation) or degradation (i.e. downcutting), which would be expected in near natural conditions. The distribution of channels with floodplain connectivity is close to that fond in reference watersheds of similar size and geology" (Potyondy and Geier 2011). Functioning at Risk ratings indicate that "channel width-to-depth ratios and vertical stability are maintained except where riparian vegetation has been disturbed. Between 5 and 25 percent of the stream channels have seen an increase in width-to-depth ratios (i.e. are widening). Channel degradation and/or aggradation are evident but limited to relatively small sections of the channel network. There is evidence of downcutting to the extent that some stream channels are no longer connected to their floodplain" (Potyondy and Geier 2011). Impaired Function ratings indicate that more than 25 percent of channels show signs of widening, "the size and extent of gullied sections of channels are extensive, currently increasing or have increased recently. Many streambanks show signs of erosion above what would be expected naturally. Channel aggradation and/or degradation are evident and widespread because of unstable stream-beds and banks." More than 50 percent of channels are "disconnected from their floodplain or are braided channels because of increased sediment loads" (Potyondy and Geier 2011).

Large woody debris ratings of Functioning Properly describe aquatic and riparian systems where wood is an important functional component and that woody is present and continues to be recruited at near natural rates. Functioning at Risk ratings indicate wood is present, but recruitment is less than natural rates because of riparian management activities. Impaired Function ratings indicate wood is lacking and resulting in poor riparian and aquatic habitat conditions. These poor conditions may manifest themselves as unstable banks, inadequate pool formation and microclimate maintenance (Potyondy and Geier 2011).

Not all subwatersheds contribute the same number of acres to the Forest, nor do they all contain the same riparian ERUs or proportions thereof. Indicator and attribute ratings were area weighted to each ERU to approximate and describe variability in conditions. The group totals are based on the individual ERU ratings and their respective contributions to the total number of riparian acres. The watershed condition classification information was updated in 2015 to reflect post-fire and flooding events that have occurred; therefore it is not necessary to use the change detection to modify the analysis results as those changes are reflected in the classification information.

Approximately 40 percent of subwatersheds intersecting the Gila NF boundary are considered Functioning Properly with respect to the riparian/wetland vegetation indicator. 49 percent are Functioning at Risk, and 11 percent are Impaired Function. However, water is a limiting factor and not all subwatersheds contain riparian/wetland vegetation nor have the potential to do so. Approximately 48 percent of subwatersheds were identified in the watershed condition classification as being limited by water in their potential to support riparian/wetland vegetation. In these subwatersheds, these indicator scores were given a lesser weight so they did not influence the overall condition classification.

Flood Frequency

Flood flows are often described in terms of return intervals. Return intervals describe the likelihood that a flood of a certain magnitude will occur. A flood with a two-year return interval has a 50 percent chance of occurring in any given year. A flood with a 100-year return interval has a one percent chance of occurring in any given year. Flood frequency analyses can include variables of magnitude, timing and duration. The flood frequency analysis presented here relies on daily streamflow data from six USGS gages[31] located on Mogollon Creek and the San Francisco, Gila and Mimbres Rivers, the streamflow analysis conducted in Chapter 7: Water, and the USGS PeakFQ model (v7.1)[32] available at http://water.usgs.gov/software/PeakFQ/.[33]

Studies evaluating flood history in the Southwest over the last 5,000 years have concluded that the largest floods cluster into distinct time periods that related to regional and global climatic fluctuations. Episodes with increased frequency of high magnitude floods coincide with cool, wet periods whereas dramatic decreases in frequency and magnitude occur during warm periods (Ely et al.1993; Ely 1997). The only streamflow reconstruction available for the Forest was conducted for the Upper Gila River using tree-ring data. In this study, the "Upper Gila River" includes the Upper Gila, Upper Gila-Mangas and San Francisco subbasins (4th level watersheds) of the context area defined in Chapter 7: Water. The reconstruction concludes that a defining characteristic of area streams is wide ranging differences between streamflow events that do not occur very often. Moreover, these differences increased in the 20th century (Meko and Graybill 1995). This creates a high level of uncertainty in departure analyses related to flood frequency.

There were no instrumental records kept prior to the arrival of Europeans. In fact, instrumental streamflow records from the plan area are limited to the last 25 to 87 years, depending on the gage. Given that area hydrology is the product of many natural and human caused changes over a much longer time period (McLean 1981), this is a very small dataset. Furthermore, to differentiate between reference and current conditions and approximate departure and trend requires this record be divided into a reference and

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[31] All streamflow gages used in this analysis lie within the plan area. One additional streamflow gage occurs within the context area on the Gila River near Virden, New Mexico. This gage was not analyzed as the difference in contributing watershed area between the Virden and Redrock gages is relatively small.

[32] "Bulletin 17B (B17B) of the Interagency Advisory Committee on Water Data (IACWD; 1982) codifies the standard methodology for conducting flood-frequency studies in the United States. B17B specifies that annual peak-flow data are to be fit to a log-Pearson Type III distribution. Specific methods are also prescribed for improving skew estimates using regional skew information, tests for high and low outliers, adjustments for low outliers and zero flows, and procedures for incorporating historical flood information. The authors of B17B identified various needs for methodological improvement and recommended additional study. In response to these needs, changes include adoption of a generalized method-of-moments estimator donated the Expected Moments Algorithm (EMA) (Cohn and others, 1997) and a generalized version of the Grubbs-Beck test for low outliers (Cohn and others, 2013). The USGS has implemented these changes in the PeakFQ program." (USGS 2013).

[33] This model calculates the magnitude of flood flows expected with various return intervals. It does not provide for the analysis of actual flood flows, nor does it provide for analysis of the timing or duration of those flows. To accomplish that level of analysis requires instantaneous data, not daily data. Assessment time frames and the limited period of record associated with instantaneous data (1990-present) do not allow for such analysis. Other studies that have included analysis of the actual occurrence and frequency, magnitude and duration of flood flows are referenced, as is the watershed condition classification's water quantity indicator as it describes alterations to the natural hydrograph.

current time period. A subset of the current time period (2000-2014) is analyzed for the purposes of approximating recent trends. The rationale behind establishing these time periods is described in further detail in Chapter 7: Water, where the same time periods are used to assess the streamflow characteristic.

Changes in flood frequency are most likely to occur where streamflow patterns are altered. Therefore, departure in flood frequency is ultimately determined by departure in streamflow. Chapter 7: Water determined departure in streamflow at the watershed (5th level) scale. These results were area weighted to the riparian ERUs, with the departure rating representing the largest percentage of the ERU or group.

Cottonwood Group

The cottonwood group includes Narrowleaf Cottonwood/Shrub, Sycamore-Fremont Cottonwood, Fremont Cottonwood/Shrub, and Fremont Cottonwood/Oak riparian ERUs.

Narrowleaf Cottonwood/Shrub (Figure 120) covers approximately 60,613 acres within the context area. This ERU is the 3rd largest riparian ERU in the context area and the largest riparian type on the Forest, containing 22,681 acres. It has the widest elevational and climatic range of any riparian ERU on the Forest. Within the context area, it is typically found at elevations ranging from 1,900 to 10,000 feet. On the Gila NF, it is mapped between 4,880 and 9,160 feet. Riparian species commonly found in the Narrowleaf Cottonwood/Shrub ERU include Fremont cottonwood (*Populus fremontii* S. Watson), narrowleaf cottonwood (*P. angustifolia* James) and lanceleaf cottonwood (*P. × acuminata* Rydb. (pro sp.) [*angustifolia × deltoides*]), boxelder (*Acer negundo* L.), willow species (*Salix* spp. L.), Arizona alder (*Alnus oblongifolia* Torr.), and Arizona walnut (*Juglans major* (Torr.) A. Heller).

Figure 120. Narrowleaf Cottonwood/Shrub ERU (Photo by M. Wahlberg)


Figure 121. Sycamore-Fremont Cottonwood ERU (Photo by L.J. WhiteTrifaro)

Sycamore-Fremont Cottonwood (Figure 121) covers approximately 46,059 acres within the context area. This ERU is the 4th largest riparian ERU in the context area and the 3rd largest on the Forest containing roughly 6,427 acres. Within the context area, it is typically found at elevations ranging from 1,400 to 7,700 feet. On the Gila NF, it is mapped between 4,160 and 6,520 feet. The primary cottonwood species is Fremont cottonwood, while narrowleaf cottonwood occurs occasionally. Other riparian species commonly found include Arizona sycamore (*Platanus wrightii* S. Watson), boxelder, velvet ash (*Fraxinus velutina* Torr.), Arizona walnut, and willow species.


Figure 122. Fremont Cottonwood/Shrub ERU (Photo by L.J. WhiteTrifaro)

Fremont Cottonwood/Shrub (Figure 122) covers approximately 116,189 acres within the context area. This ERU is the largest riparian ERU in the context area and the 6th largest on the Gila NF, containing roughly 2,059 acres. Within the context area, it is typically found at elevations ranging from 1,000 to 7,600 feet. On the Gila NF, it is mapped between 5,040 and 7,160 feet. Some areas of this ERU are dominated by Gooding's willow (*Salix gooddingii* C.R. Ball) and velvet ash but have the potential for cottonwood regeneration. Other riparian species commonly found include willow species, boxelder, and desert willow (*Chilopsis linearis* (Cav.) Sweet). This ERU also supports a mesquite bosque subtype, which does not occur on the Gila NF.

Fremont Cottonwood/Oak (Figure 123) covers approximately 2,159 acres within the context area. This ERU is the 10th largest riparian ERU in the context area and the smallest riparian type on the Gila at approximately 85 acres. Within the context area, it is typically found at elevations ranging from 2,200 to 7,500 feet. Oak species include Emory oak and Sonoran scrub oak (*Quercus turbinella* Greene). Other riparian species commonly found include Arizona sycamore and velvet ash.

Figure 123. Fremont Cottonwood/Oak ERU
(Photo @ A. Schneider, www.swcoloradowildflowers.com)

The majority of the cottonwood group is located in the central and western portion of the context area and the northwestern and southeastern portions of the Forest. Figure 124 and Figure 125 display the general locations of the cottonwood group within the context area and Gila NF.

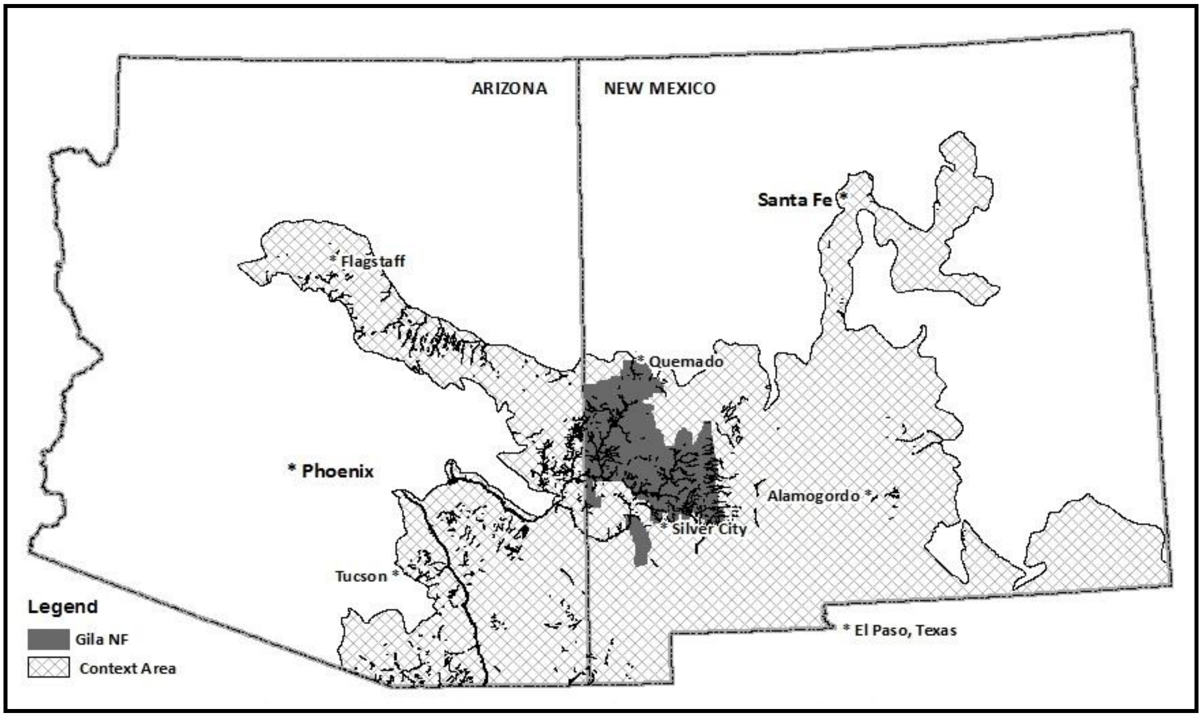

Figure 124. General location of the cottonwood group of ERUs within the context area

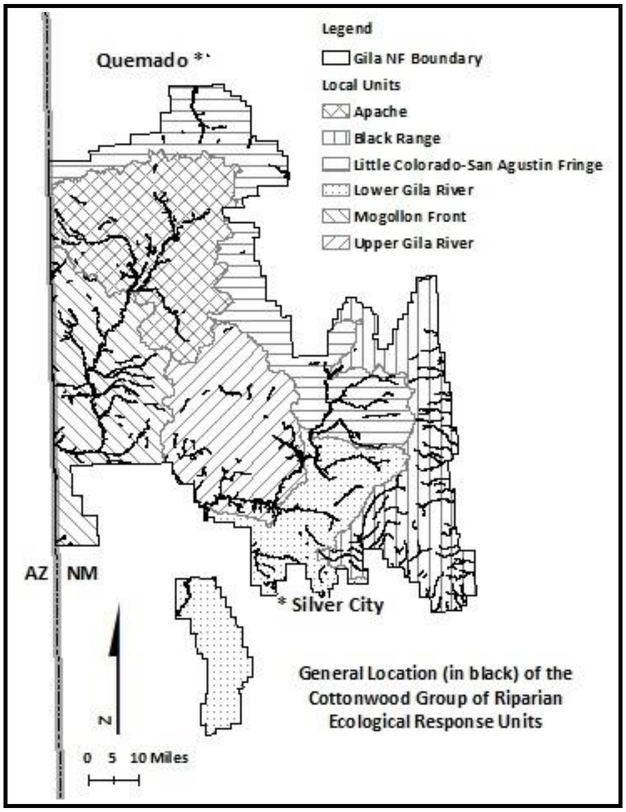

Figure 125. General location of the cottonwood group of ERUs within the Gila NF and the six local units.

Note: Local units are the polygons interior to the Forest boundary with names in callout labels

As displayed in Table 147, this group is fairly well distributed across the Forest, but the majority is located in the Black Range and Mogollon Front local units. The Fremont Cottonwood-Oak ERU occurs only in the Mogollon Front local unit.

Table 147. Local unit contributions to the cottonwood group of ERUs

Cottonwood Group ERUs	**Gila NF Local Units**												**Gila NF**
	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	
Narrowleaf Cottonwood/Shrub	3,280	14.5	6,184	27.3	4,147	18.3	3,260	14.4	2,330	10.3	3,479	15.3	22,681
Sycamore-Fremont Cottonwood	142	2.2	0	0.0	0	0.0	1,078	16.8	3,557	55.3	1,650	25.7	6,427
Fremont Cottonwood/Shrub	154	7.5	1,016	49.3	0	0.0	48	2.3	826	40.1	15	0.7	2,059
Fremont Cottonwood-Oak	0	0.0	0	0.0	0	0.0	0	0.0	85	100.0	0	0.0	85
CWG Group Total	3,576	11.4	7,200	23.0	4,147	13.3	4,386	14.0	6,798	21.8	5,144	16.5	31,252

Spatial Niche

The cottonwood group is the largest riparian group in both the context area (225,020 acres) and Forest (31,252 acres) (Table 148). This group has a greater proportional representation (0.54) on Forest than in the context area with Narrowleaf Cottonwood/Shrub and Sycamore-Fremont Cottonwood ERUs also having greater proportional representation on Forest. Fremont Cottonwood/Shrub is the exception with a greater proportional representation within the context area (-0.50) than on Forest. Fremont Cottonwood-Oak has equal representation (0.00) within both the context area and Forest. The Gila NF has a high level of responsibility for maintaining the ecological integrity of these riparian communities.

Table 148. Riparian ERUs represented in the cottonwood group

Cottonwood Group ERUs	Total ERU Area on Gila NF			Total ERU Area within Context Area			Gila NF's Contribution to Total ERU within Context Area	
	acres	% Gila NF	Seral state proportion % departure from reference	acres	% Context Area	Seral state proportion % departure from reference	from Gila NF	representation index
Narrowleaf Cottonwood/Shrub	22,681	0.7	44	60,613	0.09	8	37.4	0.77
Sycamore-Fremont Cottonwood	6,427	0.2	40	46,059	0.07	29	14	0.48
Fremont Cottonwood/Shrub	2,059	0.06	38	116,189	0.18	70	1.8	-0.50
Fremont Cottonwood-Oak	85	0.003	4	2,159	0.003	39	3.9	0.00
Group Total	31,252	0.01	42	225,020	0.003	49	13.9	0.54

Approximately 26 percent of the Fremont Cottonwood/Shrub ERU contains designated critical habitat for one or more species, with an additional four percent proposed critical habitat. In Narrowleaf Cottonwood/Shrub the percentages are 18 (designated) and 14 (proposed) percent and in Sycamore-Fremont Cottonwood it is 41 percent (designated) and 12 percent (proposed). The Fremont Cottonwood/Oak does not contain designated or proposed critical habitat. As a whole, 20 percent of this group contains designated critical habitat with an additional 11 percent proposed. Riparian areas in general also provide habitat for many potential species of conservation concern (see Chapter 8: At-Risk Species.

Thirty three percent of Narrowleaf Cottonwood/Shrub, 14 percent of Sycamore-Fremont Cottonwood and five percent of Fremont Cottonwood/Shrub are located in designated wilderness areas. Another 12 percent of Sycamore-Fremont Cottonwood is located in the Lower San Francisco Wilderness Study Area. The Fremont Cottonwood/Oak ERU is located entirely within the Hell Hole Wilderness Study Area. A total of 22 percent of this group occurs in designated wilderness. Over 10,600 acres of riparian are currently excluded from livestock grazing, including 210 acres of springs and wetland areas. Exclosures are not consistently mapped in the available geospatial data, and how much of the total excluded acres are represented by the cottonwood group ERUs has not been quantified. The reason why exclosures are not consistently mapped and available in the geospatial data is because there is no requirement for this type of accounting and it has therefore not been high enough on the Forest priority list to have resources dedicated to such an accomplishment.

Key Characteristics

Seral State Proportion (Vegetation Structure) –Reference and Current Conditions

Seral state proportion is the percent of ERU in each seral state, as described in Chapter 2: Upland Vegetation. Under reference conditions (RC) (Table 149) the majority of the CWG was made up of an understory of all size shrubs with a closed canopy and open overstory of all size trees (seral state B). These riparian communities also had a large representation of large trees with closed canopy characteristics (seral state C) as well as a good representation of shrub and tree regeneration (seral state A).

Table 149. Area-weighted seral state make-up of the cottonwood group under reference (RC) and current conditions for both the Gila NF and context area

Seral State	**Seral State Structure, Composition and Cover Class Description‡**	**Percent Proportion**			**Similarity Values to Reference†**	
		RC	current condition			
			Gila NF	context area	Gila NF	context area
A	EARLY-SERAL: Recently burned, sparsely vegetated, all herbaceous dominance types, and < 10% tree cover and < 10% shrub cover; Native shrub dominance types, and all shrub size classes, shrub cover < 25%; Native tree dominance types, and tree diameter 0-4.9", all tree cover classes	25	34	74	25	25
B	MID-SERAL: Native shrub dominance types, and all shrub size classes, shrub cover > 25%; Native tree dominance types, and tree diameterℨ > 5", tree cover < 25%	50	8	15	8	15
C	LATE-SERAL: Native tree dominance types, and tree diameter > 5" tree cover > 25%	25	58	11	25	11
D	Upland dominance types, and types dominated by exotic vegetation, and various *(occurs on contemporary landscapes only)*	0	0	0	0	0
Total		100	100	100	58	51

Departure Index Ratingɟ = 100 – ∑ similarity values: Gila NF = (100 – 58) = 42 or MODERATE; and Context Area = (100 – 51) = 49 or MODERATE

‡ USDA FS 2016d; LANDFIRE 2008d

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

ɟ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

ℨ Diameter is at diameter at breast height (dbh) or at root collar (drc)

With more than 33 percent, but less than 66 percent departure from the reference condition, departure in seral state proportion is categorized as moderate for the CWG at the context, Forest and local unit scales Within the Forest, this group currently contains more than twice the proportion of the late seral state than under the reference time period (58 percent vs. 25 percent) and nearly 10 percent more in early seral state at the expense of a reduction in mid-seral conditions which dominated under reference conditions. There is no one explanation for departure. Rather, this is a likely a reflection of several interrelated and site specific factors: timing, magnitude and frequency of flood events, floodplain and stream channel characteristics, motorized roads and trails, and herbivory.

Flooding is a natural and essential ecological process in riparian (and aquatic) ecosystems and is discussed in greater detail in the flood frequency analysis. Based on the change detection described in the preceding data section of this chapter, 22 percent of this group in the early seral state can be attributed to recent post-fire flooding. With respect to the proportion of this group in the late seral state, it is possible that the timing between the larger flood events that remove older vegetation and prepare a seedbed suitable for germination and seedling establishment, have not occurred frequently enough to support early and mid-seral conditions over late seral conditions. Additionally, the streamflow analysis in Chapter 6: Water suggests that the timing between spring runoff and seed dispersal may be changing in ways that decrease the likelihood of successful regeneration by seed events. In some instances, the flooding that has occurred may have been sufficient to accomplish this work at sometime in the past, but are no longer able to do so because of historic downcutting resulting from past fires, logging and livestock grazing practices. Where this downcutting has disconnected the floodplain, mature trees with deeper, more extensive root systems may have survived thus far, but hydrologic conditions are not conducive to the establishment and survival of regeneration. Motorized roads and trails located within the floodplain can restrict natural channel movement and floodplain connectivity, compete with riparian vegetation for space and alter the functional capacity of the soil through compaction. In some narrower valleys, motorized roads and trails may occupy enough of the potential riparian extent as to influence seral state conditions.

In recent decades, the health of riparian systems has largely been assessed and documented on a site specific basis as a part of range NEPA analyses using the Proper Functioning Condition (PFC) protocol established by the Bureau of Land Management and the Forest Service in partnership with the Natural Resource Conservation Service. Based on this protocol, riparian areas are categorized as being in Proper Functioning Condition, Functional-at-Risk or Non-Functional. Not all riparian areas on the Forest have completed PFC assessments and some conditions could have changed since assessments were done. Completed PFC assessments are not yet mapped in the geospatial data and do not contain enough riparian species data to be correlated directly to a given ERU without spatial data. Therefore the PFC information cannot be directly related to the CWG, or any other riparian ERU group. However, on a Forest-wide basis, approximately 10 percent of all PFC assessments document current herbivory by elk and/or livestock as a factor contributing to poor vegetative and streambank conditions. This may have some explanatory value for the higher percentage of the late seral state as shrubs and regenerating trees are more likely to be impacted by herbivory than are mature trees.

Ecological Status

Ecological status is a vegetative and soil characteristic that describes canopy cover by species (composition). It is an important indicator of nutrient cycling status and overall riparian function. Different riparian species have different adaptations that allow them to persist in the relatively high-frequency disturbance environment they occupy. Some produce large numbers of small seeds that are easily dispersed by wind and water to colonize seedbeds prepared by flood events. Others can re-sprout after fire, flood or partial consumption by herbivores. These species can also colonize new areas as their broken branches take root and grow in suitable conditions. Some can withstand weeks of saturated conditions, withstand some fire and are resistant to some diseases. Most riparian species have more than one of these adaptations, while some may be less able to withstand disturbance. Diverse species composition allows riparian vegetation communities to maintain themselves over a range of climatic conditions and provides for recovery after disturbance. The following figure (Figure 126) illustrates the variability in ecological status across ERUs in this group based on the TEUI data. The draft Gila NF TEUI does not include documentation in Fremont Cottonwood-Oak ERU.

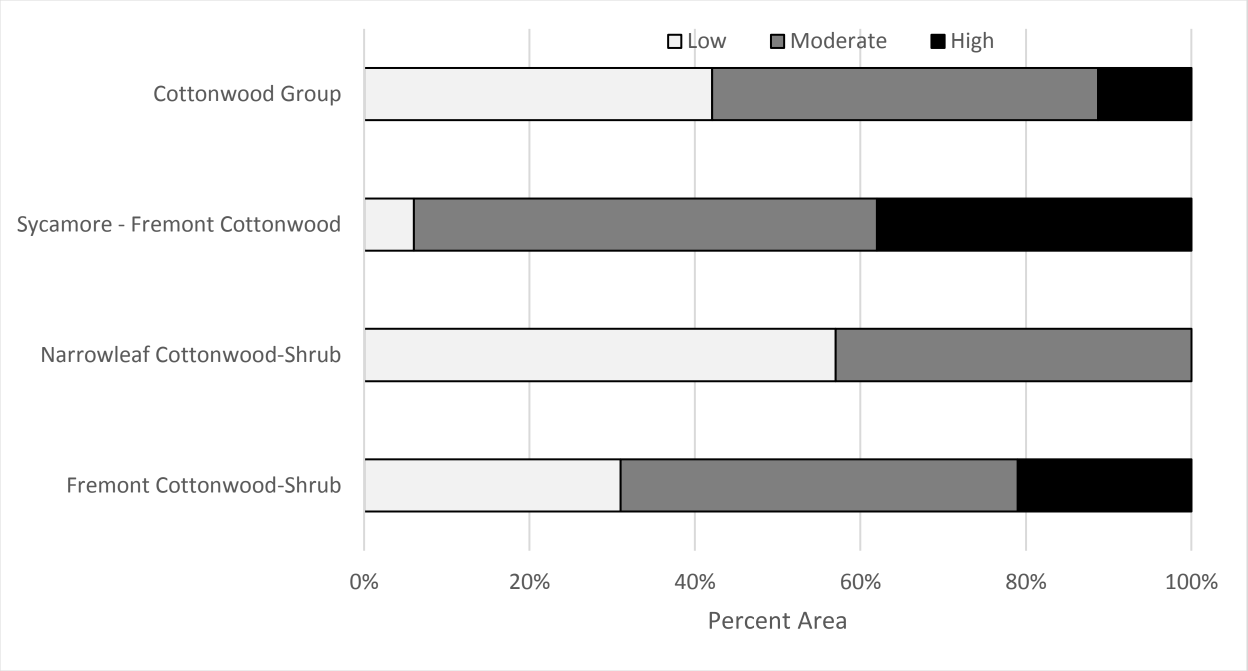

Figure 126. Plan scale variability in ecological status departure for the cottonwood group and its ERUs

With more than 50 percent of its area in low departure, ecological status departure is categorized as low in Narrowleaf Cottonwood/Shrub ERU. Departure in Fremont Cottonwood/Shrub, Sycamore-Fremont Cottonwood and the cottonwood group as a whole is moderate overall, with most of their area in that departure category (Figure 126). Where departure is moderate, there is typically less canopy cover of riparian tree, shrub and grass species and a higher proportion of canopy cover associated with forb species.

Non-native, disturbance adapted species that have been documented in the TEUI and have naturalized in these systems include but are not limited to: Kentucky bluegrass (*Poa pratensis* L.), sweetclovers (*Melilotus* spp.), mullein (*Verbascum thapsus* L.) and common dandelion (*Taraxacum officinale* G.H. Weber ex F.H. Wiggers). Naturalized species are non-native species that reproduce and spread without cultivation. Most occur at low levels, however, in some riparian areas Kentucky bluegrass has replaced the native grasses, sedges and/or rushes in the understory community. This grass does not have the deep, dense root system that native riparian species do and does not provide for streambank or floodplain stability.

Noxious weed species documented at low levels in these systems by the TEUI include, but may not be limited to cheatgrass (*Bromus tectorum* L.) and saltcedar (*Tamarix* spp.). Saltcedar control and eradication along the Gila and San Francisco Rivers and their tributaries is ongoing.These and other non-native, invasive and noxious weed species are discussed in further detail in Chapter 9: System Drivers and Stressors. With less than 33 percent of any given ERU or the group identified in the change detection as having reduced riparian canopy or, departure is not modified from the TEUI analysis.

It is probable that factors identified by the watershed condition classification as contributing to departure of seral state proportion (see previous subheading) and vegetation condition and function (see discussion under Vegetation Condition and Function subheading) also contribute to ecological status departure in the cottonwood group ERUs.

Vegetative Groundcover

Vegetative groundcover includes the basal area, litter, microbiotic crusts, lichens and mosses. Basal area is the area covered by tree trunks and stems of shrubs, forbs and graminoid species where they meet the ground. Litter includes all coarse woody and finer plant debris, a half inch or more in depth (USDA FS 1986a). Litter less than this depth is not considered effective in supporting soil stability. In upland systems, vegetative groundcover plays a critical role in soil stability as it reduces the raindrop impact energy responsible for detachment of soil particles, limits the movement of detached particles and prevents the concentration of surface runoff that can lead to rill and gully erosion. It is also an important indicator of nutrient cycling status. The contributions of vegetative groundcover to soil stability remain important in riparian zones, but of additional importance is the surface roughness it contributes. Surface roughness is important to slowing flood waters, thereby reducing erosion potential. In riparian areas, microbiotic crusts, lichens and mosses may add to biodiversity, but are not typically significant contributors to stability of the system. The following figure (Figure 127) illustrates the variability in conditions across ERUs in this group with TEUI documentation.

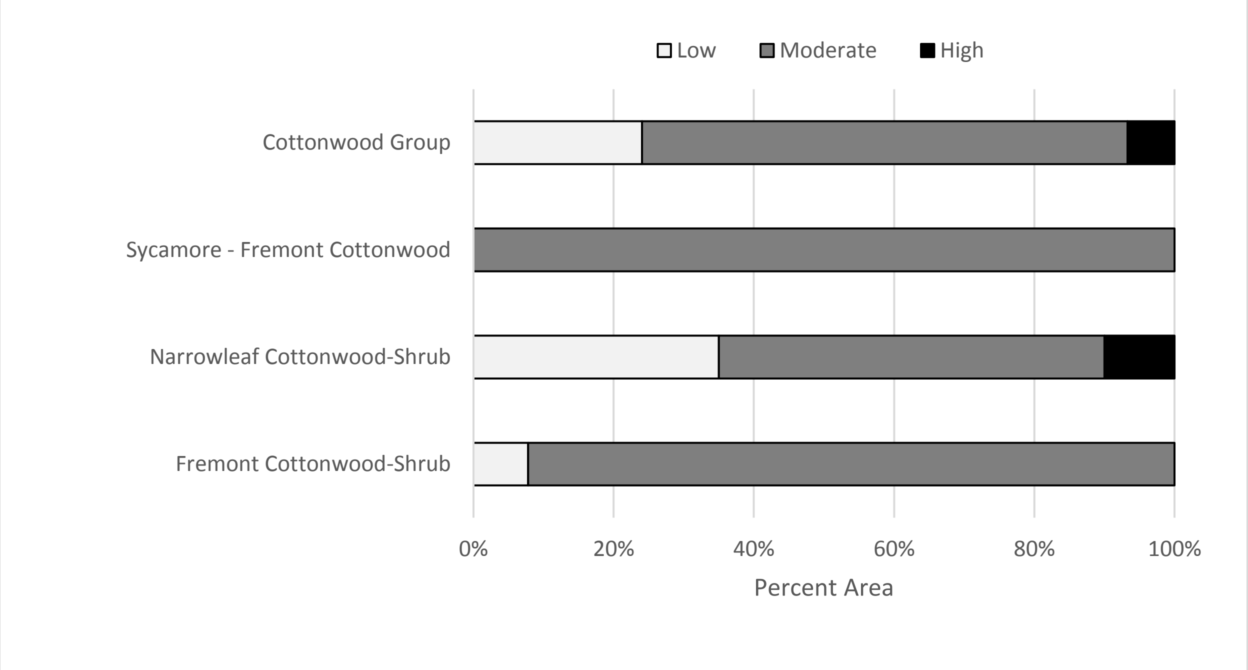

Figure 127. Area weighted vegetative groundcover departure

All ERUs and the cottonwood group as a whole are moderately departed in terms of vegetative groundcover, with the majority of their area being represented by the moderate departure category (Figure 127). However, groundcover in riparian systems is highly variable across time and space because of natural cycles of flooding which relocate and redistribute litter, and can remove basal area. Under reference conditions, vegetative groundcover ranges from 20 to 70 percent. Under current conditions, it ranges from 10 to 60 percent. It is probable that factors identified by the watershed condition classification as contributing to departure of vegetation condition and function (see discussion in the next subsection) also contribute to departure in the cottonwood group ERUs.

Vegetation Condition and Function

Healthy, diverse riparian and wetland vegetation is critical to overall ecosystem integrity. Above and below ground portions of these plants provide for flood control, floodplain and streambank stability, water quality protection, and wildlife and aquatic habitat. Riparian areas that provide multi-storied, dense canopy cover adjacent to more open upland systems support some of the greatest biodiversity (Webb et al. 2007). Table 150 displays current riparian/wetland vegetation conditions for the cottonwood group ERUs in terms of Functioning Properly, Functioning at Risk or Impaired Function. Fremont Cottonwood/Oak ERU is not included due to the small number of acres (85) mapped on the Forest.

Table 150. Current riparian/wetland vegetation conditions at the plan scale for cottonwood group ERUs

Ecological Response Unit	Percent of ERU by Subwatershed Indicator Rating		
	Functioning Properly	Functioning at Risk	Impaired Function
Fremont Cottonwood/Shrub	24	64	12
Narrowleaf Cottonwood/Shrub	23	64	13
Sycamore-Fremont Cottonwood	42	51	6
Area Weighted Group Total	**28**	**61**	**11**

All individual ERUs and the group as a whole are considered moderately departed with most subwatersheds containing ERUs in this group rated as Functioning at Risk with respect to riparian/wetland vegetation condition and function (Table 150). Reasons for departure are site specific, but include recent extents of high and moderate burn severity and post-fire flooding effects, as well as those related to older fires, such as the Bear (2006), Pigeon (1994) and Divide (1989) Fires. Other reasons cited in the watershed condition classification rationales include roads, drought, drying of the system attributed to irrigation diversions, and trespass livestock. In some cases, elk and current livestock grazing management contribute to departure as discussed in the interpretation of seral state proportion. All of these stressors are discussed in further detail in Chapter 9: System Drivers and Stressors.

Channel Shape and Function

This characteristic includes vertical stability, width to depth ratios and floodplain connectivity which play important roles in maintaining groundwater connections, stream temperatures and vegetation characteristics, as well as influencing flood and sediment transport processes. Table 151 summarizes the attribute ratings for each ERU based on the contributing area of subwatersheds containing each ERU. Fremont Cottonwood-Oak is not included due reasons previously stated.

Table 151. Channel shape and function conditions at the plan scale for cottonwood group ERUs

Ecological Response Unit	Percent of ERU by Subwatershed Indicator Rating		
	Functioning Properly	Functioning at Risk	Impaired Function
Fremont Cottonwood/Shrub	34	42	24
Narrowleaf Cottonwood/Shrub	28	41	31
Sycamore-Fremont Cottonwood	54	25	21
Area Weighted Group Total	**35**	**37**	**28**

All ERUs and the group as a whole are moderately departed from the reference condition (Functioning Properly), with most subwatersheds containing ERUs in this group rated as Functioning at Risk with respect to channel shape and function. As documented in the classification information, rationales attribute most of this departure to recent flood events and roads. These stressors are discussed in more detail in Chapter 9: System Drivers and Stressors.

Montane-Conifer Willow Group

The montane-conifer willow group includes Arizona Alder-Willow, Willow-Thinleaf Alder, Ponderosa Pine/Willow, and Upper Montane Conifer/Willow ERUs.

Arizona Alder-Willow (Figure 128) covers approximately 4,523 acres within the context area. This ERU is the 9th largest riparian ERU in the context area and the 4th largest on the Gila NF, containing roughly 3,222 acres. Within the context area, it is typically found at elevations ranging from 3,330 to 9,900 feet. It is mapped on the Gila NF between 4,700 to 8,920 feet. While both Arizona alder and willow species are indicative of this ERU, some areas of may contain only one species or the other. Common willow species include red willow (*Salix laevigata* Bebb) and arroyo willow (*S. lasiolepis* Benth). Other riparian species commonly found include Arizona walnut, velvet ash, and Rocky Mountain maple (*Acer glabrum* Torr.).

Figure 128. Arizona Alder-Willow ERU

Willow-Thinleaf Alder (Figure 129) covers approximately 7,091 acres within the context area. This ERU is the 6th largest riparian ERU in the context area and 8th largest on the Gila NF, containing roughly 1,054 acres. Within the context area, it is typically found at elevations ranging from 5,400 to 11,900 feet. On the Forest, it is mapped between 6,240 and 9,520 feet. While both thinleaf alder (*Alnus incana* (L.) Moench subsp. *tenuifolia* (Nutt.) Breitung) and willow species are indicative of this unit, some locations may contain only one species or the other. Common willow species include dewystem willow (*S. irrorata* Andersson), Drummond's willow (*S. drummondiana* Barratt ex Hook.), park willow (*S. monticola* Bebb, and grayleaf willow (*Salix glauca* L.).

Figure 129. Willow-Thinleaf Alder ERU (Photo by L.J. WhiteTrifaro)

Ponderosa Pine/Willow (Figure 130) covers approximately 6,339 acres within the context area. This ERU is the 7th largest riparian ERU in the context area and the 9th largest on the Forest, containing 862 acres. Within the context area, it is typically found at elevations ranging from 4,500 to 9,700 feet. On the Gila NF, it is mapped between 5,380 and 8,360 feet. It is typified by an overstory of ponderosa pine with an understory of shrub-form willow species. As a result of the pine overstory, this unit is particularly hard to distinguish from pine-oak systems of similar structure via remote sensing applications, and therefore is believed to be under-represented in the Regional Riparian Mapping Project (RMAP) and therefore the ERU map. Other riparian species commonly found include Arizona walnut, boxelder, and velvet ash.

Figure 130. Ponderosa Pine/Willow ERU (Photo by D. Cress)

Upper Montane Conifer/Willow (Figure 131) covers approximately 1,343 acres within the context area. This ERU is the 11th largest riparian ERU in the context area and the 10th largest on Forest, containing roughly 670 acres. Within the context area, it is typically found at elevations ranging from 6,100 to 11,400 feet. On the Forest, it is mapped between 6,750 and 9,160 feet. Conifer species include spruce, subalpine fir, white fir, and Douglas fir. Quaking aspen can be present, or even a co-dominant species. Other riparian species commonly found include thinleaf alder and boxelder.

Figure 131. Upper Montane Conifer/Willow ERU (Photo by L.J. WhiteTrifaro)

The majority of the montane-conifer willow group is located in the central, western and eastern portions of the context area, and the western and southeastern portions of the Forest. Figure 132 and Figure 133 display the general locations of the montane-conifer willow group within the context area and Gila NF.

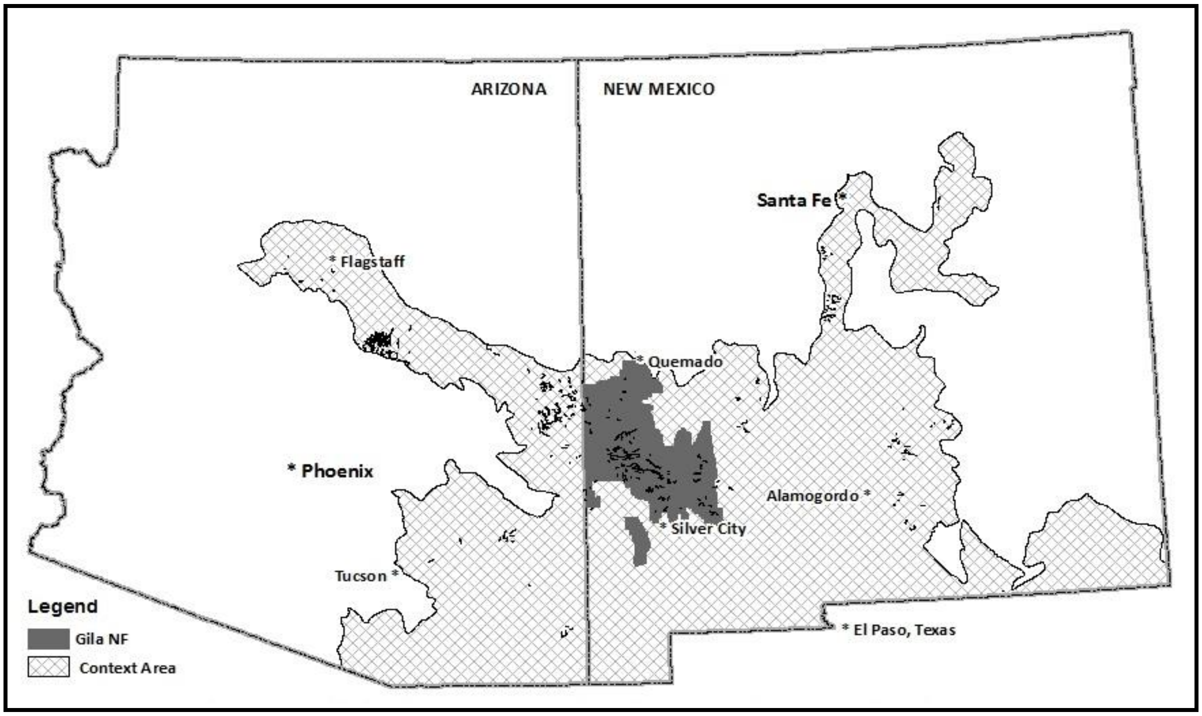

Figure 132. General location of the montane-conifer willow group of ERUs within the context area

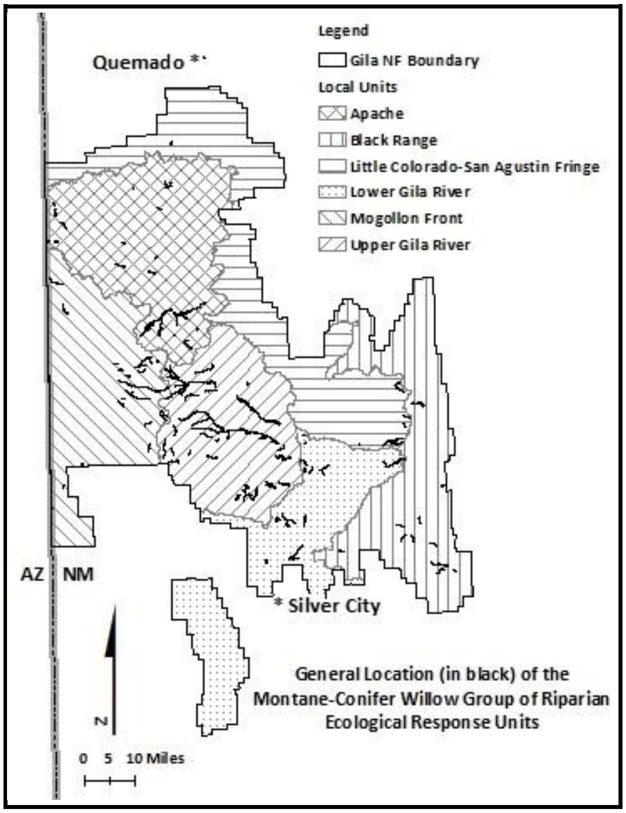

Figure 133. General location of the montane-conifer willow group of ERUs within the Gila NF and the six local units

Note: Local units are the polygons interior to the Forest boundary with names in callout labels

As displayed in Table 152, the majority of this ERU group is located in the Upper Gila River and Apache local units.

Table 152. Local unit contributions to the montane-conifer willow group of ERUs

Montane-Conifer Willow ERUs	**Gila NF Local Units**												**Gila NF**
	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	
Arizona Alder-Willow	207	6.4	283	8.8	0	0.0	317	9.8	530	16.4	1,885	58.5	3,222
Willow-Thinleaf Alder	66	6.3	19	1.8	3	0.3	0	0.0	110	10.4	857	81.3	1,054
Ponderosa Pine/Willow	794	92.1	0	0.0	6	0.7	0	0.0	62	7.2	0	0.0	862
Upper Montane Conifer/Willow	49	7.3	41	6.1	349	52.1	148	22.1	52	7.8	31	4.6	670
Group Total	1,116	19.2	343	5.9	358	6.2	465	8.0	754	13.0	2,773	47.7	5,808

Spatial Niche

Individually, and as a group, these riparian communities have greater proportional representation on the Forest than in the context area (Table 153). The Gila NF has a high level of responsibility for maintaining the ecological integrity of these riparian communities.

Table 153. Riparian ERUs represented in the montane-conifer willow group

Montane Conifer-Willow Group ERUs	**Total ERU Area on Gila NF**			**Total ERU Area within Context Area**			**Gila NF's Contribution to Total ERU within Context Area**	
	acres	% of Gila NF	Seral state proportion % departure from reference	acres	% of Context Area	Seral state proportion % departure from reference	from Gila NF	proportional representation
Arizona Alder-Willow	3,222	0.1	46	4,523	0.01	45	71.2	0.82
Willow-Thinleaf Alder	1,054	0.03	40	7,091	0.01	42	14.9	0.50
Ponderosa Pine/Willow	862	0.03	47	6,339	0.01	61	13.6	0.50
Upper Montane Conifer/Willow	670	0.02	33	1,343	0.002	56	49.9	0.82
Group Total	5,808	0.002	44	19,296	0.0003	50	30.1	0.74

Approximately eight percent of the Arizona Alder-Willow ERU contains designated critical habitat for one or more species, with an additional 32 percent proposed critical habitat. In Willow-Thinleaf Alder the percentages are 6 (designated) and 47 (proposed) percent. There is currently no designated critical habitat associated with the Upper Montane Conifer/Willow ERU, but 47 percent of it is proposed critical habitat. There is no designated or proposed critical habitat in Ponderosa Pine/Willow. As a whole, eight percent of this group contains designated critical habitat with an additional 39 percent proposed. Riparian areas in general also provide habitat for many potential species of conservation concern (see Chapter 8: At-Risk Species. Sixty one percent of Arizona Alder-Willow, 55 percent of Upper Montane Conifer/Willow and 63 percent of Willow-Thinleaf Alder are located in designated wilderness areas. Ponderosa Pine/Willow is not mapped in designated wilderness areas. A total of 67 percent of this group occurs in designated wilderness. None of these ERUs occur in Wilderness Study Areas. Total riparian acres not being grazed by livestock was disclosed in the cottonwood group analysis. Exclosures are not consistently mapped in the available geospatial data as previously discussed, and how much of the excluded acres are represented by the montane-conifer willow group ERUs has not been quantified.

Key Characteristics

Seral State Proportion (Vegetation Structure)

Under reference conditions (Table 154) the majority of the montane-conifer willow group was made up of early and mid-seral states (seral states A and B). Currently, within both the Forest and context area there is an over representation of seral state B, with an under representation of seral state A (regeneration and recruitment).

Table 154. Area-weighted seral state make-up of the montane-conifer willow group ERUs under reference (RC) and current conditions for both the Gila NF and context area

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to Reference†	
		RC	current condition			
			Gila NF	context area	Gila NF	context area
A	EARLY-SERAL: Recently burned, all corresponding herb types; all shrub dominance types, shrub cover < 25%; all tree dominance types, < 5" dbh/drc (< 5m height), all cover classes	65	21	15	21	15
B	MID- TO LATE-SERAL: All shrub dominance types, ≥ 25% canopy cover; all tree dominance types, ≥ 5" dbh/drc (≥ 5m height), all cover classes	35	79	85	35	35
C	Upland dominance types and exotic vegetation, various *(occurs on contemporary landscapes only)*	0	0	0	0	0
Total		100	100	100	56	50

Departure Index Ratingɟ = 100 – ∑ similarity values: Gila NF = (100 – 56) = 44 or MODERATE; and Context Area = (100 – 50) = 50 or MODERATE

‡ USDA FS 2016e; LANDFIRE 2007g

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

ɟ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

With more than 33 percent, but less than 66 percent departure from the reference condition, departure in seral state proportion is categorized as moderate for all local units, the Forest and context area. Within the Forest, this group currently contains more than twice the proportion of the mid-to-late seral state than under the reference time period (79 percent vs. 35 percent) and a reduction in early-seral conditions which dominated under reference conditions. Potential factors contributing to departure in seral state proportion, as discussed in that analysis for the cottonwood group of ERUs, include timing, magnitude and frequency of flood events, floodplain and stream channel characteristics, motorized roads and trails, and herbivory. Roads have less explanatory value for departure where this group occurs in wilderness.

However, these results appear counterintuitive based on the change detection results displayed under the Data subheading as Table 127. Sixty-three percent of this group has experienced post-fire flooding events that have created reductions in vegetative canopy cover visible from the satellite imagery, which is indicative of a shift from mid or late seral conditions to early seral conditions. A likely explanation for this apparent contradiction could be that results of the seral state proportion analysis illustrate a robust recovery response of willows and/or other species components that occurred after the date of the most recent available imagery (2013) and the 2016 pilot project. Still, this explanation is not without issue. If the time between early and mid seral conditions is just three to five years, as these results imply, the rate and extent of disturbance that would be required to maintain 65 percent of this ERU group in early seral conditions would be remarkably high, suggesting potential weakness in the current understanding of reference conditions and a need for further investigation of this ERU group in the future. Of particular interest may be the relationship between channel shape and function and the disturbance requirements indicated by the seral state proportion analysis, which paint potentially opposing pictures of sustainability.

Ecological Status

The following figure illustrates the variability in ecological status conditions across ERUs in this group. Ponderosa Pine-Willow is not included as there is no documentation in the draft TEUI to support analysis of this characteristic for this ERU.

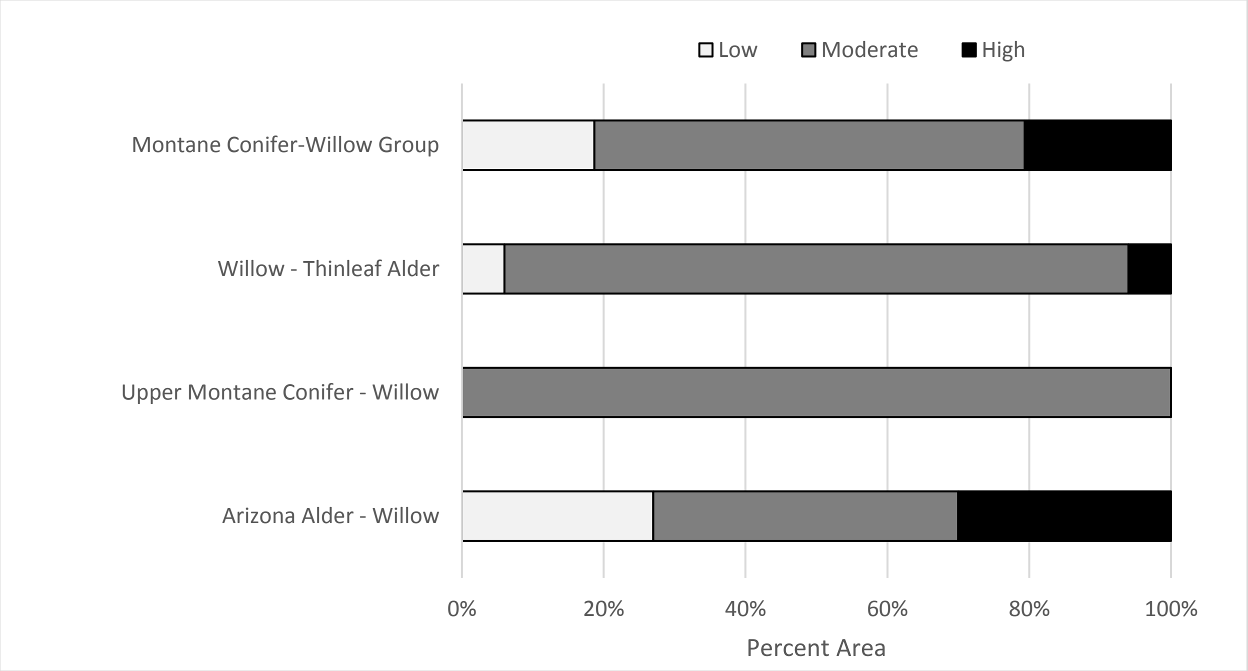

Figure 134. Plan area ecological status departure for the montane conifer willow group and its individual ERUs

Based solely on the TEUI information, all ERUs in this group are moderately departed in terms of ecological status, with the moderate departure category representing the largest percentage of each ERU area. However, with 77 percent of the Willow-Thinleaf Alder and 66 percent of the Arizona Alder-Willow identified in the change detection (see Data and Analysis Methods) as experiencing significant loss of vegetative cover since 2011 due to post-fire flooding, the departure rating for these two ERUs is modified to high. The Upper Montane Conifer/Willow ERU, remains moderately departed overall, but is within three percent of being considered in high departure (Table 146). While regeneration of willows is a reasonable expectation, alders have not been observed as reliable re-sprouters on the Gila NF, and climatic and streamflow conditions supporting successful germination and seedling establishment do not occur every year (see System Drivers and Stressors). Ecological status departure remains moderate for the group as a whole, although it is very close to the thresholds that would place it in high departure (Table 146).

Prior to the large scale post-fire flooding that has occurred, departure in ecological status was due to fewer co-dominant riparian species, such as cottonwoods, under current conditions as opposed to reference conditions. There were also fewer willows, and less grass cover under current conditions as opposed to reference. As with the cottonwood group, Kentucky bluegrass has replaced the native riparian grasses in some places within the montane conifer/willow group, but it is present in fewer instances. Again, sweetclovers, dandelion and a few other non-native species have naturalized in these ERUs but are generally present at low levels. Noxious species documented by the TEUI at low levels in these systems include cheatgrass and saltcedar, although these tend to be present at the lower end of this ERUs elevational climatic gradient, where cottonwoods begin to increase in dominance.

Where fire impacts did not occur in these ERUs, the causal factors documented in the watershed condition classification, as discussed in the cottonwood group analysis, also apply here.

Vegetative Groundcover

The following figure (Figure 135) illustrates the variability in ecological status conditions across montane-conifer willow ERUs with representation in the draft TEUI data.

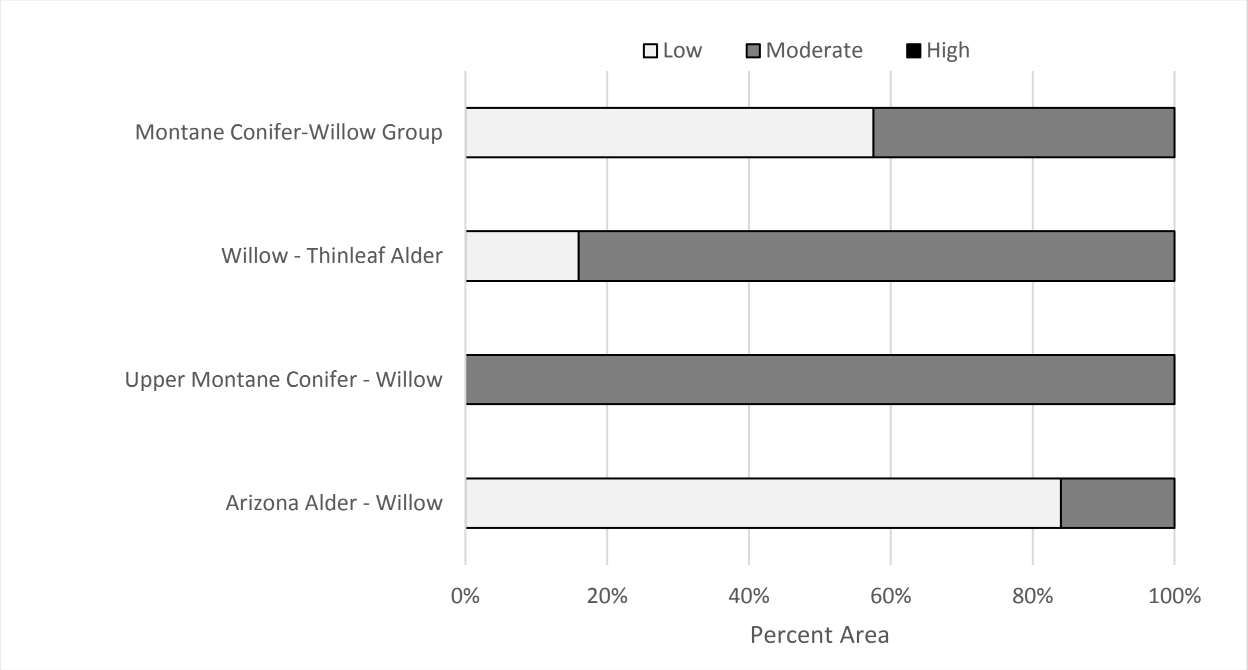

Figure 135. Plan area vegetative groundcover departure for the montane-conifer willow group and its individual ERUs

Based only on the TEUI data, vegetative groundcover is moderately departed in Willow-Thinleaf Alder and Upper Montane Conifer/Willow, with the largest percentage of their respective area being represented by the moderate departure category. Likewise, overall ERU departure in Arizona Alder-Willow is low with more than 80 percent of its area being represented by the low departure category. Because Arizona Alder-Willow makes up most of this group, the group as a whole is also in low departure. As with ecological status, these vegetative groundcover results are modified based on the change detection (see Data and Analysis Methods), moving Willow-Thinleaf Alder and Arizona Alder-Willow to high departure, and the group as a whole to high departure.

Prior to recent high and moderate burn severities in the upper watersheds and subsequent flooding, where vegetative groundcover departure occurred in these ERUs, it reflected reductions in both plant basal area and litter under current conditions. Where fire impacts did not occur in these ERUs, the causal factors documented by the watershed condition classification, as discussed in the cottonwood group analysis, also apply here.

Vegetation Condition and Function

Table 155 displays current riparian/wetland vegetation conditions for the montane conifer-willow group ERUs in terms of Functioning Properly, Functioning at Risk or Impaired Function.

Table 155. Current riparian/wetland vegetation conditions within the plan area for montane-conifer willow group ERUs

Ecological Response Unit	Percent of ERU by Subwatershed Indicator Rating		
	Functioning Properly	Functioning at Risk	Impaired Function
Arizona Alder-Willow	11	59	29
Ponderosa Pine/Willow	2	58	40
Upper Montane Conifer/Willow	25	75	0
Willow-Thinleaf Alder	<1	61	39
Area Weighted Group Total	**15**	**53**	**30**

All ERUs in this group are moderately departed for vegetation condition and function with the largest percentage of each ERU area being represented by subwatersheds with Functioning at Risk ratings. This is consistent with the seral state proportion departure results. All of the factors identified as contributing to departure in this characteristic for the cottonwood group also apply here. However, high and moderate burn severities and post-fire flooding are the primary reason for departure within the portions of these ERUs that occur within wilderness.

Channel Shape and Function

Table 156 displays current channel shape and function conditions for the montane-conifer willow group ERUs in terms of Functioning Properly, Functioning at Risk or Impaired Function.

Table 156. Channel shape and function conditions within the plan area for montane-conifer willow group ERUs

Ecological Response Unit	Percent of ERU by Subwatershed Indicator Rating		
	Functioning Properly	Functioning at Risk	Impaired Function
Arizona Alder-Willow	17	35	46
Ponderosa Pine/Willow	2	98	0
Upper Montane Conifer/Willow	29	23	48
Willow-Thinleaf Alder	<1	15	85
Area Weighted Group Total	**19**	**38**	**44**

Most ERUs in the group as a whole are highly departed with respect to channel shape and function, with the largest percentage of each ERU area being represented by subwatersheds with Impaired Function ratings. Ponderosa Pine/Willow is the exception, demonstrating moderate departure, which reflects less recent post-fire effects to channel shape and function as compared to the other ERUs. As with this characteristic in the cottonwood group, extents of high and moderate burn severity and post-fire flooding impacts, as well as roads are the primary factors contributing to departure. Extents of high and moderate burn severity and post-fire alterations to flow have the largest explanatory value for departure in the montane-conifer willow group. Roads have less explanatory value for departure where this group occurs in wilderness.

Wetland (Ciénega) Group

Figure 136. Herbaceous Riparian ERU (Photo by L.J. WhiteTrifaro)

The wetland (ciénega) group is represented by a single ERU: Herbaceous Riparian (Figure 136). This ERU covers approximately 161,391 acres within the context area. This ERU is the 2nd largest riparian ERU in the context area and the 5th largest on the Gila NF containing roughly 2,485 acres. Within the context area, it is found at nearly all elevations, ranging from 2,100 to over 12,000 feet. On the Gila NF, it is mapped at elevations between 5,880 and 9,440 feet. It supports a whole host of riparian and wetland herbaceous species depending on landscape position[34], elevation and climatic factors including but certainly not limited to: sedges (*Carex* spp.), rushes (*Schoenoplectus* spp., *Juncus* spp., *Equisetum* spp.), Rocky Mountain iris (*Iris missouriensis* Nuttall). Non-native Kentucky and Canada bluegrass (*Poa compressa* L.) have become naturalized within these systems (White 2002). This group is scattered throughout most of the context area and the Forest. Figure 137 and Figure 138 display the general locations within the context area and Gila NF.

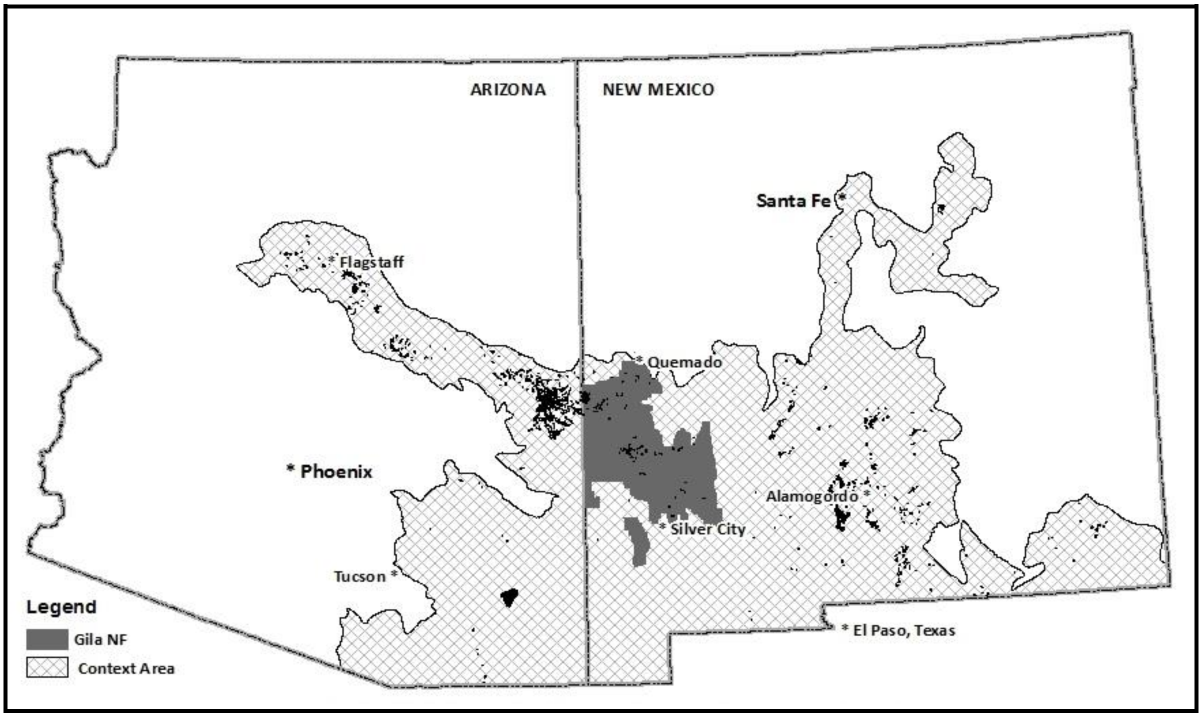

Figure 137. General location of Herbaceous Riparian ERU within the context area

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[34] Unlike the other riparian groups and ERUs, this group and ERU may occur in valley bottoms along stream corridors, or in upland positions.

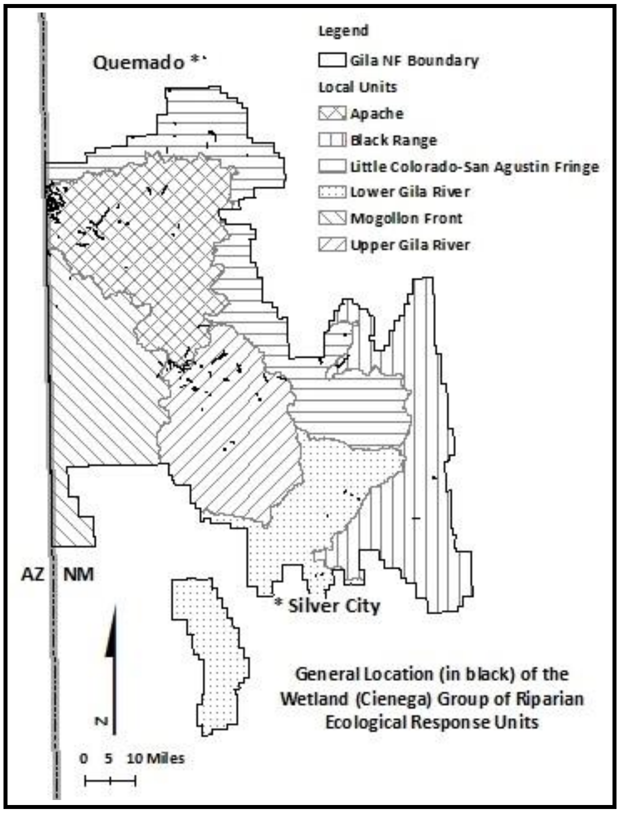


Figure 138. General location of Herbaceous-wetland riparian within the Gila NF and the six local units

Note: Local units are the polygons interior to the Forest boundary with names in callout labels

As displayed in Table 157 the majority of this ERU is located in the Apache and Upper Gila River local units.

Table 157. Local unit contributions to the Herbaceous Riparian ERU

Wetland (ciénega) Group	Gila NF Local Units												Gila NF
	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	
Herbaceous Riparian ERU	1,126	45.3	74	3.0	185	7.4	63	2.5	47	1.9	990	39.8	2,485

Spatial Niche

The Herbaceous Riparian ERU has a greater proportional representation in the context area than on the Forest (Table 158). This does not mean that the Forest has a lesser responsibility to restore and/or maintain ecological integrity in these systems, just fewer opportunities.

Table 158. Riparian ERUs represented in the wetland (ciénega) group.

Wetland (ciénega) Group	**Total ERU Area on Gila NF**			**Total ERU Area within Context Area**			**Gila NF's Contribution to Total ERU within Context Area**	
	acres	% of Gila NF	Seral state proportion % departure from reference	acres	% of Context Area	Seral state proportion % departure from reference	from Gila NF	proportional representation
Herbaceous Riparian ERU	2,485	0.08	15	161,391	0.3	7	1.5	-0.58

There are no areas in the Herbaceous Riparian that are designated or proposed critical habitat for any species. Eight percent of it is located within the Gila Wilderness, but it is also found in the Aldo Leopold Wilderness. No occurrences of this ERU are found within Wilderness Study Areas. Total riparian acres not being grazed by livestock was disclosed in the cottonwood group analysis. Exclosures are not consistently mapped in the available geospatial data, and how much of the excluded acres are represented by the Herbaceous Riparian ERU has not been quantified.

Key Characteristics

Seral State Proportion (Vegetation Structure)

Under reference conditions (Table 159) the majority of the wetland (ciénega) group was made up of a grass, forb and shrub state (seral state B, C). Currently, within the Forest there has developed a seral state dominated by trees (seral state D). The seral state successional pattern within the context area fairly closely follows the Gila NF.

Table 159. Seral state make-up of the wetland (ciénega) group ERU under reference (RC) and current conditions for both the Gila NF and context area (CA)

Seral State	**Seral State Structure, Composition and Cover Class Description‡**	**Percent Proportion**			**Similarity Values to RC†**	
		RC	current condition Gila NF	current condition context area	Gila NF	context area
A	EARLY-SERAL: Recently burned, sparsely vegetated	15	0	12	0	12
B,C	MID-SERAL: Grass/forb and all corresponding shrub types and all cover classes	85	87	81	85	81
D	Upland dominance types, and types dominated by exotic vegetation, and various *(occurs on contemporary landscapes only …)*	0	13	7	0	0
Total		100	100	100	85	93
Departure Index Rating† = 100 – ∑ similarity values: Gila NF = (100 – 85) = 15 or LOW; and Context Area = (100 – 93) = 7 or LOW						

‡ LANDFIRE 2003; USDA FS 2008a

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

† Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

At the Forest and context area scales, departure is categorized as low. At the local unit scale, departure is also low except in Mogollon Front which is associated with a high departure rating and Upper Gila River, which is associated with a moderate departure rating. Departure in seral state proportion in the Herbaceous Riparian ERU is primarily associated with the establishment and encroachment of upland species, indicating a percentage of this ERU is probably experiencing drying trends. These drying trends are most likely driven by drought, vegetative groundcover departure, and departure in channel shape and function where these systems are associated with streams. Higher departure ratings in the Mogollon Front and Upper Gila River local units are likely due historic downcutting or gully erosion resulting from less recent fire, historic overgrazing and/or the current combined grazing pressure of elk and livestock. Grazing ungulates tend to congregate in these areas due to the presence of water, amount of lush and palatable vegetation present as opposed to drier sites; this pressure reduces herbaceous canopy cover and groundcover which contributes to drying of the site and imparts a competitive advantage to some upland species, particularly woody species.

Ecological Status

Ecological status conditions described by the TEUI data in the Herbaceous Wetland ERU are evenly split between moderate (50 percent) and high departure (50 percent). Kentucky bluegrass has displaced the native riparian/wetland herbaceous community in places, and where those native species remain present, their canopy cover is lower than under reference conditions. This grass does not have the deep, dense root system that native riparian species do and does not provide for streambank or floodplain stability. Therefore, this displacement of the native species reduces channel stability where this ERU occurs along streams. Again, non-native sweetclovers and dandelion have naturalized and are present at relatively low levels. No noxious species have been documented in the TEUI data. All the factors described first in the cottonwood group analysis also apply here, with post-fire effects having less explanatory value given the information in Table 146.

Vegetative Groundcover

Vegetative groundcover departure in Herbaceous Riparian is described by this analysis method as low. However, portions of this ERU are in a gullied phase, as documented by the TEUI. This merits a closer look at the data. While the total vegetative groundcover indicates low departure, there is a large reduction in litter and a corresponding increase in basal area between the reference and current condition. This increased basal area is indicative of grass species in sod-bound growth forms. The basal area of sod-bound grasses is not as effective in maintaining site stability or productivity as grasses that are not. Productivity is also negatively impacted by the reduction in litter. In this case, the analysis methods fail to capture the actual departure in vegetative groundcover, which should be categorized as high. All the factors described first in the cottonwood group analysis also apply here. However, extents of high and moderate burn severity and post-fire is not a factor contributing to vegetative groundcover departure in this ERU or group (Table 146).

Vegetation Condition and Function

With respect to vegetation condition, nine percent of the Herbaceous Riparian ERU is represented by subwatersheds that are Functioning Properly, 88 percent Functioning at Risk and three percent Impaired Function, giving the ERU a moderate departure overall based only on the watershed condition classification information. This is not consistent with the seral state proportion departure, which is low. While this may be a demonstration of the limitations associated with applying a watershed scale dataset to the ERU scale, or the qualitative nature of the watershed scale dataset, there are other factors that may provide greater explanatory value for what appears to be a disagreement. The riparian/wetland vegetation indicator does not only consider recent burns as differentiating factors between early seral and other seral states as does the model used to assess the seral state proportion characteristics. It also provides consideration for water relationships, which is a measure of risk (see indicator rating definitions in Analysis Methods) Thus, where this ERU occurs along streams, channel downcutting, disconnection from the floodplain, altered surface-groundwater interactions, and associated alterations of species composition observed by the interdisciplinary team that conducted the classification are reflected as departure.

Channel Shape and Function

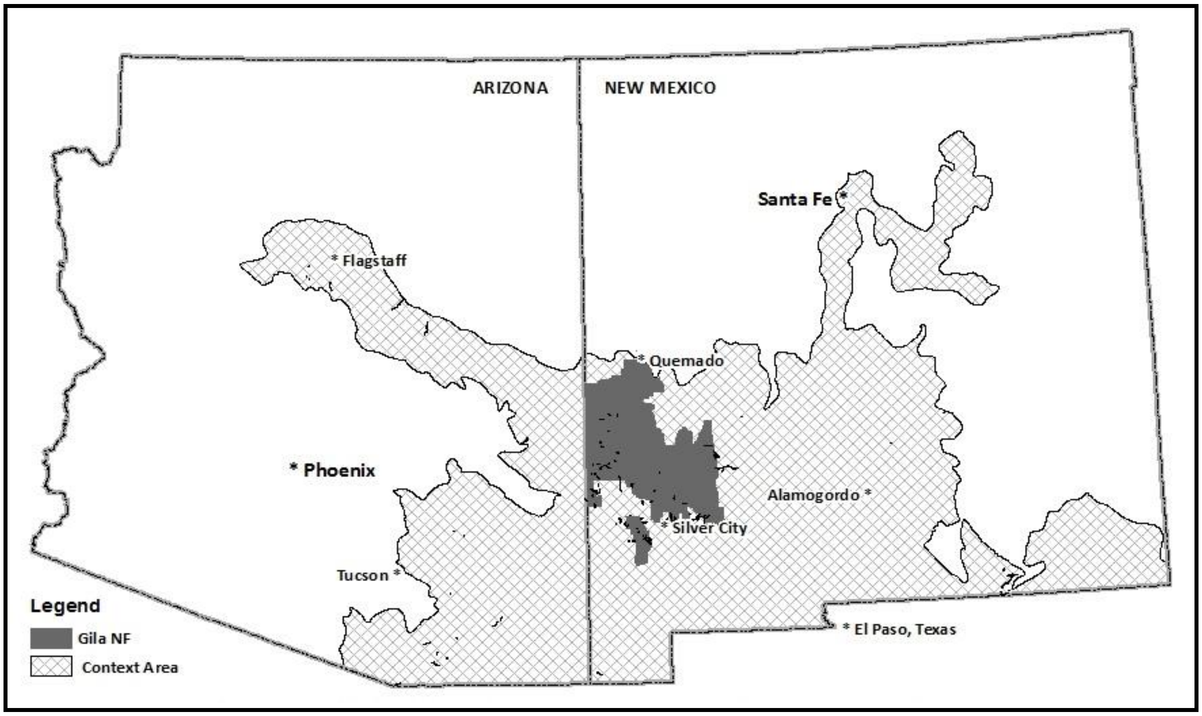
This characteristic applies only to those portions of this ERU that exist along stream corridors. Thirty eight of the Herbaceous Riparian ERU is represented by subwatersheds that are Functioning Properly, 33 percent Functioning at Risk and 30 percent Impaired Function giving this ERU a low departure rating overall. However, it is very close to the thresholds being used in this assessment. The differences between departure categories are small enough that it is likely well within the margin of error introduced by using watershed scale data at the ERU scale. No matter the departure category assigned here, there is a high degree of uncertainty. Based the displacement of native riparian/wetland species with non-native species that do not adequately provide for stream bank and floodplain stability (moderate-high ecological status departure), high vegetative groundcover departure, and notes associated with the TEUI data that identify portions of this ERU as being in a gullied phase, departure in channel shape and function is categorized as moderate to high, rather than low. Causal factors contributing to departure are those previously identified for other riparian groups, with fire and associated alterations in streamflow having the least relevance here, and historic livestock grazing having the most. Current livestock grazing may have realized improvements over historic conditions, but current livestock management and elk slow the natural rate of recovery that this system would experience without their presence.

Walnut-Evergreen Tree Group

The Walnut-Evergreen Tree Group includes the Arizona Walnut[35] (Figure 139) and Walnut/Ponderosa Pine ERUs. Arizona Walnut covers approximately 6,632 acres within the context area. This ERU is the 8th largest riparian ERU in the context area and the 7th largest on Forest, containing roughly 1,655 acres. Within the context area, it is typically found at elevations ranging from 4,000 to 8,300 feet. On the Gila NF, this ERU has been mapped between 4,160 and 8,000 feet. This highly diverse ERU occurs in dryer drainages than other riparian types and often includes species such as willows, boxelder, ponderosa pine, piñon pines, junipers, and various species of oak.

Figure 139. Arizona Walnut ERU (Photo by M. Wahlberg)

Most Arizona Walnut is located in the central and western portions of the context area, and the western and southern portions of the Forest. Figure 140 and Figure 141 display general locations within the context area and Gila NF.



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[35] RMAP includes approximately 370 acres of the Little Walnut/Ponderosa Pine ERU. However, little walnut is not known to occur on the Gila NF. Arizona walnut is the only walnut species known to occur on the Forest. These acres are included in the Arizona Walnut ERU analysis. The Little Walnut/Ponderosa Pine ERU is also lacking documentation in the Gila's draft TEUI.

Figure 140. General location of the walnut-evergreen tree group of ERUs within the context area

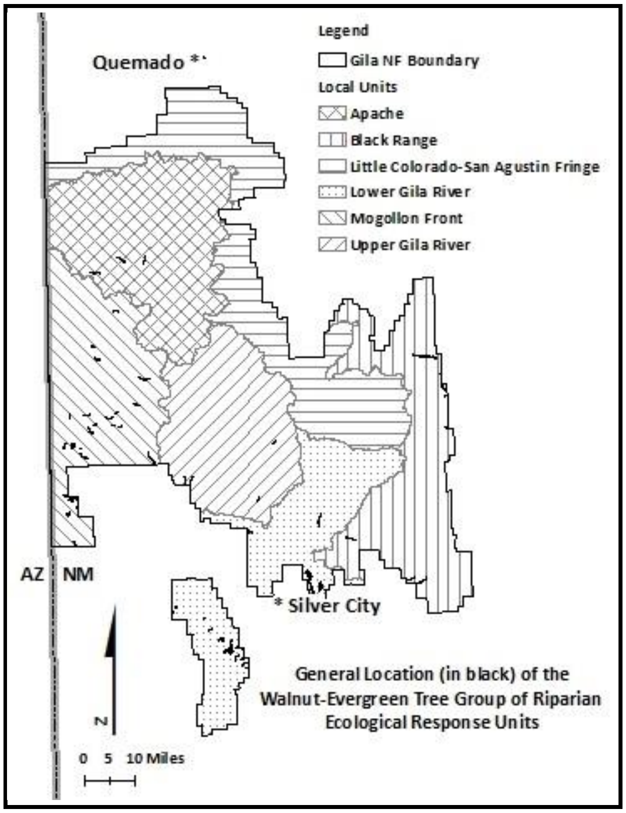

Figure 141. General location of the walnut-evergreen tree group of ERUs within the Gila NF and the six local units

Note: Local units are the polygons interior to the Forest boundary with names in callout labels

As displayed in Table 160, the majority of this ERU is located in the Lower Gila River and Mogollon Front local units.

Table 160. Local unit contributions to the walnut-evergreen tree group of ERUs

Walnut-Evergreen Tree Group	**Gila NF Local Units**												**Gila NF**
	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	
Arizona walnut ERU	125	7.6	301	18.2	0	0.0	612	37.0	523	31.6	94	5.7	1,655

Spatial Niche

The walnut-evergreen tree group of ERUs is the smallest riparian group in both the context area at 6,632 acres and Forest at 1,655 acres (Table 161). Arizona Walnut has a greater proportional representation on the Forest (0.67) than in the context area. The Gila NF has a high level of responsibility for maintaining the ecological integrity of these riparian communities.

Table 161. Riparian ERUs represented in the Arizona walnut ERU

Walnut-Evergreen Tree Group	Total ERU Area on Gila NF			Total ERU Area within Context Area			Gila NF's Contribution to Total ERU within Context Area	
	acres	% of Gila NF	Seral state proportion % departure from reference	acres	% of Context	Seral state proportion % departure from reference	from Gila NF	proportional representation
Arizona walnut ERU	1,655	0.05	49	6,632	0.01	38	25.6	0.67

Nine percent of Arizona Walnut is within designated wilderness areas with one percent occurring in the Hell Hole and Lower San Francisco Wilderness Study Areas. None of the Walnut/Ponderosa Pine occurs in designated wilderness or Wilderness Study Areas or is proposed or designated critical habitat for any species.

Key Characteristics

Seral State Proportion (Vegetation Structure)

Under reference conditions (Table 162) the majority of the walnut-evergreen tree group was made up of an understory of all size shrubs with a closed canopy and open overstory of all size trees (seral state B). These riparian communities also had a large representation of large trees with closed canopy characteristics (seral state C) as with as a good representation of shrub and tree regeneration (seral state A).

Table 162. Seral state make-up of the walnut-evergreen tree group ERU under reference (RC) and current conditions for both the Gila NF and context area

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to Reference†	
		RC	current condition			
			Gila NF	context area	Gila NF	context area
A	EARLY-SERAL: Recently burned, sparsely vegetated, all herbaceous dominance types, and < 10% tree cover and < 10% shrub cover; Native shrub dominance types, and all shrub size classes, shrub cover < 25%; Native tree dominance types, and tree 0-4.9" dbh/drc, all tree cover classes	25	38	63	25	25
B	MID-SERAL: Native shrub dominance types, and all shrub size classes, shrub cover > 25%; Native tree dominance types, and tree > 5" dbh/drc, tree cover < 25%	50	1	23	1	23
C	LATE -SERAL: Native tree dominance types, and tree > 5" dbh/drc, tree cover > 25%	25	60	15	25	25
D	Upland dominance types, and types dominated by exotic vegetation, and various *(occurs on contemporary landscapes only)*	0	0	0	0	0
Total		100	100	100	51	62

Departure Index Ratingϯ = 100 – ∑ similarity values: Gila NF = (100 – 51) = 49 or MODERATE; and Context Area = (100 – 62) = 38 or MODERATE

‡ USDA FS 2016f; LANDFIRE 2008d

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

ϯ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

At the local unit, Forest and context area scales, departure is moderate. Exceptions occur in the Mogollon Front local unit where departure is low, and in the Little Colorado-San Agustin Fringe which does not contain this riparian group. Drought and herbivory probably play the largest role in seral state departure given that most of the areas mapped in this group occur in ephemeral systems where water availability is limited, there was and is very little or no merchantable timber within or adjacent the site, and fire and post-fire impacts have been limited. While Arizona walnut is not typically palatable browse, other species that occur in this riparian group are. Past and current herbivory by wildlife and livestock may partially explain the lower incidence of mid-seral conditions where it maintains early seral conditions. Drought impacts reduce the establishment and survival of all riparian species, but may have more pronounced impacts in these systems as water is already a limiting factor. Motorized roads and trails may have less of an impact on seral state departure in these systems as opposed to others given many occur on coarse, well-drained soils leading to a natural absence of well-defined channel features and in relatively wide valley bottoms. Where any of these conditions are not met, roads and trails may have more impact on seral state departure as discussed in previous ERU group interpretations.

Ecological Status

According to the TEUI data, ecological status in the Arizona Walnut ERU is low. There is no TEUI information for the Walnut/Ponderosa Pine ERU. Kentucky bluegrass is present in some areas near the upper end of this group's elevational-climatic gradient. Native grasses tend to be present in slightly lower amounts under current conditions. Some non-natives, such as dandelion have naturalized and have been documented at low levels. No noxious weed species have been documented by the TEUI. Field observations not associated with the TEUI indicate some instances of this ERU are experiencing drought related die-off of mature Arizona walnut, with little or no regeneration of this species taking place. This is particularly true where this ERU occurs in the Burro Mountain area on the Silver City Ranger District.

Vegetative Groundcover

Vegetative groundcover departure in Arizona Walnut is low.

Vegetation Condition and Function

With respect to vegetation condition, 23 percent of the Arizona Walnut[36] ERU area is represented by subwatersheds that are Functioning Properly, 73 percent Functioning at Risk and four percent Impaired Function. Overall, departure for the walnut-evergreen tree group is moderate. This is consistent with the seral state proportion departure for the group. However, most instances of this ERU occur in watersheds where riparian and aquatic indicators received a lower weight (see Chapter 6: Water) because all or the majority of streams are ephemeral in nature.

Channel Shape and Function

With respect to channel shape and function, 20 percent of the Arizona Walnut ERU area is represented by subwatersheds that are Functioning Properly, 63 percent Functioning at Risk and 17 percent Impaired Function. Overall, departure is moderate. Again, most of these systems are associated with watersheds dominated by ephemeral channels, where channel shape and function received a lower weight in the overall classification.

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[36] While there is equivalent data in the watershed condition classification for the acres mapped as Walnut-Ponderosa Pine, their inclusion would not change departure and trend for the group because of the relatively small acreage associated with this ERU. This footnote also applies to the channel shape and function analysis.

Desert Willow Group

The desert willow group includes only one ERU (Figure 142): Desert Willow. Desert Willow covers approximately 24,331 acres within the context area. This ERU is the 5th largest riparian ERU in the context area. The Gila NF contains roughly 8,929 acres, making it the 2nd largest riparian type on the Forest, but is suspected to be over-mapped. In the context area, it is typically found at elevations ranging from 1,300 to 6,900 feet, often along ephemeral and drier reaches of interrupted alluvial channels. On the Gila NF, it is mapped between 4,320 and 6,720 feet. Other riparian species commonly found in this ERU include netleaf hackberry (*Celtis laevigata* Willd. var. *reticulata* (Torr.) L.D. Benson) and velvet mesquite (*Prosopis velutina* Wooton) although velvet mesquite is not known to occur on the Gila NF.

Figure 142. Desert Willow ERU (Photo by M. Wahlberg)

Most of this group is located in the central and southwestern portion of the context area, and the southern portion (primarily Burro Mtns.) of the Forest. Figure 143 and Figure 144 display the general locations of the DWG within the context area and Gila NF.

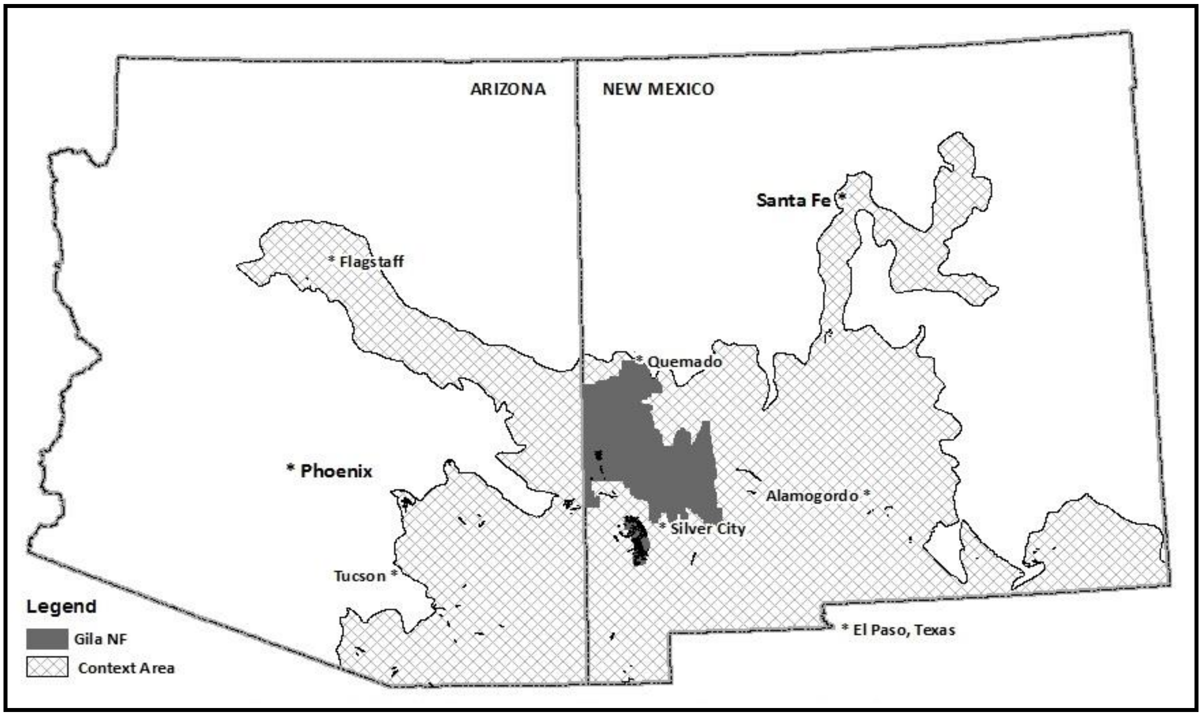

Figure 143. General location of the Desert Willow ERU within the context area

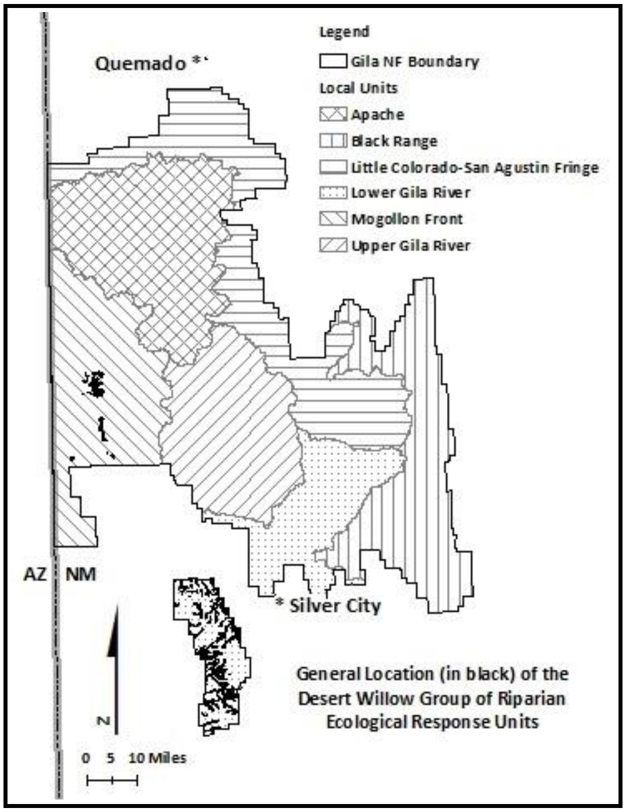

Figure 144. General location of the Desert Willow ERU within the Gila NF and the six local units
Note: Local units are the polygons interior to the Forest boundary with names in callout labels

As displayed in Table 163, this ERU only occurs in the Lower Gila River and Mogollon Front local units, with the majority occurring in Lower Gila River.

Table 163. Local unit contributions to the desert willow group of ERUs

Desert Willow Group	**Gila NF Local Units**												**Total**
	Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		
	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	
Desert Willow	0	0.0	0	0.0	0	0.0	7,331	82.1	1,598	17.9	0	0.0	8,929

Spatial Niche

The desert willow group is the 4th largest riparian group in the context area at 24,331 acres and the 2nd largest riparian group on the Forest at 8,929 acres (Table 164). As previously stated, this ERU may be overmapped on the Forest. The Desert Willow ERU has a greater proportional representation on the Forest than in the context area.

Table 164. Riparian ERUs represented in the desert willow group

Desert Willow Group ERU	Total ERU Area on Gila NF			Total ERU Area within CA			Gila NF's Contribution to Total ERU within CA	
	acres	% Gila NF	Seral state proportion % departure from reference	acres	% Context Area	Seral state proportion % departure from reference	from Gila NF	proportional representation
Desert willow	8,929	0.3	35	24,331	0.05	60	36.7	0.71

This ERU lies entirely outside of designated wilderness or Wilderness Study Areas, does not contain designated or proposed critical habitat.

Key Characteristics

Seral State Proportion (Vegetation Structure)

Under reference conditions (Table 165) the majority of the desert willow group was represented by early and mid-seral states (seral states A, B and C). Currently, within the Forest the majority seral states are C and E. Within the context area the majority state is early seral state A.

Table 165. Seral state make-up of the desert willow group under reference (RC) and current conditions for both the Gila NF and context area

Seral State	Seral State Structure, Composition and Cover Class Description‡	Percent Proportion			Similarity Values to RC†	
		RC	current condition			
			Gila NF	context area	Gila NF	context area
A	LOW-SERAL: Recently burned, sparsely vegetated, all herbaceous and shrub dominance types, and < 10% tree cover and < 10% shrub cover	20	17	77	17	20
B	MID-SERAL: Native shrub dominance types with cover 25/30-50/60% and trees < 5" dbh/drc with cover ≥ 25/30	15	13	3	13	3
C	MID-SERAL: Native shrub dominance all size classes and trees < 5" dbh/drc with cover < 25/30%	40	22	4	22	4
D	LATE-SERAL: Native tree dominance types, trees > 5" dbh/drc, and tree cover < 50/60%	20	8	8	8	8
E	LATE-SERAL: Native shrub dominance all size classes and trees ≥ 5" dbh/drc with cover ≥ 50/60%	5	40	8	5	5
F	Upland dominance types, and various types dominated by exotic vegetation (occurs on contemporary landscapes only …)	0	0	0	0	0
Total		100	100	100	65	40
Departure Index Ratingɟ = 100 – ∑ similarity values: Gila NF = (100 – 65) = 35 or MODERATE; and Context Area = (100 – 40) = 60 or MODERATE						

ǂ LANDFIRE 2005c; USDA FS 2016g

† Similarity value is the lesser of the two proportions (Gila NF to RC and Context Area to RC) for a seral state. Departure was calculated using the Czekanowski coefficient (Czekanowski 1913, as cited in Kent and Coker 1992, page 93)

ɟ Departure index ratings from RC: 0 to 33% = Low, 34 to 66% = Moderate, and 67 to 100% = High

Departure is moderate across the context area and the Forest as a whole; while departure is moderate in the Lower Gila River local unit where most of this ERU occurs, it is low in Mogollon Front. Causal factors of departure are similar to those discussed in the walnut-evergreen tree group.

Ecological Status

Ecological status departure in Desert Willow is moderate. The TEUI documents less desert willow, Apache plume, netleaf hackberry and perennial grass species canopy cover under current conditions as opposed to reference, with an increase in oak and shrub species. This ERU is strictly associated with ephemeral channels at the lower end of the Forest's elevational-climatic gradient in the Lower Gila and Mogollon Front local units. Although the vegetation present in this ERU is adapted to drier conditions, field observations not associated with the TEUI indicate recent years of drought have contributed to poor vigor and death in some instances.

Vegetative Groundcover

According to the TEUI data, vegetative groundcover departure in the Desert Willow is low

Vegetation Condition and Function

With respect to vegetation condition and function, 26 percent of subwatersheds containing Desert Willow are Functioning Properly, 61 percent Functioning at Risk and 13 percent Impaired Function. Overall, there is moderate departure which is consistent with the Forest scale seral state proportion analysis and also a reflection of ecological status departure.

Channel Shape and Function

With respect to channel shape and function, 13 percent of subwatersheds containing Desert Willow are Functioning Properly, 71 percent Functioning at Risk and 16 percent Impaired Function. Using the watershed condition classification, departure is moderate. That said, this truly does represent the limitations of using a watershed scale dataset at the ERU scale. Desert Willow depends mainly on subsurface water and is associated with ephemeral channels, which tend to be wide, open, sandy washes. These washes have poorly defined and naturally unstable banks, and transport relatively large volumes of sediment. Although many of these washes contain roads, or have been used for off-road vehicle travel, impacts to channel shape and function are minimal given the natural instability of the streambed and bank material. In reality, channel shape and function departure is low.

Large Woody Debris

Large woody debris (LWD) is important for creating habitat in streams. Large wood influences channel shape and function, creates pools and waterfalls and affects channel width and depth. Many aquatic species use pools formed by large wood as habitat and for cover. These pools are particularly important in semi-arid regions, such as the Southwest, as they provide refugia for aquatic species during periods of low streamflow. The presence of large wood in streams contributes to slowing flood waters and affects patterns of transport and deposition of sediment and nutrients. LWD in the riparian zone also provides habitat for mammals, birds, reptiles, amphibians and insects. It is important to the cottonwood group, however, LWD does not carry the same degree of importance in all riparian and stream systems.

The LWD rating is associated with aquatic and riparian systems that evolved with wood near the streams and reflects the presence and continued recruitment of LWD at near natural rates. Subwatersheds rated as Functioning at Risk may still have LWD present, but it is not being recruited at natural rates due to riparian management activities. Impaired Function rating should contain wood, but no longer does resulting in poor riparian and aquatic conditions (Potyondy and Geier 2011). Because a LWD attribute rating was not considered applicable in more than 90 percent of subwatersheds, this ecosystem characteristic is analyzed for overall riparian acres, excluding the Herbaceous Riparian ERU, which did not evolve with wood near the streams. On an area weighted basis, approximately 63 percent of the Forest's riparian areas, in which large woody debris is an important component of riparian function, are rated Functioning Properly and 37 percent are Functioning at Risk. There are no Impaired Function ratings. This characteristic is considered to be in low departure overall.

Flood Frequency

Floods of varying magnitudes have occurred throughout the reference and current time periods. Floods are a natural characteristic of streamflow, and are ecologically important to the condition and function of riparian and aquatic ecosystems. Flows important for maintaining floodplains are those that overflow the channel banks and allow for soil moisture and local groundwater recharge, as well as redistribution and deposition of sediment. These flows are also important to defining channel shape. Flows important for regeneration of riparian species and maintenance of age-class diversity are those that remove older individuals and create conditions suitable for germination. Those conditions vary by species, but the timing between those flows and seed dispersal is critical. These flows also maintain the properties of the streambed material. (Gori et al. 2014; Naiman et al. 2005). Although there are other factors involved in the persistence of native fishes, natural flow regimes tend to favor native aquatic species over non-natives (Propst et al. 2008).

Peak FQ results (see Analysis Methods subsection near the beginning of this chapter) characterizing the full period of record at each gage are displayed in Table 166, which is followed by a discussion of departure and trend. Recall that flood flows are described in terms of return intervals, which describe the likelihood of a flood of a certain magnitude will occur. For example, a flood with a two year return interval has a 50 percent chance of occurring in any given year while a flood with a 100 year return interval has a one percent chance of occurring in any given year.

Table 166. Magnitude and return interval for Mogollon Creek and the San Francisco, Gila and Mimbres Rivers, entire period of record

USGS Gage Name	Period of Record	2-Year Return Interval (cfs)	5-Year Return Interval (cfs)	10-Year Return Interval (cfs)	25-Year Return Interval (cfs)	50-Year Return Interval (cfs)	100-Year Return Interval (cfs)	500-Year Return Interval (cfs)
San Francisco River near Reserve, NM	1960-2014	774	2,041	3,504	6,397	9,573	13,890	30,370
San Francisco River near Glenwood, NM	1928-2014	2,627	6,420	10,190	16,630	22,770	30,180	53,150
Mogollon Creek near Cliff, NM	1968-2014	827	2,613	4,731	8,862	13,250	18,990	39,080
Gila River near Gila, NM	1928-2014	2,062	6,194	11,240	21,700	33,500	49,790	113,100
Gila River near Redrock, NM	1931-2014	5,952	13,090	19,370	28,960	37,260	46,480	71,590
Mimbres River at Mimbres, NM	1979-2012	570	1,793	3,140	5,549	7,893	10,730	19,400

The results of the PeakFQ modeling demonstrate a decline in the magnitude of flood flows associated with all return intervals over the current time period and the subset of the current time period at San Francisco near Reserve, Mimbres and Gila near Redrock. Post-2000 flows for the two year return interval are 11 percent of reference for San Francisco at Reserve, 25 percent of reference at Mimbres and 72 percent of reference at Gila near Redrock. The 25 year return interval is 18, 24 and 77 percent of reference and the 100 year return interval is 11, 26 and 78 percent of reference for each of these gages respectively.

In contrast to these three gages, the San Francisco near Glenwood, Gila near Gila and Mogollon Creek generally demonstrate an increasing trend in the magnitude of the flows associated with all return intervals except the two-year return interval. Changes in flow for this interval are mixed, and relatively small as opposed to the 48 to 55 percent increase associated with the 25 year return interval and the 56 to 61 percent increase associated with the 100 year return interval.

These results generally support the conclusions of the streamflow analysis presented in Chapter 6: Water and may have implications for flood frequency as an ecological process. Reductions or increases in the magnitude of the flows associated with return intervals might signal a departure from the flood frequency characteristics that native riparian systems are adapted to. However, some of this is likely due to the period of record at San Francisco near Reserve, Mimbres and Mogollon Creek gages as the reference time period includes only the relatively wet 1980s but does not include the drought of the 1950s. On the other hand, the Gila River Geomorphology Study, which included a flood frequency analysis, determined that the streamflow patterns at the San Francisco near Reserve could not be explained by precipitation (England 2002).

Chapter 6: Water also includes an analysis of monthly streamflow variables which demonstrates decreases in average streamflow in the winter and spring months (December-May) and a shift to earlier and shorter periods of peak snowmelt runoff. These changes have enormous ecological implications for riparian and aquatic systems. Recruitment of important vegetative components, like cottonwood, requires spring flood events be synchronized with seed dispersal. Changes in the timing of these floods also have implications for biological processes of many aquatic organisms.

There have been significant and widespread post-fire flood events over the last few years that have impacted riparian and aquatic communities. These impacts include changes in the abundance and composition of aquatic species and riparian vegetation, as well as changes in the physical characteristics of stream channels and patterns of streamflow. In some areas, benefits have been realized as non-native fish species did not survive the flooding, while native species did. In other areas, all fish, including natives, were removed from the stream system (Chapter 6: Water).

The removal of riparian vegetation due to fire induced changes in peak flows has negative, but potentially short-term impacts to stream temperatures and aquatic habitat. The duration of these impacts will depend on successful reestablishment of riparian vegetation communities. Reestablishment of willows has been observed in many areas. Additionally, changes in the physical characteristics of stream channels may represent long term alterations in streamflow and flood frequency. Considering the compounding factor of climate change, the reestablishment of riparian communities that resemble what existed previously, may or may not occur.

Table 167 displays departure in flood frequency for the Gila NF riparian ERUs and groups.

Table 167. Departure in flood frequency for the Gila NF riparian ERUs and groups

Ecological Response Unit	Departure Category
Cottonwood Group ERUs	Moderate
Narrowleaf Cottonwood/Shrub	Moderate
Sycamore-Fremont Cottonwood	High
Fremont Cottonwood/Shrub	Moderate
Fremont Cottonwood-Oak	Moderate
Montane-Conifer Willow Group ERUs	Moderate
Arizona Alder-Willow	Moderate
Willow-Thinleaf Alder	Moderate
Ponderosa Pine/Willow	Moderate
Upper Montane Conifer/Willow	Low
Wetland (cienega) ERU	High
Herbaceous Riparian	High
Walnut-Evergreen Tree Group ERUs	Low
Arizona Walnut	Low
Walnut/Ponderosa Pine	Low
Desert Willow Group ERU	Low
Desert Willow	Low

Flood frequency departure is low in those ERUs and groups associated with ephemeral channels. The primary reason it is low for the Upper Montane Conifer/Willow is that most of this ERU is located in the Headwaters East Fork Gila River watershed (5th level) which has seen some flow alterations since the Silver Fire, but not nearly to the extent of other watersheds. For streamside occurrences of the Herbaceous Riparian ERU where they occur in the wilderness, extents of high and moderate burn severity and post-fire alterations to streamflow are responsible for departure in flood frequency. However, most of the Herbaceous Riparian ERU is located outside wilderness areas and in the Apache local unit. Here, the causal factors for departure have been discussed in the analysis of other characteristics in that ERU. Likewise, the same factors that contribute to departure of other key characteristics in the remaining ERUs also contribute to departure in flood frequency.

Riverine Wetlands

Wetlands are defined by hydrologic, soil and vegetative characteristics (Environmental Laboratory 1987). The classification system used by the US Fish and Wildlife Service's (USFWS) National Wetland Inventory broadly describes wetlands on the Gila NF as being riverine or non-riverine. Riverine wetlands are associated with active stream channels where surface water is usually present and flowing. Non-riverine wetlands may be located in upland positions, or within stream valleys where surface water may be present at times, but where groundwater and subsurface flow have greater hydrologic significance than surface water in maintaining wetland characteristics. When they occur within stream valleys, they are located between the active stream channel and adjacent terrestrial ecosystems (Cowardin et al. 1979). Riparian ERUs include riverine wetland, non-riverine wetland, and non-wetlands areas. The extent and distribution of non-riverine wetlands are analyzed as a key characteristic of ground water in Chapter 6: Water, and in the analysis of the Herbaceous Riparian ERU (wetland (ciénega) group), of which they are a component. Riverine and non-riverine wetlands are mapped by the National Wetland Inventory in all riparian ERUs and are thus included in those analyses. Table 168 provides the number of riverine and non-riverine wetland acres contained within each riparian ERU and group as mapped by the USFWS National Wetland Inventory.

Table 168. Number and percent of wetland acres on the Gila NF by riparian ERU.

Ecological Response Unit	Acres of Riverine Wetlands	Acres of Non-Riverine Wetlands	ERU Percent Wetland
Cottonwood Group ERUs			
Narrowleaf Cottonwood/Shrub	1,150	1,409	11
Sycamore-Fremont Cottonwood	823	541	21
Fremont Cottonwood/Shrub	284	69	17
Fremont Cottonwood-Oak	0	0	0
Montane-Conifer Willow Group ERUs			
Arizona Alder-Willow	130	320	14
Willow-Thinleaf Alder	47	42	4
Ponderosa Pine/Willow	25	<1	3
Upper Montane Conifer/Willow	24	3	4
Wetland (cienega) ERU			
Herbaceous Riparian	58	145	8
Walnut-Evergreen Tree Group ERUs			
Arizona Walnut	71	<1	5
Walnut/Ponderosa Pine	4	<1	1
Desert Willow Group ERU			
Desert Willow	102	4	1
Gila NF Riparian ERU Total	**2,694**	**2,534**	**5**

While the USFWS data has not been entirely ground-truthed, several site specific, detailed wetland studies have been conducted on the Gila NF along the Gila and San Francisco Rivers and provide baseline data informative for management of these important areas and the species they support. These studies include evaluation of soils, soil-water-plant relationships and/or vegetation and wildlife species inventories (Dick-Peddie et al. 1987; Kindscher et al. 2008; Felger and Kindscher 2010; Kindscher et al. 2010; Kindscher in Gori et al. 2014; Muldavin et al. 2000).

Riparian System Drivers and Stressors

Every system driver and stressor discussed within the System Drivers and Stressors chapter apply to riparian ecosystems and characteristics analyzed. Climate and streamflow are the primary system drivers. Streamflow is assessed as an ecosystem characteristic in the Chapter 6: Water. Chapter 9: System Drivers and Stressors describes the historic and current status of the other system drivers and stressors, and their relationships with riparian ecosystems. This section identifies two additional drivers and stressors that are not discussed in that chapter: soil and upland watershed condition. Riparian soil is an additional system driver. Upland watershed condition can be a system driver or stressor depending on whether or not conditions are within the natural range of variability. This section focuses on describing the influence of soil and upland watershed condition on riparian characteristics.

Riparian soils are a system driver. Streamside riparian soils tend to have greater variability across space and time than upland soils because of the influence of streamflow. Sediment, organic matter and nutrients are deposited, redistributed or removed periodically as a result of flooding. This creates a three-dimensional mosaic of soils with different physical properties (e.g. soil texture and particle size class), and therefore different hydrologic properties (e.g. water holding capacity and infiltration capacity). The hydrological properties of riparian soils are a major determiner of the potential natural community composition[37], vegetative establishment and colonization, nutrient cycling pathways, the amount and duration of water availability, streambank and channel stability, and groundwater recharge.

In general, erosion and sedimentation rates within Gila NF riparian zones are naturally greater than the rate of soil formation. This results in weakly developed soils that can also be highly productive because of the influx of nutrients and organic matter associated with floodwaters. The Herbaceous Wetland ERU is an exception to this generality as this ERU can be found in streamside environments, but also occurs as wet meadows in upland areas. Both of these environments typically produce well developed soils with considerable organic matter content. This is due to the greater natural stability of both streamside and upland occurrences of this ERU created by the dense, fibrous root systems characteristic of herbaceous riparian species. Landform and landscape position also contribute to greater natural stability of upland herbaceous wetlands.

Upland watershed condition is important to the stability, quality and abundance of riparian (and aquatic) ecosystems through its influence on the supply of sediment, water and nutrients to the streams along which riparian corridors exist (Brooks et al. 2003). It is a system driver when conditions are within the natural range of variability, and a stressor when it is outside that range. Watershed condition is analyzed as a key ecosystem characteristic in Chapter 6: Water.

Risk

Risk to the ecological integrity of riparian ecosystem characteristics analyzed in this chapter is assessed for each ERU and group using the matrix displayed in Table 169

Table 169. Because there are no data to assess trend, risk is a direct interpretation of departure. Results of this risk assessment are displayed in Table 170, with "L" meaning low risk, "M" moderate risk, "H" high risk and "ND" meaning there was insufficient data to assess departure for that characteristic in that ERU or group. While not displayed in the risk results, a moderate or greater watershed vulnerability to climate change elevates risk one category. This is the case for all Gila NF watersheds (see Chapter 9: System Drivers and Stressors).

Table 169. Risk matrix for riparian ecosystem characteristics

Departure	Trend Toward Reference	Trend Unknown or Static	Trend Away from Reference
High	Risk Addressed	High Risk	Very High Risk
Moderate	Risk Addressed	Moderate Risk	High Risk
Low	Low Risk	Low Risk	Moderate Risk

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[37] Woody riparian vegetation such as cottonwood, willow, and sycamore prefer coarse textured soils that drain relatively quickly. Herbaceous riparian vegetation, such as sedges and rushes, tolerate longer periods of saturation and are typically associated with finer textured soils that have higher soil water holding capacities and do not drain as quickly.

Table 170 . ERU and group risk by ecosystem characteristic

Ecological Response Unit and Riparian ERU Groups	Key Ecosystem Characteristic					
	Seral State Proportion	Ecological Status	Vegetative Groundcover	Vegetation Condition/ Function	Channel Shape and Function	Flood Frequency
Cottonwood Group (CWG) ERUs	M	M	M	M	M	M
Narrowleaf Cottonwood/Shrub	M	L	M	M	M	M
Sycamore-Fremont Cottonwood	M	M	M	M	M	H
Fremont Cottonwood/Shrub	M	M	M	M	M	M
Fremont Cottonwood-Oak	M	ND	ND	M	M	M
Montane-Conifer Willow Group ERUs	M	H	H	M	H	M
Arizona Alder-Willow	M	H	H	M	H	M
Willow-Thinleaf Alder	M	H	H	M	H	M
Ponderosa Pine/Willow	M	ND	ND	M	M	M
Upper Montane Conifer/Willow	M	M	H	M	H	M
Wetland (cienega) Group ERU						
Herbaceous Riparian	L	M-H	H	M	M-H	H
Walnut-Evergreen Tree Group ERUs	M	L	L	M	M	L
Arizona Walnut	M	L	L	M	M	L
Walnut/Ponderosa Pine	M	ND	ND	M	M	L
Desert Willow Group ERU						
Desert Willow	M	M	L	M	L	L

At the ERU and group scale, very few riparian systems and characteristics are within what is known about the natural range of variation; departure, and therefore risk, tend to be higher in higher elevation systems where fire related impacts have been greatest and where herbaceous riparian vegetation potential dominates and historic and current grazing impacts are greatest. Seral state proportion is the only ecosystem characteristic analysis that relies on data that can and did assess departure directly at the local unit scale. Seral state proportion risk for the local units and the Forest as a whole are assessing the same risk matrix used for the ERU and groups (Table 169). “None” indicates that particular ERU does not occur within that particular local unit. These results are displayed in the table below (Table 171).

Table 171. Seral state proportion risk by local unit

Local Unit and Key Ecosystem Characteristic	Risk Rating				
	Cottonwood Group	Montane - Conifer Willow Group	Wetland (Ciénega) Group	Walnut-Evergreen Tree Group	Desert Willow Group
Apache	M	M	L	M	None
Little Colorado-San Agustin Fringe	M	M	L	None	None
Mogollon Front	M	M	H	L	L
Black Range	M	M	M	M	None
Upper Gila River	M	M	M	M	None
Lower Gila River	M	M	L	M	M
Gila NF	M	M	L	M	M

There is no pattern in risk associated with seral state proportion at the local unit scale for cottonwood group or montane conifer-willow group ERUs. For the wetland-ciénega group, risk tends to be lower where there are fewer occurrences of Herbaceous Riparian with the exception of the Mogollon Front local unit which has a relatively few acres and the highest risk. Determining why these 47 acres (Table 138) are at higher seral state proportion departure and risk than those acres contained in other local units requires site specific investigation. However, factors contributing to risk in all local units are the same as those contributing to departure, as discussed previously.

For the remaining characteristics, risk is assessed using the same matrix (Table 169) and displayed by the percent of each local unit and the Forest within each risk category. These results are displayed in the table below (Table 172).

Table 172. Local unit and Forest risk for ecosystem characteristics other than seral state proportion

Ecosystem Characteristic	Local Unit and Percent in each Risk Category (L=Low, M=Moderate, H=High)																				
	Apache			Little Colorado Headwaters-San Agustin Fringe			Mogollon Front			Black Range			Upper Gila River			Lower Gila River			Gila NF		
	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Ecological Status	56	6	24	88	7	4	29	62	7	82	13	5	40	19	41	28	67	3	48	39	12
Vegetative Groundcover	<1	60	24	0	96	4	22	70	7	4	91	5	1	57	41	59	35	3	19	67	12
Vegetation Condition/ Function	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0
Channel Shape and Function	0	76	24	0	86	14	16	76	8	0	95	5	0	58	42	57	39	4	17	71	13
Flood Frequency	35	36	29	56	19	25	27	36	38	49	11	40	0	100	0	44	55	1	34	50	19
Large Woody Debris	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	63	37	0

Note: Where percentages to not equal 100 is indicative of an ERU that did not have data to describe that particular characteristic

Because direct analysis of local unit departure and risk is not supported by the nature of the datasets available to assess the key characteristics listed in Table 152, the relative occurrence of ERUs and groups within each local unit retains the primarily explanatory value for observed patterns associated with these characteristics, rather than of management differences between local units. Most risk is moderate at the Forest scale with the exception of low risk associated with ecological status and large woody debris. Factors contributing to risk are the same as those contributing to departure, as discussed previously. A watershed vulnerability to climate change of moderate or greater, which is the case for all riparian ERUs, raises the degree of risk associated with each characteristic to the next highest category.

Stakeholder Input

Riparian resources area of great concern to the Gila NF and the public. Community members hold diverse perceptions of what healthy riparian systems should be like, but is largely united in their belief that the Forest is neglecting and/or mismanaging these areas. Most of the public input received during the assessment on the riparian topic was focused on livestock grazing effects, although some are concerned about negative impacts resulting from roads, recreation, fire, poor upland watershed conditions, streamflow diversions and other constructed features along streams that support riparian communities. Salt cedar is also a concern.

There are those that believe that our riparian areas have been damaged by the exclusion of livestock and are concerned that overgrown vegetation negatively effects the ability of water to move downstream and the ability of wildlife to navigate along the stream corridor. They have observed a decrease in species diversity, reduced aesthetics, and an increase of fire danger. Some believe that excluding riparian areas from livestock is not justified, scientifically or otherwise. Others point to the ability of sound grazing practices to invigorate riparian vegetation.

On the other hand, there are those that believe all riparian areas should be excluded from livestock grazing and motorized travel because these activities reduce ecological and aesthetic values. They have observed an improvement in riparian areas that have been excluded. However, some believe the Gila NF has been negligent in riparian monitoring, maintaining exclosures and enforcing the rules. Others recognize a connection between upland watershed management and riparian conditions, but do not believe that the Forest adequately recognizes this connection. Setbacks related to post-fire effects, climate change and related changes in streamflow have been observed. There is also concern about negative impacts to riparian communities resulting from an Arizona Water Settlement Act diversion, including the loss of the natural flooding regime.

After the release of the draft assessment, the Forest received additional input, feedback and comments related to riparian ecosystems, many of which were similar to those received early in the assessment process. Some stakeholders provided new ideas for managing or monitoring these ecosystems with suggestions of pursuing additional land acquisitions as a means to protect riparian ecosystems, the use of repeat photography as a simple, effective monitoring protocol, and placing greater emphasis on the habitat requirements of birds with respect to managing riparian vegetation communities. A few expressed concern about exclosures not being consistently mapped or quantified in the geospatial data and wanted to know why not. Some wanted to know what data drove the decisions to exclude these areas; if or how the effects of restoration were being measured, particularly in terms of rare plant species; what quantitative data was used to support watershed condition classification indicator ratings; and if assessments of riverine wetlands health and function and/or restoration needs had been conducted. Others wanted to know more about non-native, invasive and noxious species in the Forest’s riparian areas, including where they came from, or did not feel there was adequate discussion regarding these species in this chapter. One individual’s comments on this chapter included wanting to know what the Forest is doing to control mosquitoes associated with berms and other water storage structures.

Data Gaps

Despite the ecological importance of riparian areas, the Forest has relatively little quantitative, field based inventory and/or monitoring data related to key ecosystem characteristics of riparian. Such monitoring data could better inform management of these areas and provide a means for evaluating whether management is contributing to ecological integrity and sustainability, or not.

Summary

This assessment reviews the best available information at watershed, ERU, and Forest levels, as well as the broader landscape, to assess the ecological integrity of the Forest's riparian resources under current Forest Plan direction. Ecosystem integrity was assessed by evaluating key characteristics including: seral state proportion (vegetation structure), ecological status (vegetation composition), vegetation condition (function), vegetative groundcover (function), channel shape and function (function and connectivity), large woody debris (function), and flood frequency (process).

These areas on the Gila NF are a focal point for humans, terrestrial wildlife, and livestock activities, as well as species that are obligate-dependence on wetland, riparian and aquatic habitats. Therefore, both demand and impacts are high. Under the current climatic regime and Forest management, risk to riparian ecological integrity ranges from low to high, with most characteristics being at moderate risk at most scales. Primary stressors that have compromised the ecological integrity of riparian resources are altered fire regimes, upland watershed condition, as a result of high and moderate severity fire, and associated alterations in streamflow and flood frequency. Roads and trails and herbivory are also factors contributing risk.

Climate change is an emerging stressor that elevates this risk, making what was a moderate risk into a high risk. Because of the scarcity of water resources in the Southwest, the Forest has a major responsibility for management and maintenance of the ecological integrity and sustainability of these systems. Local, state and regional demand for water, coupled with climate change increases risk associated with Forest water resources, and therefore riparian ecosystems. While climatic conditions, drought and water allocation are outside the scope of Forest management, the Forest can look for opportunities to monitor climate change influences and reduce the risk to riparian ecosystems by considering the key characteristic status identified at the project level. Riparian systems that have high ecological integrity are more resistant and resilient to natural and human caused disturbances, or alterations in those disturbance regimes.

Chapter 8. At-Risk Species

Introduction

This chapter focuses on identifying federally recognized threatened, endangered, proposed, and candidate species, as well as potential species of conservation concern (SCC). Additionally, these species will be evaluated to determine conditions and trends of species and their habitat, as well as risk to persistence on the Gila NF. This chapter also documents information gaps relevant to at-risk species that may be filled through inventories, plan monitoring, or research. Other species of interest on the Gila NF, such as popular game species, are addressed in Chapter 11: Multiple Uses and their Economic Contributions.

Under the National Forest Management Act, the Forest Service is directed to:

> *"provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet multiple-use objectives, and within the multiple-use objectives of a land management plan adopted pursuant to this section [of this Act], provide, where appropriate, to the degree practicable, for steps to be taken to preserve the diversity of tree species similar to that existing in the region controlled by the plan."* (NFMA, 16 U.S.C. 1604(g)(3)(B))

To meet this objective, the 2012 Planning Rule adopts a complementary ecosystem and species- specific approach to maintaining species diversity, known as coarse-filter/fine-filter (36 CFR § 219.9). The premise behind this approach is that native species evolved and adapted within limits established by natural landforms, vegetation, and disturbance patterns prior to extensive human alteration. Therefore, maintaining or restoring ecological conditions and functions similar to those under which native species evolved, offers the best assurance against losses of biological diversity and maintains habitats for the majority of species in an area. However, for some species, this approach may not be adequate, either because the reference condition is not achievable or non-habitat risks to species viability.

The fine-filter approach recognizes that for some species, ecological condition or additional specific habitat features (key ecosystem characteristics) are required, and these may not be met by the coarse-filter approach. To determine which animal and plant species may require this approach, the Gila NF has identified federally listed threatened, endangered, proposed, and candidate species and developed a list of potential SCC that occur within the plan area. This list will be used to develop specific plan components that ensure continued species diversity in the plan area. Maintaining species that are vulnerable to decline within the Gila NF will maintain diversity on the Forest and thus, comply with the NFMA diversity requirement.

Plant and animal species are highly dependent on the function of ecosystems with specific conditions, such as local soil, air, water, aspect, elevation, precipitation, etc., which create areas favorable for particular species. The most important direct drivers of biodiversity loss and ecosystem service changes are habitat change (e.g., land use changes, physical modification of rivers, or water withdrawal from rivers), climate change, invasive species, overexploitation, and pollution (MEA 2005). This chapter builds on reference and current ecological conditions of other terrestrial and aquatic ecological resources assessed in this plan. It relies heavily on descriptions of current ecological conditions described within the terrestrial vegetation types, known as ecological response units (ERUs) (Chapter 1: Ecological Integrity and Sustainability), on the Gila NF and the Integration and Risk Assessment of these ERUs. Additional information can be found in the Upland Vegetation (Chapter 2) and Riparian Vegetation (Chapter 7) chapters of this assessment report.

Federally Recognized Species

The Endangered Species Act (Act; 16 U.S.C. Sec. 1531-1544), administered by the U.S. Fish and Wildlife Service (FWS), recognizes imperiled species and provides for their protection and recovery. Table 173 identifies the 12 federally endangered, 10 threatened, two proposed threatened species, one candidate species, and two experimental non-essential population species listed for the four counties (Catron, Grant, Hidalgo, and Sierra) of the Gila NF (USDI FWS 2016a). However, only five endangered species (Southwestern willow flycatcher, Gila chub, Loach minnow, Spikedace, and Lesser long-nosed bat), one non-essential experimental species (Mexican gray wolf), seven threatened species (Chiricahua leopard frog, Mexican spotted owl, Yellow-billed cuckoo, Chihuahua chub, Gila trout, Narrow-headed gartersnake, and Northern Mexican gartersnake), and two proposed threatened species (Headwater chub and Roundtail chub) are found within the planning area. Lesser long-nosed bat was initially not included as a species that occurred on the Gila NF. However, following the public engagement process with the release of the Draft Assessment Report, information was presented that showed the species does indeed occur within the plan area. This species is highlighted with shaded cells in the following tables and carried forward through subsequent tables in this chapter.

Seven endangered (Least tern, Gila topminnow, Rio Grande silvery minnow, Todsen's pennyroyal, Jaguar, Mexican long-nosed bat, and New Mexico meadow jumping mouse), three threatened (Beautiful shiner, Zuni fleabane, and New Mexican ridge-nosed rattlesnake), the one candidate species (Sprague's Pipit), and one experimental non-essential species (Northern Aplomado falcon) are listed for the four counties, but do not occur on the Gila NF and will not be carried forward in the assessment analysis. In the case of the Gila topminnow and beautiful shiner, these two species have been completely removed and no longer occur on the Gila NF.

Section 4 of the Endangered Species Act requires the FWS to identify and protect all lands, water, and air necessary to recover an endangered species; this is known as critical habitat. Critical habitats are areas that are needed for life processes, including space for individual and population growth and for normal behavior; cover or shelter; food, water, air; light, minerals, or other nutritional or physiological requirements; sites for breeding and rearing offspring; and habitats that are protected from disturbances or are representative of historical geographical and ecological distributions of a species. The Chiricahua leopard frog, Mexican spotted owl, southwestern willow flycatcher, Gila chub, Loach minnow, and Spikedace have final designated critical habitat, while Yellow-billed cuckoo, Narrow-headed gartersnake, and Northern Mexican gartersnake all have proposed critical habitat designated on the Gila NF. Critical habitat is described more in Chapter 13: Designated Areas.

Section 7 of the Endangered Species Act requires federal agencies to ensure actions they authorize, fund, or carry out are not likely to destroy or adversely modify designated critical habitat. Section 7 of the Act also requires that any federal agency that carries out, permits, licenses, funds, or otherwise authorizes activities that may affect a listed species must consult with the Fish and Wildlife Service to ensure that its actions are not likely to jeopardize the continued existence of any listed species.

Table 173. Federally listed threatened or endangered species listed for the four-county area (Catron, Grant, Hidalgo, and Sierra) of the Gila National Forest.

Note: An asterisk (*) denotes species carried forward as federally listed species for the Gila NF.

Common Name	Scientific Name	Federal Status	Critical Habitat on Gila NF
Amphibians and Reptiles			
Chiricahua leopard frog*	*Lithobates chiricahuensis*	Threatened	Yes
Narrow-headed gartersnake*	*Thamnophis rufipunctatus*	Threatened	Proposed
New Mexican ridge-nosed rattlesnake	*Crotalus willardi obscurus*	Threatened	No
Northern Mexican gartersnake*	*Thamnophis eques megalops*	Threatened	Proposed
Birds			
Least tern	*Sterna antillarum*	Endangered	No
Mexican spotted owl*	*Strix occidentalis lucida*	Threatened	Yes
Northern aplomado falcon	*Falco femoralis septentrionalis*	Experimental population , Non-essential	No
Southwestern willow flycatcher*	*Empidonax traillii extimus*	Endangered	Yes
Sprague's pipit	*Anthus spragueii*	Candidate	No
Western yellow-billed cuckoo*	*Coccyzus americanus occidentalis*	Threatened	Proposed
Fishes			
Beautiful shiner	*Cyprinella formosa*	Threatened	No
Chihuahua chub*	*Gila nigrescens*	Threatened	No
Gila chub*	*Gila intermedia*	Endangered	Yes
Gila topminnow	*Poeciliopsis occidentalis*	Endangered	No
Gila trout*	*Oncorhynchus gilae*	Threatened	No
Headwater chub*	*Gila nigra*	Proposed Threatened	No
Loach minnow*	*Tiaroga cobitis*	Endangered	Yes
Rio Grande silvery minnow	*Hybognathus amarus*	Endangered	No
Roundtail chub*	*Gila robusta*	Proposed Threatened	No
Spikedace*	*Meda fulgida*	Endangered	Yes

Common Name	Scientific Name	Federal Status	Critical Habitat on Gila NF
Flowering Plants			
Todsen's pennyroyal	*Hedeoma todsenii*	Endangered	No
Zuni fleabane	*Erigeron rhizomatus*	Threatened	No
Mammals			
Mexican Gray wolf*	*Canis lupus baileyi*	Experimental, Non-Essential population	No
Jaguar	*Panthera onca*	Endangered	No
Lesser long-nosed bat*	*Leptonycteris curasoae yerbabuenae*	Endangered	No
Mexican long-nosed bat	*Leptonycteris nivalis*	Endangered	No
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	Endangered	No

Potential Species of Conservation Concern

A species of conservation concern (SCC) is defined in the 2012 Planning Rule as "a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area." The guidance provided in the final directives for the 2012 planning regulations (Forest Service Handbook [FSH] 1909.12 – Land Management Planning, Chapter 10) is used to develop the SCC list for the Gila NF.

1. All potential SCCs ***must meet*** the following mandatory requirements for their identification as SCC:
    - The species is native to, and known to occur in, the plan area. A species is known to occur in a plan area if, at the time of plan development, the best available scientific information indicates that a species is established or is becoming established in the plan area.
    - The best available scientific information about the species indicates substantial concern about the species' capability to persist over the long term in the plan area. See FSH 1909.12, zero code, section 07, for guidance on best available scientific information.
2. A species ***should not*** be identified as a potential SCC if:
    - The species is secure and its continued long-term persistence in the plan area is not at risk based on knowledge of its abundance, distribution, lack of threats to persistence, trends in habitat, or responses to management.
    - There is insufficient scientific information available to conclude there is a substantial concern about a species' capability to persist in the plan area over the long-term that species cannot be identified as a species of conservation concern.
    - Its occurrence is thought to be "accidental," well outside its current range. A species with an individual occurrences in a plan area that are merely "accidental" or "transient," or are well outside the species' existing range at the time of plan development, is not established or becoming established in the plan area. If the range of a species is changing so that what is becoming its "normal" range includes the plan area, an individual occurrence should not be considered transient or accidental.

Species to Consider when Identifying Potential Species of Conservation Concern

1. Species native to and known to occur in the planning area.
2. Species in the following categories must be considered:
    a. Species with status ranks of G/T1 or G/T2 on the NatureServe ranking system (see below). These species are expected to be included unless it can be demonstrated and documented that known threats for these species are not currently present or relevant in the plan area.
    b. Species that were removed within the past 5 years from the Federal list of threatened or endangered species, and other delisted species that the regulatory agency still monitors.
3. Species in the following categories should be considered:
    a. Species with status ranks of G/T3 or S1 or S2 on the NatureServe ranking system (see below).

b. Species listed as threatened or endangered by relevant States, federally recognized Tribes, or Alaska Native Corporations.

c. Species identified by Federal, State, federally recognized Tribes, or Alaska Native Corporations as a high priority for conservation

d. Species identified as species of conservation concern in adjoining National Forest System plan areas (including plan areas across regional boundaries).

e. Species that have been petitioned for Federal listing and for which a positive”90-day finding” has been made.

f. Species for which the best available scientific information indicates there is local conservation concern about the species’ capability to persist over the long-term in the plan area due to:

    i. Significant threats, caused by stressors on and off the plan area, to populations or the ecological conditions they depend upon (habitat). These threats include climate change.

    ii. Declining trends in populations or habitat in the plan area.

    iii. Restricted ranges (with corresponding narrow endemics, disjunct populations, or species at the edge of their range).

    iv. Low population numbers or restricted ecological conditions (habitat) within the plan area.

NatureServe Conservation Status Ranks

NatureServe conservation status ranks are based on a scale of one to five, ranging from critically imperiled (G1) to demonstrably secure (G5). Status is assessed and documented at three distinct geographic scales–global (G), national (N), and State/province (S). The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (Table 174). (http://www.natureserve.org/explorer/ranking.htm).

Table 174. NatureServe Ranking Descriptions

Status Rank	Status Rank Definition
1	Species is Critically Imperiled At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
2	Species is Imperiled At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
3	Species is Vulnerable At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
4	Species is Apparently Secure At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
5	Species is Secure At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
Infraspecific taxa refer to subspecies, varieties, and other designations below the level of the species. The status of infraspecific taxa (subspecies or varieties) are indicated by a T-rank following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. Migratory bird species are assigned a B or N-rank as part of their state (S) rank. B refers to "Breeding" and N refers to "Non-breeding" populations. For example, the rank of a species that is globally common but migratory and commonly only winters in the state would have a rank of G5/S1B,S4N.	

Evaluating Relevant Information for At-Risk Species

Potential species of conservation concern were evaluated and information on each species was gathered and evaluated from several sources representing the Best Available Scientific Information (BASI) to determine risk to each species. Both the Planning Rule and final directives mandate the use of BASI for each resource parameter evaluated in this assessment.

According to NatureServe (NatureServe 2015), there are more than 7,000 unique animal, plant, and fungi species found in New Mexico. In developing the Gila NF potential SCC list, species records were exported from NatureServe for all species occurring in the four counties (Catron, Grant, Hidalgo, and Sierra) in which the Gila NF occurs. Species with status ranks of G or T 1, 2, or 3 and S 1 and 2 are species that have been identified by state natural heritage programs, the U.S. Fish and Wildlife Service, the International Union for Conservation of Nature, the Canadian Wildlife Service, and others as facing possible risk of extinction. To this list, we also included:

- Species that are identified as recently delisted or have a positive 90-day finding in New Mexico by the USFWS;
- Species listed as threatened or endangered by New Mexico Department of Game and Fish (NMDGF) (BISON-M 2015) and State Forestry Division (NM EMNRD 2015a);

- Species on the Southwestern Regional Forester's Sensitive Species List (USDA FS 2013c);
- Species identified as those of greatest conservation need by the New Mexico Comprehensive Wildlife Conservation Strategy (NMDGF 2006, 2016b);
- Rare plants as identified by the New Mexico Rare Plants Technical Council (NMRPTC 1999);
- Birds of Conservation Concern List by the USFWS (USDI FWS 2015a);
- New Mexico Avian Conservation Partners Bird Conservation Plan 2.1 bird list (NMPIF 2007).

This list of approximately 1,266 species formed the initial basis of the potential SCC list within the four counties in which the Gila NF occurs, and was comprised of 332 vascular and non-vascular plants, 390 invertebrates, and 544 vertebrates, which included 20 amphibians, 54 reptiles, 54 fish, 99 mammals, and 317 birds.

The next part of the process involved removing species with rankings of G/T 4 or 5, and S 3-5 from the potential SCC list, unless the species was listed as state threatened or endangered. Then we identified which of these species actually occur on the Gila NF (FSH 1909.12, 12.52c (1)). Where possible, published location information was used to filter out species that were not reported within the Gila NF itself.

Internal databases (USDA FS 2014b), breeding bird species survey data (Shook et al. 2015), and museum databases, including Arctos Collection Management Information System (Arctos 2016), Biota Information System of New Mexico (BISON-M 2016), Breeding Bird Survey data (Sauer et al. 2014); Natural Heritage New Mexico (Natural Heritage NM 2016), NatureServe (2016), New Mexico Rare Plant Technical Council (NMRPTC 1999), Southwest Environmental Information Network (SEINet 2016) were queried for Forest-specific observations.

In addition to the databases and lists cited above, Forest Service biologists at the Gila NF Supervisor's Office and ranger districts, as well as the Southwestern Regional Office were consulted in the development of the potential SCC list. Subject matter experts were interviewed via personal communications. Staff at Natural Heritage New Mexico (R. McCollough); New Mexico Department of Game and Fish (C. Hayes, J. Dominguez, K. Rodden, M. Darr, D. Propst (retired)); New Mexico State Forestry Division state botanist (D. Roth); Western New Mexico University (R. Jennings, D. Zimmerman Emeritus Professor); U.S. Fish and Wildlife Service (M. Christman); and others were able to review internal records and databases or rely on agency specialists to further filter the list.

While compiling relevant species information, several sources of data that appeared to fill gaps in the BASI were encountered. Citizen science is a growing movement in conservation and allows volunteers to collect and submit data to online databases including eBird (eBird 2016), iNaturalist (iNaturalist 2016), and BugGuide.Net (BugGuide 2016). These resources were used where it was possible to verify observations.

For highly visible and high-interest species information (e.g. birds), reliable collections and observation data were readily available. Additionally, the current Forest Plan requires monitoring for management indicator species, Region 3 sensitive species, and federally listed species. For many other species, however, this information was simply not available. In many cases there was little known about species (life history, habitat needs, etc.), other than they occur on the Gila NF. This lack of information pertained primarily to insect species such as a mayfly (*Leucrocuta petersi*) and a notodontid moth (*Oligocentria delicata*) which were not carried forward. There were also species not carried forward since they were thought to be "vagrants", or birds that stray far outside of their expected breeding, wintering, or migrating range so that they are considered accidental, such as elegant trogon (*Trogon elegans*) and Harris's hawk (*Parabuteo unicinctus*).

From the initial 1,266 potential SCC identified for the four county area encompassing the Gila NF, and several species listed by the State of New Mexico, 95 species are reliably documented on the Gila NF and meets one or more criteria for potential SCC in the directives (Table 175).

Additionally, the Gila NF Draft Assessment Report was released in September 2016 allowing interested stakeholders to provide feedback. Numerous comments from individuals, organizations, and other government agencies were and catalogued in the project record. There were numerous species we were asked to evaluate or re-evaluate for inclusion into the SCC list. Many of these species either did not occur on Gila NF lands, do not meet criteria outlined in the directives for inclusion as an SCC, or they have previously been assessed and found not to be a SCC. There were 16 species that were not originally evaluated, and of those, five are not known to occur on the Gila NF. Two of these species (Costa's hummingbird and Neotropic cormorant) are considered accidental and were not carried forward. The other nine species have been added to the following lists, bringing the total number of species carried forward for consideration as an SCC to 104. These species, identified through public engagement, are highlighted with shaded cells in the following tables and carried forward through subsequent tables in this chapter.

Table 175. Species known to occur in the plan area and carried forward for consideration as potential species of conservation concern.

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Amphibians			
Arizona toad	*Anaxyrus microscaphus*	CN, RF, G4/S2?	Ryan et al. 2015
Birds			
Abert's Towhee	*Melozone aberti*	CN, G3G4/S1B,S1N, RF, S	Natural Heritage NM 2015, BISON-M 2016, Shook et al. 2015
American Goldfinch	*Spinus tristis*	G5/S2B,S5N	NatureServe 2016, BISON-M 2016
American Peregrine Falcon	*Falco peregrinus anatum*	CN, G4T4/S2B,S3N, RF, S	USDA FS Gila NF 2016a, Natural Heritage NM 2015
Bald Eagle	*Haliaeetus leucocephalus*	CN, G5/S1B,S4N, RF, S	USDA FS Gila NF, 2016a
Bank Swallow	*Riparia riparia*	CN, G5/S2B,S5N	BISON-M 2016
Bell's Vireo	*Vireo bellii*	CN, G5/S2B,S3N, RF, S	Natural Heritage NM 2015, Shook et al. 2015
Black Swift	*Cypseloides niger*	CN, G4/S2B,S2N	BISON-M 2016, NatureServe 2016

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[38] CN = Identified as a species of greatest conservation need in the New Mexico Comprehensive Wildlife Conservation Strategy Report; PF= Federally petitioned for listing; NatureServe Ranking - Global (G), Taxonomic (T), State (S), Breeding (B), Non-breeding (N), Not Ranked (NR), or Uncertainty on ranking (?); RF = Regional Forester's Sensitive Species List; and S = State-listed as threatened or endangered. NatureServe codes futher described in Table 174.

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Blue-throated Hummingbird	*Lampornis clemenciae*	G5/S2B,S2N	BISON-M 2016, NatureServe 2016
Brown-crested flycatcher	*Myiarchus tyrannulus*	G5/S2B, S4N	BISON-M 2016, e-Bird 2016, Shook et al. 2015
Common Blackhawk	*Buteogallus anthracinus*	CN, G4G5/S2B,S3N, RF, S	BISON-M 2016, Natural Heritage NM 2015, USDA FS Gila NF 2016a, Sauer et al. 2014
Eastern bluebird	*Sialia sialis*	G5/S2B,S2N	BISON-M 2016, NatureServe 2016
Ferruginous Hawk	*Buteo regalis*	CN, G4/S2B,S4N	BISON-M 2016
Gray Vireo	*Vireo vicinior*	CN, G5/N5/S4B, S3N, RF, S	Natural Heritage NM 2015, Sauer 2014, BISON-M 2016
Gila Woodpecker	*Melanerpes uropygialis*	CN, G5/S2B,S2N, RF, S	Natural Heritage NM 2015, NatureServe 2016, Sauer et al. 2014, Shook et al. 2015
Lewis's woodpecker	*Melanerpes lewis*	CN	BISON-M 2016
Lincoln's Sparrow	*Melospiza lincolnii*	G5/S2B,S5N	NatureServe 2016, BISON-M 2016
Marsh Wren	*Cistothorus palustris*	G5/S1B,S5N	NatureServe 2016, BISON-M 2016
Northern Goshawk	*Accipiter gentilis*	CN, G5/S2B,S3N, RF	NatureServe 2016, Natural Heritage NM 2015, USDA FS Gila NF 2016a, Shook et al. 2015
Northern Harrier	*Circus cyaneus*	CN, G5/S2B,S5N	NatureServe 2016, BISON-M 2016
Osprey	*Pandion haliaetus*	CN, G5/S2B,S4N	NatureServe 2016, BISON-M 2016
Pinyon jay	*Gymnorhinus cyanocephalus*	CN	BISON-M 2016
Ring-necked Duck	*Aythya collaris*	G5/S1B,S4N	NatureServe 2016, BISON-M 2016
Savannah Sparrow	*Passerculus sandwichensis*	G5/S2B,S5N	NatureServe 2016, BISON-M 2016

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Wilson's Phalarope	*Phalaropus tricolor*	CN, G5/S2B,S4N	NatureServe 2016, BISON-M 2016
Wilson's Warbler	*Cardellina pusilla*	G5/S2B,S4N	NatureServe 2016, BISON-M 2016
Yellow-eyed Junco	*Junco phaeonotus*	CN, G5/S2B, S2N, S	e-Bird 2016, Zimmerman pers. comm. 2016
Fish			
Desert Sucker	*Catostomus clarkii*	CN, G3G4/S2, RF	USDA FS Gila NF 2016a, Natural Heritage NM 2015, NMED SWQB 2015c, NatureServe 2016, FishNET 2015
Rio Grande cutthroat trout	*Oncorhychus clarkii virginalis*	CN, G4/T3/S2, RF	USDA FS Gila NF 2016a, Natural Heritage NM 2015, NMED SWQB 2015c, NatureServe 2016, FishNET 2015
Rio Grande sucker	*Catostomus plebeius*	CN, G3G4/S2, PF, RF	USDA FS Gila NF 2016a, Natural Heritage NM 2015, NMED SWQB 2015c, NatureServe 2016, FishNET 2015
Sonora Sucker	*Catostomus insignis*	CN, G3G4/S2, RF	USDA FS Gila NF 2016a, Natural Heritage NM 2015, NMED SWQB 2015c, NatureServe 2016, FishNET 2015
Invertebrates			
"Gila" May Fly	*Lachlania dencyanna*	CN, G1/SNR, RF	NatureServe 2016, BISON-M 2016
A Stonefly	*Capnia caryi*	CN, G1/SNR, RF	NatureServe 2016, BISON-M 2016, Bauman and Jacobi 2002
Arizona Snaketail	*Ophiogomphus arizonicus*	CN, G2G3/SNR	NatureServe 2016, BISON-M 2016, IUCN 2016

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Bearded Mountainsnail	*Oreohelix barbata*	CN, G1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Black Range Mountainsnail	*Oreohelix metcalfei acutidiscus*	CN, G2/T1/SNR, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Black Range Mountainsnail	*Oreohelix metcalfei hermosensis*	CN, G2/T1T2/SNR	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Black Range Woodlandsnail	*Ashmunella cockerelli cockerelli*	G1/T1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Cockerell Holospira Snail	*Holospira cockerelli*	CN, G1/S1	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Cross Snaggletooth	*Gastrocopta quadridens*	G2G3/S4	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Dashed Ringtail	*Erpetogomphus heterodon*	CN, G2G4/SNR, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, IUCN 2016
Dry Creek Woodlandsnail	*Ashmunella tetrodon tetrodon*	G3/T3/SNR, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Four-spotted Skipperling Skipper	*Piruna polingii*	CN, G3/SNR	Natural Heritage NM 2016, BISON-M 2016, NatureServe 2016, Zimmerman 2001
Gila Springsnail	*Pyrgulopsis gilae*	CN, G2/S2, RF, S	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, IUCN 2016, USDA FS Gila NF 2016a
Iron Creek Woodlandsnail	*Ashmunella mendax*	CN, G1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Marsh Slug Snail	*Deroceras heterura*	CN, G1G2/SNR	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Mineral Creek Mountainsnail	*Oreohelix pilsbryi*	CN, G1/S1, RF, S	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Monarch Butterfly	*Danaus plexippus plexippus*	PF, G4/T3	NatureServe 2016, USFWS 2014
Morgan Creek Mountainsnail	*Oreohelix swopei*	G1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
New Mexico Hot Springsnail	*Pyrgulopsis thermalis*	CN, G1/S1, RF, S	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, IUCN 2016, USDA FS Gila NF 2016a
Nitrocris Fritillary Butterfly	*Speyeria nokomis nitocris*	CN, G3/T3/SNR	Natural Heritage NM 2016, BISON-M 2016, NatureServe 2016, Zimmerman 2001
No Common Name Snail	*Ashmunella cockerelli argenticola*	G1/T1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
No Common Name Snail	*Ashmunella cockerelli perobtusa*	G1/T1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
No Common Name Snail	*Ashmunella tetrodon animorum*	G3/T3/S3, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
No Common Name Snail	*Ashmunella tetrodon inermis*	G3/T2/SNR, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
No Common Name Snail	*Ashmunella tetrodon mutator*	G3/T2/SNR, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
No Common Name Snail	*Oreohelix metcalfei radiata*	CN, G2/T2/SNR, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
No Common Name (Black Range mountainsnail)	*Oreohelix metcalfei concentrica*	CN, G2/SNR, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Silver Creek Woodlandsnail	*Ashmunella binneyi*	CN, G1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Sonoran Snaggletooth Snail	*Gastrocopta prototypus*	CN, G1/SNR	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Stonefly	*Taenionema jacobii*	CN, G2/SNR	NatureServe 2016, BISON-M 2016, Stewart 2009
Tiger Moth	*Alexicles aspersa*	CN, G1G2/SNR	NatureServe 2016, BISON-M 2016, Metzler 2014
Western Bumble Bee	*Bombus occidentalis occidentalis*	PF, G4/T1T3/SNR	NatureServe 2016, USDI FWS 2016b
Whitewater Creek Woodlandsnail	*Ashmunella danielsi*	G1/S1, RF	Natural Heritage NM 2015, BISON-M 2016, NatureServe 2016, Metcalfe and Smartt 1997
Plants			
Blumer’s dock	*Rumex orthoneurus*	G3/S2?	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016
Cliff Brittlebush	*Apacheria chiricahuensis*	G2/S2	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Davidson's Cliff Carrot	*Pteryxia davidsonii*	G2/S2, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Gila Thistle	*Cirsium gilense*	G3G5Q/S2, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Goodding's Bladderpod	*Lesquerella gooddingii*	G3?/S3	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Gooding's Onion	*Allium gooddingii*	G4/S1, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Greene Milkweed	*Asclepias uncialis* ssp. *uncialis*	G3G4/T2T3/S2, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Heartleaf Groundsel	*Packera cardamine (=Senecio cardamine)*	G3/S3, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Hess's Fleabane	*Erigeron hessii*	G1/S1, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Horned Spurge	*Euphorbia brachycera*	G5/S2	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Metcalfe's Groundsel	*Packera neomexicana* var. *metcalfei*	G5/T3?Q/S3?	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Metcalfe's Penstemon	*Penstemon metcalfei*	G1/S1, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Mimbres Figwort	*Scrophularia macrantha*	G2/S2, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Mogollon Clover	*Trifolium neurophyllum*	G2/S2	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Mogollon Death Camas	*Zigadenus mogollonensis*	G3/S3	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Mogollon Hawkweed	*Hieracium brevipilum (=H. fendleri* var. *mogollense)*	G4/T2?/S2?, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Mogollon Mountain Lousewort	*Pedicularis angustifolia*	G2/S2	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Mogollon Whitlowgrass (Draba)	*Draba mogollonica*	G3/S3	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Mt. Graham Beardtongue	*Penstemon deaveri*	G3?/S3?	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
New Mexican Gumweed	*Grindelia arizonica* var. *neomexicana*	G4/T3?/SNR	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
New Mexico Groundsel	*Packera quaerens*	G2/S2	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Nutrioso Milkvetch	*Astragalus nutriosensis*	G3?/SNR	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999, Isely 1998
Pinos Altos Flame Flower	*Talinum humile*	G2/S2, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Porsild's Starwort	*Stellaria porsildii*	G1/S2, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Silver Mock Orange	*Philadelphus argenteus*	G5?Q/S1?	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Threadleaf Giant-hyssop	*Agastache rupestris*	G3?/S3?	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Villous Groundcover Milkvetch	*Astragalus humistratus* var. *crispulus*	G4G5/T3?/SNR, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
White Mountain Groundsel	*Packera cynthioides*	G3?/S3?	NatureServe 2016, SEINet 2016, NMRPTC 1999
Winn Falls Fleabane	*Erigeron scopulinus*	G3?/S3?	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Wooton's Hawthorn	*Crataegus wootoniana*	G2/S2, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999

Common Name	Scientific Name	Rationale for Consideration[38]	Source(s) for Presence
Wright's Catchfly (campion)	*Silene wrightii*	G3/S2	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Wright's Dogweed	*Adenophyllum wrightii* var. *wrightii*	G1?/S1, RF	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Yellow Lady's-Slipper	*Cypripedium parviflorum* var. *pubescens*	G5/T5/S2?, RF, S	NatureServe 2016, Natural Heritage NM 2015, SEINet 2016, NMRPTC 1999
Mammals			
Arizona Gray Squirrel	*Sciurus arizonensis arizonensis*	CN, G4/S2, RF	NatureServe 2016, BISON-M 2016, Natural Heritage NM 2015
Arizona Montane Vole	*Microtus montanus arizonensis*	CN, G5/T4/S1, RF, S	NatureServe 2016, BISON-M 2016, Natural Heritage NM 2015, Frey 1995
Bighorn Sheep	*Ovis canadensis*	CN, G4/S1	NatureServe 2016, BISON-M 2016, Natural Heritage NM 2015
Gunnison's Prairie Dog (prairie population)	*Cynomys gunnisoni*	CN, G5/S2, RF	NatureServe 2016, BISON-M 2016, Natural Heritage NM 2015
Hooded Skunk	*Mephitis macroura*	G5/S2, RF	NatureServe 2016, BISON-M 2016, Natural Heritage NM 2015
Spotted Bat	*Euderma maculatum*	RF, S	NatureServe 2016, BISON-M 2016, Natural Heritage NM 2015
White-nosed Coati	*Nasua narica*	CN, G5/S2	NatureServe 2016, BISON-M, 2016, Natural Heritage NM 2015

Identify species that are at risk of persisting over the long term in the plan area.

The next step of the SCC analysis process determined which species can be removed from the potential SCC list because it is secure and its continued long-term persistence in the plan area is not at risk. Criteria for this removal step were: (1) “transient” (e.g. northern harrier) or “vagrant” (e.g. elegant trogon) species (also called “accidental” species) are species that have been documented to use the Gila NF only occasionally for foraging; (2) species inhabit areas not known to be affected by threats; (3) there is insufficient information to evaluate whether or not the species is at risk for persistence within the plan area; (4) species has a stable to upward population or habitat trend on the Gila NF; or (5) is a “game” species according to NMDGF meaning that the population is secure enough to withstand harvest, and as such its population is secure.

Based on knowledge of the species’ abundance, distribution, lack of threats to persistence, trends in habitat, or responses to management, 53 of the 104 species identified as potential SCC are secure and their continued long-term persistence in the plan area are not at risk. As such, these species are no longer considered for further analysis as potential SCCs. Table 176 lists the species removed and the rationale for removing them. More detailed rationale for each species removed from SCC consideration is provided in Appendix G.

Table 176. Potential species of conservation concern removed from further analysis, and rationale for removal

Common Name	Rationale for Removal from Potential SCC List
Birds	
Abert's towhee	Permanent resident on Gila NF (NatureServe 2016). Piñon-juniper woodlands and cottonwood group riparian ERUs in low to moderate departure, and population trend appears to be relatively stable to slightly increasing (Sauer et al. 2014).
American goldfinch	Fairly common winter resident on Gila NF (Zimmerman 2011, NatureServe 2016) with increasing population trend in New Mexico (Sauer et al. 2014).
American peregrine falcon	Relatively well-distributed across Gila NF in cliff habitat that is not likely departed from reference conditions, particularly in wilderness areas. Protected habitat through inaccessibility, and trend is relatively stable to slightly increasing (Sauer 2014).
Bald eagle	Only nesting pair on Gila NF is tolerant of campgrounds where they build their nest. Typically occur on Gila NF during winter. Population increasing in Western United States (Sauer 2014).
Bank swallow	Transient on Gila NF (Zimmerman 1995, NatureServe 2016). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing open or partly open areas, usually near flowing water (NatureServe 2016) or riparian ERUs. These ERUs are in low to moderate departure.
Bell's vireo	Distributed through the lower Gila and lower San Francisco River drainages. Protections for other threatened and endangered species habitat also benefit this species and has alleviated some threats. Trend appears stable to slightly increasing in New Mexico (Sauer 2014) and showing a significant increase on the Gila NF (Shook et al. 2015).
Black swift	Transient on Gila NF (Zimmerman 2011, NatureServe 2016). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing bare rock or cliff habitat (NatureServe 2016). Rock and cliff habitat are likely not departed from reference conditions.
Blue-throated hummingbird	Species has been found from the town of Mogollon, southeast to the Mimbres Valley and Pinos Altos (e-Bird 2016). Population trends show relatively stable to increasing (NatureServe 2016). ERUs of occurrence are in low to moderate departure except for semi-desert grassland that is highly departed. However, species commonly nests in altered habitats nesting on buildings or other structures (NatureServe 2016).
Brown-crested flycatcher	Species is fairly well distributed in the San Francisco, Gila, and Mimbres River drainages (e-Bird 2016). May occur in woodland and riparian ERUs, all of which are in low to moderate departure. Population trends show an increase in the western United States (Sauer 2014), with a significant increase in numbers on the Gila NF in the Gila Birding Area (Shook 2015).
Common Blackhawk	Relatively well-distributed in lower elevations of major river systems on the Gila NF. ERUs of occurrence are in low to moderate departure. Populations thought to be stable to increasing (NatureServe 2016, IUCN 2016, Shook and Walkup 2012).

Common Name	Rationale for Removal from Potential SCC List
Eastern bluebird	Rare winter residents on Gila NF (Zimmerman 1995). Utilizes piñon/juniper woodlands, piñon/juniper grassland, and riparian ERUs that are in low to moderate departure.
Ferruginous hawk	Uncommon transient and winter resident on the Gila NF (Zimmerman 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing open grasslands, savannahs, and open piñon/juniper woodlands, tending to avoid dense vegetation (NatureServe 2016). Grassland and woodland ERUs this species uses are in low to moderate departure, and population is increasing in New Mexico (Sauer 2014).
Gray vireo	While this species is a rare summer resident on the Gila NF (Zimmerman 2011), population trend on the Gila NF and in the region are stable to increasing (Sauer 2014). Species uses hot arid regions utilizing primarily juniper, piñon pine, and oak (NMDGF 2007) that occur within several woodland ERUs that are in low to moderate departure.
Lincoln's sparrow	Uncommon winter residents and common transients through the Gila NF (Zimmerman 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing herbaceous wetlands, riparian areas, and shrubby woodland areas (NatureServe 2016). This would include several woodland, shrubland, and riparian ERUs, all of which are in low to moderate departure. Population in New Mexico is increasing (Sauer 2014).
Marsh wren	Uncommon winter residents and common transients through the Gila NF (Zimmerman 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing herbaceous wetlands or riparian areas (NatureServe 2016). Riparian ERUs are in low to moderate departure. Populations stable to increasing in Southern Rockies/Colorado Plateau and Western United States (Sauer 2014).
Northern goshawk	Species is well-distributed across the Gila NF. Current management practices have alleviated threats from timber removal and are designed to help improve habitat. These will be carried forward in the new forest plan. Trend is stable on the Gila NF (USDA FS Gila NF 2012) and relatively stable to increasing in New Mexico (Sauer 2014).
Northern harrier	Uncommon winter residents and transients through the Gila NF (Zimmerman 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing herbaceous wetlands, grasslands, meadows, or cultivated fields (NatureServe 2016). Woodland and grassland ERUs this species would utilize are in low to moderated departure.
Osprey	No osprey nests are known on Gila NF, and they are transients to Gila National Forest (Zimmerman, 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing riparian areas near large water bodies (NatureServe 2016). Riparian ERUs are in low to moderate departure. Population increasing in Western United States (Sauer 2014).
Pinyon jay	This species is widely distributed across the Gila NF and commonly found (e-Bird 2016). This species occurs in woodlands with piñon pine, but may also occur in pine/oak woodlands as well as shrubland ERUs on the Gila NF. All of these ERUs are in low to moderate departure (Chapter 2: Upland Vegetation). This species declines in numbers have been associated with legacy actions (i.e. chaining) that is no longer practiced on the Gila NF.
Ring-necked duck	Ring-necked ducks are uncommon summer residents but fairly common transients to Gila National Forest (Zimmerman, 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing riparian areas near large water bodies (NatureServe 2016). Riparian ERUs are in low to moderate departure. Populations increasing in Western United States (Sauer 2014). This a game species and as such, the species is abundant enough to allow for take of individuals (NMDGF 2016c).

Common Name	Rationale for Removal from Potential SCC List
Savannah sparrow	Uncommon winter residents and fairly common transients through Gila National Forest (Zimmerman, 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing open woodland or grassland ERUs (NatureServe 2016). Woodland and grassland ERUs this species may use are in low to moderate departure.
Wilson's phalarope	Rare transients through the Gila NF (Zimmerman 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing riparian areas near large water bodies (NatureServe 2016). Riparian ERUs are in low to moderate departure.
Wilson's warbler	Common transients through the Gila NF (Zimmerman 1995). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing open woodland or grassland ERUs (NatureServe 2016). The species may utilize riparian or woodland ERUs that are in low to moderate departure.
Yellow-eyed junco	Species has been found in the Burro Mountains (e-Bird 2016, Zimmerman pers. comm. 2016), and it is believed to be breeding since the late 2000s. However, there is a belief by some that they may be hybrids between yellow-eyed junco and dark-eyed junco (e-Bird 2016). Species appears to be expanding its range as it was only known from the Animas and Peloncillo Mountains in the bootheel of New Mexico (BISON-M 2016). The pine-oak forest and woodland ERUs this species can occur in are in low to moderate departure.
Fish	
Desert sucker	Species is well distributed and still occurs in most streams it was present in historically in the Gila and San Francisco River drainages, even though their trend appears to be declining over the last 10 years. Third most collected fish during this study (Paroz et al. 2006). Long-term decline of 10-30% regarded as relatively stable (NatureServe 2016).
Rio Grande cutthroat trout	Animas Creek no longer has any fish species as a result of the ash flows from the 2013 Silver Fire. Rio Grande cutthroat trout will be reintroduced into the creek as soon as conditions warrant, where they were believed to occur historically
Sonora sucker	Species is well distributed and still occurs in most streams it was present in historically in the Gila and San Francisco River drainages, even though their trend appears to be declining over the last 10 years. Second most collected fish during this study (Paroz et al. 2006). Short term decline of <30% to relatively stable, and long-term decline of <30% to an increase of 25% (NatureServe 2016).
Invertebrates	
Arizona snaketail	Populations appear stable, species is reasonably widespread, and can be locally common (NatureServe 2016, IUCN 2016). Occurs in pine woodland streams with silt that provides for larval habitat where National Forest lands provide a level of protection (NatureServe 2016).
Cross snaggletooth	Little is known about distribution, abundance, and trend of this species on the Gila NF, although it has been found in the Mogollon Mountains (Metcalf and Smartt 1997). Habitat consists of forest openings consisting of calcareous bedrock (Metcalfe and Smartt 1997), which is likely not departed from reference conditions.
Dashed ringtail	May occur in clear, rocky, mountain streams or rivers (NatureServe 2016). Not enough information known about species. Unknown life history as only adult form of this species have been found, and it is unknown what the larvae look like (NatureServe 2016). Population trend is stable (IUCN 2016). Lacking information to evaluate whether or not the species is at risk for persistence.

Common Name	Rationale for Removal from Potential SCC List
Dry Creek woodlandsnail (*A.t. tetrodon*)	This species occurs in Dry Creek Canyon in the Mogollon Mountains, and occurs along creek bottoms where deciduous trees produce abundant leaf litter where snails occur under and around stones and logs (Metcalf and Smartt 1997). Habitat is intact post 2013 Whitewater Baldy Fire. Their numbers are likely stable as they have been found in the mid-1990s where they were originally described in the early 1900s, where they have likely persisted following several flooding events.
Four-spotted skipperling skipper	Unknown habitat and life history needs as it is not known what larval host plant the species uses. Species may occur in several different ERUs from narrowleaf cottonwood/shrub, ponderosa pine forest, up to spruce/fir forest. All of these ERUs are in low to moderate departure, with the exception of ponderosa pine forest that is in high departure. Species is frequently encountered in the Gila NF, although it never seems to be too common (Zimmerman 2001). Lacking information to evaluate whether or not the species is at risk for persistence as we don't know habitat requirements for persistence (larval host plant).
Mayfly	Unknown habitat and life history needs. Known from warm, medium sized rivers, occurring in rivers with silt covered rocks and sandy bottoms (NatureServe 2016). Lacking information to evaluate whether or not the species is at risk for persistence (Bednarik and Edmunds 1980).
Monarch butterfly	Not known to breed on the Gila NF and only passes through on its way, presumably to its wintering grounds (Zimmerman 2001). Flowering plants available for the monarch are abundant when they migrate through. This species is mostly observed migrating through using the Gila NF only temporarily and is not normally subject to impacts from management activities.
Notodontid moth	The species has historically been found in oak/juniper/pine woodlands (NatureServe 2016), mostly on the Coronado NF. Woodland ERUs on the Gila NF are in low to moderate departure. Unknown habitat and life history needs, and only one historic location is mentioned in Grant County with no location data. It is unknown if it occurs on Gila NF lands. Lacking information to evaluate whether or not the species is at risk for persistence (NatureServe 2016).
Mammals	
Arizona gray squirrel	Frey et al. (2008) notes that Arizona gray squirrel occupies mid-elevation riparian areas, distributed well across the Gila NF, and has experienced no expansion or contraction of their distribution. These ERUs are in low to moderate departure on the Gila NF. The NM Department of Game and Fish list gray squirrels as a game species as they don't make a distinction for Arizona gray squirrels (NMDGF 2016c). Habitat and distribution appear to be stable.
Bighorn sheep	Population trends for Rocky Mountain bighorn sheep within the Gila NF were decreasing from 2004-2012, but have been on the increase since 2013 with a large jump in the San Francisco population in 2014 (NMDGF 2016b). This species is managed as a game species (NMDGF 2016c), and as such are secure enough to be hunted.
Hooded skunk	Unprotected furbearer (NMDGF 2016c). Relatively well-distributed in several ERUs on Gila NF, and thrives in areas of human disturbance (BISON-M 2016). Population trends show increase (IUCN 2016).
Spotted bat	Fairly well-distributed on the Gila NF (Natural Heritage NM 2015). This species occupies cliff and crevice habitat and is effectively protected from most threats. Trend appears to be relatively stable (NatureServe 2016) to stable (IUCN 2016).

Common Name	Rationale for Removal from Potential SCC List
White-nosed coati	Relatively well-distributed across the Gila NF (Natural Heritage NM 2015). Threats have been alleviated through protections implemented through the State of NM where they are classified as "a protected furbearer that cannot be taken" (NMDGF 2016c). Distribution has increased on the Gila NF since 1970.
Plants	
Blumer's dock	Species is relatively well distributed across the Gila NF (SEINet 2016). Occurs near perennial springs, in unshaded meadows or along stream sides in canyons, in moist, organic soils (NatureServe 2016). Riparian ERUs that this species may occur within are in low to moderate departure. Range has expanded as plants previously thought to have been *R. occidentalis* were identified as *R. orthoneurus* (Regional Foresters Region 3 Sensitive Species List 2013). Since the species is relatively well distributed, range has been expanded, and the riparian ERUs in which this species may occur are in low to moderate departure from reference conditions, then the species is not considered to be at risk for persistence on the Gila NF.
Gila thistle	It is not threatened by prevailing land uses within its range. It is known to increase with disturbance (NMRPTC 1999) and may be increasing after the fires that have burned within known occupied sites (Roth 2016).
Gooding's bladderpod	Occurs in several different ERUs, some of which have low to moderate departure. Prevailing land uses do not threaten the species within its range. It can occupy disturbed areas, such as highway rights-of-way. Since species is relatively well distributed and habitat is quite abundant on the Gila NF, with the majority not highly departed, then the species is not considered to be at risk for persistence on the Gila NF.
Horned spurge	Little known about threats, trends, abundance, or habitat requirements for this species. It is well-distributed across the Gila NF and globally secure. Lacking information to evaluate whether or not the species is at risk for persistence. Since the species is well distributed across the Gila NF and habitat is quite abundant on the Gila NF, with the majority not highly departed, then the species is not considered to be at risk for persistence on the Gila NF
Metcalf's groundsel	Fairly well-distributed and occurs within several different ERUs. There appear to be no significant land use threats to the species or its habitat, and it is quite common within its limited range (NMRPTC 1999). There are few external threats impacting its populations and/or their habitat, and habitat is quite abundant across the Gila NF, therefore its persistence on the Forest is not considered at risk.
Mogollon whitlowgrass (Draba)	Well-distributed across Gila NF, and the habitat this species occupies essentially removes most threats. Species is well distributed across Gila NF, current land uses pose no threat to species because habitat is relatively inaccessible, and the plant is often found in large populations throughout its range, this species is not considered to be at risk for persistence on the Gila NF.
Mt. Graham beardtongue	Current land uses pose no threat to the species (NMRPTC 1999). Given that this species is fairly well distributed across Gila NF, current land uses apparently pose no threat to species, and habitat is abundant across the forest, this species is not considered to be at risk for persistence on the Gila NF.
New Mexican gumweed	Relatively well-distributed across Gila NF, can occur in many different ERUs, and trends are not known (SEINet 2016). Since species is relatively well distributed and habitat is quite abundant on the Gila NF, with the majority not highly departed, then the species is not considered to be at risk for persistence on the Gila NF.

Common Name	Rationale for Removal from Potential SCC List
Nutrioso milkvetch	Most recent description of the species by Isely (1998) does not record the species in NM. SEINet removed this species from occurrence on the Gila NF in 2017. Species is a narrow endemic to the Rio Nutrioso Drainage in AZ. Not palatable to livestock, but may be subject to weed eradication programs. No other threats known and trend is unknown. Not present on Gila NF, so removed from consideration as an SCC.
Silver mock orange	Little known about threats, trends, abundance, or specific habitat requirements for this species. It is fairly well-distributed across the Gila NF and globally secure. Since the species is fairly well distributed, and amount of acreage within ERUs it may occur in is abundant on the Gila NF, with the majority not highly departed, then the species is not considered to be at risk for persistence on the Gila NF.
Threadleaf giant-hyssop	Relatively well-distributed, no threats noted, and no authors make note of rarity of species (NMRPTC 1999). Habitat is abundant and the majority is not highly departed. Species not considered to be at risk for persistence on Gila NF.
Villous groundcover milkvetch	Fairly well-distributed, occurs within several ERUs, occurs in disturbed areas, no identified threats or trends (NMRPTC 1999). Habitat is abundant and the majority is not highly departed. Species not considered to be at risk for persistence on Gila NF.
White Mountain groundsel	Well-distributed across Gila NF, occurs within several ERUs, some of which have low to moderate departure. Prevailing land uses do not threaten the species. It can occupy disturbed areas like road cuts (NMRPTC 1999). Since the species is well distributed, prevailing land uses do not threaten the species, and habitat is quite abundant on the Gila NF, with the majority not highly departed, then the species is not considered to be at risk for persistence on the Gila NF.
Winn Falls fleabane	Well-distributed across Gila NF, populations can be locally abundant, cliff habitat effectively removes threats to this species (NMRPTC 1999) and have not likely changed from reference conditions. This species is not considered to be at risk for persistence on the Gila NF.
Wright's catchfly (campion)	The species is tied to cliff/crevice habitat. These features offer considerable protection where current land uses pose no threat to the species (NMRPTC 1999). Given that this species is fairly well distributed across Gila NF, current land uses apparently pose no threat to species because habitat is relatively inaccessible, and cliff habitat is not likely departed from reference conditions, this species is not considered to be at risk for persistence on the Gila NF.

There are 51 potential SCC with substantial concern about their capability to persist in the plan area over the long term. Gunnison's prairie dog remained on the potential SCC list as these species have concerns for persistence in the plan area; however, the concerns for persistence are due to actions or activities outside of agency control, authority, or capability (Sylvatic plague).

In summary, Table 177 lists the potential 51 SCC that are documented to occur on the Gila NF and that the best available scientific information indicates substantial concern about their capability to persist over the long term in the plan area. Information was presented during public engagement that changed the determination of the Arizona toad to being a potential species of conservation concern. Therefore, it is highlighted with shaded cells in the following tables and carried forward through subsequent tables in this chapter.

Table 177. Potential species of conservation concern for the Gila National Forest

Common Name	Scientific Name	NatureServe Ranking[39]
Amphibians		
Arizona toad	*Anaxyrus microscaphus*	G4/S2?
Birds		
Gila woodpecker	*Melanerpes uropygialis*	G5/S2B,S2N
Lewis's woodpecker	*Melanerpes lewis*	G4/S3B,S3N
Fish		
Rio Grande sucker	*Catostomus plebeius*	G3G4/S2
Invertebrates		
A Stonefly	*Capnia caryi*	G1/SNR
Bearded Mountainsnail	*Oreohelix barbata*	G1/S1
Black Range Mountainsnail	*Oreohelix metcalfei acutidiscus*	G2/T1/SNR
Black Range Mountainsnail	*Oreohelix metcalei hermosensis*	G2/T1T2/SNR
Black Range Woodlandsnail	*Ashmunella cockerelli cockerelli*	G1/T1/S1
Cockerell Holispera Snail	*Holispera cockerelli*	G1/S1
"Gila" Mayfly	*Lachlania dencyanna*	G1/SNR
Gila Springsnail	*Pyrgulopsis gilae*	G2/S2:Threatened
Iron Creek Woodlandsnail	*Ashmunella mendax*	G1/S1
Marsh Slug Snail	*Deroceras heterura*	G1G2/SNR
Mineral Creek Mountainsnail	*Oreohelix pilsbryi*	G1/S1:Threatened
Morgan Creek Mountainsnail	*Oreohelix swopei*	G1/S1
New Mexico Hot Springsnail	*Pyrgulopsis thermalis*	G1/S1:Threatened
Nitrocris Fritillary Butterfly	*Speyeria nokomis nitocris*	G3/T3/SNR
No Common Name Snail	*Ashmunella cockerelli argenticola*	G1/T1/S1
No Common Name Snail	*Ashmunella cockerelli perobtusa*	G1/T1/S1
No Common Name Snail	*Ashmunella tetrodon animorum*	G3/T3/S3
No Common Name Snail	*Ashmunella tetrodon inermis*	G3/T2/SNR
No Common Name Snail	*Ashmunella tetrodon mutator*	G3/T2/SNR
No Common Name Snail	*Oreohelix metcalfei radiata*	G2/T2/SNR
No Common Name (Black Range mountainsnail)	*Oreohelix metcalfei concentrica*	G2/SNR

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[39] NatureServe Ranking - Global (G), Taxonomic (T), State (S), Breeding (B), Non-breeding (N), Not Ranked (NR), or Uncertainty on ranking (?)

Common Name	Scientific Name	NatureServe Ranking[39]
Silver Creek Woodlandsnail	*Ashmunella binneyi*	G1/S1
Sonoran Snaggletooth Snail	*Gastrocopta prototypus*	G1/SNR
Stonefly	*Taenionema jacobii*	G2/SNR
Tiger Moth	*Alexicles aspersa*	G1G2
Western Bumble Bee	*Bombus occidentalis occidentalis*	G4/T1T3
Whitewater Creek Woodlandsnail	*Ashmunella danielsi*	G1/S1
Mammals		
Arizona montane vole	*Microtus montanus arizonensis*	G5/T4/S1:Endangered
Gunnison's prairie dog	*Cynomys gunnisoni*	G5/S2
Plants		
Cliff Brittlebrush	*Apacheria chiricahuensis*	G2/S2
Davidson's Cliff Carrot	*Pteryxia davidsonii*	G2/S2
Gooding's Onion	*Allium gooddingii*	G4/S1
Greene Milkweed	*Asclepias uncialis* ssp. *uncialis*	G3G4/T2T3/S2
Heartleaf Groundsel	*Packera cardamine (=Senecio cardamine)*	G3/S3
Hess's Fleabane	*Erigeron hessii*	G1/S1
Metcalfe's Penstemon	*Penstemon metcalfei*	G1/S1
Mimbres Figwort	*Scophularia macrantha*	G2/S2
Mogollon Clover	*Trifolium neurophyllum*	G2/S2
Mogollon Death Camas	*Zigadenus mogollonensis*	G3/S3
Mogollon Hawkweed	*Hieracium brevipilum (=H. fendleri var. mogollense)*	G4/T2?/S2?
Mogollon Mountain Lousewort	*Pedicularis angustifolia*	G2/S2
New Mexico Groundsel	*Packera quaerens*	G2/S2
Pinos Altos Flameflower	*Talinum humile*	G2/S2
Porsild's Starwort	*Stellaria porsildii*	G1/S1
Wooton's Hawthorne	*Crataegus wootoniana*	G2/S2
Wright's Dogweed	*Adenophyllum wrightii var. wrightii*	G1?/S1
Yellow Lady's-Slipper	*Cypripedium parviflorum* var. *pubescens*	G5/T5/S2?

Ecological Conditions

The next step associated the 51 remaining potential SCC (Table 177) and 15 federally listed species (Table 173) with ecological condition and key ecosystem characteristics described within ecological response units (ERUs) on the Gila NF. Vegetation is one of the primary factors that influences species diversity and abundance and is one of the more obvious habitat components influenced by management, land use, and natural disturbance. To make the species risk assessment relevant to other ecological risk assessments presented in this document, and because vegetation is such a significant habitat component for species, vegetation types and key ecosystem characteristics were categorized following ERUs, as applied in Chapter 2: Upland Vegetation and Chapter 7: Riparian. These ERUs are a stratification of ecosystem settings that are each similar in indicator plant species, succession patterns, and disturbance regimes that, in concept and resolution, are most useful to management. In other words, ERUs are the range of plant associations (USDA FS 1997), along with structure and process characteristics that would occur when natural disturbance regimes and biological processes prevail (Schussman and Smith 2006a).

A departed ERU may not contain the vegetation that would have existed under the natural range of variation (NRV) and historical disturbance regime. However, the assessment of vegetation characteristics within each ERU quantifies the current ecological conditions of each ERU. Species presence and absence on the Forest is, in many cases, directly tied to availability, current ecological condition, and key ecosystem characteristics of ERUs. Associating particular ERUs with specific species is critical for assessing future management needs. The description of current ecological condition for each ERU (see Chapter 2: Upland Vegetation and Chapter 7: Riparian) was used to discern the status of the ecological conditions on the Forest needed to recover federally listed species, conserve proposed and candidate species, and maintain viable populations of species of conservation concern.

Federally threatened, endangered, and proposed species, as well as potential SCC were associated with dominant ERU types in Table 178 below. These associations were informed by a number of different sources, including the Biota Information System of New Mexico (BISON-M 2016), the New Mexico Rare Plants Website (NMRPTC 1999), NatureServe Data Explorer (NatureServe 2015), and personal communications with ecologists, species experts, and agency biologists.

In many cases, species habitat needs were not represented solely by the overall ecological conditions of ERUs, but by more specific ecosystem characteristics required by the species (e.g., birds requiring snags or rocky outcrops for perching or nesting). In these cases, specific ecosystem characteristics were recorded and assessed separately from the ERUs (Table 180). Overall, an effort was made to associate species with ERUs (based on current ecological conditions described therein) whenever possible, because later stages of forest plan revision will center on the management of ERUs. This relationship between species and ERUs is the premise of the coarse-filter approach discussed above and appropriate management of ERUs is expected to benefit at-risk and common species. The relationship between species and key ecosystem characteristics will help to identify fine-filter approaches necessary for preserving species diversity on the Gila NF.

Table 178. Federally listed (*) and potential species of conservation concern currently known to occur in the plan area and associated ecological response unit types[40], riparian/aquatic habitats, and features[41].

[1]=Unknown habitat or life history needs

Common Name	SDG	MSG	CPGB	MMS	PJG	PJO	MPO	JUG	PPE	PPF	MCD	MCW	SFF	Riparian/ Aquatic	Feature
Amphibians and Reptiles															
Arizona toad														X	
Chiricahua leopard frog*														X	
Narrow-headed gartersnake*														X	
Northern Mexican gartersnake*														X	
Birds															
Gila woodpecker														X	X
Lewis’s woodpecker									X	X	X			X	X
Mexican spotted owl*										X	X	X	X	X	X
Southwestern willow flycatcher*														X	
Western yellow-billed cuckoo*														X	
Fish															
Chihuahua chub*														X	
Gila chub*														X	
Gila trout*														X	
Headwater chub*														X	
Loach minnow*														X	
Rio Grande sucker														X	

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[40] SDG=semi-desert grassland, MSG=montane sub-alpine grassland, CPGB=Colorado Plateau, Great Basin grassland, MMS=mountain mahogany mixed-shrubland, PJG= piñon-juniper grassland, PJO= piñon-juniper woodland, MPO=madrean pine-oak woodland, JUG=juniper grassland, PPE=ponderosa pine-evergreen oak woodland, PPF=ponderosa pine forest, MCD=mixed conifer frequent fire, MCW=mixed conifer with aspen, SFF=spruce-fir forest.

[41] Features include cliffs, talus slopes, rock scree, snags, leaf litter, and soils.

Common Name	SDG	MSG	CPGB	MMS	PJG	PJO	MPO	JUG	PPE	PPF	MCD	MCW	SFF	Riparian/ Aquatic	Feature
Roundtail chub*														X	
Spikedace*														X	
Invertebrates															
A Stonefly (*C. caryi*)[1]														X	
Bearded Mountainsnail														X	X
Black Range Mountainsnail (*O.m. acutidiscus*)															X
Black Range Mountainsnail (*O.m. hermosensis*)															X
Black Range Woodlandsnail															X
Cockerell Holospira Snail							X								X
“Gila” Mayfly (*L. dencyanna*)[1]														X	
Gila Springsnail														X	X
Iron Creek Woodlandsnail									X	X	X	X		X	X
Marsh Slug Snail															X
Mineral Creek Mountainsnail															X
Morgan Creek Mountainsnail										X	X	X			X
New Mexico Hot Springsnail														X	X
Nitrocris Fritillary Butterfly													X		
No Common Name (*A.c. argenticola*)															X
No Common Name (*A.c. pertubosa*)															X
No Common Name (*A.t. animorum*)															X
No Common Name (*A.t. inermis*)														X	X

Common Name	SDG	MSG	CPGB	MMS	PJG	PJO	MPO	JUG	PPE	PPF	MCD	MCW	SFF	Riparian/ Aquatic	Feature
No Common Name (*A.t. mutator*)														X	X
No Common Name (*O.m. radiata*)															X
No Common Name (*O.m. concentrica*)															X
Silver Creek Woodlandsnail											X	X			X
Sonoran Snaggletooth Snail														X	
Stonefly (*T. jacobii*)[1]														X	
Tiger Moth (*A. aspersa*)[1]															
Western Bumble Bee		X	X	X	X	X	X	X	X	X	X	X	X	X	
Whitewater Creek Woodlandsnail															X
Mammals															
Arizona montane vole										X	X	X		X	
Gunnison's prairie dog		X	X		X			X							
Lesser long-nosed bat*	X				X	X	X							X	X
Mexican gray wolf*		X	X	X	X	X	X	X	X	X	X	X	X		
Plants															
Cliff brittlebrush															X
Davidson's cliff carrot															X
Gooding's onion											X	X	X	X	
Greene's milkweed			X					X							X
Heartleaf groundsel												X	X		
Hess's fleabane															X
Metcalfe's penstemon														X	X

Common Name	SDG	MSG	CPGB	MMS	PJG	PJO	MPO	JUG	PPE	PPF	MCD	MCW	SFF	Riparian/ Aquatic	Feature
Mimbres figwort						X			X					X	X
Mogollon clover										X	X			X	X
Mogollon death camas												X	X		
Mogollon hawkweed										X	X	X			
Mogollon Mountain Lousewort												X	X		
New Mexico groundsel										X	X	X		X	X
Pinos Altos flame flower						X	X		X						
Porsild's starwort										X	X	X			
Wooton's hawthorn														X	
Wright's dogweed					X	X									
Yellow lady's-slipper										X	X	X			X

Grouping of Species

Species can be grouped a number of different ways that are useful for identifying broad threats to their continued existence on the Gila NF. For efficiency during the risk assessment portion of this evaluation, species were grouped according to their associated ERUs described above and presented in Table 178. This information is summarized by taxonomic group in Table 179. It is acknowledged that grouping species in this manner will not accurately capture all of their specific habitat needs, and so they have also been sorted by key ecosystem characteristics (Table 180).

Table 179. Federally listed species and potential species of conservation concern summarized by taxonomic group and their associated ERUs, riparian/aquatic habitat, and features.

ERU	Amphibs	Birds	Fish	Inverts	Mammals	Plants	Reptiles	Total
Semi-Desert Grassland (SDG)					1			
Montane Subalpine Grassland (MSG)				1	2			3
Colorado Plateau-Great Basin Grassland (CPGB)				1	2	1		4
Mountain Mahogany Mixed Shrubland (MMS)				1	1			2
Piñon-Juniper Grassland (PJG)				1	3	1		5
Piñon-Juniper Woodland (PJO)				1	2	3		6
Madrean Pine-Oak (MPO)				2	2	1		5

ERU	Amphibs	Birds	Fish	Inverts	Mammals	Plants	Reptiles	Total
Juniper Grass (JUG)				1	2	1		4
Ponderosa Pine-Evergreen Oak (PPE)		1		2	1	2		6
Ponderosa Pine Forest (PPF)		2		3	2	5		12
Mixed Conifer with Frequent Fire (MCD)		2		4	2	6		14
Mixed Conifer with Aspen (MCW)		1		4	2	8		15
Spruce-Fir Forest (SFF)		1		2	1	4		8
Riparian/Aquatics	1	5	8	11	2	6	2	35
Features (cliffs,talus,rock,tree,soil)		3		20	1	9		33

Table 180. Key ecosystem characteristics associated with federally listed species (*) and potential species of conservation concern known to currently occur in the plan area

Associated Key Ecosystem Characteristics	Associated Species
Tree features **(cavities, snags, leaves, bark, downed logs, leaf or forest litter)**	▪ Mexican spotted owl* ▪ Gila woodpecker ▪ Lewis's woodpecker ▪ No Common Name (*A.c. argenticola*) ▪ Whitewater Creek Woodlandsnail ▪ Sonoran Snaggletooth Snail ▪ Bearded Mountainsnail
Rock features **(canyons, cliffs, crevices, outcrops)**	▪ Mexican spotted owl* ▪ Lesser long-nosed bat* ▪ No Common Name (*A.c. argenticola*) ▪ Black Range Woodlandsnail ▪ No Common Name (*A.c. pertubosa*) ▪ Whitewater Creek Woodlandsnail ▪ No Common Name (*A.t. animorum*) ▪ Black Range Mountainsnail (*O.m. actutidiscus*) ▪ Black Range Mountainsnail (*O.m. hermosensis*) ▪ Mineral Creek Mountainsnail ▪ No Common Name (*O.m. concentrica*) ▪ No Common Name (*O.m. radiata*) ▪ Hess's fleabane ▪ Metcalfe's penstemon ▪ Porsild's starwort
Riparian and aquatic features **(riparian areas, springs, permanent water)**	▪ Chiricahua leopard frog* ▪ Narrow-headed gartersnake* ▪ Northern Mexican gartersnake* ▪ Mexican spotted owl* ▪ Gila woodpecker ▪ Southwestern willow flycatcher* ▪ Western yellow-billed cuckoo* ▪ Chihuahua chub* ▪ Gila chub* ▪ Gila trout* ▪ Headwater chub* ▪ Loach minnow* ▪ Rio Grande sucker ▪ Roundtail chub* ▪ Spikedace* ▪ Bearded Mountainsnail ▪ Iron Creek Woodlandsnail ▪ Gila Springsnail ▪ A Stonefly (*C. caryi*) ▪ Stonefly (*T. jacobii*) ▪ "Gila" mayfly (*L. dencyanna*) ▪ New Mexico Hot Springsnail ▪ Sonoran Snaggletooth Snail ▪ Mogollon clover ▪ New Mexico groundsel ▪ Arizona montane vole

Associated Key Ecosystem Characteristics	Associated Species
Meadows and small openings	▪ Greene Milkweed ▪ Yellow Lady's-Slipper ▪ New Mexico Groundsel ▪ Porsild's Starwort ▪ Mogollon Clover ▪ Nitrocris Fritillary Butterfly ▪ Gunnison's prairie dog ▪ Arizona montane vole
Alpine and tundra	▪ Gooding's Onion ▪ Hess's Fleabane ▪ Heartleaf Groundsel ▪ New Mexico Groundsel ▪ Mogollon Death Camas ▪ Mogollon Mountain Lousewort ▪ Nitrocris Fritillary Butterfly
Soil features (soil type, soil permeability, and soil condition)	▪ Black Range Woodlandsnail ▪ No Common Name (*A.c. pertubosa*) ▪ Whitewater Creek Woodlandsnail ▪ No Common Name (*A.t. animorum*) ▪ Black Range Mountainsnail ▪ No Common Name (*O.m. concentrica*) ▪ No Common Name (O.m. radiata) ▪ Greene Milkweed ▪ Yellow Lady's-Slipper ▪ Porsild's Starwort

During the data-gathering and risk assessment portions of this assessment, species were also grouped by individual zones within the Gila NF (local scale). This grouping is valuable in identifying where particular issues may need attention and drive Forest Plan components for some species. It is expected that this may also benefit other planning purposes; however, this scale is not as likely to drive ecological need for change (Chapter 1: Ecological Integrity and Sustainability). Table 181 displays the at-risk species summarized by taxonomic group and associated local scale.

Table 181. Federally listed, proposed, and potential species of conservation concern summarized by taxonomic group and associated local scale on the Gila National Forest

Local Scale	Amphibs	Birds	Fish	Inverts	Mammals	Plants	Reptiles	Total
Apache (AP)	2	3	4	1	2	4	1	17
Black Range (BR)	2	2	3	15	1	5	0	28
Little Colorado – San Agustin Fringe (LCSAF)	2	2	5	1	2	3	1	16
Lower Gila River (LGR)	2	5	4	5	1	4	1	22
Mogollon Front (MF)	2	3	6	3	1	10	2	27
Upper Gila River (UGR)	2	3	6	8	1	11	1	32

Federally Listed Species and Species of Conservation Concern Status

All of the federally listed species and potential SCC can be affected by the management activities authorized under the current Gila NF plan. Risk was not assessed for ERUs or other habitat factors on non-Forest Service lands. Therefore, it is not possible to state with certainty the overall risk to the species at the context scale. However, for many of these species, habitat provided on the Forest represents the majority of habitat available. Changing land use patters, habitat degradation or loss, or simply the lack of suitable habitat off of the Forest, places a particular emphasis on the Gila NF to maintain these species.

Federally Listed Species

There are 15 federally listed species within the plan area (USDI FWS 2016a) (Table 182). Although federally listed species are not to be included as a species of conservation concern (separate list), making a determination on the presence or absence of a listed species in the plan area determines whether or not that species is to be considered in the planning phase.

Table 182. Federally listed species relevant to the plan area.

Common Name	Scientific Name	Federal Status
Amphibians and Reptiles		
Chiricahua leopard frog	*Lithobates chiricahuensis*	Threatened
Narrow-headed gartersnake	*Thamnophis rufipunctatus*	Threatened
Northern Mexican gartersnake	*Thamnophis eques megalops*	Threatened
Birds		
Mexican spotted owl	*Strix occidentalis lucida*	Threatened
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Threatened
Fishes		
Chihuahua chub	*Gila nigrescens*	Threatened
Gila chub	*Gila intermedia*	Endangered
Gila trout	*Oncorhynchus gilae*	Threatened
Headwater chub	*Gila nigra*	Proposed Threatened
Loach minnow	*Tiaroga cobitis*	Endangered
Roundtail chub	*Gila robusta*	Proposed Threatened

Common Name	Scientific Name	Federal Status
Spikedace	*Meda fulgida*	Endangered
Mammals		
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	Endangered
Mexican Gray wolf	*Canis lupus baileyi*	Experimental, Non-Essential population

There are five federally endangered species occurring on the Gila NF, Southwestern willow flycatcher, Gila chub, Loach minnow, Spikedace, and Lesser long-nosed bat, seven federally threatened species, Chiricahua leopard frog, Mexican spotted owl, Yellow-billed cuckoo, Chihuahua chub, Gila trout, Narrow-headed gartersnake, and Northern Mexican gartersnake, two federally proposed species, Headwater chub and Roundtail chub, and one federally listed experimental, non-essential species, Mexican gray wolf. There are no candidate species currently present on the Gila NF.

Section 4 of the ESA requires the USFWS to identify and protect all lands, water, and air necessary to recover an endangered species; this is known as critical habitat. Critical habitat includes areas that have been determined to be needed for life processes for a species including space for individual and population growth and for normal behavior; cover or shelter; food, water, air, light, minerals, or other nutritional or physiological requirements; sites for breeding and rearing offspring; and habitats that are protected from disturbances or are representative of the historical geographical and ecological distributions of a species. The Southwestern willow flycatcher, Gila chub, Loach minnow, Spikedace, Chiricahua leopard frog, and Mexican spotted owl have designated critical habitat on the Gila NF, the Yellow-billed cuckoo, Narrow-headed gartersnake, and Northern Mexican gartersnake have proposed critical habitat on the Gila NF. No other federally listed species has designated or proposed critical habitat on the Gila NF.

Section 7 of the Endangered Species Act requires federal agencies to ensure actions they authorize, fund, or carry out are not likely to destroy or adversely modify designated critical habitat. Section 7 of the Act also requires that any federal agency that carries out, permits, licenses, funds, or otherwise authorizes activities that may affect a listed species must consult with the Fish and Wildlife Service to ensure that its actions are not likely to jeopardize the continued existence of any listed species.

Species Status

Amphibians and Reptiles

Chiricahua leopard frog (*Lithobates chiricahuensis*) is federally listed as threatened with approximately 2,488 acres of designated critical habitat on the Gila NF. In New Mexico and on the Gila National Forest, Chiricahua leopard frogs are thought to be most abundant in the Gila and San Francisco River drainages (Degenhardt et al. 1996), but they also occur in Beaver Creek (tributary to the East Fork Gila River), North Seco Creek, and in the Mimbres River drainage. Chiricahua leopard frogs prefer habitat with a variety of structure and cover, including emergent and submergent vegetation, overhanging banks and organic debris (Degenhardt et al. 1996). Although they can survive drought by burrowing in the mud, they require a perennial source of running or standing water in the form of streams, springs, stock tanks, ponds, or lakes (USDI FWS 2007a). Threats include disease particularly chytrid fungus, reduced water sources, habitat degradation through unmanaged grazing and recreation or other factors altering hydrologic function, and predation from non-native aquatic species (USDI FWS 2007a).

Narrow-headed gartersnake (*Thamnophis rufipunctatus*) is federally listed as threatened with approximately 52,430 acres of proposed critical habitat on the Gila NF. The New Mexican distribution includes the Gila and San Francisco river drainages in Catron, Grant, and Hidalgo counties, at elevations of 1,125-2,100 meters (Degenhardt et al. 1996, NMDGF 1997 as cited in NatureServe 2016). This species is regarded as one of the most aquatic of all garter snakes (Conant 1963 as cited in NatureServe 2016). It often occurs along well-lit sections of rocky streams with abundant riparian vegetation. In New Mexico, fed exclusively on fishes (NMDGF 1985 as cited in NatureServe 2016). Threats include direct predation from non-native aquatic species, competition by non-native fish, and loss of riparian habitat through unmanaged grazing and recreation.

Northern Mexican gartersnake (*Thamnophis eques megalops*) is federally listed as threatened with approximately 8,717 acres of proposed critical habitat on the Gila NF. In New Mexico, this snake is known from the lower Gila River basin, along Duck and Mule creeks in Grant County and near Virden in Hidalgo County (Hubbard and Eley 1985 as cited in NatureServe 2016). It may now be eliminated from Duck Creek (NMDGF 1997 as cited in NatureServe 2016). A record from a single locality along Mule Creek is the only recent evidence of the presence of this species in New Mexico, but the current status of that population is unknown (Center for Biological Diversity 2003 as cited in NatureServe2016). This snake is strongly associated with permanent water with vegetation, including stock tanks, ponds, lakes, cienegas, cienega streams, and riparian woods (Degenhardt et al. 1996, Manjarrez 1998). The diet includes fishes, amphibians, earthworms, leeches, and various other small animals (NatureServe 2016). Threats include loss of streams, wetlands, and riparian zones through unmanaged grazing, water diversions, decline of native fish, and predation/competition from non-native aquatic species.

Birds

Mexican spotted owl (*Strix occidentalis lucida*) is federally listed as threatened with designated critical habitat on the Gila NF of which there is approximately 1,122,802 acres. The Mexican spotted owl (MSO) inhabits mixed coniferous and pine/oak forests, canyons, desert caves, cliff faces, and riparian areas throughout the Southwest. On the Gila National Forest mixed conifer and pine-oak habitat is considered either protected or recovery habitat in the recovery plan for this species. Protected habitat are Protected Activity Centers (PAC's), and unoccupied mixed conifer and pine-oak is considered recovery habitat (USDI FWS 2012). Many timber management activities negatively affected habitat before the MSO was listed as threatened in 1995. Timber harvest, prescribed burning, and other management activities are now designed following the 2012 Mexican Spotted Owl Recovery Plan along with consultation with the USFWS. These management activities can still have disturbance affects to the Mexican spotted owl and its habitat. Threats include habitat loss due to silvicultural treatments, uncharacteristic wildfire, and increased human activities in proximity to nest/roost territories.

Southwestern willow flycatcher (*Empidonax traillii extimus*) is federally listed as endangered with approximately 1,547 acres of designated critical habitat on the Gila NF. The species has been documented in the Gila and San Francisco River drainages. Habitat includes riparian and wetland thickets, generally of willow, tamarisk, or both, sometimes boxelder or Russian olive (USDI FWS 2013). On the Gila National Forest we have had two sites that have been consistently occupied for over 10 years along the Gila River.

These two areas are in locations known as the Gila Bird Management Area (GBMA) and the Fort West ditch site. In 2008 seven territories were found at the GBMA and four territories at the Forest West ditch site (Shook 2009). In 2007 a new breeding site was discovered on the Forest along the San Francisco River (Keller Canyon site). The Keller Canyon site, located on the reach between Deep Creek and Alma Highway 180, had three flycatcher territories in 2007, 2008, and 2009. Threats include loss of riparian habitat from floods, unmanaged grazing, uncharacteristic fire, nest parasitism, and unmanaged recreation.

Yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is federally listed as threatened with approximately 1,680 acres of proposed critical habitat on the Gila NF. The western population of the yellow-billed cuckoo (*Coccyzus americanus occidentalis*), an insect-eating bird found in riparian woodland habitats, winters in South America and breeds in western North America (USDI FWS 2014). On the Gila NF it is found in the Gila and San Francisco River drainages. Threats include loss or degradation of riparian habitat, agriculture, water diversions, unmanaged grazing, uncharacteristic wildfire, and non-native plant invasion, particularly tamarisk (USDI FWS 2014).

<u>Fish</u>

Chihuahua chub (*Gila nigrescens*) is federally listed as threatened with no designated critical habitat on the Gila NF. Chihuahua chub is native to the Mimbres River drainage in New Mexico and the Guzmán and Laguna Bustillos basins in Chihuahua (Smith and Miller 1986). Specimens were first collected in the Mimbres River in 1851 (Baird and Girard 1854), but it was not again found in the Mimbres River drainage until 1975 when Rogers (1975) found a small, reproducing population in Moreno Spring. Chihuahua chub probably occupied all warmwater reaches in the Mimbres River drainage, but they now are found regularly only in Moreno Spring. They irregularly occur in about a 9.3 mile reach of the Mimbres River from the confluence of Allie Canyon downstream to the New Mexico Department of Game and Fish Mimbres Property south of Mimbres (Propst 1999). Ash-laden flows from wildfires have reduced Chihuahua chub abundance in the Mimbres River (Myers pers. comm. 2016). Threats include changes in flow regimes and stream characteristics from uncharacteristic fire in the uplands, unmanaged grazing, agricultural, water diversions, and competition/predation by non-native aquatic species.

Gila chub (*Gila intermedia*) is federally listed as endangered with approximately 764 acres of designated critical habitat on the Gila NF. Gila chub have been recorded in approximately 43 rivers, streams, and spring-fed tributaries throughout the Gila River basin in southwestern New Mexico, central and southeastern Arizona, and Northern Sonora, Mexico (Miller and Lowe 1967; Minckley 1973; Rinne 1976; DeMarais 1986; Bestgen and Propst 1989). Gila chub commonly inhabit pools in smaller streams, springs, and cienegas (a desert wetland), and can survive in small artificial impoundments, such as man-made ponds (Miller 1945; Minckley 1973; Rinne 1975). Gila chub are highly secretive, preferring quiet, deeper waters, especially pools, or remaining near cover including terrestrial vegetation, boulders, and fallen logs (Minckley 1973). Threats include changes in flow regimes and stream characteristics from uncharacteristic fire in the uplands, unmanaged grazing, and competition/predation by non-native fish species.

Gila trout (*Oncorhynchus gilae*) is federally listed as threatened with no designated critical habitat on the Gila NF. Historically, Gila trout was native to the Gila River drainage (including the San Francisco) in New Mexico and the Verde River drainage in Arizona (Miller 1950; 1972; Minckley 1973; Behnke 1992). Gila trout is found in moderate- to high-gradient perennial mountain streams above 1,660 m (5,400 ft) elevation. Streams typically flow through narrow, steep-sided canyons and valleys. Abundant invertebrate prey, cover, and water free from contaminants are also required. Cover typically consists of undercut banks, large woody debris, deep pools, exposed root masses of trees at water’s edge, and overhanging vegetation (USDI FWS 2003). A great deal of time and effort has been invested in Gila trout restoration on the Gila NF. Many streams have been cleaned out using piscicide, while others have been through ash flows from wildfire, and Gila trout have been repatriated into those streams. Threats include changes in flow regimes and stream characteristics from uncharacteristic fire in the uplands, unmanaged grazing, and competition/predation/hybridization by non-native salmonid species.

Headwater chub (*Gila nigra*) is federally proposed for listing on the Gila NF. Headwater chub historically occur in a number of tributaries of the Verde River, most of the Tonto Creek drainage, much of the San Carlos River drainage, and parts of the upper Gila River in New Mexico (USDI FWS 2015b). It currently persists in all forks of the Gila River, but distribution and numbers have decreased. Habitats in the Gila River containing headwater chubs consist of tributary and mainstem habitats at elevations of 1,325 meters (m) (4,347 feet (ft)) to 2,000 m (6,562 ft) (Bestgen 1985; Bestgen and Propst 1989). Threats include changes in flow regimes and stream characteristics from uncharacteristic fire in the uplands, unmanaged grazing, and competition/predation by non-native aquatic species.

Loach minnow (*Tiaroga cobitis*) is federally listed as endangered with approximately 11,673 acres of designated critical habitat on the Gila NF. The loach minnow is endemic to the upper Gila River drainage of southwestern New Mexico, southeastern and east-central Arizona, and northeastern Sonora (Miller and Winn 1951; Koster 1957; Minckley 1973). The minnow was found throughout the San Francisco and Gila rivers in New Mexico, as well as lower elevation reaches of several tributaries (Koster 1957; Propst et al. 1988). Loach minnows are now restricted to the following areas: portions of the Gila River and its tributaries, the West, Middle, and East Fork Gila River (Grant, Catron, and Hidalgo counties, New Mexico); San Francisco and Tularosa rivers and their tributaries, Negrito and Whitewater creeks (Catron County, New Mexico); Blue River and its tributaries, Dry Blue, Campbell Blue, Pace, and Frieborn creeks (Greenlee County, Arizona, and Catron County, New Mexico) (NatureServe 2016). Loach minnows persist mainly in streams having relatively natural flow regimes and a predominance of native species (Propst and Bestgen 1991). Recurrent flooding is important in keeping substrate free of sediments and in helping this species maintain a competitive edge over invading non-native fishes (NatureServe 2015). Threats include changes in flow regimes and stream characteristics from uncharacteristic fire in the uplands, unmanaged grazing, and competition/predation by non-native fish species.

Roundtail chub (*Gila robusta*) is federally proposed for listing on the Gila NF. The species was historically considered common in deep pools and eddies of large streams throughout its range in the Upper and Lower Colorado River basins in Wyoming, Utah, Colorado, New Mexico and Arizona. Today the roundtail chub occupies about 52 percent of its historical range in the Lower Colorado River Basin and is limited to Arizona’s Little Colorado, Bill Williams, Salt, San Carlos and Verde River drainages, Eagle and Aravaipa creeks, and New Mexico’s upper Gila River (USDI FWS 2015b). Threats include changes in flow regimes and stream characteristics from uncharacteristic fire in the uplands, unmanaged grazing, and competition/predation by non-native aquatic species.

Spikedace (*Meda fulgida*) is federally listed as endangered with approximately 9,968 acres of designated critical habitat on the Gila NF. The spikedace is endemic to the Gila River drainage of southwestern New Mexico and southeastern and central Arizona, and perhaps northern-most Sonora (Koster 1957; Minckley 1973; Miller and Winn 1951). In New Mexico, spikedace was moderately common to abundant in the San Francisco River, the mainstem Gila River, and lower reaches of the three forks of the Gila River (Anderson 1978; Propst and Bestgen 1986). Spikedace have been extirpated from the San Francisco River (Anderson 1978; Propst and Bestgen 1986). The spikedace has a discontinuous distribution in the Gila River in New Mexico. It is irregularly collected in low numbers in the East Fork Gila River, regularly collected, but in declining numbers, in the West Fork Gila River, and may be extirpated from the Middle Fork Gila River (Propst and Bestgen 1986; NMDGF unpublished data as cited by NatureServe 2016. The Cliff-Gila Valley as recently as the mid-1980s supported the largest New Mexico population of spikedace (Propst and Bestgen 1986), but its abundance there declined considerably in the late 1990s (NMDGF unpublished data as cited by NatureServe 2016). Threats include changes in flow regimes and stream characteristics from uncharacteristic fire in the uplands, unmanaged grazing, and competition/predation by non-native fish species.

Mammals

Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*) is federally listed as an endangered species with no critical habitat on the Gila NF. The lesser long-nosed bat is a nectar, pollen, and fruit-eating bat that migrates seasonally from Mexico to southern Arizona and southwestern New Mexico. This bat pollinates species of columnar cacti and paniculate agaves and disperses seeds of columnar cacti throughout its range (USDI FWS 1995). This species has been found in southern Arizona from the Picacho Mountains southwest to the Agua Dulce Mountains and southeast to the Chiricahua Mountains, in far southwestern New Mexico in the Animas and Peloncillo Mountains, and south from Arizona and New Mexico throughout the drier parts of Mexico, including Baja California (USDI FWS 1995). In 2011, lesser long-nosed bats were captured and photodocumented at two separate sites in the Burro Mountains, on both sides of the Continental Divide. Both sites were on private land, but one piece was a private inholding within National Forest System lands and the other was adjacent to the Forest. However, it is believed that the bats are foraging at nearby Palmer's agaves (primarily on Forest), or at least checking them out for nectar (M. Ramsey, pers. comm. 2016). Threats from grazing on food plants, the tequila industry, and prescribed fire are likely not as severe as once thought. Bootleg tequila production often utilizes wild agaves and may still be a threat to forage resources, but legitimate tequila producers likely have minimal effects on natural forage availability. Human disturbance of roost sites, urban development, catastrophic fire, and changing fire regimes resulting from non-native invasive plants are threats. Two new threats that have been identified include illegal border activities and their enforcement actions, as well as new wind farms (USDI FWS 2007b).

Mexican gray wolf (*Canis lupus baileyi*) is federally listed as an experimental, non-essential population on the Gila NF. Mexican gray wolves are the southernmost occurring (Nowak 1995 and 2003 as cited in Mexican Wolf Blue Range Adaptive Management Oversight Committee and Interagency Field Team 2005), rarest, and most genetically distinct gray wolf in North America (Garcia-Moreno et al. 1996). Historically the Mexican gray wolf primarily inhabited forested, mountainous terrain. The wolf does not require specific vegetation, however it reportedly most often occurred above 4,500 feet elevation in or near pine, oak, or piñon-juniper woodlands, interspersed with grassland. They occurred in the mountainous regions of the Southwest from throughout portions of southern Arizona, New Mexico, and Texas into central Mexico (NatureServe 2016). Mexican gray wolves were extirpated in the United States by aggressive predator control programs. Mexican gray wolves were reintroduced into the Blue Range Wolf Recovery Area within the Apache-Sitgreaves National Forests in Arizona in March 1998 (USFWS Mexican Wolf Recovery Program web-site https://www.fws.gov/southwest/es/mexicanwolf/BRWRP_home.cfm). In March 2000, Mexican gray wolves were translocated into the Gila Wilderness. At the end of April 2016, the wild Mexican wolf population consisted of 53 wolves with functional radio collars dispersed among 19 packs and two single wolves. The reintroduced wolves are classified as a "nonessential, experimental" population. Threats include in-breeding and human harassment.

Species of Conservation Concern

One hundred four species met the initial criteria for being identified as a species of conservation concern on the Gila NF (Table 175), 53 of those species were removed from the list (Table 176; Appendix G) due to one of the following conditions: 1) the species was not known to occur on the Forest, or 2) the best available scientific information did not indicate substantial concern for the species to persist on the Forest. Fifty-one species were identified as potential species of conservation concern on the Gila NF (Table 183).

Table 183. Potential Species of Conservation Concern (SCCs) relevant to the plan area.

Common Name	Scientific Name	NatureServe Rank
Amphibians		
Arizona toad	*Anaxyrus microscaphus*	G4/S2?
Birds		
Gila Woodpecker	*Melanerpes uropygialis*	G5/S2B,S2N
Lewis’s Woodpecker	*Melanerpes lewis*	G4/S3B,S3N
Fish		
Rio Grande sucker	*Catostomus plebeius*	G3G4/S2
Invertebrates		
"Gila" May Fly	*Lachlania dencyanna*	G1/SNR
A Stonefly	*Capnia caryi*	G1/SNR
Bearded Mountainsnail	*Oreohelix barbata*	G1/S1
Black Range Mountainsnail	*Oreohelix metcalfei acutidiscus*	G2/T1/SNR
Black Range Mountainsnail	*Oreohelix metcalfei hermosensis*	G2/T1T2/SNR
Black Range Woodlandsnail	*Ashmunella cockerelli cockerelli*	G1/T1/S1
Cockerell Holospira Snail	*Holospira cockerelli*	G1/S1
Gila Springsnail	*Pyrgulopsis gilae*	G2/S2
Iron Creek Woodlandsnail	*Ashmunella mendax*	G1/S1
Marsh Slug Snail	*Deroceras heterura*	G1G2/SNR

Common Name	Scientific Name	NatureServe Rank
Mineral Creek Mountainsnail	*Oreohelix pilsbryi*	G1/S1
Morgan Creek Mountainsnail	*Oreohelix swopei*	G1/S1
New Mexico Hot Springsnail	*Pyrgulopsis thermalis*	G1/S1
Nitrocris Fritillary Butterfly	*Speyeria nokomis nitocris*	G3/T3/SNR
No Common Name Snail	*Ashmunella cockerelli argenticola*	G1/T1/S1
No Common Name Snail	*Ashmunella cockerelli perobtusa*	G1/T1/S1
No Common Name Snail	*Ashmunella tetrodon animorum*	G3/T3/S3
No Common Name Snail	*Ashmunella tetrodon inermis*	G3/T2/SNR
No Common Name Snail	*Ashmunella tetrodon mutator*	G3/T2/SNR
No Common Name Snail	*Oreohelix metcalfei radiata*	G2/T2/SNR
No Common Name (Black Range mountainsnail)	*Oreohelix metcalfei concentrica*	G2/SNR
Silver Creek Woodlandsnail	*Ashmunella binneyi*	G1/S1
Sonoran Snaggletooth Snail	*Gastrocopta prototypus*	G1/SNR
Stonefly	*Taenionema jacobii*	G2/SNR
Tiger Moth	*Alexicles aspersa*	G1G2/SNR
Western Bumble Bee	*Bombus occidentalis occidentalis*	G4/T1T3/SNR
Whitewater Creek Woodlandsnail	*Ashmunella danielsi*	G1/S1
Plants		
Cliff Brittlebush	*Apacheria chiricahuensis*	G2/S2
Davidson's Cliff Carrot	*Pteryxia davidsonii*	G2/S2
Gooding's Onion	*Allium gooddingii*	G4/S1
Greene Milkweed	*Asclepias uncialis* ssp. *uncialis*	G3G4/T2T3/S2
Heartleaf Groundsel	*Packera cardamine (=Senecio cardamine)*	G3/S3
Hess's Fleabane	*Erigeron hessii*	G1/S1
Metcalfe's Penstemon	*Penstemon metcalfei*	G1/S1
Mimbres Figwort	*Scrophularia macrantha*	G2/S2

Common Name	Scientific Name	NatureServe Rank
Mogollon Clover	*Trifolium neurophyllum*	G2/S2
Mogollon Death Camas	*Zigadenus mogollonensis*	G3/S3
Mogollon Hawkweed	*Hieracium brevipilum (=H. fendleri* var. *mogollense)*	G4/T2?/S2?
Mogollon Mountain Lousewort	*Pedicularis angustifolia*	G2/S2
New Mexico Groundsel	*Packera quaerens*	G2/S2
Pinos Altos Flame Flower	*Talinum humile*	G2/S2
Porsild's Starwort	*Stellaria porsildii*	G1/S2
Wooton's Hawthorn	*Crataegus wootoniana*	G2/S2
Wright's Dogweed	*Adenophyllum wrightii* var. *wrightii*	G1?/S1
Yellow Lady's-Slipper	*Cypripedium parviflorum* var. *pubescens*	G5/T5/S2?
Mammals		
Arizona Montane Vole	*Microtus montanus arizonensis*	G5/T4/S1
Gunnison's Prairie Dog (prairie population)	*Cynomys gunnisoni*	G5/S2

Species of Conservation Concern – Considered on Gila NF

Fifty-one species were identified as potential species of conservation concern on the Gila NF. The BASI indicates substantial concern about each species' capability to persist over the long term in the plan area. All species listed met one or more of the initial requirements for SCC. A number of sources, including professionals within Federal and State government were consulted to determine whether the species was at-risk on the Gila NF. For all potential SCCs, the ecological conditions for persistence were compared against the current and future trend of those conditions on the Forest as well as other key risk factors associated with those conditions. Concerns for persistence of the following species on the Gila NF are as follows:

Justifications

Amphibians

Arizona toad (*Anaxyrus microscaphus*) is well distributed on the Gila NF, occurring within the Gila, San Francisco, and Mimbres watersheds in the Gila Region of the Mogollon Rim, with disjunct populations in the Black Range (Ryan et al. 2015). The New Mexico portion of the toads range habitat consists of highly variable riverine habitats that occur at higher elevation than populations in Arizona, Nevada, and Utah (Ryan et al. 2015). Habitat includes rocky stream courses in the pine-oak zone, or stream courses bordered by willows and cottonwoods, irrigation ditches, flooded/irrigated fields, and reservoirs (NatureServe 2016). They may also utilize piñon/juniper woodlands and ponderosa pine forests, but have demonstrated a "strong preference" for associating with lotic systems and appear to be restricted to breeding in slow-flowing and shallow streams (BISON-M 2016). They appear to require clear water conditions with sand or cobble substrates (Ryan et al. 2015). ERUs that may be utilized on the Gila NF include the riparian, shrubland, and woodland ERUs, as well as ponderosa pine-evergreen oak, and ponderosa pine forest ERUs. All these ERUs are in low to moderate departure, with the exception of ponderosa pine forest ERU that is highly departed. Potential threats to the Arizona Toad in New Mexico include climate change, forest fires, hybridization, and the disease chytridiomycosis (Ryan et al. 2015). The disease chytridiomycosis (Bd) has been responsible for many enigmatic amphibian population die-offs and declines (Wake & Vredenburg 2008), and is responsible for declines in some New Mexico species (Ryan et al 2015). The apparent declines we have observed in the Arizona Toad do not necessarily fit the pattern of a Bd outbreak, but other factors such as land-use change or climatic factors appear to be driving declines (Ryan et al 2015). Additionally, high spring river flow rates can decrease reproductive activity, while drying of sites could exclude potential breeding sites. The reduction in available breeding sites may be the driving factor in the low number of occupied sites we have found over the last three years (Ryan et al. 2015). There was a positive 90-day finding- July 1, 2015, the USFWS found that “based on our review of the petition and sources cited in the petition, we find that the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted for the Arizona toad (*Anaxyrus microscaphus*) based on Factor E.” (USDI FWS 2015d). Factor E warrants listing based on other natural or man-made factors affecting its continued existence. There was substantial evidence showing that genetic integrity/hybridization was the threat that warranted listing. Ryan et al. (2015) found that on the Gila NF specifically, there is no morphological evidence of hybridization between *A. microscaphus* and *A. woodhousii* throughout the Gila Region, and Grant and Sierra Counties, specifically, where the two species co-occur. There have been several large fires on the Gila NF in the past 5 years. The burned uplands likely contribute to increased stream flows and flash flooding events through the range of the species. This species appears to be highly sensitive to increased flow rates, changing water levels, and drying of sites that can decrease reproductive activity. While toads do reproduce in lentic habitats, they are usually not successful (Ryan et al 2015). Arizona toad appears to be at risk on the Gila NF because it is sensitive to increased flows, particularly flash flooding events, changing water levels, and drying of sites that could cause reproductive failure. Long-term local population trends and persistence of the species could be at risk if reproductive failure occurs over several consecutive years (Ryan et al. 2015). Until the uplands stabilize from the recent fires, this will continue to be of concern. Additionally, while the short-term population trend in the Ryan et al. (2015) study was stable, there has been an approximate 70% decline in the number of occupied Arizona Toad localities (Ryan et al 2015).

Birds

Gila Woodpecker (*Melanerpes uropygialis*) occurs in low elevation, riparian woodlands. Found in the Burro Mountains along the Gila River near Patterson and Pancho Canyons. In New Mexico the species is confined to lower elevation woodlands, especially those dominated by mature cottonwoods and/or sycamores, along stream courses (Hubbard 1987 as cited in NatureServe 2016, NMDGF 1997 as cited in BISON-M 2016). These habitat types are characterized within the Cottonwood Group of ERUs as described in Chapter 7: Riparian and are distributed across all local units. These ERUs are moderately departed from reference conditions and approximately 66% of these ERUs contain ecological conditions necessary for persistence of the species. Riparian ERUs were not modelled using VDDT, but TEUI documentation suggests these ERUs have a stable trend. Diversions or other flood control practices can alter habitat through changes in the flood disturbance regimes and altered hydrographs necessary for establishment of certain riparian species. Competition with other cavity nesters (NatureServe 2016), particularly European starling, that compete aggressively for excavated cavities and may limit productivity (Kerpez and Smith 1990). The Gila woodpecker are only known from the Gila River Birding Area, and all Breeding Bird Survey regions, except one (Sierra Madre Occidental), show the population is declining (Sauer et al. 2014). Gila woodpecker appears to be at-risk on the Gila NF because the habitat it inhabits is uncommon, habitat is moderately departed from reference conditions, they only appear to inhabit a portion of the available habitat on the Forest, and there is a high uncertainty of the species occurrence on the rest of the Forest.

Lewis's Woodpecker (*Melanerpes lewis*) occurs in low, riparian woodlands, and in ponderosa pine forests with large trees and open canopy (NMPIF 2007). The species is distributed across the western two-thirds of the Gila NF based on e-Bird (2016) locations. It may use existing holes or natural cavities, or excavate holes in trees that are in an advanced stage of decay. Typically, larger-than-average trees are chosen for nesting (NMPIF 2007). In the lowlands, this species uses habitat types that are characterized within the Cottonwood Group of ERUs as described in Chapter 7: Riparian and are distributed across all local units. These ERUs are moderately departed from reference conditions and approximately 66% of these ERUs contain ecological conditions necessary for persistence of the species. Riparian ERUs were not modelled using VDDT, but TEUI documentation suggests these ERUs have a stable trend. Diversions or other flood control practices can alter habitat through changes in the flood disturbance regimes and altered hydrographs necessary for establishment of certain riparian species. In Idaho, Saab and Vierling (2001) suggest that cottonwood habitat may be a population sink due to proximity to agricultural lands and increased predation. In the uplands, this species occupies PPE, PPF, and likely MCD ERUs. These ERUs are moderately to highly departed on the Gila NF. These ERUs tend to be overstocked with smaller diameter trees, lacking large diameter trees, which in turn leads to a lack of large diameter snags that this species requires. This has likely caused a reduction in suitable habitat that will likely persist for some time regardless of restoration efforts, as it takes time to grow large trees. There is a long-term population decline for this species and the Breeding Bird Survey routes on the Gila NF also show declining trends (Sauer 2014). Lewis's woodpecker appears to be at-risk on the Gila NF because of their declining population trends, the riparian habitat it uses has been found to be a sink for populations in one study, and the upland ponderosa pine habitat it uses is highly departed and lacks large diameter snags.

Fish

Rio Grande Sucker (*Catostomus plebeius*) habitat includes rocky pools, runs, and riffles of small to medium rivers (Lee et al. 1980, Page and Burr 2011), usually over gravel and/or cobble, but also in backwaters and pools below riffles. This species is rarely found in waters with heavy silt and organic detritus (Sublette et al. 1990). Rio Grande sucker is found in the Mimbres, Gila, and San Francisco River drainages, as well as in Rio Grande drainages east of the Continental Divide on the Black Range. It should be noted that this fish is not native to the San Francisco River drainage and may have been introduced into the Gila River drainage, although it is uncertain (Sublette et al. 1990). A risk rating was developed for several different characteristics on the Forest and is detailed in Chapter 6: Water, including watershed condition, perennial streams, and streamflow. The two watersheds where Rio Grande sucker is present are both determined to be likely high risk for both perennial streams and streamflow, and potential high risk for watershed condition. Of the 10 sub-watersheds on the Gila NF that the Rio Grande sucker is known to be native and occurs or was historically present, they are only currently present in five. Four of those are moderately to highly departed in terms of fish assemblages, while one has low departure. Threats include habitat alteration from water management and flow modifications such as channelization, diversions, fire effects etc., as well as non-native predators and competitors. This is particularly evident in the Mimbres River drainage as there is a large amount of private lands that are allocated water for irrigation, and the 2013 Silver Fire burned in the uplands that may be affecting water flow, ash, etc. The amount of non-native competitors and predators is very high in the Mimbres River drainages that are likely contributing to population declines. Trend is stable in the Rio Grande and Mimbres River drainages (Sublette et al. 1990, NatureServe 2016, IUCN 2016). Overall short-term trend (<10 years) is relatively stable to decline of <30%, while long-term trend shows a decline of 10-50% (NatureServe 2016). This species should be considered at-risk on the Gila NF because of the small number of sub-watersheds in which it currently occurs, population declines, non-native species, and watershed conditions after recent wildfires that can affect perennial streams and streamflow.

Invertebrates

"Gila" May Fly (*Lachlania dencyanna*) was found in a high gradient, warm, medium river. It has only been found at junction of East Fork and mainstem Gila River clinging to woody debris. The area it was located was characterized as a warm, unshaded, turbid, and rapid stream. Specific threats are generally unknown, but likely anything that would affect other macroinvertebrates such as diversions or other de-watering of streams, reducing dissolved oxygen, pollution, or increased sediments could be considered threats. Distribution appears to be limited to the Gila River drainage in New Mexico and is the only endemic mayfly in New Mexico (McCafferty et al. 1997). Authors made no notes on abundance or trend, but felt that the Gila River drainage may be a refugium for this as well as other southwest species (McCafferty et al. 1997). This species should be considered at-risk on the Gila NF because of its restricted distribution, the proposed Gila River Diversion Project, large wildfires in the uplands, and it is identified as globally “critically imperiled” (G1) in NatureServe.

A Stonefly (*Capnia caryi*) was found in Iron Creek on the Gila NF in a clear, cool stream with scattered boulders and a mixture of cobble with gravels, and low (<3%) gradient. The species is only known from 2 tiny creeks; one in AZ (Mamie Creek at Escudilla Mtn.) and the other in NM (Upper Iron Creek, Catron Co). This species was only discovered in NM in February 1999 with another specimen found in March 2001 in AZ, and recently described as a new species by Bauman and Jacobi (2002). Specific threats are not known, but likely anything that may affect other macroinvertebrates such as diversions or de-watering of streams, reducing dissolved oxygen, pollution, or increasing sediments could be considered threats. On the Gila NF it appears to be limited in its distribution to Upper Iron Creek, which is a small tributary of the Middle Fork Gila River. The authors only found and described <15 specimens, so it is likely not very abundant where it does occur. This species should be considered at-risk on the Gila NF because of its restricted distribution, large wildfires in the uplands, and it is identified as globally “critically imperiled” (G1) in NatureServe.

Stonefly (*Taenionema jacobii*) occurs in Gila River watershed where it was examined from larvae collected in Cherry Creek (Stewart 2009). The species has been found in the Gila River watershed into Arizona as well (NatureServe 2016). Specific threats are not known, but likely anything that may affect other macroinvertebrates such as diversions or de-watering of streams, reducing dissolved oxygen, pollution, or increasing sediments could be considered threats. In New Mexico, the species is known from <10 occurrences (NatureServe 2016), so it is likely not very abundant, and there is no trend data available for this species. This species should be considered at-risk on the Gila NF because of its restricted distribution, large wildfires in the uplands, and it is identified as globally “imperiled” (G2) in NatureServe.

Silver Creek Woodlandsnail (*Ashmunella binneyi*) occurs in the upper ends of Silver, Bull Top, and Spring Canyons in Black Range between 8,000-8,500 feet elevation. It has a limited distribution of approximately

2 miles north to south and occurs in ponderosa pine and Douglas-fir at the heads of these canyons. The Ponderosa Pine Forest (PPF) and Mixed Conifer with frequent fire (MCD) ERUs are highly departed across the Gila NF (Chapter 2: Upland Vegetation), and often burn in a way that is not within its historic range of variability. The 2013 Silver Fire burned with high intensity through all the canyons in which this species was known. Little is known about habitat needs other than it occurs in rocks at the upper ends of the canyons mentioned above. The effects of fire to the species are not known, but they do occur within fire adapted ecosystems and likely evolved in the presence of fire. The high departure of these systems may not have exposed them historically to effects of higher severity fire. Threats may include uncharacteristic wildfire or any ground disturbing activities such as mining or road construction and/or maintenance; however, the terrain where this species occurs is very rugged and mostly inaccessible, so mining and road construction are not likely to occur. Metcalfe and Smartt (1997) only mention this species as being less abundant than *A. mendax* which has a broader distribution and is described as being "quite abundant". Trend appeared to be relatively stable prior to the fire as the species was found in the mid-1990s in the same areas it was originally described at the turn of the 20th century. This species should be considered at-risk on the Gila NF because of its restricted distribution, the 2013 Silver Fire burned all known locations of this species, and it is identified as globally and taxonomically "critically imperiled" (G1/T1) in NatureServe.

No Common Name (*Ashmunella cockerelli argenticola*) and **Morgan Creek Mountainsnail (*Oreohelix swopei*)** *A. c. argenticola* has been found in flourishing colonies along Forest Road 523 where it crosses Silver Creek Canyon and further north where it crosses Rustlers Canyon (a tributary or Silver Creek Canyon). It is found in the higher elevations where habitat is more mesic on rocks in deciduous leaf litter near creeks (Metcalf and Smartt 1997). *O. swopei* is found in canyons of northern Black Range, Turkey Run, head of Morgan Cr., Diamond Cr., and Black Canyon, both eastern and western slopes. These canyons are all mesic canyons with flowing water and riparian leaf litter amongst rock. Threats for both species include uncharacteristic wildfire, flooding, and any disturbances that may impact canyon bottoms and leaf litter covering rocks. The 2013 Silver Fire burned through all the canyons *A. c. argenticola* was known, as well as the uplands that feed Silver Creek and Rustlers Canyons. This will likely increase the intensity of water flow events throughout these canyons. Abundance for *A. c. argenticola* is described by Metcalfe and Smartt (1997) as being found in "flourishing colonies" in both Silver Creek and Rustlers Canyons. *O. swopei* was described as "not abundant nor easy to find" by Metcalfe and Smartt (1997). Trend for these species appeared to be relatively stable prior to the fire as these species were found in the mid-1990s in the same areas they were originally described at the turn of the 20th century. These species should be considered at-risk on the Gila NF because of their restricted distribution, the 2013 Silver Fire burned all known locations of *A. c. argenticola*, and they are identified as globally "critically imperiled" (G1) in NatureServe.

Black Range Woodlandsnail (*Ashmunella cockerelli cockerelli*), No Common Name (*Ashmunella cockerelli perobtusa*), Cockerell Holospira Snail (*Holospira cockerelli*), Black Range Mountainsnail (*Oreohelix metcalfei acutidiscus*), No Common Name (Black Range mountainsnail), (*Oreohelix metcalfei concentrica*), Black Range Mountainsnail (*Oreohelix metcalfei hermosensis*), No Common Name (*Oreohelix metcalfei radiata*), and **Mineral Creek Mountainsnail (*Oreohelix pilsbryi*)** are all species that occur on the Black Range and whose habitat is described as talus of igneous rock, limestone talus or other calcareous rock, or limestone bedrock or outcrops. Also, all these species occur within the same range of woodland ERUs that are all moderately departed in the Black Range local area (Chapter 2: Upland Vegetation). These ERUs tend to have longer fire return intervals than ponderosa pine or mixed conifer with frequent fire and tend to have fires burn that are of mixed-severity. The effects of fire to the species are not known, but they do occur within fire adapted ecosystems and likely evolved in the presence of fire. The 2013 Silver Fire burned through the known locations for all these species except *H. cockerelli, O. m. hermosensis*, and *O. pilsbryi*, although many of the areas within these woodlands burned with a low to mixed-severity. Additional threats may include any ground disturbing activities that would affect any of the rock formations mentioned above. The terrain where these species occur is very rugged and mostly inaccessible, so mining and road construction are not likely to occur. Distribution of these species is quite limited, often only known from one canyon, although some are described as being quite abundant where they do occur Trend for these species appeared to be relatively stable prior to the fire as they were found in the mid-1990s where they were originally described at the turn of the 20th century. These species should be considered at-risk on the Gila NF because of their restricted distribution, the 2013 Silver Fire burned all known locations of many of these species increasing the risk for severe flooding, and they are identified as globally or taxonomically "critically imperiled" (G1/T1) or globally or taxonomically "imperiled" (G2/T2) in NatureServe.

Whitewater Creek Woodlandsnail (*Ashmunella danielsi*), No Common Name (*Ashmunella tetrodon inermis*), No Common Name (*Ashmunella tetrodon mutator*), No Common Name (*Ashmunella tetrodon animorum*), Sonoran Snaggletooth Snail (*Gastrocopta prototypus*), and **Bearded Mountainsnail (*Oreohelix barbata*)** are all species that occur in canyon bottoms in riparian areas near creeks or springs in the Mogollon Mountains and the Black Range. Habitat for these species consists of igneous rock in talus on moist northern slopes, moss covered in places, and damp leaf litter in interstices, or deep canyons with riparian areas where deciduous trees produce an abundant leaf litter where snails occur under and around stones and logs. They occur from Dry Creek Canyon in the southwest Mogollon Mountains to Whitewater Creek Canyon and Willow Creek Canyon. *G. prototypus* is also found in the West Fork Gila River and fossils have been found in Trujillo Canyon in the Black Range and off Forest Service lands. Likely this species occurs in other ranges in Southwest New Mexico (Metcalf and Smartt 1997). *A. t. animorum* was only found at Holden Spring in the Black Range. All of the *A. tetrodon* subspecies need further study to determine if they are truly subspecies or all individual species (Metcalfe and Smartt 1997). The 2012 Whitewater Baldy and 2013 Silver Fires burned known locations or the uplands that drain into the creeks where these species occur on the Gila NF. This will likely increase the intensity of water flow events throughout these canyons and dry out the areas some species were found. Additional threats to these species may include flooding, or any other activities that could impact stream courses. No mention of these species abundance is mentioned, but their distribution is limited to only a few known canyons. Trend for these species appeared to be relatively stable prior to the fires as they were found in the mid-1990s where they were originally described at the turn of the 20th century. These species should be considered at-risk on the Gila NF because of their restricted distribution, the 2012 Whitewater Baldy and 2013 Silver Fires burned known locations and much of the uplands of many of these species increasing the risk of severe flooding, and they are identified as globally or taxonomically "critically imperiled" (G1/T1) or globally or taxonomically "imperiled" (G2/T2) in NatureServe.

Iron Creek Woodlandsnail (*Ashmunella mendax*) occurs in wooded canyons at lower elevations but it is more widespread in wooded zones of higher elevations in the Black Range. It has been found from the town of Kingston on the east side of the Black Range crest, all the way to Gallinas Canyon on the west side of the crest. It is abundant where found and wide ranging in elevation from 5,500-9,000 feet (Metcalfe and Smartt 1997). It occurs from piñon-juniper woodlands all the way up to moist mixed conifer forests. Woodland, mixed conifer with frequent fire forest, and mixed conifer with aspen forest ERUs are moderately departed (Chapter 2: Upland Vegetation) in the Black Range local area, but the ponderosa pine forest ERU is highly departed and likely to experience a higher fire severity than historically occurred. The upper elevations where this species occurs was burned in the 2013 Silver Fire. Effects from fire are unknown for this species, but the ponderosa pine forest ERU it occurs in likely experienced severe fire effects. Additional threats may include, increased effects due to flooding from the burned vegetation in the uplands, timber harvest, or other activities that would affect wooded canyons. Harvest activities are unlikely because of the steep, inaccessible terrain along the Black Range crest. Trend for this species appeared to be relatively stable prior to the fire as was found in the mid-1990s where it was originally described at the turn of the 20th century. This species should be considered at-risk on the Gila NF because of its restricted distribution, the 2013 Silver Fire burned approximately half of this species fairly restricted range, and it is identified as globally and taxonomically "critically imperiled" (G1/T1) in NatureServe.

Marsh Slug Snail (*Deroceras heterura*) is endemic to Willow Creek in the Mogollon Mtns. and from Sawyers Peak north to Morgan Creek (>20 miles as crow flies) Black Range, but appears to be widespread, and it occurs above 8,000 feet elevation. It occurs from ponderosa pine to moist mixed conifer forests (Metcalfe and Smartt 1997). Ponderosa pine forest ERU is highly departed on the Gila NF, while the mixed conifer with frequent fire and mixed conifer with aspen ERUs are moderately departed (Chapter 2: Upland Vegetation). Much, if not all of the areas this species has been described as occupying has burned, either in the 2012 Whitewater-Baldy or 2013 Silver Fires. It appears this species requires more mesic habitats that may experience a drying trend because of the large fires. Additional threats may include timber harvest, road construction, or any other ground disturbing activities in these vegetation types. Much of the area this species occurs is wilderness area and/or very rugged terrain, thereby eliminating most threats to the species. No information was found about this species abundance or trend, and no efforts have been made to re-locate the species since originally being described by Pilsbry in the mid-1940s (Metcalfe and Smartt 1997). This species should be considered at-risk on the Gila NF because of its restricted distribution, the 2012 Whitewater Baldy and 2013 Silver Fire burned most, if not all, of this species fairly restricted range, it is identified as globally and taxonomically "critically imperiled" (G1/T1) in NatureServe, and there is a high uncertainty of the species occurrence on the rest of the Forest.

Gila Springsnail (*Pyrgulopsis gilae*) occurs in cool to warm springs in rhyolite fissures adjacent to the Gila River. The species is common within cool water springs within its range. There are 1,807 known seeps and springs on the plan area, with 51% of those occurring on Forest Service lands (Chapter 6: Water). It is possible this species occurs in locations that are not on Forest Service lands that have had no survey. It is known from the East Fork, Middle Fork, and Mainstem Gila River, as well as tributaries forming the East Fork (Beaver, Taylor, Whitetail, and Whitewater Creeks). Gila springsnail is relatively well distributed in the Gila River Drainage. USFWS determined listing of the species was not warranted after additional survey attempts yielded several additional locations of the species. Threats include habitat modification from water diversion, drying of springs/creeks, livestock trampling, and wetland habitat loss (NatureServe 2016, BISON-M 2016). The areas the Gila springsnail occupies already offer protections because other listed species occur in the same locations that also benefit this species. The short-term trend of this species is relatively stable (<10% change) (NatureServe 2016), and current management already offers some protections that would benefit this species. Long-term trend for this species is unknown (NatureServe 2016). This species should be considered at-risk on the Gila NF because it is identified as globally "imperiled" (G2) in NatureServe.

New Mexico Hot Springsnail (*Pyrgulopsis thermalis*) this species inhabits thermal waters (91-100 degrees F) issuing from multiple sources along a vertical cliff feature along the Gila River. Principal outflows are generally too hot for the snail, so they occur in cooler portions of the outflows. While seeps and springs have been mapped and assessed in the Chapter 6: Water, it does not separate springs by warm or cold springs. Species occurs along a 3 mi stretch of the lower East Fork Gila River and another population 1.5 mi below the confluence of the East and West Forks Gila River (NatureServe 2016). Threats include habitat degradation from recreational bathing and water pollution/contaminants. The species only occurs within wilderness areas which may afford it some protections. It is only known from 2 sites and threats are potentially affecting both. One from recreational bathing and unauthorized digging/diverting water, and the other from water diversions on private land. The short-term trend is relatively stable (<10% change), while the long-term trend is unknown (NatureServe 2016). This species should be considered at-risk on the Gila NF because both known populations are potentially being impacted by human disturbance, and it is identified as globally "imperiled" (G1) in NatureServe.

Nitrocris Fritillary Butterfly (*Speyeria nokomis nitocris*) is limited to moist, montane meadows and occurs in alpine meadows on the Gila NF (Zimmerman 2001). The historic population known from the confluence of Little Creek and the Gila River was surveyed for and not found in 2000. Willow Creek campground is the only known extant population on the Gila NF, and it appears to hold fewer numbers than in years past (Zimmerman 2001). Threats may include Willow Creek campground development, collection, overgrazing, or any disturbance that reduces or eliminates *Viola nephrophylla* (Zimmerman 2001). Much of the spruce-fir forest ERU this butterfly occupies has been burned by wildfire in the last 5 years, is very departed, and it is modelled to worsen in the future. This ERU historically experienced high-severity, stand replacement fire; however, not likely at the scale it has seen in recent years (Chapter 2: Upland Vegetation). This species should be considered at-risk on the Gila NF because there is only one extant site, numbers appear to be declining, and it is located in a high recreational use area.

Tiger Moth (*Alexicles aspersa*) - *Alexicles* is known from extreme NE Arizona and NW New Mexico. Details of its distribution in New Mexico is not recorded. Its life history and habitat requirements are not known. *Alexicles aspersa* was probably added to the NM list because of its limited distribution in New Mexico in habitats that are generally inaccessible because the lands are in Tribal Reservations (Metzler 2014). Two historical sightings are documented in southwestern New Mexico, one in Grant Co. and one in Sierra Co., but no specific locations were given (BugGuide 2016), so it is unknown if locations were on the Gila NF. This species life history and ecology are unknown, but it has been raised on dandelion and lettuce leaves in captivity (NatureServe 2016). Because nothing is known of *A. aspersa's* life history or habitat requirements, it is not possible to identify any specific threats (Metzler 2014). This species should be considered at-risk on the Gila NF because it is identified as globally "imperiled" (G2) in NatureServe.

Western Bumble Bee (*Bombus occidentalis occidentalis*) has been collected on the Gila NF along the Bursum Road in 1961. The habitat for this species is described as open grassy areas, urban parks and gardens, chaparral and shrub areas, and mountain meadows (Williams et al. 2014). Bumble bees, including *B. occidentalis*, are generalist foragers and have been reported visiting a wide variety of flowering plants (Hatfield et al. 2015). Rangewide, example food plants of *Bombus occidentalis* include *Ceanothus*, *Centaurea*, *Chrysothamnus*, *Cirsium*, *Geranium*, *Grindellia*, *Lupinus*, *Melilotus*, *Monardella*, *Rubus*, *Solidago*, and *Trifolium* (Williams et al. 2014). Prior to 1998, the western bumble bee was both common and widespread throughout the western United States and western Canada. The U.S. states included in the former range of this species are: northern California, Oregon, Washington, Alaska, Idaho, Montana, western Nebraska, western North Dakota, western South Dakota, Wyoming, Utah, Colorado, northern Arizona, and New Mexico. Since 1998, this bumble bee has undergone a drastic decline throughout some areas of its former range. While viable populations still exist in Alaska and east of the Cascades in the Canadian and U.S. Rocky Mountains, the once common populations of central California, Oregon, Washington and southern British Columbia have largely disappeared (Xerces Society 2016). The Gila NF appears to be the southern periphery of the bumble bees range. There has been a positive 90-day finding by the USFWS that listing of this species may be warranted (USDI FWS 2016b). This species should be considered at-risk on the Gila NF because it is identified as taxonomically "imperiled" (T2) in NatureServe.

Plants

Wright's Dogweed (*Adenophyllum wrightii* var. *wrightii*) occurs in piñon/juniper woodland, in sandy or silty soils in swales or drainages. The piñon-juniper woodland and piñon-juniper grassland ERUs have a low to moderate departure across the Gila NF (Chapter 2: Upland Vegetation). On the Gila NF it is found from near the town of Fierro at the south end of the Forest, north and east to HWY 59, north of the town of Winston. Threats to this species are not well known, but may include unmanaged grazing and possibly spraying for unwanted weeds. In some areas of Mexico, it grows in abundance and it is treated as a weed (NMRPTC 1999). The species appears to be fairly well distributed on the Gila NF and it occurs within ERUs that have low to moderate departure. Populations in New Mexico were reported as "healthy and reproducing normally" (NMRPTC 1999). Range was expanded during the abnormally wet summer of 2006 when numerous populations of the plant were discovered. Additional surveys during wet summers may further extend this species range into other mountain ranges in New Mexico (NMRPTC 1999). The NMRPTC (1999) now considers this species common within its range in New Mexico. Because of the increase in the number of populations of this species, the trend is thought to be increasing. This species should be considered at-risk on the Gila NF because it is identified as globally "critically imperiled" (G1?) in NatureServe.

Gooding's Onion (*Allium gooddingii*) occurs in spruce-fir forest, mixed conifer with aspen from 6,500-9,400 ft. Mixed conifer with aspen and spruce-fir forest ERUs are moderately to highly departed on the Gila NF, and spruce-fir forest is modelled to get worse into the future (Chapter 2: Upland Vegetation). This is likely because the majority of this ERU burned in the last 5 years with high severity. While the spruce-fir ERU historically burned on a 150-400 year cycle with mixed severity to stand replacement fire, the mean patch size of the disturbances was historically 200-1,000 acres (Chapter 2: Upland Vegetation). A total of 28 out of 30 known occupied sites have been burned by wildfires since 2006, with 21 of them 30 burning during the Whitewater Baldy fire in 2012 (Roth 2016). Surveys post-fire found the species was present even in areas that burned with high severity. Surveys by Roth (2016) show that the plant is able to survive direct effects of fire, but likely will not persist in post-fire environment as evidenced by disappearance of a known population consisting of thousands of plants within the 2006 Bear Fire. This species is adapted to growing under the canopy of mixed conifer forests (Roth 2016), therefore it is likely that it persisted historically even though the ERUs it occurs in burn typically with severe conditions. The extent of fires that burned historically were not likely as broad as the most recent fires, which could impact persistence with fewer sites that are considered suitable. This species occurs from Freiborn Canyon, north of Eagle Peak in Long Canyon, south to Willow Creek Campground. Additional threats include impacts from flooding in the post-fire erosion events (Roth 2016), collection, grazing, logging, but it has been known to return following disturbance (NatureServe 2016). Results from Roth (2016) surveys show that abundance may have decreased, and the trend appears to be declining. This species should be considered at-risk on the Gila NF because approximately 93% of existing sites have burned within the last 10 years, ERUs this species occurs in are moderately and highly departed and not modelled to improve in the future, and both abundance and trend appear to be declining on the Gila NF.

Cliff Brittlebush (*Apacheria chiricahuensis*) occurs in areas containing bare rock/talus/scree/cliff, such as limestone or rhyolitic rock outcrops in Rocky Mountain montane conifer forests between 5,500-7,000 feet elevation (NMRPTC 1999). On the Gila NF it is found in Running Water Canyon, a tributary to Diamond Creek, in the Aldo Leopold Wilderness area. Mineral exploration and development are identified threats that could possibly impact some populations. However, on the Gila NF the cliff habitat in which the species occurs effectively removes threats to this species as it occurs in a wilderness area where mining is withdrawn. Although it has only been found in one canyon on the Gila NF, it is likely undersurveyed as the areas it inhabits are very inaccessible. The geologic formations necessary for the species are likely in low departure from reference conditions. No information on abundance has been noted on the Gila NF specifically, but it is reported to be common and abundant in suitable habitat in the San Mateo and Animas Mountains (NMRPTC 1999) which the Gila NF falls right in between both. Trend is not described for the species either, but given the habitat in which it occurs, it is likely stable. This species should be considered at-risk on the Gila NF because it is only known from one canyon on the Gila NF, and it is identified as globally "imperiled" (G2) in NatureServe.

Greene Milkweed (*Asclepias uncialis* ssp. *uncialis*) occurs in grasslands, on sandy to rocky soils and within an elevational range of 5,000-7,000 ft. On the Gila NF it has only been found in one location approximately 1/4 mile from NM/AZ border (6 plants). The location where this population is mapped puts the species within the Colorado Plateau/Great Basin grassland ERU, but it may potentially occur within the juniper grassland ERU where they intergrade. The Colorado Plateau/Great Basin grassland ERU is highly departed, while the juniper grassland ERU is in low to moderate departure across the Gila NF, and they are not modelled to improve in the future (Chapter 2: Upland Vegetation). Identified threats to the species include residential development (particularly in Arizona), agriculture, and livestock operations. The trend over the last 100 years is not well known, but it is likely declining (NatureServe 2016). This species should be considered at-risk on the Gila NF because it is only known from one population of 6 plants on the Gila NF, it occurs within an ERU that is highly departed and not modelled to improve into the future, and it is identified as taxonomically "imperiled" (T2) in NatureServe.

Wooton's Hawthorn (*Crataegus wootoniana*) occurs in riparian habitat in montane conifer forest at an elevational range of 6,500-8,000 ft. Riparian ERUs are in low to moderate departure on the Gila NF (Chapter 7: Riparian). The species is distributed from the head of Little Creek off of the West Fork Gila River, south to Silver City. This species has been infrequently described on the Gila NF historically, with no documentation on abundance (NatureServe 2016). It is likely this species is not very abundant on the Gila NF because of this. Identified threats may include drought, climate change, timber harvest activities, possibly riparian disturbances, and wildfire effects. Because this species has been described infrequently with little work being done on it, little is known about the abundance and trend of the species. This species has not been specifically surveyed for, but it has been documented on the Forest and continuously documented in certain areas so the trend may be stable. This species should be considered at-risk on the Gila NF because it is identified as globally "imperiled" (G2) in NatureServe.

Yellow Lady's-Slipper (*Cypripedium parviflorum* var. *pubescens*) occurs in mesic meadows in ponderosa pine and mixed conifer forests, and wet areas along streams. Much of the ERUs (Ponderosa Pine Forest, Mixed Conifer with Frequent Fire, and Mixed Conifer with Aspen) this plant occurs in, including both known populations, have been burned in the last 5 years, and these ERUs are very departed and modelled to worsen in the future (Chapter 2: Upland Vegetation). The species also appears to prefer growing in acidic soils. The species has only been documented at 2 sites on the Gila NF (Little Creek Box, and Little Turkey Creek) in 1978 and 1966, respectively, but no collections or surveyors named (Natural Heritage NM 2015). The Gila NF appears to be on the very periphery of the species range. Both known locations likely burned in the Dry Lakes Fire in 2003, and the Miller Fire in 2011, but the severity of the fires in the occupied sites is not known. No known attempts have been made to relocate the historic plant locations, so abundance and trend of the species on the Gila NF is not known. Identified threats include plant collection and habitat loss/degradation (NMRPTC 1999). There has been a range-wide decline of the species of 10-30% (NatureServe 2016). This species should be considered at-risk on the Gila NF because the ERUs in which it occurs are moderately to highly departed, the species is only known from two sites that are isolated from any other known plants, and the two known sites have both burned in wildfires.

Hess's Fleabane (*Erigeron hessii*) occurs in mixed conifer or sub-alpine forest at an elevational range of 9,500-10,200 feet. This species is a very narrow endemic with three sites documented near Whitewater Baldy. The species occurs exclusively and is dependent upon exposed rock or rocky outcrops (NMRPTC 1999). All three sites of this species occurred within the 2012 Whitewater-Baldy Fire perimeter, but it is not likely impacted or possibly even positively impacted by the fire. Also, it is experiencing few, if any, alterations to its habitat from direct impacts of the fire or post-fire impacts (Roth 2016). Exposed rock and cliff habitat where this species grows has not been altered and is likely in low departure from reference conditions. The fact that the species occurs in wilderness areas, offers protections from most threats to the species. One site had approximately 100 plants in full to late flowering stage on a rock outcrop during a 2013 survey of the known sites (Roth 2016). No surveys or studies have been conducted on this species, so trend is unknown but likely stable as they occur and persist in the known historic locations. This species is expected to persist into the future (Roth 2016). This species should be considered at-risk on the Gila NF because it is identified as globally “critically imperiled” (G1) in NatureServe.

Mogollon Hawkweed (*Hieracium brevipilum* (=*H. fendleri* var. *mogollense*)) occurs in ponderosa pine to mixed conifer forests from 8,200-10,500 feet elevation (NMRPTC 1999). Much of the ERUs (Ponderosa Pine Forest, Mixed Conifer with Frequent Fire, and Mixed Conifer with Aspen) this plant occurs in are moderately to highly departed and modelled to worsen in the future (Chapter 2: Upland Vegetation). This species is found from near Mogollon Baldy, north to Willow Creek. More work needed to determine effects from logging, as well as determining abundance and habitat requirements, but the species appears to respond positively to disturbance from fires. This species occurs within the 2012 Whitewater-Baldy Fire perimeter and it is not likely impacted or possibly even positively impacted by the fire, and it is experiencing few, if any, alterations to its habitat from direct impacts of the fire or post-fire impacts (Roth 2016). This species is known from wilderness areas that provide protections from most management activities. Surveys for this species were conducted after the 2012 Whitewater Baldy Fire and they were found to be highly localized, but abundant where they occurred, ranging from 50 to thousands of plants at each site (Roth 2016). Previously undocumented sites were also located during this survey, and it is felt that additional surveys in suitable habitat would likely document additional currently unknown populations. Since surveys by Roth (2016) located historic populations and identified new ones, the trend appears to be stable to slightly increasing. This species is expected to persist into the future (Roth 2016). This species should be considered at-risk on the Gila NF because it is identified as taxonomically “imperiled” (T2) in NatureServe.

Heartleaf Groundsel (*Packera cardamine* (=*Senecio cardamine*)) occurs in mixed conifer wet and spruce-fir forest, typically above 8,000 feet elevation (Roth 2016). It is generally associated with Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), Mountain spray (*Holodiscus dumosus*), aspen (*Populous tremuloides*), alpine woodsorrel (*Oxalis alpina*), wild geranium (*Geranium* sp.), nodding ragwort (*Senecio bigelovii*), and Canadian violet (*Viola canadensis*) (Roth 2016). These ERUs are at moderate to high departure from reference conditions on the Gila NF and not modelled to improve over time (Chapter 2: Upland Vegetation). Populations of this plant are distributed around Willow Mountain, just northwest of Whitewater-Baldy. Likely threats include drying out of sites because of timber harvest or forest fire. Many populations are on steep, inaccessible slopes (NMRPTC 1999, Roth 2016), but most populations likely burned in the 2012 Whitewater-Baldy Fire. While the spruce-fir ERU historically burned on a 150-400 year cycle with mixed severity to stand replacement fire, the mean patch size of the disturbances was historically 200-1,000 acres (Chapter 2: Upland Vegetation). This species is adapted to growing under the canopy of mixed conifer forests (Roth 2016), therefore it is likely that it persisted historically even though the ERUs it occurs in burn typically with severe conditions. The extent of fires that burned historically were not likely as broad as the most recent fires, which could impact persistence with fewer sites that are considered suitable. This species still occupied the general areas and habitat from where they were documented prior to the 2012 fire. Surveys conducted by Roth (2016) showed that plants were found in groupings of a few plants to thousands of plants, well past flowering stage. It can be assumed that these rare plants generally survive the direct impacts of fires, regardless of fire severity (Roth 2016). However, long term impacts of radical habitat alteration caused by severe fires may ultimately cause the decline or even disappearance of several species from their current occupied habitats (Roth 2016). This species should be considered at-risk on the Gila NF because all but one existing site has burned within the last 5 years, and ERUs this species occurs in are moderately and highly departed and not modelled to improve in the future.

New Mexico Groundsel (*Packera quaerens*) occurs in wet meadows and streambanks in upper montane coniferous forest (8,000-9,000 feet elevation). Its locations on the Gila NF have been mapped in the Arizona alder-willow, upper montane coniferous-willow, and ponderosa pine-willow ERUs, all of which are in low to moderate departure from reference conditions (Chapter 7: Riparian). Several of the species in the *Packera hartiana* complex, which includes *P. quaerens*, are very difficult to differentiate, but *Packera quaerens* is treated as its own distinct species in the NRCS PLANTS database (NMRPTC 1999). Plants do not appear to recolonize eroded or disturbed areas (NatureServe 2016). The species is distributed across the Gila NF from the Burro Mountains, northeast to the town of Kingston on the eastern boundary of the Gila NF, north and west to the Arizona state line north of Alpine, Arizona. Identified threats include livestock grazing, recreation, logging, stream siltation, flooding, erosion, loss of habitat due to reservoir construction, and collecting (NatureServe 2016). Loss of habitat due to large wildfire and climate change may also be a factor, as 12 of the 17 known collection sites for this species were likely burned in the 2012 Whitewater-Baldy Fire. Severity of the fire at the sites is not known, and surveys have not been conducted to document abundance or trend for the species on the Gila NF. Overall trend for the species appears to be declining in New Mexico, but the rate of decline is unknown (NatureServe 2016). This species should be considered at-risk on the Gila NF because it is identified as globally “imperiled” (G2) in NatureServe.

Metcalfe's Penstemon (*Penstemon metcalfei*) occurs in cliffs and steep north slopes of montane conifer forest from 6,600-9,500 feet elevation. This species occurs within the ponderosa pine and mixed conifer with frequent fire ERUs, which are moderately to highly departed from reference conditions (Chapter 2: Upland Vegetation). Associated species include Douglas fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), Gambel oak (*Quercus gambelii*), orange gooseberry (*Ribes pinetorum*), alpine woodsorrel (*Oxalis alpina*), scarlet penstemon (*Penstemon barbatus*), New Mexico locust (*Robinia neomexicana*), red elderberry (*Sambuccus racemosa*), chokecherry (*Prunus virginiana*), canyon maple (*Acer grandidentatum*), and aspen (*Populus tremuloides*) (Roth 2016). It is presently known from a small region of the Black Range in Trujillo and Percha canyons. The majority of the occupied habitat and all 5 knowns sites of Metcalfe’s penstemon burned moderately to severely in the 2013 Silver Fire (Roth 2016). In addition to fire severity impacts and canopy removal, much of the stream bank habitat of Metcalfe’s penstemon was significantly impacted by post-fire erosion, including stream bank scouring and incision, debris flows and large volumes of debris deposition (Roth 2016). Because very few plants were documented in 2014 and Metcalfe’s penstemon appears to have a preference for growing in cool, shady areas, underneath the canopy of mixed conifer forests and along stream banks, the species may not persist over time in the majority of documented sites on the Gila National Forest, due to radical habitat alterations caused by the Silver Fire (Roth 2016). A total of 138 plants were found during the post-fire surveys conducted by Roth (2016), and no plants were found at the type locality where there were once “thousands” documented. Trend for this species appears to be declining on the Gila NF. This species should be considered at-risk on the Gila NF because the majority of its habitat and all known locations have burned in the last 5 years, the ERUs it occurs within are moderately to highly departed from reference conditions, and it is identified as globally “critically imperiled” (G1) in NatureServe.

Davidson's Cliff Carrot (*Pteryxia davidsonii*) occurs on moist, rocky places on sheer north facing cliffs in woodland ERUs between 6,500-8,000 feet elevation (NMRPTC 1999). The woodland ERUs are in low to moderate departure from reference conditions across the Gila NF (Chapter 2: Upland Vegetation). The species is found in the Burro Mountains, near Silver City, and near the town of Mogollon. Threats are not well known but may include mining or mineral exploration. This plant inhabits cliff faces that are very inaccessible, and which effectively removes most threats to this species. Geologic features that comprise cliff habitat likely are in low departure from reference conditions. Another threat to the species may include uncharacteristic wildfire. The 2012 Whitewater-Baldy fire may have burned one of the known sites, but no surveys have been conducted to evaluate effects. There is no documentation on abundance or trend for this species on the Gila NF, but it may be more abundant than we think because it inhabits rugged, inaccessible habitat that is difficult to survey. Also, trend for the species on the Gila NF may be stable based on that same inaccessibility. Range-wide, short-term trend is relatively stable <10% change, while the long-term trend is estimated to be stable with no evidence to the contrary (decline of <30% to increase of 25%) (NatureServe 2016). This species should be considered at-risk on the Gila NF because it is identified as globally “imperiled” (G2) in NatureServe.

Mimbres Figwort (*Scrophularia macrantha*) occurs on north facing slopes in piñon-juniper woodlands to dry mixed conifer between 6,500-8,200 feet elevation (NMRPTC 1999). Woodland ERUs are in low to moderate departure from reference conditions, but ponderosa pine and mixed conifer forest with frequent fire are moderately to highly departed from reference conditions (Chapter 2: Upland Vegetation). Fire may have impacted frequent fire ERUs (ponderosa pine and mixed conifer with frequent fire forests) more severely than the woodland ERUs. This species is located along the HWY 152 corridor in Gallinas, Railroad, and Bear Canyons on the east side of the Black Range crest. Many of these populations may have been misidentified as the similar looking mountain figwort (*Scrophularia montana*), which occurred within the habitat of Mimbres figwort (Roth 2016). This may explain why several of the historic populations may not have been found, particularly the locations outside the 2013 Silver Fire boundary. Mimbres figwort may be far more rare than previously thought (Roth 2016). Currently, 15 of 16 existing sites occur within the 2013 Silver Fire boundary. Most of these previously documented sites did not burn, but may have experienced some post-fire flooding and associated scouring of the stream banks. Nonetheless, plants should still be expected along the slopes adjacent to the stream banks, from where they were previously reported. Because Mimbres figwort appears to have a preference for growing in cool, shady areas, underneath the canopy of mixed conifer forests and along stream banks, the species may not persist over time in the majority of documented sites on the Gila National Forest due to radical habitat alterations caused by the Silver Fire (Roth 2016). Additional threats may include mining or mineral exploration, road construction or maintenance, and collection, particularly adjacent to campgrounds where this plant was historically found. No documentation on abundance was available before the fire on the Gila NF, but post-fire surveys conducted by Roth (2016) documented fewer than 400 individuals within the fire perimeter and only 10 outside. They were located in groups of 25 individuals or less. Trend has not been documented for this species on the Gila NF, but the plant was not found at historic sites, most of which were outside the fire boundary. The trend may therefore be declining, but it may be due to factors other than the fire effects. Also, misidentification of the plant within several of the historic sites may explain why the plant was absent from some of the sites and the trend may be more stable. This species should be considered at-risk on the Gila because its trend may be declining, all but one known site was burned in the 2013 Silver Fire, and it is identified as globally “imperiled” (G2) in NatureServe.

Porsild's Starwort (*Stellaria porsildii*) occurs in shade and partially open understory of mixed conifer with aspen between 7,900-8,200 feet elevation (NMRPTC 1999). Mapped locations on the Gila NF show that this plant may occur within ponderosa pine, mixed conifer with frequent fire, and mixed conifer with aspen ERUs on the Gila NF. The Ponderosa pine forest ERU is highly departed from reference conditions, while the mixed conifer with frequent fire and mixed conifer with aspen ERUs are moderately departed from reference conditions (Chapter 2: Upland Vegetation). These ERUs are not modelled to improve in the future. This species is occasionally found scattered on roadsides with steep, loamy and rocky embankments. It has been found along roadsides on the road to Signal Peak in the Pinos Altos Range and in the immediate vicinity of Signal Peak on the Gila NF. Road maintenance activities may impact populations that occur along roadsides or road cuts. Drought is reported as a threat as plants may not emerge during dry periods. Additionally, forest fire, grazing, and recreational impacts may be threats but have not been studied (NatureServe 2016). All known populations on the Gila NF have been burned in the 2014 Signal Fire. There is no documentation for abundance on the Gila NF, but this species has only been found in two disjunct populations (one in AZ and one in NM) and are known to occupy only a small area in each. This species is not likely very abundant. Trend has also not been documented for this species as it has not been studied, but may be declining since this is a shade-loving species and much of the forest overstory where this plant occurred was removed by the 2014 Signal Fire. This species should be considered at-risk on the Gila because its trend may be declining, all known sites were burned in the 2014 Signal Fire, and it is identified as globally “critically imperiled” (G1) in NatureServe.

Pinos Altos Flame Flower (*Talinum humile*) occurs in pine/oak woodland on rocky, south facing slopes, usually on shallow, gravelly, usually clayey soils overlaying rhyolite (NMRPTC 1999). Mapped locations on the Gila NF place this species in piñon-juniper woodland, Madrean pine-oak woodland, and ponderosa pine-evergreen oak forest ERUs. The woodland ERUs are currently in low to moderate departure from reference conditions, while the ponderosa pine-evergreen oak ERU is moderately departed (Chapter 2: Upland Vegetation). Modelling suggests these ERUs will remain in the same conditions or get worse in the future. This species is distributed in the Pinos Altos Range and around the Mimbres Valley. It is located along HWY 15 in the Pinos Altos Range north of Silver City, east to Noonday and Gallinas Canyons, and in Rabb Park. Threats include grazing and, to a lesser extent, housing developments. Threats from grazing in at least two sites in New Mexico have been alleviated causing those populations to "explode" until other vegetation became competitive. This plant seems to grow in inaccessible areas where grazing is the only threat (NMRPTC 1999). Abundance is not well known on the Gila NF, but it is likely not very abundant as range-wide numbers are a little more than 2,000 individuals. Trend is not well documented on the Gila NF, but the locations where the numbers “exploded” are at sites immediately adjacent to the Forest boundary. Grazing occurs on Forest Service lands, so trend may be stable to declining. Overall trend for the species range-wide shows a short-term trend of a 30-70% decline (NatureServe 2016). This species should be considered at-risk on the Gila because its trend may be declining, and it is identified as globally “imperiled” (G2) in NatureServe.

Mogollon Clover (*Trifolium neurophyllum*) occurs in wet meadows, springs, and along riparian corridors in montane coniferous forest from 6,500-9,000 feet elevation (NMRPTC 1999). It can occur within ponderosa pine forest, mixed conifer with frequent fire forest, upper montane coniferous-willow, ponderosa pine-willow, Arizona alder-willow, and herbaceous wetland ERUs on the Gila NF (Chapter 2: Upland Vegetation). The two forested ERUs are moderately to highly departed from reference conditions, while the riparian ERUs are in low to moderate departure across the Gila NF. There is no departure data for herbaceous wetlands, so the departure of that ERU is not known. The forested ERUs have been modelled and show no improvement into the future, but the riparian ERUs have not been modelled because there was insufficient data for model runs (Chapter 7: Riparian). In AZ the plant has been found in drier areas (ponderosa pine forest, mixed conifer with frequent fire ERUs), but not in NM. The species has a fairly broad distribution on the Gila NF and is found from just east of the town of Mogollon, north and east to the Tularosa Mountains, north to the Mangas Mountains, and west to the Arizona state line. Threats include drought and impacts to riparian habitat due to grazing, both native and domestic, or drying of streams or wet meadows through water developments (NatureServe 2016, NMRPTC 1999). Abundance is not well documented on the Gila NF, but estimates of known sites show there are approximately between 10,000-16,000 individuals distributed across the Gila NF with several populations containing several thousand individuals. Trend has not been documented on the Gila NF, but it may be decreasing due to continued habitat disturbance from grazing pressures and continued drought conditions (NatureServe 2016). This species should be considered at-risk on the Gila because its trend may be declining, and it is identified as globally “imperiled” (G2) in NatureServe.

Mogollon Death Camas (*Zigadenus mogollonensis*) occurs in wet mixed conifer, sub-alpine fir >8,700 ft (NMRPTC 1999). The mixed conifer with aspen and spruce-fir forest ERUs are moderately to highly departed from reference conditions on the Gila NF, and the spruce-fir ERU is modelled to worsen into the future (Chapter 2: Upland Vegetation). While the spruce-fir ERU historically burned on a 150-400 year cycle with mixed severity to stand replacement fire, the mean patch size of the disturbances was historically 200-1,000 acres (Chapter 2: Upland Vegetation). This species is adapted to growing under the canopy of mixed conifer forests (Roth 2016), therefore it is likely that it persisted historically even though the ERUs it occurs in burn typically with severe conditions. The extent of fires that burned historically were not likely as broad as the most recent fires, which could impact persistence with fewer sites that are considered suitable. All known populations burned during the Whitewater-Baldy Fire in 2012. Thirty-four sites where this plant occurred within the 2012 Whitewater-Baldy fire perimeter were documented, and only 6 of the sites had not burned. In 28 of the sites, fire burned severely and up to several thousand plants were found at these sites. In the 6 unburned sites there were 71 plants found. The species was found to be growing post-fire in numerous locations, but because Mogollon death camas has never been observed to grow naturally in open areas, the species may not persist over time in the majority of documented sites on the Gila National Forest due to radical habitat alterations caused by the Whitewater-Baldy Fire (Roth 2016).The species is distributed in the Mogollon Mountains, centered around Willow Mountain, in an area of approximately 5 miles x 6.5 miles (Roth 2016). This plant is not threatened by current forest uses, and livestock will not intentionally eat them as they are thought to be poisonous (NMRPTC 1999). Trend has not been documented on the Gila NF, but may decline due to alterations to its habitat after the 2012 Whitewater-Baldy fire. This species should be considered at-risk on the Gila because its trend may be declining, and the ERUs in which the species occurs are moderately to highly departed and modelled to get worse in the future.

Mogollon Mountain Lousewort (*Pedicularis angustifolia*) occurs in mature forests in Catron County between 7,000-9,000 feet elevation (NatureServe 2016). It has been found in mixed-conifer and spruce-fir forests on mature forest floors (SEINet 2016). This species has been found in mixed-conifer with aspen, and spruce-fir forest ERUs that are moderately departed. The locations where this species has been found have had wildfire burn through them, but it is not known at what intensity. This plant is dependent on mature forests as it is a hemiparasitic perennial herb (NatureServe 2016). This species has a small distribution on the Gila NF as it only occurs within a 400 square mile area in Catron County (NatureServe 2016). Threats to the species would include anything that would remove mature forests, such as logging and uncharacteristic wildfire. It has been described as rare overall, but locally “common on mature forest floors” (NatureServe 2016). Trend has not been documented on the Gila NF, but it may be decreasing due to uncharacteristic wildfires that have burned through many of the known locations of this plant. This species should be considered at-risk on the Gila because its trend may be declining, and it is identified as globally "imperiled" (G2) in NatureServe.

Gunnison's Prairie Dog (prairie population) (*Cynomys gunnisoni*) occurs in grasslands/shrublands 6,000-12,000 ft. The species is relatively well distributed in the north half of the Gila NF as it is found from Kemp Mesa, near Beaverhead, north and west to the northern boundary of the Gila NF. Information is lacking on population size or trends, but it is thought some of the populations on the Gila NF are declining (Jerry Monzingo pers. comm.). Habitat restoration work currently being conducted in areas that are occupied may benefit the species by moving grasslands more toward reference conditions. Short-term trend appears to be relatively stable to <30%, but the long-term trend shows a 70-90% decline (NatureServe 2016). This species should be considered at-risk on the Gila NF because the ERUs they inhabit are moderately to highly departed and not modelled to improve in the future, numbers on the Gila NF may be declining, and high susceptibility to Sylvatic plague.

Arizona Montane Vole (*Microtus montanus arizonensis*) occurs in mesic meadows in ponderosa pine and mixed conifer. The ponderosa pine forest, mixed conifer with frequent fire, and mixed conifer with aspen ERUs are highly, moderately to highly, and moderately departed, respectively (Chapter 2: Upland Vegetation). The species is found in two disjunct and isolated locations on the Gila NF. One location is in the northwest part of the Forest in Centerfire Bog, while the other is located to the west near the Arizona state line in Jenkins Creek (Frey et al. 1995). These two locations are separated by approximately 8 miles. Threats include habitat alteration through over-grazing or other activities that dry out mesic meadows (BISON-M 2016). Abundance of the species may be quite low as trap attempts yielded only one vole, even though 40 Sherman traps were set and there was an abundant number of vole runways with fresh feces and grass clippings (Frey et al. 1995). In New Mexico, the trend is unknown as the previously mentioned sites are the only locations the vole has been found. However, in Arizona surveys have found that it is much more abundant than once thought (BISON-M 2016). This species should be considered at-risk on the Gila NF because the ERUs they inhabit are moderately to highly departed and not modelled to improve in the future, only two isolated populations have been found on the Gila NF, and numbers at both sites appear to be very low.

Stakeholder Input

Over the past year, the Gila NF has initiated the first phase of Forest Plan Revision and began working on an Assessment of the Gila NF resources. Throughout that time period there have been community meetings, symposiums, and presentations given on the various aspects of the assessment where the public and other stakeholders have been encouraged to provide any input, comments, or additional information sources to aid in the development of the assessment. The comments have been compiled by resource area and evaluated to help create the most comprehensive assessment from which to base the revised forest plan.

There were many comments regarding at-risk species and species of conservation concern (SCC) ranging from a few words to several pages. Several of the comments were quite polarized in the message including comments on grazing (too much, too little), threatened and endangered species (too many, too few), predators (too many wolves and coyotes, need more apex predators), and human influence to the ecological landscapes (reduce human influence, actively manage Forest). Some comments brought up things that the Forest Service has no control over (i.e. species listings, hunting regulations) which highlights that there may be misconceptions about what the Forest Service does and the responsibilities the agency has. There were also several suggestions on where to find relevant information to incorporate into the assessment.

Even with these polarized comments, there were some common themes that most people felt the Gila NF needs to capture and take forward into the plan revision phase. The use of sound science in developing management practices for all issues from grazing to fire use to fisheries management. This appeared to be the single most commonality amongst commenters providing input. Another important item was the need for not just monitoring, but focused and meaningful monitoring. It is felt that better information to inform managers will aid in providing adaptive management for a resilient landscape. There was also a feeling that the agency needs to manage the Forest more holistically to get away from single species management and manage in a way that benefits multiple species and resources.

Additionally, the Gila NF Draft Assessment Report was released in September 2016 allowing interested stakeholders to provide feedback. Numerous comments from individuals, organizations, and other government agencies were and catalogued in the project record. There were numerous species we were asked to evaluate or re-evaluate for inclusion into the SCC list. Many of these species either did not occur on Gila NF lands, do not meet criteria outlined in the directives for inclusion as an SCC, or they have previously been assessed and found not to be a SCC. Many excellent suggestions were made, which in turn we incorporated into this final draft, including the addition of four species to be added to the potential SCC list.

Fortunately the 2012 Planning Rule Directives attempt to address the very comments the Gila NF received during public input. They direct the Gila NF to use Best Available Scientific Information as well as guiding the Forest to manage landscapes using the Ecological Response Unit and SCC concepts. The general premise of these concepts is to manage the Forest in a way that restores or maintains ecological integrity which in many cases will move the Forest closer to reference conditions. This ecological integrity should provide conditions favorable to species that occur and evolved in those systems, thus managing in a holistic manner.

Summary

The Gila NF is home to hundreds of animal and plant species, some of which are found only on the Gila NF, and others for which changing land-use patterns in the broader landscape have increased their reliance on Gila NF managed lands. These species provide many ecosystem services, including: (1) supporting services, such as nutrient cycling, soil formation and manipulation, primary production, and seed dispersal; (2) regulating services, including carbon sequestration, pollination, and erosion control; (3) provisioning services, such as food, fiber, medicine, and forest products; and (4) cultural services, including recreation, opportunities for scientific discovery and education, and cultural, intellectual, or spiritual inspiration. The most important drivers of change in ecosystem services are habitat change, climate change, invasive species, overexploitation, and pollution. This chapter focuses on at-risk species that occur on the Gila NF, which indicate the ecosystem services provided by these species are decreasing and at risk.

At-risk species decisions are based on best available scientific information. Unfortunately many species lack specific information on current population status, distribution, or abundance making it difficult to determine risk. Another confounding issue is scale. Although some species information indicate increase or a decline on a large geographic scale (i.e. nationwide or statewide), forest-wide expertise may not suggest a similar determination. Should any new information become available the plan can be amended to accommodate the new information.

There are 66 at-risk species on the Gila NF, 15 are federally listed threatened or endangered and 51 are identified as species of conservation concern. A total of 15 federally recognized species (six endangered, seven threatened, two proposed threatened) were determined to be relevant to the plan area. Of the 15, seven are fish, three birds, two reptiles, two mammals, and one amphibian.

Potential SCC were determined following guidance in the proposed directives issued for the 2012 Planning Rule. Wildlife and plant species identified as at-risk by a number of different entities were considered. The species that were ultimately considered to be at-risk met the following criteria: (1) met the initial requirements; (2) had been documented on the Gila NF; and (3) had the potential to be both positively and negatively affected by Forest Service management activities. An overall risk assessment for each species was calculated from data identifying the status of historic, current, and future population trends and associated ERUs and data identifying threats to the species or to key ecosystem characteristics. A total of 51 potential SCC were determined to have substantial concern over species' capability to persist over the long term in the plan area, including: 27 invertebrates, 18 plants, two mammals, one fish, one amphibian, and two birds.

If management activities focus on ecosystem integrity and diversity goals by including disturbance-absorbing connected habitats, then ecological conditions could be effectively restored and maintained. These improved ecological conditions would maintain the diversity of plant and animal communities and support the abundance, distribution, and long-term persistence of common and secure, imperiled, or vulnerable native species. Species-specific plan components within each ERU will be developed for those species with additional or key ecosystem characteristic needs or where ecological conditions are not otherwise met.

Chapter 9. System Drivers and Stressors

Introduction

System drivers are factors or processes that determine what is ecologically possible on the landscape and the natural range of variability in conditions. Stressors are natural or human caused alterations in system drivers that may directly or indirectly threaten resource sustainability. It is the combination of and interactions between system drivers and stressors that have resulted in current conditions discussed throughout the ecological volume of the assessment. This chapter identifies, describes and evaluates the reference and current status of system drivers and stressors common to water resources and terrestrial, riparian and aquatic ecosystems. Drivers and stressors that apply to individual resources or characteristics are briefly described in those respective chapters.

In the context of system drivers and stressors, recall that the NRV approach to reference conditions is defined by the period prior to European settlement; this means that the NRV includes the influence of Native American populations. Ecological conditions during the reference period were by no means pristine. As described in Chapter 17: Cultural and Historic Resources, some aspects of ecological change during this time period responded directly to the influence of human populations. On the Gila NF, archeological and anthropological researchers have compiled evidence and drawn inferences regarding the human dynamics of this time period and how it influenced, and was influenced by, the distribution of plant and animal species and other natural resources (Creel et al. 2010; Creel and Speakman 2012; Minnis 1985; Schoolmeyer 2009; Shafer 2006). However, there are limits to our knowledge of these dynamics.

Predominant Climatic Regime

Climate, or the average weather, is the primary system driver. It largely determines the timing, quantity, duration and distribution of available water, and influences all ecological processes and ecosystem characteristics including but not limited to: the potential natural vegetation community, natural rates of soil formation and loss, fire regimes and patterns of insects and disease.

For the most part, climate across the plan and context areas is characterized as semiarid and warm, with low annual precipitation and a high number of sunny days. Past precipitation and temperature of the region has varied sharply at time scales ranging from annual to multi-decadal. Climate also varies by elevation, topography and aspect. North facing slopes tend to be cooler and wetter than south facing slopes due to differences in solar radiation. Topographic features such as mountain ranges, influence wind patterns that carry air masses with different temperatures and moisture content. Mountain ranges can force approaching air masses to move upward quickly, resulting in cooling and precipitation. Annual precipitation data for the context area is displayed in Figure 145. The area in gray is the Gila NF. No equivalent data is available for the portion of the context area in Mexico.

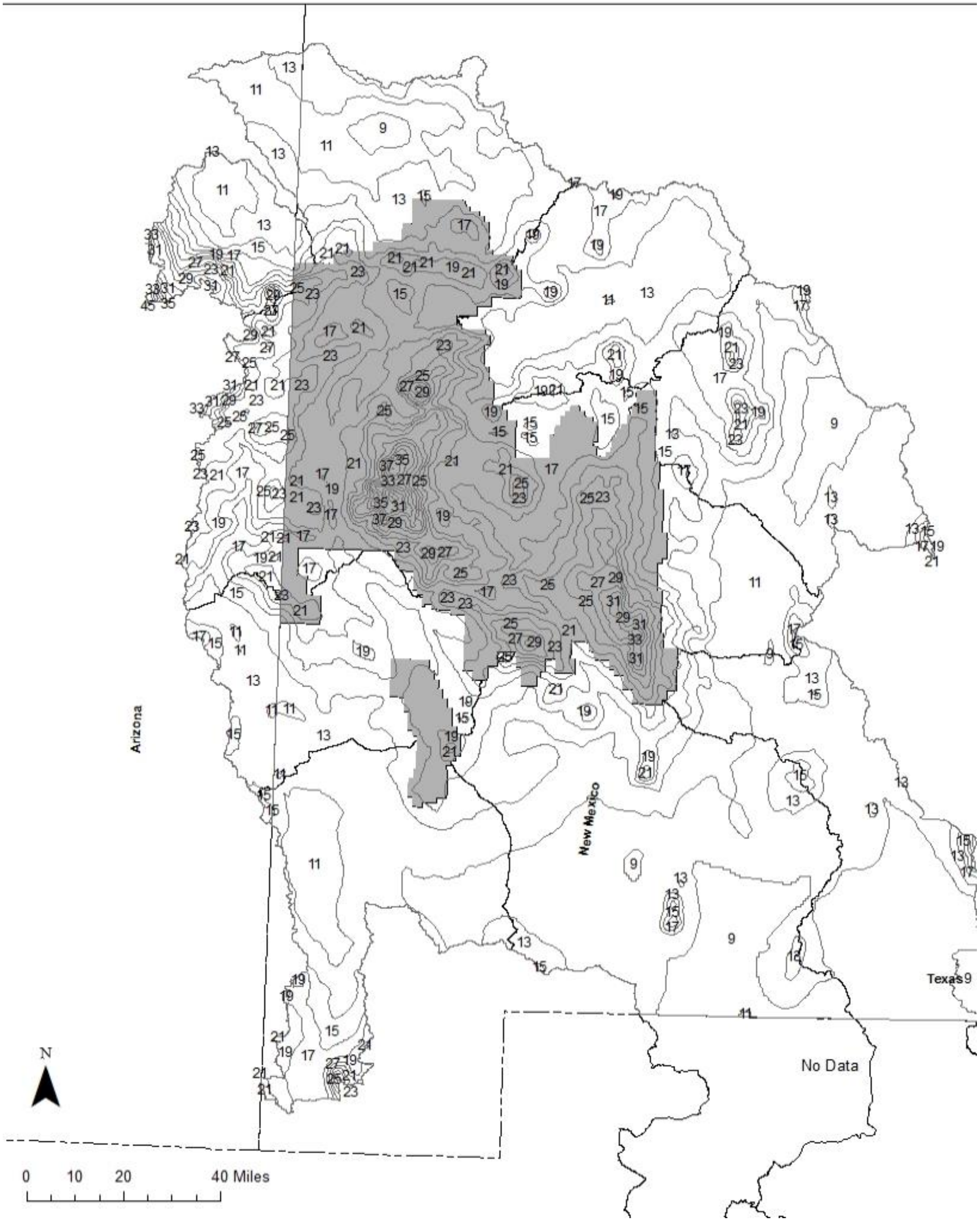

Figure 145. Average annual precipitation in inches, 30 year normals, time period 1981-2000.

Note: From Parameter-Elevation Regressions on Independent Slopes Model (PRISM)

Areas of higher precipitation are found at higher elevations in the Mogollon and Black Range Mountains on the Gila NF and along the Mogollon Rim in Arizona. Areas of lower precipitation occur throughout the lower elevations of the context area, but become more common toward the south and west. Average annual precipitation by subbasin and watershed, and the percent falling on the Gila NF are included in Appendix D.

Across the context area, there are generally two principal periods of precipitation. The summer monsoon season typically occurs July through August. Rainfall during this time period is characterized by convective, high intensity, short duration storms. These are usually small storms, averaging an estimated five square miles. Late in the monsoon season and continuing into October, the area can experience high intensity, longer duration storms of cyclonic origin associated with hurricanes in the Gulf of Mexico and Pacific Ocean. These do not occur with the same regularity of the monsoon rains.

The second principal period of precipitation typically occurs from December through February when easterly storm tracks originating from the Pacific Ocean cross over the Forest allowing for widespread precipitation. This precipitation usually falls as snow in the higher elevations. The snow pack at these higher elevations generally develops continuously over this period but melts over a much shorter time span. In years where there is an El Niño event, winter precipitation tends to be higher than normal. In La Niña years, drier than normal conditions exist from late summer and into the winter.

There is limited snow pack data for the context and plan area. The available data comes from the Natural Resources Conservation Service and National Water and Climate Center’s Snow Telemetry (SNOTEL) and Snow Course datasets. Periods of record are highly variable between stations and the characteristics measured (e.g. snow depth or snow water equivalent). Prior to 2004, many stations were not consistently recording data for the same months every year. Table 184 summarizes what snow pack information exists by subbasin (4th level watershed) and watershed (5th level watershed).

Table 184. Snow pack characteristics by subbasin and watershed[1]

Watershed Name	Station Name	Elevation (ft)	On Gila NF (yes/no)	Average Monthly Snow Depth (in)						Average Snow Water Equivalent (in)					
				Jan	Feb	Mar	Apr	May	June	Jan	Feb	Mar	Apr	May	June
Mimbres Subbasin															
Gallinas Canyon-Mimbres River	McKnight Cabin Snotel	9,240	Yes	9.6	12.5	16.1	2.6	0.3	0.1	2.2	3.4	3.6	0.9	<0.1	<0.1
	Emory Pass	7,800	Yes	4.3	4.6	2.7	0.6	0	No data	0.9	1.3	0.9	0.1	0	No data
Little Colorado Headwaters															
	Baldy	9,125	No	12.6	20.4	21.6	7.2	0.2	0	3.4	5.8	7.3	4.6	0.3	0
	Cheese Spring	8,700	No	11.3	17.8	21.0	12	0	No data	2.4	4.0	5.5	3.6	0	No data
	Fort Apache		No	15.6	24.7	28.0	20.8	No data	No data	3.6	6.0	7.7	6.7	No data	No data
Upper Gila Subbasin															
Sapillo Creek	Signal Peak	8,360	Yes	8.8	11.0	8.5	1.2	0	0	2.3	4.0	4.35	0.7	0	0
Middle Fork Gila River	Whitewater	10,070	Yes	41.4	54.4	67.0	65.3	No data	No data	9.5	14.8	19.6	22.5	No data	No data
Headwaters East Fork Gila River	Lookout Mountain	8,500	Yes	4.9	4.2	1.6	0.2	0.2	0	1.5	2.2	1.5	<0.1	<0.1	0
Outlet East Fork Gila River	McKnight Cabin Aerial Marker	9,300	Yes	8.1	14.3	16.0	6.1	No data	No data	1.8	3.6	4.7	2.2	No data	No data
San Francisco Subbasin															
Centerfire Creek-San Francisco River	Frisco Divide	8,000	Yes	6.8	7.4	2.9	0.1	2.9	0	1.4	2.5	2.4	<0.1	0	0
Pueblo Creek-San Francisco River	Silver Creek Divide	9,000	Yes	21.9	16.8	20.7	12.6	1.6	0.1	3.8	6.1	8.5	8.3	1.8	0
	Stateline	8,000	No	5.5	10.3	8.7	2.0	0	No data	1.2	2.5	2.3	0.7	0	No data
	Coronado Trail	8,425	No	6.4	10.8	9.1	2.6	0.1	0	1.5	2.8	2.8	0.8	<0.1	0
	Nutrioso	8,500	No	4.8	7.5	9.4	2.0	0	0	1.1	1.9	1.8	0.6	0	0
Gila NF Average				**14.0**	**21.0**	**24.1**	**19.7**	**1.1**	**<0.1**	**2.9**	**5.3**	**6.4**	**5.5**	**0.4**	**<0.1**
Total Average				**11.6**	**15.5**	**16.7**	**9.7**	**0.5**	**<0.1**	**2.6**	**4.4**	**5.2**	**4.3**	**0.5**	**0**

[1] Watersheds are not listed for those stations outside the plan area. The data for the Coronado Trail Snow Course and Snotel were averaged because they are in the same watershed with a 50 foot elevation difference. The data for the Nutrioso Snow Course and Snotel were averaged because they are in the same watershed at the same elevation.

The United States is divided into climate divisions. Each division represents an area with relatively similar climate conditions. The Forest's distribution across these climate divisions is displayed in Figure 146.

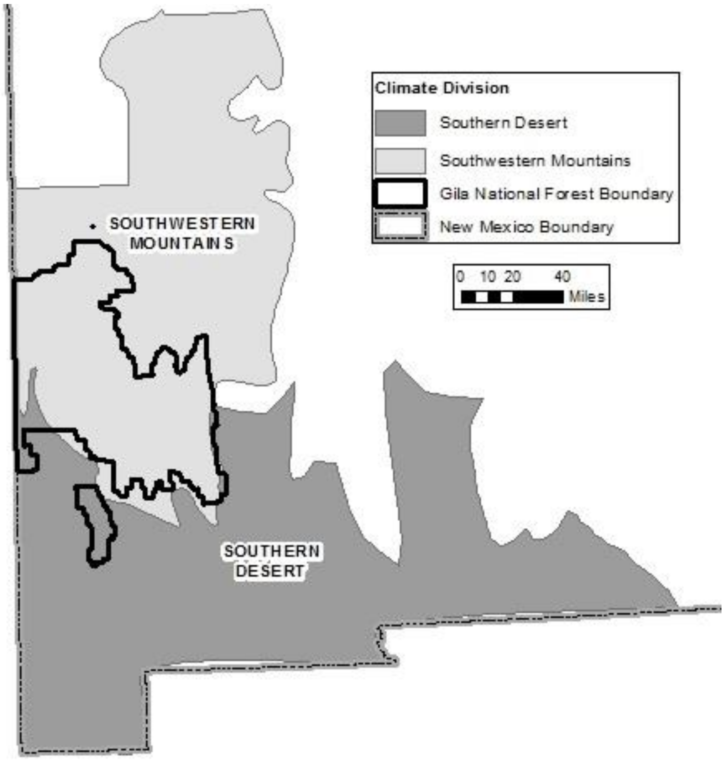

Figure 146. Climate Divisions of the Gila NF

The plan area falls primarily in the Southwest Mountains, but portions also fall within the New Mexico Southern Desert. Figure 147 displays temperature data for these climate divisions from 1895-2014.

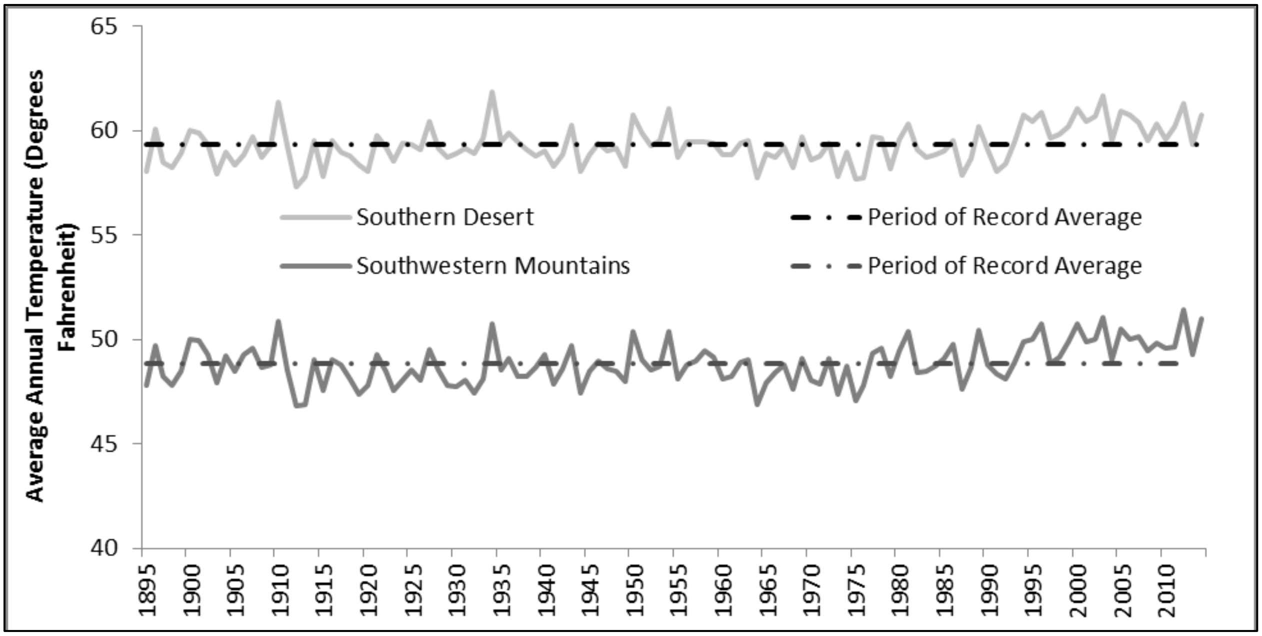

Figure 147. Average annual temperature for the New Mexico Southwestern Mountains and Southern Desert climate divisions, 1895-2014 time periods

In the Southwestern Mountains, the average annual temperature across all years is 48.9 degrees Fahrenheit. The highest annual average temperature was 50.9 degrees Fahrenheit in 1910. The lowest annual average temperature (46.8 degrees Fahrenheit) occurred in 1912. In the Southern Desert, the average annual temperature across all years is 59.1 degrees Fahrenheit with the hottest year being 1934 (61.9 degrees Fahrenheit) and the coolest year also being 1912 (57.3 degrees Fahrenheit). Although higher temperatures have always occurred in the Southern Desert, the pattern of annual and decadal variability is similar for both divisions.

Temperature exerts a significant influence on precipitation patterns, from the El Niño-La Niña cycles which are largely driven by temperatures in the Pacific Ocean, to the more regional and local convective heating that contributes to the summer monsoons. Figure 148 displays the average annual precipitation for the climate divisions.

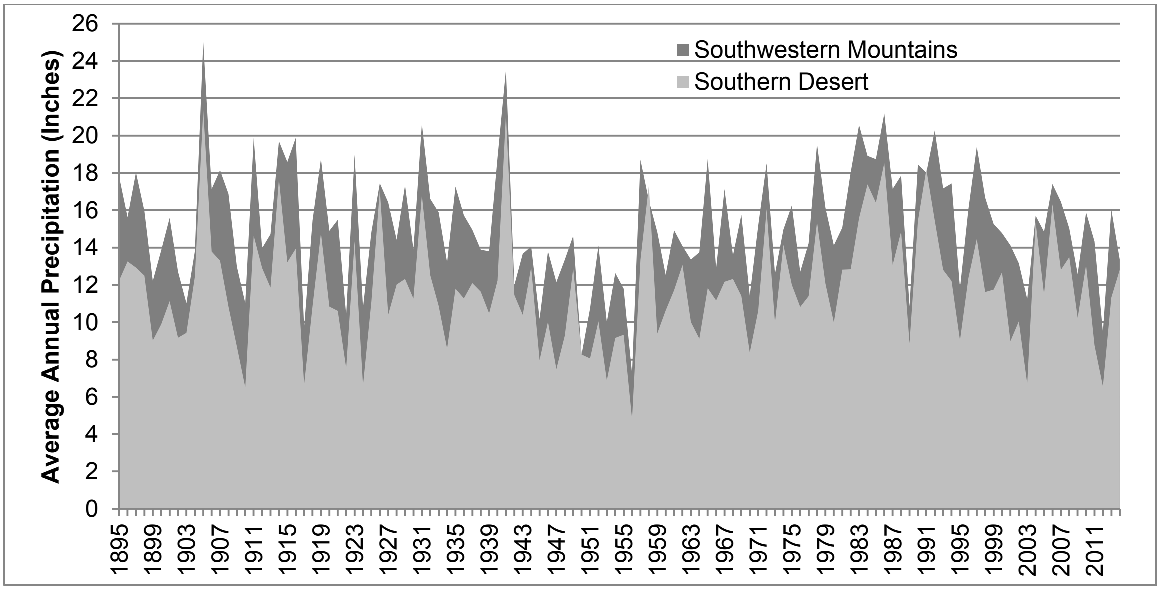

Figure 148. Average annual precipitation for the New Mexico Southwestern Mountains and Southern Desert climate divisions, 1895-2014 time periods

In the Southwestern Mountains, the average annual precipitation across all years is 15.3 inches. The highest annual average precipitation was just over 20 inches and occurred in 1905. The lowest annual average precipitation (7.2 inches) occurred in 1956. In the Southern Desert, the average annual precipitation across all years is 11.9 inches with the driest year also being 1956 (4.8 inches) and the wettest year 1905 (21.4 inches). Although higher precipitation has always occurred in the Southwestern Mountains, the pattern of annual and decadal variability is similar for both divisions.

The instrumental record does not extend to the time prior to European settlement. The Climate Assessment for the Southwest (CLIMAS) at the University of Arizona has developed a Paleoclimate Tool which provides a reconstruction of cool season precipitation for each climate division in Arizona and New Mexico back to the year 1000. This tool is based on data collected from tree ring studies across the southwest and is available at http://www.climas.arizona.edu/paleoclimate-tool. Cool season precipitation can be correlated to annual tree-ring widths with more certainty than warm season precipitation. Efforts by the North American Monsoon Project may prove the reconstruction of the warm season precipitation to be possible in the future. Figure 149 and Figure 150 display the reconstructions for the Forest's two climate divisions. This work was completed in 2006 and has not been updated to include subsequent years.

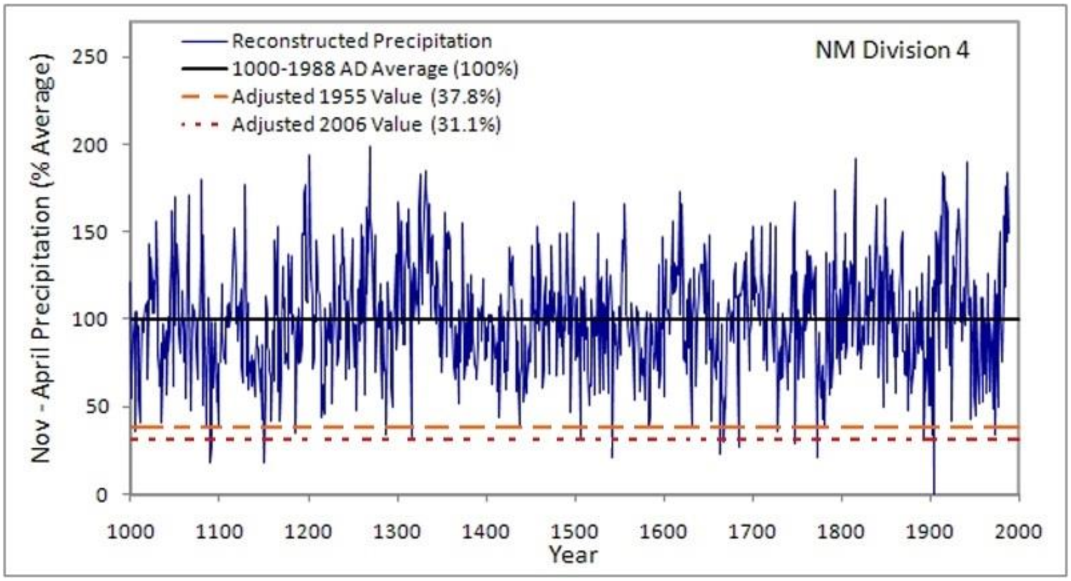

Figure 149. Reconstructed cool season precipitation for the Southwestern Mountains climate division

Note: The adjusted 1955 and 2006 value lines were altered from the original CLIMAS graph to improve readability in black and white.

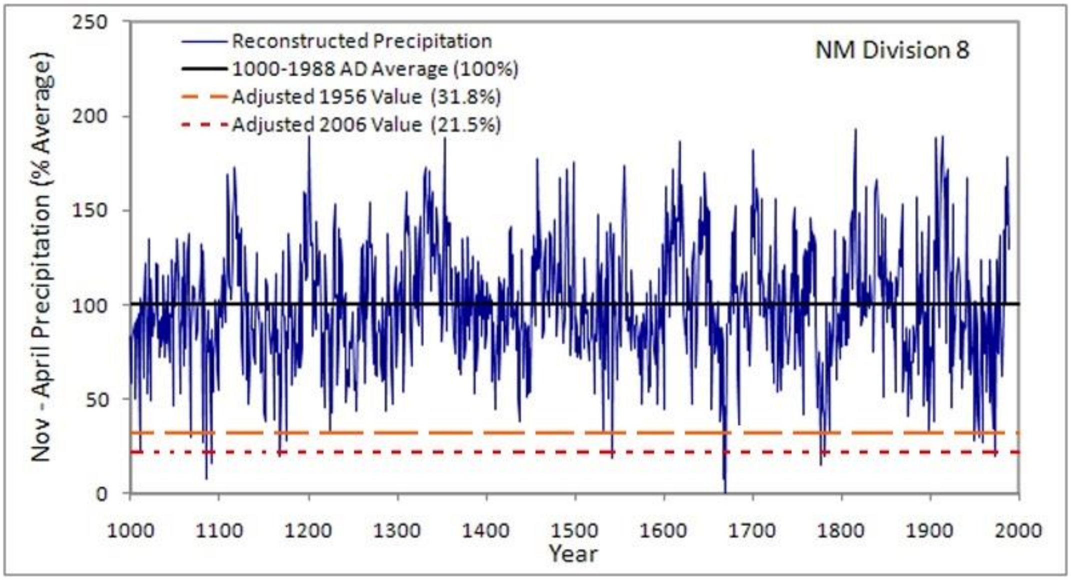

Figure 150. Reconstructed cool season precipitation for the Southern Desert climate division

Note: The adjusted 1955 and 2006 value lines were altered from the original CLIMAS graph to improve readability in black and white.

The reconstructions show not many years in the last 1000 years were drier than 1956 and even fewer drier than 2006. Table 185 and Table 186 compare the driest and wettest five year period using the reconstructed time period (1000-1894) and the instrumental record (1895-2006).

Table 185. Comparison of reference and current precipitation for the New Mexico Southwestern Mountains climate division

	Reference Time Period (1000-1894)					Instrumental Record (1895-2006)				
Driest Five-Year Period										
	1666-1670	1090-1094	1778-1782	1147-1151	1214-1218	1902-1906	1955-1959	1900-1904	1972-1976	1901-1905
Precipitation (in)	9.0	9.7	10.0	10.1	10.6	11.3	12.6	12.7	12.7	13.3
Percent of Average (1000-2006)	49	53	55	55	58	63	65	66	66	68
Wettest Five-Year Period										
	1330-1334	1267-1271	1197-1201	1325-1329	1309-1313	1993-1997	1985-1989	1986-1990	2003-2007	1940-1944
Precipitation (in)	30.8	29.2	28.1	26.8	26.3	28.8	27.6	26.9	26.5	26.4
Percent of Average (1000-2006)	159	156	156	155	154	186	163	162	157	157

The higher percent of average values suggest that in the Southwestern Mountains, cool season precipitation has generally been greater during the last 111 years than in the reference time period.

Table 186. Comparison of reference and current precipitation for the New Mexico Southern Desert climate division

	Reference Time Period (1000-1894)					Instrumental Record (1895-2006)				
Driest Five-Year Period										
	1777-1781	1667-1671	1782-1786	1090-1094	1166-1170	1955-1959	1902-1906	1911-1915	1954-1958	1910-1914
Precipitation (in)	7.4	7.6	9.8	10.1	10.2	10.1	10.5	10.6	10.7	11.0
Percent of Average (1000-2006)	43	43	56	58	58	63	65	66	66	68
Wettest Five-Year Period										
	1330-1334	1617-1621	1812-1816	1837-1841	1116-1120	1993-1997	1994-1998	1985-1989	1992-1996	1991-1995
Precipitation (in)	27.8	27.3	27.2	27.1	27.0	30.1	26.4	26.2	25.4	25.4
Percent of Average (1000-2006)	159	156	156	155	154	186	163	162	157	157

In the Southern Desert, the reconstructions also suggest that cool season precipitation has generally been higher than it was during the reference time period.

Drought

A drought is a prolonged period of time of below average precipitation. Droughts are normal and recurrent climatic features that have occurred both before and after European settlement on time scales ranging from single growing seasons to multiple years, even decades (Sheppard et al. 2002). Drought impacts can include, but are not limited to: reduced streamflow; reduced water quantity and reliability of upland water sources; reduced vigor, growth and regeneration of riparian species and a reduction in the ability of re-sprouting species to do so after fire; reduced canopy cover, vigor, growth and seed production in grasses; reduced vegetative groundcover and decreased fuel moisture. Drought also has cascading effects associated with increased risk of erosion, sedimentation and wildfire, as well as downward trends in rangeland condition.

The Palmer Drought Severity Index (PDSI) is considered the most appropriate drought index for unirrigated land. It uses precipitation and temperature data, incorporates soil moisture and calculates water supply and demand (Climate Prediction Center Internet Team 2005). Figure 151 illustrates the patterns of drought that have occurred over the instrumental record for both climate divisions. Drought years are indicated by negative values.

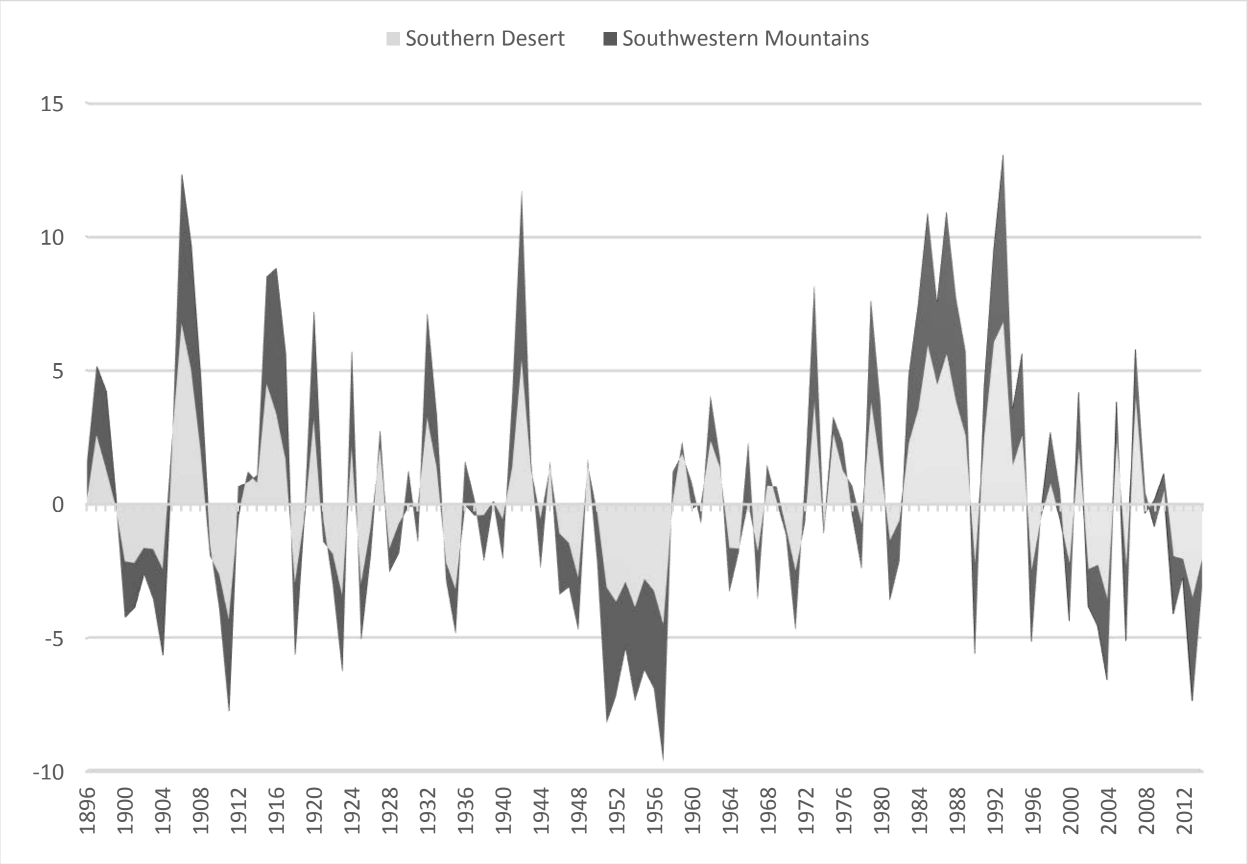

Figure 151. Drought cycles as depicted by the climate division PDSI values, period of record 1896-2014

The droughts of the last 110 years pale in comparison to some of the decades-long "megadroughts" that the region has experienced over the last 2000 years (Seager et al. 2008). The most severe drought in the period of record occurred in the 1950s and was more severe in the Southwestern Mountains than in the Southern Desert. The most recent drought began in the late-1990s and has been made worse by record increases in temperature. Although average to above average precipitation in 2015 relieved some of the short-term drought conditions, multiple years of average to above average precipitation are needed for long-term relief (University of Arizona CLIMAS 2015). Climate change is projected to increase the frequency, severity and duration of droughts (IPCC 2007; Seager et al. 2007).

Climate Change

Although regional climatic regimes persist for centuries, they do change and vegetation responds on a similar scale (Delcourt and Delcourt 1983). However, recent climate change is a stressor. The USDA FS Southwestern Regional Office has compiled the best available science for climate change relevant to forest planning in the Southwest; this includes the scientific consensus that human caused increases in carbon dioxide and other greenhouse gases are among the causes of global temperature increases (USDA FS 2010a)

In the Southwest, climate modelers agree there is a drying trend that will continue well into the latter part of 21st century (IPCC 2007; Seager et al. 2007). While some models have predicted an increase in precipitation (Seager et al. 2007), associated temperature increases are expected to increase evaporation such that an overall decrease in available moisture remains likely. Regional warming and drying trends have occurred twice in the 20th century during the 1930s Dust Bowl and the 1950s Southwest Drought.

Climate change is projected to increase the frequency, severity and duration of droughts (IPCC 2007; Seager et al. 2007). Models predict the slight warming trend observed in Southwest over last 100 years may continue into the next century, with temperature rising approximately five to eight degrees Fahrenheit by the end of the century. The greatest warming is expected to occur during winter (IPCC 2007). While the region is expected to get drier, it is likely to see larger, more destructive flooding events. Average air temperatures are rising. It is likely that continued warming will accentuate the temperature difference between the Southwest and the tropical Pacific Ocean, enhancing the strength of the westerly winds that carry moist air from the Pacific Ocean into the Southwest during the monsoon. This scenario may increase the monsoon's intensity, or its duration, or both, in which case floods will occur with greater frequency (Guido 2008). Along with storms in general, hurricanes and other tropical cyclones are projected to become more intense overall. New Mexico and Arizona typically receive 10 percent or more of their annual precipitation from storms that begin as tropical cyclones in the Pacific Ocean. In fact some of the largest floods in the Southwest have occurred when a remnant tropical storm hit a frontal storm from the north or northwest (Guido 2008).

Climate change is likely to modify ecological conditions, processes and ecosystem services in many regions and ecosystems (Westerling et al. 2006; Bowman et al. 2009; Flannigan et al. 2009) including the context and plan areas, by altering precipitation patterns, and the timing, quantity, duration and distribution of available water. The effects of climate change could be particularly profound for native fishes and aquatic ecosystems of the Rocky Mountains and Arizona-New Mexico Mountains because those systems often lack resilience and are strongly dependent on temperature and stream flow regimes that are already documented to be changing (Rieman and Isaak 2010). In addition, plants in the arid Southwest already live near their physiological limits for water and temperature stress (Archer and Predick 2008). Vegetative productivity may decrease with increasing temperatures, as water becomes a greater limiting factor, although this may be partially offset if CO_2 fertilization significantly increases water-use efficiency in plants (USDA FS 2010a).

Vegetative communities are expected to shift upward in elevation and contract in elevation range. Compositional changes in vegetative communities are also predicted, as individual species respond differently to changes in climate. In fact, changes such as these have already been documented in the montane grassland and mixed conifer vegetation types of the Southwest (Brusca et al. 2013) and impacts are expected to increase as climate change continues and perhaps even accelerates (Staudt et al. 2012a). According to Swetnam and Falk (2015), a predicted net decline in summer precipitation relative to winter precipitation may lead to woody plants being favored over grasses in some locations. On the other hand, another study suggests the Southwest could experience massive conifer die off (≥ 50 percent) over the next 85 years (McDowell et al. 2015), which could have serious consequences in terms of biodiversity, nutrient cycling and carbon storage (USDA FS 2016h).

Eighty percent of the habitats in the Southwest have warmed over the last 55 years; some have warmed twice as fast as others (Karl et al. 2009, Robles and Enquist 2010, Beschta et al. 2012). The climate data presented in the previous discussion on the predominant climate illustrates that average annual temperatures within the Forest's two climate divisions have not dropped below the period of record average since the mid-1990s

The vulnerability of biodiversity to climate change is dependent on the character, magnitude, and rate of changes experienced by a species or system (exposure), the degree to which they are, or are likely to be, affected by or responsive to those changes (sensitivity), and the ability to accommodate or cope with impacts with minimal disruption (adaptive capacity) (IPCC 2007; Williams et al. 2008; Glick et al. 2011). Each of these factors is difficult to measure due to uncertainties in climate change projections in the coming decades, and gaps in our knowledge of biological and ecological responses to these changes (Glick et al. 2011). In addition, biodiversity is already impacted by a range of anthropogenic stressors including land use change, exploitation, pollution, non-native invasive species, and disease. In many cases, these other stressors have been, are currently (Flather et al. 1997; Wilcove et al. 1998; Jetz et al. 2007; Master et al. 2012), or are expected to be the primary drivers of biodiversity loss (Clavero 2011). Overall, it is anticipated that the impacts of climate change will become increasingly pervasive and influential in the coming decades, and interact synergistically with existing stressors to affect biodiversity's vulnerability (Brook et al. 2008; Barnosky et al. 2011; Mantyka-Pringle et al. 2011). For example, new bioclimatic conditions and altered community compositions may enable invasions by non-native species, thus further stressing biological systems (Walther et al. 2009). Although the net effect on biodiversity globally is expected to be markedly negative (Bellard et al. 2012), an increasing number of studies shows that a range of species and populations may experience local benefits and thrive under the changing climate conditions (Schmidt et al. 2009; Hare et al. 2010; Schmidt et al. 2011).

In 2015, the Forest Service Southwestern Region prepared the Climate Change Vulnerability Assessment (CCVA) for the Gila NF (Triepke 2015). This is an ecosystem-based vulnerability assessment for all major upland ecosystems in Arizona and New Mexico based on the anticipated effects of climate change. Four vulnerability categories are reported: low, moderate, high and very high. Vulnerability categories are accompanied by uncertainty categories to account for difference in climate model predictions. These uncertainty categories are low, moderate and high. Vulnerability and uncertainty results are summarized at the ERU, Forest and local unit scales. Vulnerability is also summarized by subwatershed, but these ratings are not accompanied by uncertainty ratings. Although riparian systems were not specifically analyzed, some inferences can be made related to their vulnerability based on the subwatershed summary.

Essentially, the CCVA describes the relative susceptibility of an ecological type conversion (Triepke 2015). The conversion of a mixed conifer-frequent fire type to a Gambel oak shrubland type, or montane grassland, or a ponderosa pine-willow type to a ponderosa pine type would be an examples of ecological type conversions.

The CCVA provides a means to account for climate change predictions in forest planning and modify risk assessments to reflect those predictions. While climate change is a stressor largely outside the control of Gila NF management key climate change factors may be addressed by:

- Enhancing adaptation by anticipating and planning for disturbances from intense storms
- Reduce vulnerability by maintaining and restoring resilient native ecosystems
- Increase water conservation and plan for reductions in upland water supplies
- Avoid management actions that could exacerbate the effects of drought
- Anticipate increased demand for forest resources
- Monitoring climate change influences

Table 187 summarizes the CCVA results for the Forest's upland ERUs at the plan and local scales, followed by Figure 152 providing the watershed vulnerability ratings and Table 188 summarizing the watershed ratings on an area weighted basis for the Forest's riparian ERUs. If no ratings were generated for a particular ERU or unit, the table cell is blank; otherwise "L" indicates low, "M" indicates moderate, "H" indicates high and "VH" indicates very high.

Table 187. Ecological Response Units of the Gila NF and the summarized Climate Change Vulnerability Assessment vulnerability and uncertainty ratings

		Local Units													
		Apache		Black Range		Little Colorado-San Agustin Fringe		Lower Gila River		Mogollon Front		Upper Gila River		Gila NF (Plan Unit)	
ERU Name	**ERU Percent of Gila NF**	**Vulnerability**	**Uncertainty**	**Vulnerability**	**Uncertainty**	**Vulnerability**	**Uncertainty**	**Vulnerability**	**Uncertainty**	**Vulnerability**	**Uncertainty**	**Vulnerability**	**Uncertainty**	**Vulnerability**	**Uncertainty**
Spruce-Fir Forest	1									VH	L	VH	L	VH	L
Mixed Conifer with Aspen	2	M-H	M	H-VH	L-M					M	M	M-H	M-H	M-VH	L-M
Mixed Conifer-Frequent Fire	11	M	M-H	H-VH	L-M	M-H	M-H	H-VH	L-M	M	M	M-H	M	M-H	M
Ponderosa Pine Forest	19	M	M	H	M	M-H	M	VH	L	M-VH	L-M	M-H	M	M-H	M
Ponderosa Pine Evergreen Oak	12	M	M-H	M-H	M	M	M	M	M-H	M-H	M	M	M	M	M
Madrean Piñon-Oak Woodland	1									L	M			L-M	M
PJ Evergreen Shrub	<1														
PJ Woodland	26	L-M	M			L	M	H	M	M	M	L	M	L-M	M
PJ Grass	9	M-H	M	M	M	L	M	H-VH	L-M	M-H	M	M-H	M	M	M
Juniper Grass	3							H	M	M	M	M	M-H	M-H	M
Mountain Mahogany Mixed Shrubland	5			L	M			M-H	M	L	M	L-M	M	L-M	M
Montane Subalpine Grassland	3	M	M-H	M-H	M	M	M-H					M	M	M	M-H
Colorado Plateau Great Basin Grassland	3	M	M-H			L-M	M-H	M-H	M	VH	L			M	M
Semidesert Grassland	2	L-M	M					M	M	M	M			L-M	M
Unit Total		L-M	M	M	M	M	M	M	M	L-M	M	M-H	M	M	M

Figure 152. Climate change vulnerability categories by watershed

Table 188. Climate change vulnerability ratings for Gila NF riparian ERUs

	Percent of ERU by Subwatershed Vulnerability Rating		
Ecological Response Unit	Moderate	High	Very High
Arizona Alder-Willow	48	52	0
Arizona Walnut	89	11	0
Desert Willow	68	32	0
Fremont Cottonwood-Shrub	94	6	0
Herbaceous Wetland	93	7	0
Walnut-Ponderosa Pine	100	0	0
Narrowleaf Cottonwood-Shrub	77	23	0
Ponderosa Pine-Willow	100	0	0
Sycamore-Fremont Cottonwood	75	25	0
Upper Montane Conifer-Willow	74	26	0
Willow-Thinleaf Alder	56	44	0

Overall, most of the Forest's uplands fall into the moderate vulnerability and uncertainty categories. Vulnerability depends on the range of climatic conditions under which a given plant community can persist and the projected climate for a given location. The Spruce-Fir Forest ERU has the highest vulnerability to climate change with the lowest degree of uncertainty. This is due to the narrow range of climatic conditions on the Forest that support this community and climate projections that predict those climatic conditions over less area, if any of the Gila NF in the future (Triepke 2015). Those ERUs that can tolerate wider ranges of climatic conditions tend to have the lower vulnerability. In general, vulnerability also tends to increase with elevation.

Watershed vulnerability, at the subwatershed scale (6th level) is a composite of the upland ERUs contained in those watersheds (Triepke 2015). These vulnerabilities were summarized at the watershed scale (5th level). The Headwaters Burro Ciénega watershed is the only watershed containing area within the very high vulnerability category. This is primarily a reflection of projected climate change within that watershed, rather than the ERUs it contain, as it is a lower elevation watershed and none of the very high vulnerability ERUs occur in this watershed. This is also the case for Headwaters and Outlet San Vincente Creek, and Outlet Burro Ciénega watersheds. In general, watershed vulnerability is greatest at both the highest and lowest elevations on the Forest. For the remaining watersheds with areas of high vulnerability, it is a combination of projected climate within those watersheds, and the vulnerabilities associated with the upland ERUs those watersheds contain. The riparian vulnerability reflects the vulnerability of the watersheds with which a given ERU is located in, not a direct assessment, therefore, the same factors affecting watershed vulnerability ratings apply. For example, Arizona Alder-Willow and Willow-Thinleaf Alder have larger percentages of contributing watershed area in the high vulnerability category because they occur in watersheds that contain high vulnerability upland ERUs and/or projected climate within those watersheds is outside the range of climatic conditions that are suitable for those upland ERUs.

Water Supply and Demand

Water directly or indirectly influences all resources. The quantity, distribution, timing and duration of water supplies are both characteristics for analysis (see Chapter 6: Water) and a system driver. In the arid and semi-arid Southwest, the relationship between water supply and demand is a system stressor. The right to use water, and the allocation of that right are administered by the State. Water use is outside of the Gila NF's authority and ability to control.

Prior to European settlement, Native Americans used surface water for domestic and irrigation purposes. Extensive water controls in the form of irrigation diversions and canal systems across New Mexico have been associated with this time period (Harris 1984). It is assumed that water demand did not exceed supply except in times of severe drought.

The arrival of the Spanish brought with it an increased demand for water and a European system governing the use of water. This system involved the formation of acequias, or community ditches. Under that system, the ditch master granted the right to use water and delegated maintenance duties (Harris 1984).

Beginning in the last half of the 19th century as populations increased and technology developed, irrigation projects became increasingly large in size and scope, upland water sources were created to improve livestock management, and groundwater began to supplement surface water supplies. Other industries such as mining also increased the human demand for water.

There are currently 30 acequias or community ditches that depend on water that flows from the Forest. According to the watershed condition classification water quantity indicator, the cumulative effects of these relatively small irrigation diversions alter natural streamflow patterns, reduce streamflow, and contribute to aquatic habitat fragmentation in roughly 12 percent of all subwatersheds. An estimated 49 percent of springs occurring on the Gila NF have been developed for livestock waters.

In addition to water contained in naturally occurring features such as streams, springs, seeps and wetlands, water is provided by the Forest through constructed features, such as waterbodies and wells. Waterbodies on the Gila NF are nearly all constructed features, although a few natural depressions that may hold water seasonally do occur. Most waterbodies are earthen tanks built to provide livestock water (stock tanks), with a secondary benefit of providing water to wildlife. Not all stock tanks hold water year round, some are poorly located or designed, and many are in need of maintenance. The most reliable livestock tanks are associated with areas of groundwater discharge. A few have been stocked with non-native fish for recreational purposes by the New Mexico Department of Game and Fish (NMDGF). NMDGF also constructed, and has the management responsibility for dams that create the three lakes or reservoirs located, entirely or in part, on the Forest for recreational fisheries purposes. These lakes are Quemado Lake, Snow Lake and Lake Roberts. Similarly, wells constructed on the Gila NF are mostly to provide livestock water, with the exception of 15 drinking water systems associated with recreation and administrative sites (see Chapter 14: Infrastructure).

The Forest does not have an inventory of storage capacity and condition related to all stock tanks located within its boundaries, but is currently conducting an inventory in the Gila-San Francisco River basin (3rd level), which includes the Upper Gila, Upper Gila-Mangas and San Francisco subbasins (4th level). The Forest is also lacking a complete water rights inventory. In general, there are relatively few wells located within the Gila NF. Similarly, there are relatively few stock tanks located on Forest in most plan area watersheds with the exception of those watersheds that are located primarily on Forest, or have few naturally occurring surface water resources. Appendix D contains a table based on information from the NHD and New Mexico, Arizona, and Texas Offices of the State Engineers about the number of waterbodies and wells within the context and plan areas, both on and off-Forest.

Although local populations in southwestern New Mexico are projected to remain stable over the next several decades (UNM-BBER 2014), the supply of and demand for surface water is regional in nature. Climate change, coupled with one of the fastest growing regional populations in the nation, may present major management challenges in the Southwest.

Work by Christensen and Lettenmaier (2006) predicts precipitation across the context area is to drop by 5-10 percent by 2100. Such a decrease in precipitation could have a more serious impact than the numbers suggest. The decrease of water draining from the landscape into rivers and reservoirs typically can be double or triple the proportional reductions in rainfall amounts, especially when combined with higher temperatures, which leads to increased evaporation (Christensen and Lettenmaier 2006). It has been estimated that just over four percent of New Mexico's precipitation is delivered to streams, and then 30 percent of that four percent is transpired by streamside vegetation (McLean 1981).

Recent warming in some areas of Southwest is occurring at a rate that is among the most rapid in the nation (Seager et al. 2007), and significantly higher than the global average in some areas. Overall water quantity on the Gila and San Francisco rivers has been predicted to decrease between six and 11 percent between 2040 and 2070 (Gori et al. 2014).

In a drought of the magnitude of the worst one-year drought on record, water demand may exceed supply by 68 percent. In the five-year scenario modeled after the worst drought in the historical record, water demand in Arizona could exceed supply by 67 percent, and in the ten-year scenario, demand may exceed supply by 59 percent (Lenart 2007). In the Southwest, intense debate will likely continue over water allocation. As supplies become increasingly scarce, trade-offs among competing uses could potentially lead to conflict.

Indeed, this is happening as illustrated by the Arizona Water Settlements Act (AWSA) which approves the consumptive use of an additional 14,000 acre-feet of water from the Gila and/or San Francisco rivers, their tributaries, and groundwater sources in New Mexico. The AWSA has polarized communities over proposals for a diversion project on the Gila River and potentially placed ecological flow needs and human demands into direct conflict (Gori et al. 2014).

Even without considering climate change or ecological flow needs, more water has been committed to users in the Southwest than is available (Phillips et al. 2011; Unruh and Liverman 2013). The increased severity and duration of drought predicted as a result of climate change could very well lead to decreased water availability in streams, springs, lakes and earthen tanks on the Forest. This would likely alter patterns of use by livestock and wildlife and reduce carrying capacity.

A smaller supply of surface water will inevitably lead to an increased demand for groundwater, which is not widely developed on the Forest. Although the Office of the State Engineer has recently required meters be installed as existing wells are deepened or new wells are drilled, there is not enough data over a sufficient period of time to understand groundwater supply and demand in the planning area. However, the New Mexico Water Resources Research Institute at New Mexico State University has estimated that 73 percent of the groundwater withdrawals made state-wide constitute depletion (Unruh and Liverman 2013). According to a 1997 USGS investigation, 76 percent of groundwater withdrawals constituted depletion in Catron County (Basabilvazo 1997). Depletion means water is being withdrawn faster than the rate of recharge. Groundwater withdrawals can impact streamflow. Groundwater recharge and discharge are assessed as a key characteristic in Chapter 6: Water.

There has been, and remains considerable interest in the potential of forest thinning to increase water yield across the scientific community, within land management agencies and with Gila NF stakeholders. Results of watershed experiments conducted in the Southwest indicate that mechanical restoration of piñon-juniper woodlands or mechanical conversion of these woodlands to herbaceous covers have little effect on water yields (Ffolliott and Gottfried 2012). This holds true for all ecological types receiving less than 18 inches of precipitation per year or where the total annual precipitation is less than potential evapotranspiration (Ffolliott and Gottfried 2012; Gottfried et al. 2008).

Potential evapotranspiration (PE) is a measure of the ability of the atmosphere to remove water from the surface through evaporation and transpiration, assuming unlimited water supply. It changes hourly, daily, monthly and annually. PE increases with exposure to solar radiation and wind, higher temperatures and lower humidity. All of these things can result from decreases in vegetative cover. The predicted and observed increases in temperatures across the planning area, discussed in the previous sections on climate and climate change, will also result in higher PE.

Where total annual precipitation is greater than PE, relatively small and short-lived increases in water yield may occur until re-growth (Ffolliott and Gottfried 2012; Gottfried et al. 2008). However, those increases may be economically significant in arid regions (Simonit et al. 2015). Recent work conducted on the Mogollon Rim in Arizona by Moreno et al. (2016) suggests that increased water yield may be more a function of soil compaction rather than reductions in evapotranspiration. This study also concluded that in the Southwestern climate, increases in streamflow as a result of mechanical thinning are likely to be realized during the winter months, but during summer months may lead to drier conditions. Additionally, increases in water yield (i.e. streamflow) are likely offset by decreases in storage (e.g. soil moisture). This may increase ecosystem vulnerability to the hydrologic conditions and extremes expected with climate change (Moreno et al. 2016).

Natural Vegetation Succession

Natural succession is a system driver. It is the progressive change in species composition and structure over time. Early successional stages, or seral states, are often dominated by small, disturbance adapted, short-lived, poorly competitive, non-woody species such as annual forbs and grasses. These species take advantage of available space, nutrients and sunlight in the absence of more competitive, perennial species after disturbance. As succession proceeds, soil nutrients accumulate, those nutrients are converted into plant biomass and the dominant species shift toward larger, longer-lived species that are better competitors for space, nutrients and sunlight. For example, in forested systems this progression might include a shift to shrubs, then to shade-intolerant tree species, and eventually shade-tolerant tree species. Disturbances like wildfire, drought and grazing can interrupt or reverse succession.

Disturbances like wildfire, drought, unmanaged grazing and herbivory by wildlife and livestock grazing can interrupt or restart succession. After such disturbances, successional processes may span upwards of decades or centuries before conditions are suitable and the pre-disturbance vegetation communities begin to re-establish. For example, areas of mixed conifer that experienced stand replacement fire in the 1950s McKnight Fire that were dominated by Gambel oak and New Mexico locust, were just beginning to see the establishment of conifer seedlings and saplings prior to being burned again in the 2013 Silver Fire. Climate change and the associated changes in disturbance regimes such as drought and fire, are likely to alter the outcomes of vegetation succession (Savage and Mast 2005; Savage et al. 2013; Swetnam and Falk 2015), as discussed in the previous subsection on climate change.

Reference and Current Disturbance Regimes

Fire

Fire is an integral part of many ecosystems across the western United States and on the Gila NF. Wildfire frequency and effects vary from short return intervals and low severity to long return intervals and high severity. In fuel types where fires historically burned frequently, like ponderosa pine, the interaction between pattern and process was integral in maintain characteristic species composition, structure and spatial pattern. That is, frequent fires removed surface fuels, but maintained forest structure that encouraged continued low-severity fires (Reynolds et al. 2013). In other systems, like spruce-fir forest or piñon-juniper woodlands, fire was less frequent and had less influence on stand structure, but may have significantly influenced landscape scale patterns.

Native Americans both managed fire as a tool and suppressed it during the reference time period (Liebmann et al. 2016; Williams 2000). However, the extent and frequency of fire use and fire suppression patterns on the Forest prior to the arrival of Europeans remain largely unknown. However there is some evidence to suggest it was not extensive in upland systems (Abolt 1997). In some riparian areas, such as the Mimbres River valley, Native Americans used fire to clear riparian zones for agricultural purposes (Williams 2000; Schollmeyer 2005) to the extent that some riparian tree species may have gone locally extinct (Schollmeyer 2005).

The arrival of Europeans and the decline in Native American populations introduced changes in land management that began to alter fire regimes in complex ways. This included an increase in woody vegetation (Liebmann et al. 2016). At the turn of the 19th century, the policy of fire suppression contributed to an increase in woody vegetation and fuel loading. Livestock grazing practices reduced herbaceous vegetation (fine fuels) and contributed to an increase in woody vegetation as a result of reduced competition for water and nutrients (Boucher and Moody 1998; Dahms and Geils 1997; Rummel 1951; Madany and West 1983; Savage and Swetnam 1990; Smith 2006b, among others). These changes in vegetative cover altered fuel types and distributions, as well as nutrient availability, distribution and cycling.

Each ERU has evolved under a specific fire regime to adapt to the frequency and severity of fire characteristic in that ERU, such that ecological integrity is maintained over time. Fire may either restart the successional process by establishing an earlier seral state as in infrequent fire systems (e.g. spruce-fir), or maintain a given seral state, as occurs in frequent fire systems (e.g. ponderosa pine). Multiple interacting influences may alter an ERU's fire regime; some are legacies of past human impacts, while others are still evolving. A history of fire suppression and overgrazing, leading to a lack of fine fuels to carry fire, has resulted in fewer fires since the late-1800s. The subsequent accumulation of live and dead fuels in some ERUs has created the potential for larger and more severe fires (Kaufmann et al. 1990). Tree mortality from drought or insect and disease outbreaks contributes to fuel accumulation. Into the future, according to Westerling et al. (2006), changing climate is expected to continue to lengthen the fire season and favor larger, more frequent fires. Thus, prescribed or natural fire may be either a driver or a stressor, depending on whether its effects are characteristic of the system or not. Large extents of high and moderate burn severity are in many cases stressors, because their effect can degrade the integrity of the system, and may convert the system to a condition that may never recover to pre-fire conditions (Savage and Mast 2005; Roccaforte et al. 2012; Savage et al. 2013). Fire regime (frequency and severity) is an upland vegetation characteristic analyzed at the ERU scale in Chapter 2: Upland Vegetation. There is not sufficient information related to the natural role of fire in riparian systems to provide for such an analysis. Altered fire regimes can contribute to climate-changing greenhouse gases, provide a pathway for establishment and/or spread of invasive plant species, alter watershed conditions and present a direct risk to biodiversity and human habitation (Shlisky et al. 2007).

Since the Gila NF become one of the first national forests to begin using fire as a tool in the mid to late 1970s (Boucher and Moody 1998), approximately 875 prescribed burns are documented in the Forest's Fire History database, totaling 408,886 acres. Between 1996 and 2014, the Forest averaged 11,326 acres of prescribed burning per year (see timber section of Chapter 11: Multiple Uses). Over 1,400 wildfires have been managed on an additional 564,891 acres, putting fire on the equivalent of 30 percent of the Forest. The actual acres of prescribed and wildfire use fires are greater than this amount, but prior to 1984, most of the records remain as hardcopy and have not been entered into the Fire History database. Additionally, the fire history data does not include severity information and does not provide a picture of what happened within these fire perimeters. Also, some of these acres included in the database may have burned more than once. The Gila NF does not prescribe burning of riparian areas.

Fire severity, pattern and extent determine post-fire soil and watershed effects. In general, prescribed fire has minor and relatively short-term negative effects on watershed condition as severities are typically lower than those associated with wildfires. Over the long term, prescribed fire can have positive effects as it reduces the risk of larger, more severe wildfires. High burn severities result in removal of vegetative canopy and ground cover, soil organic carbon and nutrient loss, and alteration of soil properties and function (Busse et al. 2014). These things can occur at moderate severity as well, depending on the degree, depth and length of time at which soil heating occurs. High burn severities are typically associated with relatively long return interval, stand replacing wildfires. Low severity fire can also impact soil quality in both positive and negative ways depending on a variety of site specific factors, and the frequency at which the site is burned. These negative effects can be mitigated by planning for and integrating fuel and soil quality objectives (Busse et al. 2014).

Following moderate to high severity fire, watershed responses include: accelerated erosion and sediment delivery to stream channels; increased peak flow and stream power; changes in stream channel geometry, gradient and elevation; removal of riparian vegetation; long and short-term impacts to the quantity and distribution of large woody debris in stream systems; and water quality impacts. There is also an increased risk of invasive and/or noxious weed populations becoming established and/or expanding. The amount of time it takes for watersheds to stabilize depends burn severity, topography, geology, soils, vegetative species present pre-fire, post-fire treatments and precipitation patterns. In some areas, livestock management practices and/or concentrated use of burned areas by elk can also affect the rate of watershed recovery.

According to the Gila NF's Fire History and the Monitoring Trends in Burn Severity (MTBS) dataset, there have been a total of 2,502 wildfires where suppression was the management strategy. These wildfires have burned over a million acres. About 884 of these fires and half of these acres burned between 2011 and 2013. Large fires in this time frame include the 2011 Miller and Wallow, 2012 Whitewater Baldy Complex, and 2013 Silver Fires. The Wallow Fire burned primarily on the neighboring Apache-Sitgreaves NFs, but burned almost 16,400 acres on the Gila NF with 12 percent at high or moderate severity. The Miller Fire burned 84,817 acres in 10 fifth-code watersheds with 25 percent at high or moderate severity. The Whitewater Baldy Fire, the largest fire in New Mexico history, burned 307,052 acres in 26 watersheds, again with 25 percent at high or moderate severity. The Silver Fire burned 140,839 acres in 23 watersheds with 48 percent at high or moderate severity. Overall, high and moderate burn severities have increased over the last several years, accounting for 29 percent of all burned acres in the 2010-2014 time period, as opposed to the 19 percent in the 1984-1999 time period and 16 percent in the 2000-2009 time period. Since 2000, 83 percent of the Spruce-Fir Forest, 60 percent of the Mixed Conifer with Aspen and 25 percent of the Mixed Conifer-Frequent Fire have burned at high or moderate severity with the vast majority of these acres burning in the Whitewater Baldy Complex and Silver Fires. Prior to these fires, the historical size of high severity fire in the upper elevation mixed conifer and spruce-fir forests in the wilderness could be estimated based on the extent of quaking aspen stands. Aspen stands within the Whitewater Baldy Complex Fire perimeter ranged in size from between 14 and 254 acres, and in age from between 59 and 264 years old (Abolt 1997).

The increase in the number and size of fires are consistent with climate change predictions. In general, these trends are expected to continue across the Southwest. However, due to recent wildfire activity, the probability of the Gila NF to experience large, high severity fires in the near future has been reduced (Parks et al. 2014 and 2015a), but not eliminated. Recent studies including those in the Gila and Aldo Leopold Wildernesses concluded that the ability of burn scars to limit the occurrence of fire on the Forest may last approximately nine years (Parks et al. 2015b), the size of fires by two to six years depending on weather conditions (Parks et al. 2015a).

Most wildfires on the Forest have been started by lightning with notable exceptions being the 1998 Leggett, 2000 Saliz, 2006 Bear, and 2014 Signal fires. Although the area's population is expected to remain static over the next decade or more (UNM-BBER 2014), predicted increases in recreational use (Chapter 12: Recreation) could lead to an increase in human started fires. Lightning strikes are predicted to increase with climate change (Reeve and Toumi 1999).

Burned Area Emergency Response (BAER) teams have conducted 19 post-fire assessments on the Gila NF since 1995. Between 1995 and 2000, four of these assessments resulted in recommendations for seeding treatments. Approximately 1,300 acres were seeded with certified weed-free seed mix comprised of native and non-native annual and perennial species. The weed-free certification means that no species designated as noxious are present. After 2000, treatment recommendations included seeding on seven fires, and seeding and mulching on two: the 2012 Whitewater Baldy Complex Fire and 2013 Silver Fire. Seed mixes remained certified weed-free and included annual cereal grains, but no longer included non-native perennials. Only native perennial grass species such as Junegrass, muttongrass, blue grama, sideoats grama, mountain brome, western wheatgrass, slender wheatgrass, Arizona fescue, squirreltail and little bluestem have been applied since that time. Sufficient quantity and diversity of local ecotypes have not been, nor are currently available to meet the volume requirements for BAER treatments. Seed was applied to approximately 59,000 acres. Seed and straw mulch, also certified weed-free, was applied to approximately 18,800 acres. The certification process for straw mulch is not as rigorous as for seed, which is genetically tested in a laboratory and delivered with a report of the species contained in a given package. Straw fields are currently subject to a walk through inspection 10 days prior to harvest in order to receive certification (NMSU 2011).

Treatment effectiveness monitoring of seeding, and seeding and mulching has varied in its rigor and duration. Monitoring methods have included viability testing of the native seed bank, visual inspection, repeat photography, quantitative canopy, groundcover and species data collection, and/or measurement of soil loss rates using sediment traps or erosion bridges. The most rigorous monitoring efforts include the 1998 BS, 2013 Silver and 2014 Signal Fire treatments. The Plant Materials Center in Los Lunas, New Mexico tested the viability of the native seed bank on the 1998 BS Fire. This testing demonstrated very low to no viability (USDA FS Gila NF 1999). Although it is not possible to completely eliminate accelerated post-fire erosion, monitoring has documented treatment effectiveness in keeping more soil in place after high severity fire (USDA FS Gila NF 1999, 2013b and 2014a). Interim reports for the Silver and Signal Fire monitoring efforts are available upon request. The final monitoring report associated with the 2013 Silver Fire is expected in 2017, with the 2014 Signal Fire’s final report due in 2018. These monitoring efforts include the effect of treatments on soil loss, natural recovery (i.e. establishment of native species and successional processes) and the establishment invasive or noxious weed species. As with the interim reports, the final reports will be available upon request.

Fire characteristics and impacts in riparian areas are different than those in adjacent upland ecosystems, however there are also similarities. Effects depend on the relationships between fire frequency, severity and timing, climate conditions, vegetation community and landscape characteristics, as well as position within the watershed. With few exceptions, the current scientific understanding is that natural fire frequency and severity in riparian areas are less than surrounding uplands. Fires occur less often and at lower severity largely because of higher fuel moisture, soil moisture and relative humidity. Riparian areas are more susceptible to fire related impacts because of their high edge to area ratio (Pettit and Naiman 2007; Dwire and Kauffman 2003).

Landscape features such as topography, watershed position and aspect are also important factors. Steeper toe slopes leading into the valley floor tend to restrict the movement of fire into and through the riparian zone, contributing to longer fire return intervals, whereas shallower valleys tend to have return intervals closer to those of the adjacent upland ecosystems (Pettit and Naiman 2007). Fire frequency also tends to increase with decreasing valley width, making the period between fire shorter in headwater streams in the higher elevations of the watershed, and longer at middle and lower watershed elevations. Aspect influences burn patterns associated with fires entering riparian zones from the uplands, as cooler and wetter north slopes do not typically burn as often as south facing slopes. In some areas riparian community structure exerts a stronger influence over fire return intervals than landscape features. This includes where trees have been removed from riparian areas. Where canopy gaps are created, fuels dry out quicker and may decrease the fire return interval and increase severity (Pettit and Naiman 2007; Dwire and Kauffman 2003).

Timing, as it relates to pre- and post-fire climate conditions, is an important determiner of ecological effects. Fires that occur early in annual dry periods tend to be lower in terms of severity and negative impacts as fuel and soil moisture remain relatively high. Fires that occur late in annual dry periods tend to occur at higher severity and ecological impact, as fuel and soil moistures are at their lowest. Periods of drought magnify both fire risk and severity when it does occur. It can also reduce the ability of species to recover from fire disturbance (Pettit and Naiman 2007; Dwire and Kauffman 2003).

Most riparian species are disturbance adapted. The ability to re-sprout following disturbance is an important characteristic following fire. Re-sprouting allows for rapid regeneration of the riparian community as this mode of reproduction is not dependent on the timing of seed dispersal and flooding. Seed longevity is typically short for these species, with germination and seedling establishment dependent on the timing between seed dispersal and the floods that prepare the seedbed and maintain adequate soil moisture (Gori et al. 2014). These events do not occur with any annual regularity. Shifts toward earlier and shorter snowmelt runoff periods, discussed in Chapter 6: Water, have enormous implications for riparian reproduction by seed.

While cottonwoods, willows, alders, sycamore may re-sprout after fire (and flood) in some regions and circumstances, willows are the only species that have been observed to re-sprout after fire with any reliability on the Gila NF. Although this has not been documented quantitatively, it has been widely observed that Fremont and narrowleaf cottonwood, sycamore and alder do not typically re-sprout after fire. This is of particular concern in alder communities as their thin bark makes them highly susceptible to mortality, even at low severity, and are largely single age-class communities. On the other hand, saltcedar is fire adapted, re-sprouts readily and can therefore displace native riparian vegetation more efficiently in the post-fire environment.

Prescribed fire and wildfire use are projected to increase with the continued emphasis on the restoration of fire to fire-adapted ecosystems. However, forest management and the public should not expect to completely restore the historic fire regime given altered fuel characteristics, climate change and operational, budget, policy and political constraints. The two most important factors for determining fire regimes are vegetation type and weather and climate patterns (Sommers et al. 2011). Changing climate regimes may not support historic fire regimes or vegetation types.

There is some evidence suggesting that the higher temperatures predicted to occur with climate change may lead to increasing trends in fire related tree mortality, independent of fire intensity (van Mantgem et al. 2012). This might mean that fire intensities that did not result in tree mortality in the past, could be expected to result in tree mortality in the future. Furthermore, research suggests that historic return intervals under a changing climate, without thinning, could result in a decline in some forest types, while longer than historic intervals (e.g. 20 years instead of 5 years in the ponderosa pine) could provide for the long term maintenance of restoration treatments (Diggins et al. 2010). Fire and climate change interactions are the subject of many scientific studies in progress that will produce information and technology to inform fire management into the future. In late 2016, the 3rd Southwest Fire Ecology Conference: Beyond Hazardous Fuels: Managing Fire for Social Economic and Ecological Benefits, provided several examples: Parks and others are currently conducting a study on fire facilitated ecological type conversions under climate change, including a high resolution, high severity burn probability map (Parks 2016); Iniguez and others are studying the effects of subsequent fire in areas previously burned at high severity (Iniguez 2016); and Hurteau and others are studying the effect projected climate scenarios might have on post-fire vegetation dynamics (Hurteau 2016). All of these studies, and others, will provide a better understanding of potential management outcomes as climate change progresses.

While the best available science utilized in this assessment is based multiple corroborating lines of evidence, a need for a wider spectrum of reference condition datasets across environmental gradients has been identified in General Technical Reference (GTR)-310 (Reynolds et al. 2013). Return intervals are described by vegetation type and only indirectly account for soil, slope, elevation, aspect, topography and local climate variability within those vegetation types. All of these things have been directly or indirectly identified as important variables in pre-settlement fire regimes and in some cases, more important than vegetation type (Abolt 1997; Baisan and Swetnam 1990; Parks et al. 2015; Rollins et al. 2000).

There has been some relevant data collected on the Gila NF, only in the Gila and Aldo Leopold wildernesses for the Ponderosa Pine, Mixed Conifer-Frequent Fire, and Mixed Conifer with Aspen ERUs, and to a very limited extent, the Spruce-Fir Forest (Abolt 1997; Baisan and Swetnam 1990; Rollins et al. 2000). These data are embedded in the fire regime reference conditions for those ERUs, but the estimates also include data from other locations across the Southwest. Recent work by Korb et al. (2013) suggests a need for caution when using fire return interval and forest structure information from specific localities and applying it elsewhere, particularly in warm/dry mixed conifer forests. While such information might generate too fine-scale a portrait for use in forest plan revision, where these local data are available they can be used to guide project-level planning in the future.

Fire has and will remain the most important management tool in supporting sustainable, fire-adapted ecosystems in the face of climate change (Fulé 2008; Tarancón et al. 2014). Accounting for site specific variability in reference forest structure and fire frequency may become increasingly important given climate change projections of larger and more frequent wildfires (Korb et al. 2013). Increasing frequency, intensity and duration of drought conditions expected to accompany climate change may also reduce the frequency and duration of weather conditions favorable for prescribed burning (USDA FS 2016h). Future forest management will be faced with finding a balance between actions or inactions to resist climate change impacts to protect highly valued resources, those that create resilience or those that facilitate the vegetation type conversions expected to accompany climate change (Millar et al. 2007).

Non-Fire Vegetation Management Activities

Non-fire vegetation management activities, either mechanical, manual or chemical, are a system stressor. However, they may act as a system driver for a limited set of vegetation related ecosystem characteristics if they move conditions toward the natural range of variability. Many of the negative ecological impacts that can potentially result from these activities can be mitigated with adequate planning and effective implementation of Best Management Practices (BMPs). These activities also provide forest products and economic benefits; have the potential to reduce fire behavior and therefore the ecological costs of uncharacteristic wildfire; may reduce the socioeconomic costs associated with fire suppression; and can provide options for fire management when they are strategically located.

Chemical vegetation management activities are discussed in the pesticide use section of this chapter. Manual activities include harvesting of trees for fuelwood, construction or hazardous fuel reduction purposes using hand-held equipment like axes or chainsaws. Mechanical activities include but are not limited to: timber harvest, non-commercial thinning and pushing, chaining or mastication[42] of woody vegetation using heavy equipment such as backhoes, skidders, bulldozers etc. Mechanical activities alter the structure and composition of vegetative communities on a larger scale than is possible with manual activities. At this larger scale, these activities may be used to move vegetative communities toward or away from reference condition; however, they do not replicate the ecological functions associated with the reference fire regime. They have the potential to disrupt soil hydrologic function, stability and nutrient cycling as heavy equipment causes surface or subsurface soil compaction or other detrimental changes in soil structure, disturbs the vegetative groundcover important for soil stability or in the case of mastication, can produce thick layers wood mulch that may delay the establishment of herbaceous species. Any of these practices prepare a seedbed that may favor woody species (Severson 1986) and some can also result in displacement, redistribution and/or mixing of the topsoil with less productive subsurface soils.

Compaction is generally the greater concern, where these activities take place on level ground. Compaction results in a change in soil structure and reduction of pore space and rooting depth. This alters the patterns of air and water exchange between the soil and atmosphere, reducing infiltration, soil moisture holding capacity, rooting depth, soil microbial activity and nutrient cycling. Soils with higher clay content are more susceptible to compaction, as are those that are wet at the time the activity occurs. The pounds of equipment per square inch of soil and operator skill are additional factors contributing to the degree of soil disturbance. Freeze-thaw action is a natural process that can break up compaction.

Non-fire vegetation manipulation prior to European settlement was limited to small-scale manual activities with non-motorized equipment. Similar to the previous discussion regarding Native American use of fire on the Gila NF, impacts were likely greatest in riparian areas as there is evidence that Native Americans harvested some riparian species for construction purposes to the extent that some may have gone locally extinct (Schollmeyer 2005). Despite the ecological values and ecosystem services provided by riparian vegetation, there was a time after European settlement when it was widely viewed as undesirable and even hazardous. Riparian species were targeted for removal, although how much of this was accomplished through fire versus non-fire treatments is not well known or described in the literature.

In the present time, the viewpoint that riparian vegetation is undesirable, is still held by some members of the public, as expressed during the assessment. This viewpoint originated owing to the fact that riparian vegetation slows water and spreads it out across a wider area which influences where flooding impacts occur. Human infrastructure and other values that occur upstream have a higher flood hazard, while those values downstream have a lower hazard. Riparian vegetation also uses relatively high volumes of water and occupies land often suitable for farming (Webb et al. 2007).

There is also a long history of mechanical vegetation treatments in the upland systems of the Gila NF. After the establishment of the Gila River Forest Reserve in 1899, the USGS sent Theodore Rixon to complete an inventory and examination of resources and conditions. Rixon described logging operations as having endangered the remaining stands by increasing the losing them to fire and/or exposure to wind and drought (1905). Since that time, lumber production continued to increase, but logging practices presumably improved. After 1952, New Mexico lumber production declined dramatically and further declined after 1996 due to forest plan amendments that incorporated guidance for northern goshawk habitat and Mexican spotted owl recovery (USDA FS 1996; see timber section of Chapter 11: Multiple Uses).

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[42] Pushing refers to uprooting individual trees with heavy machinery. Chaining refers to uprooting multiple trees with a chain secured between two pieces of equipment. Mastication refers to grinding, shredding or chopping of individual trees without uprooting.

Since 1996, thinning of upland vegetation on the Forest has been limited to relatively small timber sales, and post, pole and fuelwood harvest with total treatments averaging just under 18,000 acres per year (see timber section of Chapter 11: Multiple Uses). In the last few years, pushing of piñon-juniper has regained favor. Mastication is a method that has not yet been used on the Gila NF, but may be in the future. Because of the small number of acres treated annually, this disturbance regime is not currently a major stressor. However, in the future it may increase in significance as the emphasis on restoration continues.

Intended outcomes of treatments are related to reductions in fuels and wildfire risk, wildlife habitat restoration, forest health restoration, watershed protection, and increased grass production.

The Forest has not conducted quantitative, short or long-term treatment effectiveness or soil disturbance monitoring associated with non-fire vegetation manipulation. However, qualitative observations made across the Forest suggests variability in outcomes. Pre-treatment vegetative community composition and structure, soils, and site specific climatic conditions contribute to this variability. Decreases in canopy cover as a result of treatment has often produced increases in canopy cover and/or stems per acre of shade intolerant, re-sprouting species such as evergreen oak and alligator juniper[43]. While there is research demonstrating that thinning treatments followed by prescribed fire are more likely to be effective in long-term restoration and ecosystem resilience than thinning alone (Covington et al. 2007; Tarancón et al. 2014), the previous observations have been made where thinning treatments were followed by prescribed fire and where they were not.

Graminoid responses are variable due to differences in the production potential of particular soils. A robust response by perennial grass species does not typically occur on shallow soils of many rhyolites and conglomerates, and on all shallow rhyolitic ash tuff. On soils with higher production potentials, increases in herbaceous cover do occur. Graminoid responses are also affected by the amount and timing of precipitation.

Scientific information about the effectiveness of mechanical control of alligator juniper is limited as most of the research on piñon-juniper control is related to species that do not re-sprout. A study conducted on the Gila NF near Fort Bayard, NM included both one-seed and alligator juniper. One-seed juniper, and other shaggy bark junipers found on the Forest do not re-sprout. The Fort Bayard study concluded that there was no difference in tree density between top thinning and areas that were not treated within 13 to 18 years. Treatments that involved uprooting and pushing trees over with a bulldozer had a slower rate of reestablishment of those tree species. The study demonstrated that no method of treatment produced a grass response, but did produce woody regeneration even though the area was not grazed during the 13 year study period (Severson 1986). Herbicides may represent a cost effective means of controlling re-sprouting and regeneration of woody species after these treatments, and limit soil disturbance. Recent work supported by New Mexico State Forestry indicates herbicide application significantly reduces re-sprouting and regeneration of woody species after treatments (Boykin pers. comm. 2016), lengthening the time between initial treatment and any maintenance that might be needed. Therefore, herbicides represent a potential means to reduce soil disturbance.

Vegetation treatments within riparian zones are limited to the restoration of the native riparian species. Activities include the removal of upland species where they are not part of the potential natural community, and planting of willow and cottonwood poles. Neither of these activities are being done at a large scale. Vegetation treatments in the upland portions of contributing watersheds also have the potential to impact riparian areas by altering the delivery of water, sediment and nutrients.

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[43] *Juniperus deppeana*

The increase in drought frequency, severity and duration anticipated with climate change has implications for these non-fire vegetation treatments as described (USDA FS 2016h). While stand dynamics are complex and the need for additional research is recognized, continuing the same treatment strategy under a changing climate may increase the frequency of unintended and/or undesirable results. In general, thinning and treatments that promote uneven-age stands tend to promote resilience to drought. However, while thinning may benefit individual trees over the short term by decreasing competition and increasing the amount of precipitation that reaches the forest floor, over-thinning vulnerability to drought may increase in the long-term. Vulnerability may increase due to increased water demand by individual residual trees, higher understory water demand where thinning creates a denser understory, and increased evaporative losses due to warmer nature of the more open site (USDA FS 2016h). Increased evaporative losses may have the greatest impact in stands occurring on shallow soils as soil water holding capacity is lower. Over thinning also increases the probability of losing residual trees to blow down, particularly on shallow soils. Thinning and/or burning shortly before or during drought tends to favor re-sprouting species such as alligator juniper and oak but may have negative implications for quaking aspen (USDA FS 2016h). The potential negative impacts of long-term alterations of stand-level hydrology resulting from over-thinning and increased competition from re-sprouting species better adapted to drought conditions may also have implications for the natural regeneration of some conifer species. The likelihood of thinning treatments creating these conditions might be reduced through increased consideration of soils, geology, topography, and site specific stand structure and species composition.

Herbivory

Herbivory has been a disturbance regime in all ecological types both before and after the arrival of Europeans. In the reference time period, this disturbance regime was a system driver. In the current time period it is both a system driver and stressor. It is a driver when the timing, frequency, intensity, duration, and pattern are similar to those that existed prior to the introduction of domestic livestock, and a stressor when one or more of these characteristics are outside what occurred during the reference period. There is evidence that supports properly managed domestic livestock grazing can act as a system driver (Koerner and Collins 2014) in ecosystems where native populations of large, wild herbivores existed during the reference period but are greatly reduced or absent in the present.

In pre-European times, native ungulate species such as deer, elk, pronghorn antelope and bighorn sheep grazed across the Gila NF, with populations being kept in check by predators, weather patterns and natural cycles of disease. Grazing and browsing by native species during the reference period differed in degree, location, pattern, diet, slope preference, time spent in a single area and ground disturbance (Currie 1977; Osmond et al. 2007). After the arrival of Europeans, native ungulate populations declined, and in the case of elk, were completely eliminated from the Forest. The introduction of domestic livestock grazing in the late 1800s is one of the events that marks the end of the reference period (Smith 2006b).

Historically New Mexico rangelands were overstocked, primarily with cattle and sheep but also goats, burros and horses. Combined with drought, this resulted in deteriorated rangeland conditions. Evidence of these degraded conditions remain to this day. Examples include woody species encroachment and expansion, and gully erosion, although gully erosion also resulted from roads and trails (see roads and trails subheading).

Permitted and authorized use have fluctuated in recent years. This is due in large part to the preference of the grazing permittee as an adaptive management response to drought conditions. Historic and current rangeland and grazing management is discussed in more detail in the range section of Chapter 11: Multiple Uses. As of 2001, an estimated 9,779 acres of riparian were excluded from livestock grazing, including roughly 210 acres of springs and wetland areas. 641 acres of riparian pastures had been created to better control livestock use and 1,445 acres of riparian were not grazed because the allotment was vacant.

Permits were not expected to be reissued at that time. Since 2001, an estimated 860 additional riparian acres were excluded and 184 acres of riparian pastures were created, bringing the current total to more than 10,600 acres excluded riparian, including 210 acres of springs and wetland areas. These exclosures were primarily created due to conditions in threatened and endangered species habitats in consultation with the US Fish and Wildlife Service (USFWS) based on Proper Functioning Condition (PFC) assessments or field observations by Forest Service and/or USFWS personnel. Riparian areas outside of proposed or designated critical habitat have also been excluded, or recommended for exclosure where poor conditions have been documented by PFC assessments. Monitoring of these exclosure and outcomes have largely been informal and qualitative and has occurred irregularly but noticeable improvements in riparian conditions are typically observed when those exclosures remain functional.

Concerning the riparian acres not grazed because the allotment was vacant and the permit was not expected to be reissued, grazing is now permitted on two of those allotments and portions of another, while ten additional allotments are now currently vacant, bringing the total riparian acres not grazed for these reasons to 1,102.

Herbivory has the potential to impact the composition (White 2002), structure and function of upland and riparian vegetative communities, and soil hydrologic function, stability and nutrient cycling. Composition and structure of a plant community are directly linked to qualities of wildlife habitat structure (Krausman et al. 2009) and ecological function (Printz et al. 2014).

Reductions in vegetative canopy cover can reduce the above and below ground vigor of the plant, and reduce the amount of material available to create litter. Hoof action can break up vegetative groundcover and compact soil. In extreme cases, compaction results in a change in soil structure and reduction of pore space. This alters the patterns of air and water exchange between the soil and atmosphere, reducing infiltration, soil moisture holding capacity, rooting depth, soil microbial activity and nutrient cycling. Reductions in vegetative cover and soil compaction can lead to decreased water infiltration, increased runoff and accelerated erosion (Belsky and Blumenthal 1997; Smith et al. 2009; Holechek et al. 2010) depending on the degree and extent to which they occur.

Where decreases in herbaceous biomass occur, the ability of frequent fire ecosystems to carry low intensity fire can be reduced (Belsky and Blumenthal 1997; Holechek et al. 2010). It also reduces the risk of moderate and high intensity fire. Decreases in fine fuels can also lower fire severity when fires do occur. Additionally, decreases in the herbaceous component reduces competition by grasses with woody species, allowing those woody species to expand or encroach into grasslands and woodland and forest openings (Allen 1984; Moore and Huffman 2004).

While there is evidence that heavy grazing can degrade arid rangelands (Todd and Hoffman 1999; Loeser et al. 2007 among others),even under short durations (Loeser et al. 2007)and rest from grazing has been shown to improve ecosystem function in areas degraded by overgrazing (Schultz and Leininger 1990; Dalldorf et al. 2013 among others), there is also evidence that properly managed grazing can be sustainable (Pieper 1994; Loeser et al. 2007; Holechek et al. 2006, Holechek et al. 2010; Davies et al. 2011, among others). However, total cessation of all grazing may not return systems to a historic reference state (Pieper, 1994), depending on the degree of soil loss and the amount, timing and patterns of precipitation.

The amount and timing of precipitation also plays a large role in determining rangeland vegetation conditions. Through adaptive management of the timing, intensity and duration of grazing, effects to vegetation productivity and species composition can be managed (Holechek et al. 2010). Livestock grazing management has led to the development of upland water sources, which has the secondary benefit of providing water for wildlife. In some cases, these waters have also been used in wildfire suppression activities.

Based on the rangeland vegetation condition indicator score from the watershed condition classification, 23 percent of the Forest is considered Functioning Properly, 70 percent Functioning at Risk and six percent Impaired Function. The watershed condition classification, and the rangeland vegetation indicator are described in the data section of Chapter 6: Water. It bears repeating that the watershed condition classification translates range condition ratings of very poor and poor to Impaired Function, fair to Functioning at Risk, and good and excellent to Functioning Properly. District range specialists referenced the data collected at permanent range monitoring sites and used the national ruleset provided in the technical guide (Potyondy and Geier 2011) and professional judgement to rate this indicator. According to Chapter 11: Multiple Uses, range conditions are stable, or are trending upward across the majority of the Forest. There is no trend associated with the watershed condition classification indicator rating as the technical guide and model do not contain a provision for documenting trend. Repeat measurements at permanent range monitoring sites (clusters) have been collected using the Parker 3-step method. The strength of this dataset lies in its relatively long period of record. Weaknesses of this methodology include the fact that range condition ratings do not consider site potential, only the conditions that are suitable to support livestock. This means that there can be areas rated in fair (Functioning at Risk) or poor (Impaired Function) that are actually at their ecological potential. Many of these areas are located on steep, rocky slopes with shallow soils and are unlikely places for range monitoring sites to have been established given the low likelihood of these areas to see much use by livestock. Also, because of the way it differentiates between rock and bare soil, bare soil may be overestimated and rock underestimated.

In general, rangeland conditions on the Forest have improved substantially over the last several decades due to adaptive management responses to changing conditions. As previously mentioned, these adaptive responses are frequently implemented at the request of the permittee. These responses include reductions in actual use during times of drought and subsequent restocking to permitted numbers once conditions have improved. However, legacy issues remain and future trends in rangeland condition will increasingly depend on the ability of monitoring and adaptive management to respond effectively to climate change.

Elk were officially reintroduced to the Forest in the 1950s, although some migration from earlier reintroduction efforts on adjacent lands likely occurred. These populations have steadily increased, particularly on the Quemado and Reserve Ranger Districts, and have caused negative ecological impacts in some areas. Ecological impacts are typically highest in wet meadows, riparian areas and aspen stands. The Forest is also current experiencing negative impacts from feral, trespass livestock, primarily in areas within the Gila Wilderness.

Invasive and Noxious Species

Invasive species are defined by Executive Order 13112 (1999) as those species that are non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive plants generally have one or more of the following characteristics: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host for serious insects or disease and being non-native or new to or not common to the United States (EO 13112 1999). Not all non-native species are invasive. Some invasive plant species are so harmful they have been given regulatory designation of “noxious” by the Federal or State Departments of Agriculture[44]. Noxious weed species are highly competitive, disturbance adapted, prolific reproducers and are readily disseminated by wind, water, animals and humans. They often have the advantage over native species because they have been introduced unaccompanied by their natural predators or diseases that would normally keep them in

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[44] The Noxious Weeds Management Act (76-7D-1-6) directs NMDA to develop a noxious weed list for the state, identfity methods of control for designated species, and educate the public about noxious weeds. NMDA coordinates weed management among local, state, and federal land managers as well as private landowners. NMDA maintains an officiat state noxious weeds list that has been recently updated.

check. A list of plants designated as noxious by the New Mexico Department of Agriculture (NMDA) and additional information on these and other troublesome species can be found on the NMDA website at http://www.nmda.nmsu.edu/apr/noxious-weed-information/.

The presence of these species constitutes a system stressor. Potential harmful effects include but are not limited to decreased soil stability, interrupted upland and riparian forest succession, changes in wildfire frequency and intensity (Levine et al. 2003; Brooks et al. 2004; Brooks 2008; and Invasive Species Advisory Committee 2006), and reduced water quality. Some invasive plant species may alter the physical and/or chemical properties of soil in a way that promotes their own dominance over native species (Jordan et al. 2008). Prior to European settlement, invasive and noxious species were not known to occur. European settlement introduced many non-native plants which are now permanent components of the systems they inhabit. Since that time, plants, and other organisms have continued to enter systems they did not originate in. The threat these species do or do not pose depends on the degree of ecological and economic harm they cause. Many of these species have naturalized, meaning established populations are able to reproduce and spread without human assistance. Many non-native species were introduced unintentionally, arriving from Europe or other parts of the world with the people, animals, tools, etc. that came or were brought to the United States. Cheatgrass (*Bromus tectorum* L.) is an example of a noxious species that was introduced in this manner. Some were introduced as ornamentals and later escaped cultivation (e.g. tree of heaven (*Ailanthus altissima* (Mill.) Swingle)). Others were introduced intentionally for pasture forage and/or erosion control. In fact, many non-native invasive and/or designated noxious weed species were made available and/or introduced intentionally to rangelands including but not limited to: Kentucky bluegrass (*Poa pratensis* L.), Johnsongrass (*Sorghum halepense* L.), weeping lovegrass (*Eragrostis curvula* (Schrad.) Nees), sweetclovers (*Melilotus* spp.), and others. Although Kentucky bluegrass is not designated as noxious, it is common in many of the Forest's riparian ecosystems where it has replaced the native herbaceous riparian vegetation. Streambank and floodplain stability are compromised in these instances as Kentucky bluegrass lacks the deep, extensive root system of the native species it has replaced. At least 35 non-native invasive plant species that are not noxious commonly occur across the Forest including but not limited to wooly mullein (*Verbascum thapsus* L.), Russian thistle (*Salsola tragus* L.), yellow sweetclover (*Melilotus officinalis* (L. Lam.), weeping lovegrass (*Eragrostis curvula* (Schrad.) Nees) and watercress (*Nasturtium officinale* R. Brown).

Noxious plant species are not generally well established on the Gila NF as compared to other western forests as reflected in the terrestrial invasive species indicator rating. However, there have been few noxious weed surveys on the Forest. Known populations of species designated as Class A[45] noxious weeds by the State of New Mexico include less than five acres of camelthorn (*Alhagi maurorum* Medik)and less than 10 acres of yellow starthistle (*Centaurea solstitialis* L.). Occurrences of spotted knapweed (*Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek), Canada thistle (*Centaurea arvensis* L.), leafy spurge (*Euphorbia esula* L.), oxeye daisy (*Leucanthemum vulgare* Lam.) and whitetop or hoary cress (*Cardaria draba* (L.) Desv.) (SEINet 2016) are known, but acres affected are not. One small infestation of purple loosestrife (*Lythrum salicaria* L.) was treated repeatedly between 2006 and 2010 and has not been documented since. The Gila NF also has a concern about the Class A listed yellow toadflax (*Linaria vulgaris* Mill.) as it has been documented in close proximity to the Forest boundary.

Known populations of species designated as Class B[46] noxious weeds by the State of New Mexico are limited to tree of heaven (*Ailanthus altissima* (Mill.) Swingle which is estimated to affect more than 500 acres. These populations occur mainly in riparian areas, but have been documented in upland ecosystems

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[45] "Class A noxious weed species are those not currently present in New Mexico, or having limited distribution. Preventing new infestation of these species and eradicating existing infestations is the highest priority" (NM Department of Agriculture 2009).

[46] "Class B noxious weed species are those limited to portions of the state. In areas with severe infestations, management should be designed to contain the infestation and stop any further spread" (NM Department of Agriculture 2009).

as well. Occurrences of Russian knapweed (*Acroptilon repens* (L.) DC.), musk thistle (*Carduus nutans* L.), chicory (*Cichorium intybus* L.), and poison hemlock (*Conium maculatum* L.) are known, but acres affected are not (SEINet 2016). African rue (*Peganum harmala* L.), also a Class B listed species is a concern as it has been documented in close proximity to the Forest boundary.

Known populations of species designated as Class C[47] noxious weeds include more than 80 estimated acres of bull thistle (*Cirsium vulgare* (Savi) Ten.), 600 acres of cheatgrass(*Bromus tectorum* L.), unknown acreage of Russian olive (*Elaeagnus angustifolia* L.), 300-1000 acres of saltcedar (*Tamarix* L.) and more than 100 acres of Siberian elm (*Ulmus pumila* L.). Cheatgrass is of high concern because it is fire adapted, which may have implications for the future of fire management. General observations by Forest staff not associated with a formal noxious weed species inventory indicate Siberian elm is far more widespread than saltcedar. Saltcedar is of particular concern to riparian and aquatic resources as it creates salty conditions that favor itself, potentially excluding native riparian species if flood flows are insufficient to remove accumulating salts.

Other Class C noxious weeds with documented occurrences on the Forest include jointed goatgrass (*Aegilops cylindrical* Host.), Scotch thistle (*Onopordum acanthium* L.) and the aquatic species Eurasian watermilfoil (*Myriophyllum spicatum* Kom.) and curlyleaf pondweed (*Potamogeton crispus* L.). Again, acres affected are unknown, but believed to be limited (SEINet 2016).

Spiny cocklebur(*Xanthium spinosum* L.), a species on the noxious weed Watch List[48], has been documented adjacent to the Forest in Arizona as recently as 1978 and was documented in 1951 on the San Francisco River near Glenwood (SEINet 2016) and more recently in the Cosmic Campground (P. Morrison 2016 pers. comm.). Quackgrass (*Elymus repens* (L.) Gould) is another Watch List species that has been documented at two locations on the Silver City Ranger District (SEINet 2016).

Many of the populations described here were known as of 1997 (USDA FS Gila NF 1997). The Gila NF also uses an Integrated Pest Management strategy of early detection and rapid response to deal with other invasive species that pose risks to the Forest. The Gila NF works with the Southwestern New Mexico Cooperative Weed Management Area to coordinate noxious weed inventory and management efforts. An additional non-native plant survey of the Aldo Leopold Wilderness area conducted between 2011 and 2014 by the Upper Gila Watershed Alliance, in support of the Gila NF's Wilderness Stewardship Challenge. This survey focused on approximately 66 miles of trails and streams, 18 off-trail miles, seven corrals, six stock tanks and numerous springs. While many non-native species were observed, a single Siberian elm was the only noxious species found (Keith 2014). The Forest has an ongoing partnership with the Upper Gila Watershed Alliance to treat salt cedar on the Gila River and tributaries. The Forest also receives informal reports of potential invasive species populations from various stakeholders.

Burned areas are at higher risk of invasion by noxious weeds due to lack of competition for sunlight, water and nutrients. With the wildfires that have occurred and the proximity of the burned areas to known invasive plant populations, the Forest has an elevated concern for the spread of invasive species and the establishment of invasive species that have not been documented. In addition, there is a risk of further invasive species introduction and establishment from adjacent private land.

The application of certified weed-free seed, as discussed in the prescribed fire and wildfire section of this chapter provides a secondary benefit to soil and watershed stabilization by providing for more immediate

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[47] "Class C noxious weed species are those that are wide-spread in the state. Management decisions for these species should be determined at the local level, based on feasibility of control and level of infestation" (NM Department of Agriculture 2009).

[48] "Watch List species are of concern in the state. These species have the potential to become problematic. More data is needed to determine if these species should be listed. When these species are encountered, their location should be documented and the appropriate authorities contacted" (NM Department of Agriculture 2009).

competition. The certification process includes genetic laboratory testing of random samples to ensure no species designated as noxious are present. The certification process for straw mulch is not as rigorous as it only involves a walk-through field inspection 10 days prior to harvest. While the Silver Fire BAER monitoring includes a noxious weed survey, much more noxious weed inventory and monitoring is needed. The final monitoring report is expected in 2017.

At the subwatershed level, the watershed condition classification indicator documents one percent of subwatersheds as having established populations of invasive species with the rate of expansion or potential impact on watershed resources considered moderate. All other subwatersheds have few or no invasive species that would affect soil and water resources and necessitate treatment for that purpose.

In addition to the successful treatment of the small population of purple loosestrife, the Forest has had successes treating yellow starthistle and spotted knapweed. Bull thistle is a growing concern, and therefore surveys and treatment are ongoing. Both hand-pulling and herbicide treatments are treatment tools.

Cut-stump herbicide application to saltcedar has been successful in some areas, but much more inventory and treatment is needed. As a Class C noxious weed species, saltcedar is wide-spread in the state, but populations on the Gila NF are relatively small and discontinuous. This is due to several factors. The existing native riparian community structure and condition, and the free-flowing, perennial nature of the Forest streams on which most populations are found being chief among those factors. Because saltcedar is shade-intolerant, the multi-storied and/or dense canopy cover provided by native riparian communities prevent saltcedar populations from expanding in size and number.

Where saltcedar is found on intermittent streams, or where streamflow is regulated by dams, saltcedar has the advantage over native species. Depth to groundwater is typically lower along intermittent streams. Native species, cottonwoods and willows in particular, tolerate a smaller range of depth to groundwater that saltcedar does. Large and/or sudden fluctuations in the water table depth are common along streams where flows are regulated by dams other control structures. Saltcedar remains subdominant to native species on free-flowing streams where the natural flood frequency, timing and duration favors natives. Drying trends, changes in flood frequency and reductions in native canopy cover increase the risk associated with saltcedar infestations on the Gila NF.

Vegetation changes associated with climate change are expected to be species specific, making it difficult to determine what future threats might be posed by invasive and noxious plant species. More research is needed to predict trends with any confidence, however it is likely that shifts in vegetation community composition will provide new opportunities for invasion (Middleton 2006).

While there are not documented feral hogs on the Gila NF, there exists the potential for them to arrive and cause issues as they do in other areas of the state. The State of New Mexico considers feral hogs to be unprotected and are actively trying to eradicate them in several areas. Efforts will be made to eradicate feral hogs if they are documented to occur within the Gila NF.

Aquatic invasive animal species also exist on the Gila NF, are a continuing challenge and a threat to native fish. Crayfish (*Cambaridae*) can be found within reservoirs, streams, irrigation canals, or silt-covered/rocky or gravel substrates, particularly in lentic, or still, very slow moving, water. Bullfrogs (*Lithobates catesbiana* Shaw) have invaded habitats for native aquatic species, and may be common in any permanent water bodies within lower elevations of the Gila NF, particularly in lentic waters (Hayes, NMDGF 2015 pers. comm.).

Insects and Disease

Insects and diseases are important components of forest and woodland ecosystems, greatly influencing structure and species composition over time. They can be both a system driver and stressor. Forested systems have developed under locally specific pathogen levels that were sustainable historically and may help maintain ecosystem function. An outbreak may have uncharacteristic effects to which the system may or may not be resilient to, either because the outbreak is more severe, or because of factors that amplify damaging effects.

Insects and disease have been disturbance mechanisms throughout time, and have many positive impacts. In cases of severe infection levels or periodic outbreaks of insects, the effects are more obvious and can be negative (Ryerson 2015), including increased fuel loading and an elevated risk of wildfire. Conditions such as these were readily observed prior to the 2013 Silver Fire in the southern portions of the Black Range along NM Highway 152. With the exception of white pine blister rust (*Cronartium ribicola* A. Dietr), which is established on the Gila NF, the primary forest insects and diseases are native with outbreaks tied primarily to drought or disturbance (Ryerson 2015).

White pine blister rust is native to Asia and was introduced to the US from Europe in the early 1900s. In the Southwest, it was first detected on the Lincoln NF in 1990 and has since been found on the Cibola, Gila and Santa Fe NFs. The first infection on the Gila NF was in Johnson Canyon in 2005. In 2007, surveys found infections at Bearwallow Mountain, Signal Peak and Silver Creek. The disease is expected to spread and impact white pine populations in many more areas, potentially eradicating white pine from the most susceptible sites. The rust requires two hosts to complete its life cycle: a five needle pine and a gooseberry or currant (*Ribes* spp.), paintbrush (*Castilleja* spp.), or snapdragon (*Pedicularis* spp.). Non-pine hosts are not killed by the rust. Moist drainages and higher elevation stands are the most vulnerable, especially where orange gooseberry (*Ribes pinatorum* Greene), the preferred alternate host, is present. Some trees, even in the conditions most favorable to the rust, may be resistant and provide a seed source for natural selection and eventual recovery. On drier sites, infection rates and mortality are expected to be relatively low. These sites will serve as important genetic refugia for white pines. Maintaining and promoting genetic diversity among white pine should help to ensure the long-term survival of these unique trees. From a forest health perspective, retention of white pine during thinning treatments is advocated in order to conserve the broadest possible genetic diversity. Removing the alternate host species is not considered a viable control strategy (Ryerson 2015).

The period of record documenting insect and disease patterns on the Gila NF is relatively short, and less detailed than other forests in the Southwestern Region prior to the beginning of aerial detection surveys in the 1950s owing to the remoteness and accessibility of the terrain. Since aerial detection surveys began, relatively little activity has been documented compared to other forests. This may be partly due to the Gila NF's proactive fire management. Regardless, the record demonstrates no clear changes in native insect and disease outbreaks (Ryerson 2015).

On a watershed scale, the forest health indicator from the Gila NF's watershed condition classification classifies 99 percent of the Forest as Functioning Properly, with less than 20 percent of any subwatershed anticipated or experiencing tree mortality as a result of insects, disease or air pollution. In the future, the non-native white pine blister rust is expected to expand in terms of occurrence and severity. Climate change is anticipated to substantially change insect and disease dynamics, likely leading to increased tree mortality (Ryerson 2015).

Diseases affecting aquatic species also pose a threat. *Batrachochytrium dendrobatidis* fungus, also known as Chytrid, has been documented in amphibians in multiple locations of the Gila NF including the Upper Gila/San Francisco, Lower Gila, and Mimbres River/Black Range areas (Hayes, NMDGF 2015 pers. comm.).

Chytrid fungus infects amphibian species with the chytridiomycosis disease, which is linked to devastating population declines or species extinctions (Kilpatrick et al. 2009). Another bacterial disease has been detected on the Gila NF is *Renibacterium salmoninarum*, also known as bacterial kidney disease (BKD). *Renibacterium salmoninarum* is an obligate pathogen of salmonid fishes. To date, the bacterium has not been found to infect other species of fish or other animals. It can be transmitted from fish to fish (Mitchum and Sherman 1981), or from adults to their progeny via eggs (Bullock 1980; Bullock et al. 1978).

Pesticide Use

Pesticides, including herbicides, insecticides and piscicides (pesticides that target fish) have been used to a limited extent on the Forest. As these types of chemicals did not exist in the reference period, in a strict sense their use is considered a system stressor. However, non-native invasive and/or noxious species are also system stressors that might otherwise go unchecked without the use of pesticides. Noxious species are typically the target of current pesticide use on the Forest. The use of chemicals as a management tool raises concerns about water quality, aquatic species and human health for some members of the public, as was expressed during the assessment.

According to a Southwest Regional pesticide-use report from 1987, 835 acres were treated with Picloram and 150 acres with Hexazinone for range vegetation improvement. 250 additional acres were treated the Hexazinone for noxious weeds and 80 acres for thinning (USDA FS 1987). The location of these applications are not included in the documentation and no monitoring documentation has been located. In more recent years, only species designated as noxious by the State of New Mexico have been treated with herbicides. The Forest has had some successes where cut-stump applications of Garlon 3A has been applied to saltcedar, but ongoing inventory and monitoring demonstrate that the saltcedar infestation is not yet resolved.

Insecticides are only known to have been used in a single instance. This occurred in the Catwalk area of Whitewater Canyon on the Glenwood Ranger District in 1966, prior to the National Environmental Policy Act (NEPA) and Clean Water Act. Carbaryl was used to control a heavy infestation of an unidentified tussock moth causing ‘light” damage to boxelder seedlings (USDA FS Gila NF 1965). Piscicide has been an important tool in the Gila trout (*Oncorhynchus gilae*) recovery program, beginning with a 1961 application of Antimycin A in Iron Creek. Since that time, both Rotenone and Antimycin A have been used in various streams identified as important to Gila trout recovery. .

Piscicide will continue to be utilized where determined to be the appropriate method to manage and control nonnative fishes. Piscicide use and trends in the future will likely depend on the New Mexico Department of Game and Fish, US Fish and Wildlife Service, and native fish management needs. Herbicide use and trends will likely be tied to invasive and noxious weed management. Although, it may be considered as tool to remove alligator juniper and other re-sprouting species as restoration of grassland and woodland vegetation communities continues.

Roads and Trails

The presence of roads and trails represents a system stressor. Roads directly affect natural sediment and hydrologic regimes by altering stream flow, sediment loading, sediment transport and deposition, channel morphology, channel stability, substrate composition, stream temperatures, water quality, and riparian conditions in a watershed (USDA FS 2000). They also provide a vector for the spread of invasive and noxious species and contribute to habitat fragmentation.

Roads have three primary effects on hydrologic processes. They intercept rainfall directly on the road surface and road cut and fill slopes, and intercept subsurface water moving down the hillslope; they concentrate flow either on the surface or in an adjacent ditch or channel; and they divert or reroute water from natural flow paths (USDA FS 2000).

Roads contribute more sediment to streams than any other land management activity (USDA FS 2000). Large increases in the amount of sediment delivered to the stream channel can greatly impair or even eliminate fish and aquatic invertebrate habitat and alter the structure and width of stream banks and adjacent riparian zone. The amount of sediment can affect channel shape, sinuosity, and relative balance between pools and riffles. Indirect effects of increased sediment loads may include increased stream temperatures and decreased inter-gravel dissolved oxygen (USDA FS 2000).

Prior to European settlement, Native Americans created trails as they followed game, seeds, nuts and fruits of native plants; conducted commerce and warfare; and visited places of religious significance. While these trails existed on the Gila NF, because of the relatively low density and small footprint of these trails, modes of travel and frequency of use, it is assumed that they did not have significant impacts.

After the arrival of Europeans, many of these trails were used by an increasing number of people and new trails and wagon roads were created, many of which followed streams. Upland wagon roads that became too rutted and eroded to use were abandoned and new roads created. Evidence of some of these roads persists on the landscape today. As travel became more commonly motorized, the impacts on soil and other watershed resources increased.

The roads and trails indicator from the watershed condition classification describes the likelihood of altered hydrologic and sediment regimes in terms of road density, maintenance and proximity to water attributes. Ratings of Functioning Properly indicate the hydrologic and sediment regimes are largely intact. Functioning at Risk and Impaired Function ratings indicate moderate and higher likelihoods of alteration of hydrologic and sediment regimes. Between 64 and 67 percent of subwatersheds are Functioning Properly with respect to road density and proximity to water while only approximately 12 percent are considered Functioning Properly with respect to maintenance. Roads in close proximity to water not only have some of the highest maintenance requirements, but also have the most immediate effects on riparian vegetation, channel shape and function, and sediment and hydrologic regimes.

For this assessment, road density was calculated specific to each ERU and is displayed in the following two tables.

Table 189. Road density in the upland ERUs of the Gila NF.

Roads and Trails	Forests					Woodlands					Shrubland/Grasslands			
	Ponderosa Pine Forest (mi/mi^2)	Mixed Conifer Frequent Fire (mi/mi^2)	Ponderosa Pine-Evergreen Oak (mi/mi^2)	Mixed Conifer with Aspen (mi/mi^2)	Spruce Fir Forest (mi/mi^2)	PJ Woodland (mi/mi^2)	PJ-Grass (mi/mi^2)	Juniper Grass (mi/mi^2)	Madrean Piñon-Oak (mi/mi^2)	PJ-Evergreen Shrub (mi/mi^2)	Mountain Mahogany Mixed Shrubland (mi/mi^2)	Montane Subalpine Grassland (mi/mi^2)	Colorado Plateau-Great Basin Grassland (mi/mi^2)	Semidesert Grassland (mi/mi^2)
Open	1.1	0.3	0.9	0.4	0.3	0.5	0.5	0.9	0.1	1.2	0.1	1.9	2.4	2.0
Closed	0.6	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.1	0.05	0.1	0.3	0.3	0.4
All Roads	1.7	0.5	1.2	0.6	0.4	0.7	0.7	1.2	0.2	1.3	0.2	2.2	2.8	2.4
Motorized Trails	0.02		0.04	0.01		0.05	0.01	0.1			0.04		0.01	0.02
Non-motorized Trails	0.2	0.8	0.4	0.4	0.9	0.1	0.3	0.1	0.1	0.03	0.2	0.1	0.1	0.1
Total Roads and Trails	2.0	1.3	1.6	1.0	1.3	0.9	1.0	1.4	0.3	1.3	0.5	2.3	2.9	2.5

Table 190. Road density in the riparian ERUs of the Gila NF.

Roads and Trails	Cottonwood Group				Montane Conifer-Willow Group				Walnut-Evergreen Oak Group	Desert Willow Group	Wetland-Ciénega Group
	Fremont Cottonwood-Oak (mi/mi^2)	Fremont Cottonwood-Shrub (mi/mi^2)	Narrowleaf Cottonwood-Shrub (mi/mi^2)	Sycamore-Fremont Cottonwood (mi/mi^2)	Upper Montane Conifer-Willow (mi/mi^2)	Willow-Thinleaf Alder (mi/mi^2)	Arizona Alder-Willow (mi/mi^2)	Ponderosa Pine-Willow (mi/mi^2)	Arizona Walnut (mi/mi^2)	Desert Willow (mi/mi^2)	Herbaceous-Wetland Riparian (mi/mi^2)
Open		8.4	3.5	2.6	0.8	1.2	1.5	5.9	5.7	5.6	3.5
Closed		0.2	0.8	0.9	0.1	1.0	0.2	1.2	1.5	1.5	1.1
All Roads		8.6	4.3	3.5	0.9	2.2	1.6	7.0	7.3	7.1	4.6
Motorized Trails			0.5				0.02		0.5	0.7	
Non-motorized Trails		1.0	3.9	1.4	13.3	7.5	7.7	0.9	1.5	0.2	0.9
Total Roads and Trails		9.6	8.7	4.9	14.2	9.7	9.3	7.9	9.5	8.1	5.5

After implementation of the Travel Management decision resulting in motorized travel being restricted to a designated transportation system, impacts to riparian ecosystems and watershed condition are expected to decline (USDA FS Gila NF 2013a). As future projects include decommissioning of unneeded system roads and unauthorized roads, impacts will be further reduced. On the other hand, as described in the Chapter 14: Infrastructure, the Forest's ability to conduct sufficient road maintenance is limited by budgets. Road maintenance on the Gila NF is of larger concern than road density. If the budget trends continue downward, so will soil conditions associated with the road and motorized trail system on the Forest.

Recreation

Any natural resource impacts caused by unmanaged, illegal, or inappropriate recreation use on Forest lands may be a stressor. This may include illegal and/or inappropriate recreation use incompatible with particularly sensitive areas (such as OHV use in riparian areas), littering, numbers of visitors exceeding the designed capacity of a developed site, excessive use of an area for dispersed recreation activity, and excessive numbers of, or unsuitably located, user developed campsites within General Forest Areas.

Based on National Visitor Use Monitoring (NVUM) survey results, total recreation visitation to the Gila National Forest increased by 69%, or from 305,000 to 514,000 visitors, between 2006 and 2011. The same survey results also showed that certain recreation site types demonstrated longer duration stays per visit, including General Forest Areas (increased by 19.3 hours per visit), Overnight Use Developed Sites (increased by 17 hours per visit), and Designated Wilderness (increased by 1.8 hours per visit). This recent trend of longer duration per visit may indicate that a significant number of visitors are now staying for three-day visits, as compared to two-day visits. Day Use Developed Sites were the only site type that demonstrated a shorter visitor stay duration, reduced by 1.4 hours. The overall duration of a National Forest visit between these surveys has increased by 2.4 hours per visit.

General Forest Areas (GFAs) are National Forest lands that are considered undeveloped, with the exception of system roads and trails. These areas are typically associated with dispersed recreation. Examples of uses on General Forest Areas are dispersed camping, OHV riding, hunting, backpacking, and horseback riding. Most recreation special uses requiring the issuance of a special use permit also involve some type of dispersed recreation activity.

There are many user-developed dispersed campsites distributed throughout the Gila National Forest. Most user-developed campsites are in good physical condition, and many Forest visitors use existing, hardened user-developed campsites and are observed to maintain a clean camp and minimize resource impacts. However, common resource impacts associated with dispersed camping include litter, wheel ruts from driving during wet conditions, and human-caused wildfire caused by unattended campfires.

Developed recreation sites are those designated areas where the agency provides constructed facilities and improvements for both visitor convenience and resource protection. These sites are designed for concentrated use of an area by a set maximum number of visitors, reducing the likelihood of human-caused resource impacts when used as intended. The Gila National Forest currently has 33 developed campgrounds (including 2 group sites), 6 picnic sites (including 3 group sites), 98 developed trailheads, 3 public target shooting ranges on the Glenwood, Silver City, and Reserve Ranger Districts, an observation site, and an Interpretive Site Visitor Center near the Gila Cliff Dwellings National Monument. Developed sites and areas experience greater use during the summer through fall seasons and on holidays, although some remain open and in use year-round.

The current trend for some developed recreation facilities is of declining conditions due to a backlog of deferred maintenance, age of infrastructure, budget limitations, and vandalism (e.g., graffiti, litter, physical damage to facilities, etc.). This trend may also contribute to increased resource damage due to improperly functioning facility improvements, or by concentrations of larger numbers and more frequent visitation exceeding design capacity at some sites. For more information on dispersed and developed recreation trends and threats, see Chapter 12: Recreation.

Designated Wilderness includes areas designated under laws passed in Congress for preservation and protection in their natural condition, but may also contain ecological, geological, or other feature(s) of scientific, educational, scenic, or historical value. The Gila NF currently has three designated wilderness areas – Gila Wilderness, Aldo Leopold Wilderness, and Blue Range Wilderness. The Wilderness Act requires management of human-caused impacts and protection of wilderness character to insure that they are "unimpaired for the future use and enjoyment as wilderness." Wilderness character as defined under the Wilderness Act consists of five qualities: untrammeled (free from control or manipulation), natural, undeveloped, outstanding opportunities for solitude or primitive unconfined recreation, and other features of value.

Acceptable recreation uses in wilderness, as mandated by law, policy and regulation, only allow non-mechanized travel and non-motorized uses, which have a lower potential to cause significant resource damage. The Gila's wilderness areas are considered "destination attractions" for visitors seeking a wilderness experience. Increased visitation may create stressors to wilderness character, which the Forest is mandated by the Wilderness Act of 1964 and agency policy to protect, and there is a trend in increased wilderness visitation demonstrated between the two previous NVUM surveys. Current levels of overall wilderness visitation are not considered to be of concern, although some localized areas may be experiencing concentrated use that may diminish wilderness character. Wilderness character is a measure only applied to an entire wilderness, and may not be directed to only specific areas within, therefore any localized effects are an impact to overall wilderness character.

Mineral Resource Extraction

Disturbances to the soil resource related to the extraction of mineral resources include erosion and contamination. The Gila NF has a long history of mining activities, which are described in greater detail in Chapter 16: Energy and Mineral Resources. Although large-scale mining did not occur prior to European settlement, Native Americans utilized the Forest's mineral resources for many things including pottery, jewelry and tool production. Ground disturbing activities were of relatively small extent and no contaminants were produced.

Mining on the Forest began in the late 1800s with gold, silver and copper being the primary minerals extracted. Mining practices that disturbed riparian communities has occurred to a very limited extent and was associated primarily with placer gold deposits in Bear Creek and isolated areas in the Burro Mountains. As a whole, mining activity has declined in recent years. At present, mineral extraction on the Forest is limited to crushed stone, construction sand and gravel, recreational gold panning and noncommercial collection outside of wilderness areas. Two large open-pit copper mines, Tyrone and Cobre, operated by Freeport McMoRan Inc. are located immediately adjacent Forest boundaries. While the potential for increased mining activities on the Forest exists for some minerals, mining activity trends follow the metal or commodity prices.

Abandoned Mine Lands (AMLs) are known abandoned mines and/or mining-related hazards in need of reclamation or restoration. These lands may contain arsenic, cadmium, copper, lead, mercury and zinc which cause human health and environmental hazards. An inventory of these lands, conducted in the late 1990s, identified 353 AMLs within the Gila NF. The work to reclaim these problem areas is conducted as time and money permits. Soil contamination concerns related to AMLs is documented qualitatively by the soil condition indicator from the watershed condition classification. Mining related soil contamination is noted in approximately three percent of subwatersheds, but is not known to affect overall soil quality. Water quality, on the other hand, is known to be affected by mining related pollutants. There are just over

7.5 stream miles in the context area, 1.7 of which occur on Forest, where cadmium and lead concentrations have resulted in a 303(d) listing where the likely cause is a nearby historic mining operation.

Stakeholder Input

Stakeholder input received during the assessment regarding system drivers and stressors centered around fire and climate change and their relationships with the disturbance regimes described in this chapter such as non-fire vegetation management and herbivory. Invasive species and insects and disease were also topics of concern for some.

Most stakeholders that provided input recognize fire as a natural, ecological process and an important management tool, although a few suggest prevention, suppression of all wildfires and discontinued use of prescribed fire is warranted based on smoke related human health concerns. Of those that recognize fire as a natural ecological process, most agree that fuel loading, fire frequency and severity have been altered by Gila NF management actions and inactions. Some also point to the relationship between altered fire regimes, drought and climate change, and are concerned the negative and potentially long-term ecological and watershed impacts observed following recent large, high severity wildfires. Others suggest that while watershed impacts might be negative, the ecological impacts might be beneficial.

These fires have also limited stakeholder access to the Forest in some areas, either by Forest Service closure, or by deteriorating road and trail conditions. Some see these fires as a waste of natural and economic resources (such as timber) and suggest expedited, wide-spread salvage logging should be a priority. This group of stakeholders also suggests that increases in timber harvest and livestock grazing should be used to supplement or replace fire as a disturbance regime to promote ecosystem and economic health and that declines in both of these practices are responsible for current conditions.

On the other hand, there are others that provided references during the assessment, pointing to the body of science that suggests the legacy of historic livestock grazing practices and fire suppression both contributed to current conditions. This group of stakeholders also asserts that restoring natural fire regimes on the Forest is key to climate change adaptation and points to the science supporting restoration of process is more important that restoration of structure or composition.

In general, stakeholders view fire management on the Gila as largely reactive, not pro-active and note that this approach has a high cost in ecological and economic terms as observed by the increasing size and severity of wildfires. Some note the cost associated with large suppression efforts and question why those dollars are not spent instead on preventative measures such as thinning and prescribed fire. Others point to livestock grazing practices that reduce the fine fuels that carry fire as restricting fire. Still others are concerned about the combined effects of climate change and the large, high severity fires the Gila NF has seen in recent years and wonder if the Forest isn't already seeing ecosystem type conversions (e.g. mixed conifer to shrubland) that could be expected to accompany climate change. Stakeholders are also concerned about post-fire emergency stabilization treatments. Many support post-fire seeding of grasses as a method to reduce flooding, erosion, sedimentation hazards. A few wonder why the Gila NF doesn't re-plant trees after fire. Some are concerned about the use of non-native species and/or straw mulch.

Several comments asserting Forest managers should be demonstrating stronger consideration of climate change and a more active approach to increasing ecosystem adaptive capacity to climate change were received. Increasing extents of insect and disease outbreak were referenced in relationship to climate change and overgrown forests. A few suggested using timber harvest to remove existing bark beetle damaged trees. Some want to make sure that future desired conditions described in the revised Forest Plan are actually possible given "new climate normals" and stress the need for management to place emphasis on ecosystem resiliency. Others are concerned about climate change and the possibility of threatened, endangered and otherwise at-risk species reaching extinction. Conversely, existing and future extents of invasive and noxious species, particularly saltcedar are worrisome to many as climate change could favor invasive species. These stakeholders indicate a need for more inventory, monitoring and treatment and some suggest the Forest work with Cooperative Weed Management Areas to coordinate efforts with New Mexico Department of Agriculture.

After the release of the draft assessment report, stakeholders provided additional input, feedback and comments regarding this chapter of the assessment. Many of the comments reiterated those provided earlier in the assessment phase of plan revision, but many new ideas and concerns were also provided. Some expressed understanding the intent of this chapter, but argued that organizing the discussion into topics (e.g. climate, climate change, water supply and demand, etc.) did not provide the synergistic treatment these topics deserve. Others requested more clarity about where in the report these discussion were located as much of the management interpretation of departure, trends and risk are explained by the status of system drivers and stressors.

With regard to specific topics, it was argued that the Forest does have the ability to control or influence water use as the Forest Service and/or its permittees are responsible for maintenance of constructed livestock and wildlife water features and that a better job needs to be done in keeping up with that maintenance. Some felt climate change science, OHV use in riparian areas, invasive and noxious species, insects and disease, herbivory by wildlife were not covered adequately, or that pesticide use should be considered a system driver, rather than a stressor. A few commented that clarifying and more consistent language differentiating historic overgrazing practices and sustainable livestock grazing was needed throughout the assessment report. One individual expressed concern that the discussion of non-fire vegetation treatments did not fully consider the positive aspects of mechanical thinning, especially the skilled and conscientious work of operators to minimize the negative impacts to the soil resource. One individual perceived that there is too much fire use in the spring and summer when fires burn too hot and that management should shift to burning in late summer and fall and increase emphasis on burning downhill and buffering riparian areas. With so much focus on fire-adapted ecosystems and restoration of those historic fire regimes, some were concerned about indiscriminate fire use in the face of climate change and "fire sensitive" ecosystems such as riparian areas, Spruce-Fir Forest and Mixed Conifer with Aspen. Issues related to this concern include drying of sites and fire-facilitated climate-induced changes in vegetation types. The concern for drying of sites and fire-facilitated vegetation type conversions was extended to mechanical treatments as well and some suggested incorporating plan components that set a minimum percent retention level for basal area and updating the Forest's stand exam data. Several comments were received regarding emergency post-fire BAER activities and long-term rehabilitation. Related to BAER, stakeholders wanted to see local ecotype seed used if seeding was recommended, offered their opinions on seeding and mulching activities, and wanted to know about post-fire rare plant and BAER monitoring efforts. Some questioned why the Gila NF has not planted trees, as other Forests have done while others recommended protection of snags left by stand replacement fire for habitat or removal of livestock from the post-fire environment for a minimum of two years to allow recovery of native herbaceous perennials.

Summary

This chapter reviews the best available information related to system drivers and stressors on the Gila NF. Major system drivers include the predominant climatic regime and cycles of drought, natural vegetation succession, and fire. Major system stressors include climate change and cycles of drought, water supply and demand, woody vegetation encroachment, fire, roads and trails, and herbivory. While insects and disease, and terrestrial and invasive species are not currently major system drivers, climate change projections could increase their significance in the future. Climate change and ecosystems are intricately connected and impacts on one will often feedback to affect the other. As the health of the ecosystem is a function of water availability, temperature, nutrient availability, and many other factors, it is difficult to determine the extent, type and magnitude of ecosystem change, and the associated changes in services provided, under future climate scenarios.

Regardless, the Gila NF has the opportunity to manage for ecosystem adaptation and resilience to climate change by integrating ecological and watershed restoration. Fire has and will remain the most important management tool in supporting sustainable, fire-adapted ecosystems in the face of climate change (Fulé 2008; Tarancón et al. 2014). Accounting for site specific variability in reference forest structure and fire frequency may become increasingly important given climate change projections of larger and more frequent wildfires (Korb et al. 2013). Accounting for watershed impacts to riparian and aquatic ecosystems will also become increasingly important, especially in those systems where cottonwood and alder are present.

Other than fire, which can be either a system driver or stressor, the available tools to accomplish restoration are all stressors. However, a balanced approach that considers site specific factors and the potential trade-offs associated with of each management tool, or combination of tools, may provide for restoration of some ecosystem characteristics and contribute to adaptation and resilience. Monitoring treatment effectiveness will be important to inform these decisions.

While there may be responsibility and opportunity related to Forest management, there are also limitations, budget and staffing being primary among them. These limitations may be overcome, in part, by collaborating with new and existing partners.

Section II.
Social, Economic and Cultural Sustainability

Elk in Wahoo Canyon by Micah Kiesow

Introduction

The Gila NF is responsible for sustainable management of ecological resources within its boundaries, and the ecosystem services provided by those resources. This means that people are just as affected by forest management as are the ecological resources that are managed by the Forest. People benefit, either directly or indirectly from multiple use of forest resources. The plan area has a long human history of occupation that precedes the establishment of the Gila NF. Native American, Hispanic and Anglo-American traditional communities continue to use the Forest for economic, social and cultural purposes. Local communities, surrounding areas and visitors all gain some benefit and have expectations of what the Gila NF can offer them in terms of livelihoods, traditional uses, clean air and water, forest products and recreation to name a few. This section of the report focuses on the human dimension of forest management, and when considered hand in hand with the ecological analysis, provides for a comprehensive assessment.

The management of the Gila NF contributes to social and economic sustainability by maintaining a set of desired social, cultural and economic conditions within the Forest and beyond the Forest boundary that benefit people. Since this forest planning effort informs decisions about how to manage the Gila NF, understanding how that management contributes to, or affects social, economic and cultural conditions in this area of influence is the focus for evaluating sustainability. The Gila NF area of influence is comprised of the four counties that contain the Gila NF within their boundaries: Catron, Grant, Hidalgo, and Sierra counties (Figure 153). Areas beyond these four counties are part of the broader landscape where Forest contributions can affect a specific interest, but do not fundamentally affect the social, cultural, and economic conditions.

This section is broken into nine chapters to fully address the social, cultural and economic components of the Gila NF as follows:

Chapter 10: **Social, Cultural and Economic Conditions** provides context related to current social, cultural and economic conditions, depicts the demographic make-up of the area and shows the economic contributions provided by the Gila NF.

Chapter 11: **Multiple Uses** assesses the contributions of wood products and other plant resources, livestock grazing, water, wildlife and fish and the sustainability of those contributions.

Chapter 12: **Recreation** addresses sustainable recreation opportunities, including settings, access, current demands and future trends, conflicts between uses and opportunities for community involvement.

Chapter 13: **Designated Areas** describes the congressionally and administratively designated areas on the Forest including wilderness, wilderness study areas, inventoried roadless areas, wild and scenic rivers, a national scenic trail, and a research natural area.

Chapter 14: **Infrastructure** includes the physical facilities and systems that support the use of the Forest. The five major categories of facilities and systems are transportation, administrative, recreation and both privately owned and public facilities or utilities sited on the Forest and operated under permit.

Chapter 15: **Lands** analyzes patterns of landownership, access and travel across the Forest. It includes ownership patterns affecting the Forest, special uses on the Forest, land and resource plans from adjacent jurisdictions and current and historic access issues.

Chapter 16: **Minerals** identifies the mineral resources that have historically been developed on the forest, as well as the potential availability of mineral resources for current and future exploration and development. These include renewable and non-renewable energy resources, leasable, locatable and saleable minerals.

Chapter 17: **Cultural and Historic Resources** provides the historic and cultural context in which the Gila NF resides. Cultural and historic resources and uses are critical to the social, economic and ecological sustainability.

Chapter 18: **Areas of Tribal Importance** identifies and evaluates available information regarding tribal rights and areas of known tribal importance within the Gila NF that are affected by management and the condition and trends of Forest resources that might affect them.

Chapter 10. Social, Cultural, and Economic Conditions

Introduction

One of the most unique characteristics of southwestern New Mexico is its diversity of people, culture, traditions, and values. This chapter describes the area's demographics illustrating the area's diversity; and highlighting the social, cultural, and economic conditions and trends. This chapter presents demographic and economic statistics within the context of a multi-county "area of influence." The Final Directives define the area of influence as "where the management of the plan area substantially affects social, cultural, and economic conditions" (FSH 1909.12, section 13.21). The area of influence concept recognizes that the Forest provides contributions and has effects outside the Forest boundary. The Gila NF area of influence is comprised of the four counties that contain the Gila NF within their boundaries: Catron, Grant, Hidalgo, and Sierra counties (Figure 153). Areas beyond these four counties are part of the broader landscape where Forest contributions can affect a specific interest, but do not fundamentally affect the social, cultural, and economic conditions.

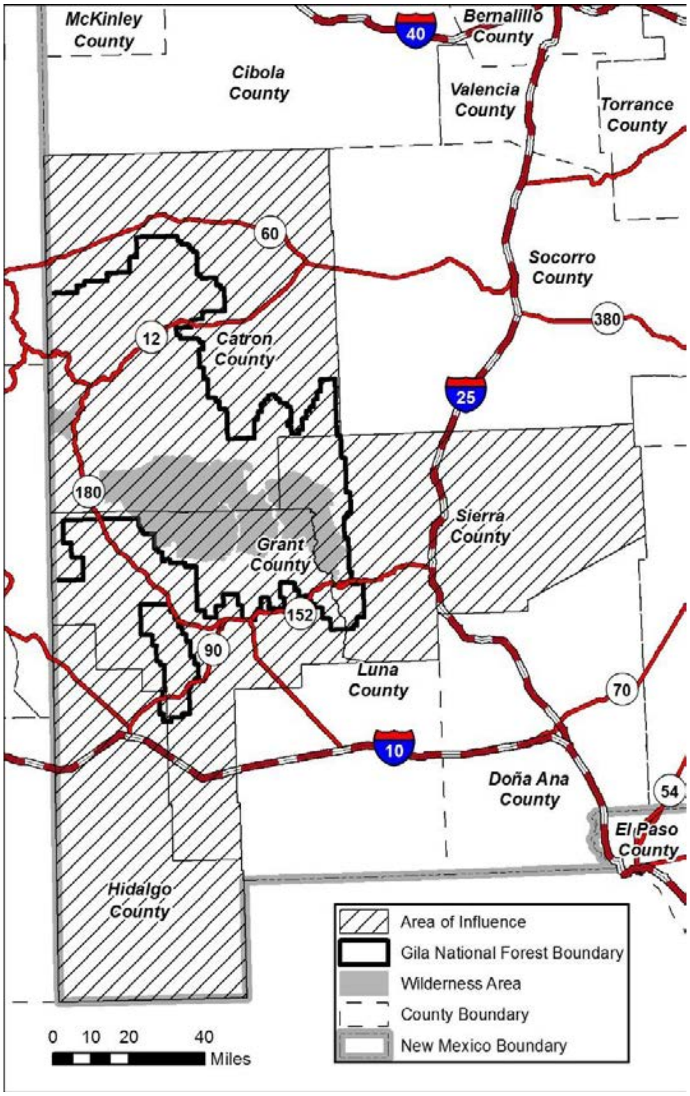

Figure 153. Gila National Forest Area of influence for the social, cultural, and economic analysis

This information provides context for understanding the setting of the Gila NF, stakeholders, and the social and economic demands that influence forest management on the Gila NF. Demographic and socioeconomic data reported for the area of influence are based on the U.S. Census Bureau county-wide data. Statistics for the State of New Mexico are presented for comparison with the area of influence. In some cases, the data for the multi-county area of influence has been aggregated using a program economic tool kit from Headwaters Economics (2015a). Many statistics were compiled by the University of New Mexico Bureau of Business and Economic Research (UNM-BBER). Not all of the data are reported in this assessment report, and to read more please see the UNM-BBER Socioeconomic Assessment Supplement for the Gila NF (2014) and the UNM-BBER Socioeconomic Assessment for the Gila NF (2007), which are part of the planning record.

Population Statistics

Total Population

In 2010, New Mexico was home to more than 2 million people (less than 1% of the U.S. population) (U.S. Census Bureau 2000a.). Since 1980, the state's population has grown more rapidly than that of the U.S. New Mexico’s population grew by 16, 20, and 13 percent between 1980 and 1990, 1990 and 2000, and 2000 and 2010, respectively. In comparison, the U.S. population grew at 10, 13, and 10 percent during these same time periods. UNM Geospatial and Population Studies has projected state population growth rates for the next two decades of 14 and 11 percent, which will result in a 2030 population of more than 2.6 million people (UNM BBER 2014).

Figure 154 depicts the percentage change in each New Mexico county population between 2000 and 2010. The population growth rate varies greatly among counties with some experiencing population increases and others decreases. Where population declines occurred in New Mexico during these years is in part a result of the Great Recession requiring many people to move to find work (UNM-BBER 2014). The Great Recession refers to a period of severe economic decline in 2008 and 2009 due to a housing market correction and subprime mortgage crisis.

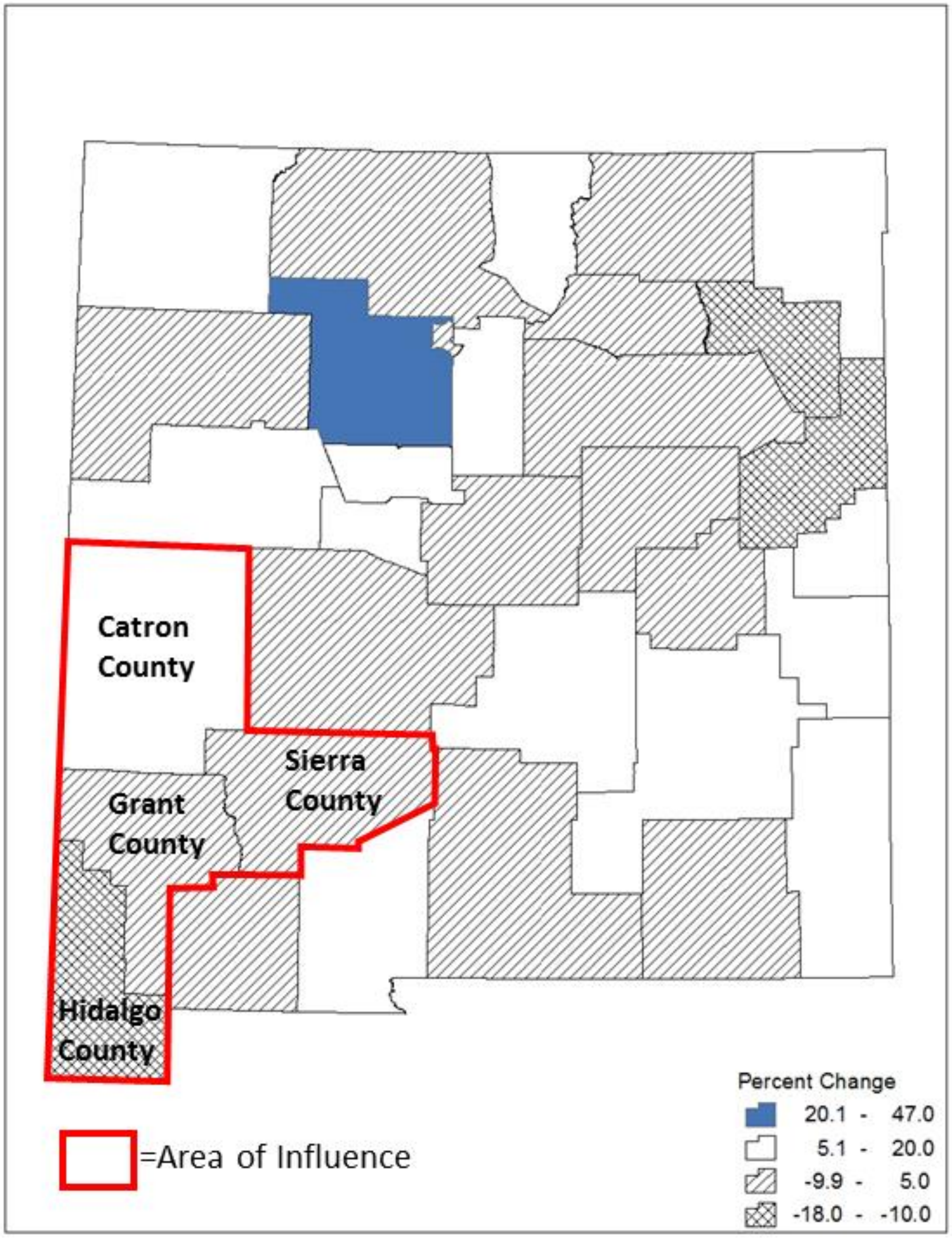

Figure 154. Percentage change in each New Mexico county population between 2000 and 2010. Figure from UNM-BBER 2014.

The area of influence (Catron, Grant, Hidalgo, and Sierra Counties) contains approximately 2.4 percent of the population of New Mexico. In 2010, the area of influence had a population of 50,121 with Grant County being the most populous (29,514) and Catron County being the least (3,725). Figure 155 graphically depicts the population trend for the four-county area, which has increased slowly from the 1980s to the early 2000s when it reached a peak, and then declined slightly in 2010 due to the Great Recession and depressed copper prices leading to temporary mine operation suspension and layoffs in Grant County in 2009. Between 2010 and 2030 the area's population is expected to hold relatively constant (UNM-BBER 2014).

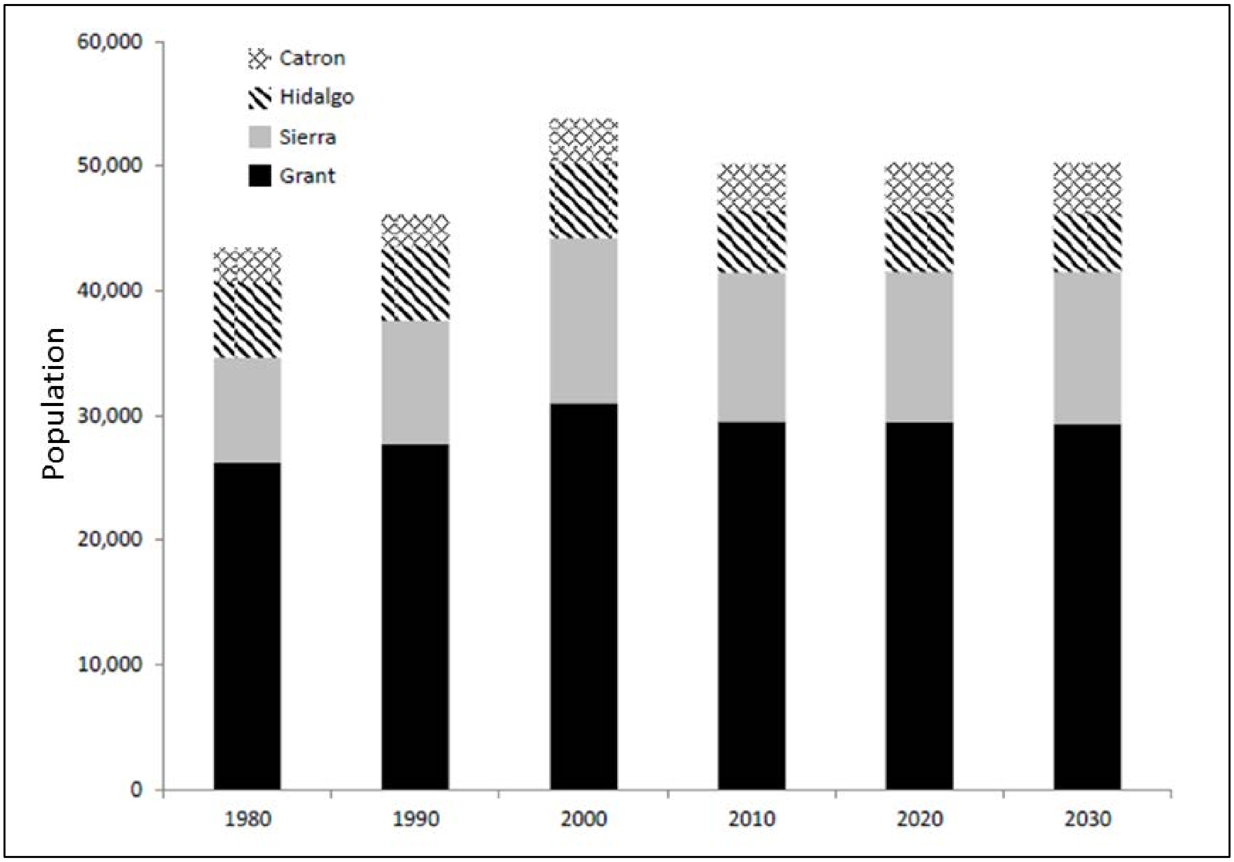

Figure 155. Historical and projected population of Gila NF area of influence counties. Figure from UNM-BBER 2014.

Population Density

Compared to other states, New Mexico has a relatively small population. In 2010 New Mexico's population rank was 36 with only 14 states having smaller populations. In addition to having a small population, New Mexico's land area is large resulting in a low average population density. In 2010, New Mexico had a population density of only 17 people per square mile. Only four states have a lower population density: Alaska, Montana, North Dakota, and Wyoming. The Gila NF area of influence is rural, with an average 2010 population density of fewer than 3 people per square mile. Due to the presence of Silver City, densities have historically been highest in Grant County, where the population density was more than 7 people per square mile in 2010. Catron County's population density is exceedingly low, at 0.5 persons per square mile, making it one of New Mexico's least densely-populated counties (UNM-BBER 2014).

Net Migration

Net migration is a useful indicator of the population dynamics of an area. Are people moving in or leaving or is the population stable? Migration has played a relatively minor role in New Mexico's population growth. Net in-migration to New Mexico was approximately 150,000 people between 1990 and 2000, and approximately 100,000 people between 2000 and 2010. Between 1990 and 2000, most counties associated with the Gila NF area of influence experienced some level of net in-migration. Hidalgo County was the one exception possibly due to not attracting as much of an influx of retirees from the baby-boomer generation (UNM-BBER 2007). Between 2000 and 2010 migration patterns changed with the exception of Catron County, all area of influence counties experienced net out-migration likely due to many people moving to find employment during the Great Recession (Figure 156) (UNM BBER 2014).

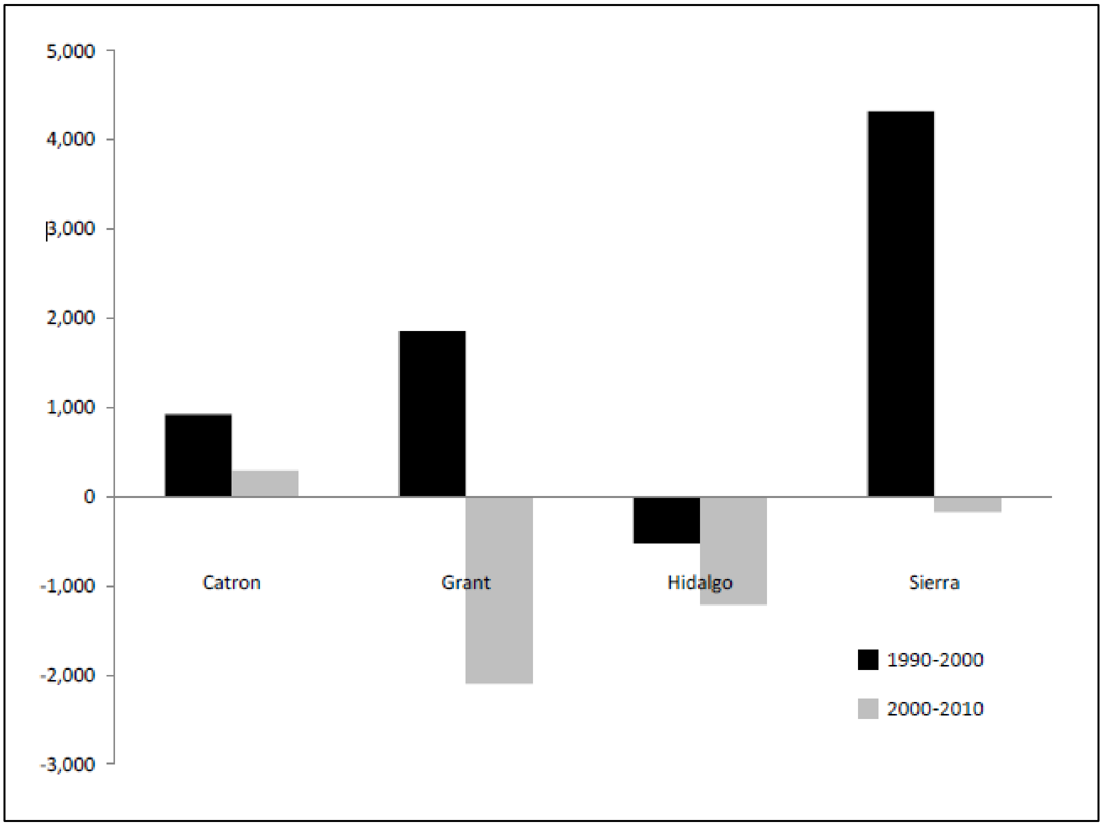

Figure 156. Net migration to/from Gila NF area of influence counties. Figure from UNM-BBER 2014.

Age and Gender Distribution

Changes in the age structure of New Mexico's population are similar to that of the United States. The portion of the population in the 14 and under group steadily declined between 1990 and 2010 (from 25 to 21 percent), while the portion that is age 65 or older steadily increased from 11 to 13 percent. These trends are expected to continue. The BBER report (2014) projects that by 2030, those of ages 0 to 14 will comprise 20 percent of New Mexico’s population, and individuals age 65 and older will comprise 21 percent. Between 1990 and 2010, the portion of New Mexico's population of working age (ages 15 to 64) grew from 64 to 66 percent, but is expected to decline to 60 percent by 2030 (UNM BBER 2014).

Since at least 1990, compared to the rest of New Mexico, a smaller portion of the area of influence population is between the ages of 0 and 14, while a larger portion is age 65 or older. Age structure differences between the area of influence and New Mexico have increased over time. The portion of the population that is less than 15 years of age has declined more rapidly in the area of influence than in New Mexico, while at the same time the portion of the population that is over the age of 64 has increased more rapidly in the area of influence than in New Mexico. Figure 157 shows a continued increase in the proportion of the population over 64 projected in the area of influence for 2030, while the proportion of the population between 15 and 64 is expected to decline (UNM-BBER 2014). Facing limited opportunities for employment, younger people migrate to larger communities, accelerating the aging of the population. In addition, some counties in the area of influence are attracting an influx of retirees from the baby-boomer generation (UNM-BBER 2007). Older populations are likely to have different needs and preferences related to Forest use than younger populations.

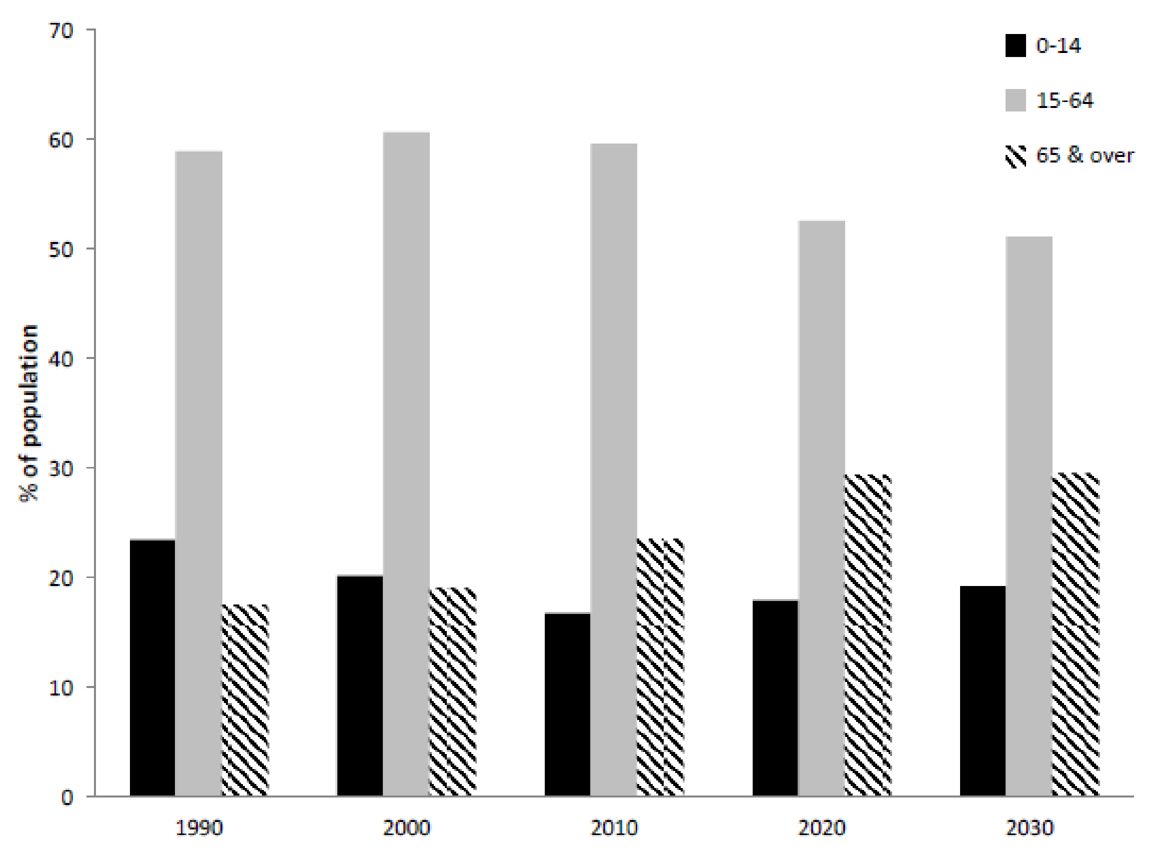

Figure 157. Historical and projected age distribution in Gila NF area of influence. Figure from UNM-BBER 2014.

The gender makeup of the area of influence (49.8% male; 50.2% female) is quite similar to the State of New Mexico (49.5% male; 50.5% female) (U.S. Census Bureau 2014).

Racial Composition and Ethnicity

Cultural diversity is rich and evident in New Mexico. In 2000, New Mexico became a majority-minority state, with a total minority population exceeding that of the white non-Hispanic population (UNM-BBER 2007). The portion of the New Mexico population that identified themselves as of Hispanic descent increased from 38 to 46 percent between 1990 and 2010 (UNM-BBER 2014). As a whole, the Hispanic/Latino composition of the area of influence remained fairly stable between 1990 and 2010.

The ethnic compositions of the four counties differ notably. Since 1990 the populations of Catron and Sierra Counties have been between approximately 70 and 80 percent non-Hispanic White, while between 40 and 50 percent of the populations of Grant and Hidalgo Counties have been non-Hispanic White (UNM-BBER 2014). In comparison to New Mexico, Table 191 shows that the area of influence population is notably more White and less African American, American Indian, and Asian.

Table 191. Those who self-identify as Hispanic, within the area of influence (4 counties), New Mexico, and the U.S.

Hispanic & Race/Population	Area of Influence (pop.)	New Mexico (pop.)	U.S. (pop.)	Area of Influence (%)	New Mexico (%)	U.S. (%)
Total population	49,462	2,080,085	314,107,084	--	--	--
Hispanic/Latino (any race)	21,131	978,189	53,070,096	42.7%	47.0%	16.9%
Not Hispanic or Latino	28,331	1,101,896	261,036,988	57.3%	53.0%	83.1%
White alone	26,744	824,291	197,159,492	54.1%	39.6%	62.8%
Black or African American alone	117	37,519	38,460,598	0.2%	1.8%	12.2%
American Indian alone	497	177,555	2,082,768	1.0%	8.5%	0.7%
Asian alone	201	26,991	15,536,209	0.4%	1.3%	4.9%
Native Hawaiian & other Pacific Is. alone	4	942	493,155	0.0%	0.0%	0.2%
Some other race alone	8	3,718	611,881	0.0%	0.2%	0.2%
Two or more races	760	30,880	6,692,885	1.5%	1.5%	2.1%

Source: US Census Bureau 2010-2014

Language

Over 70 percent of people who live in the area of influence primarily speak English (Table 192). Spanish is spoken by 28 percent while 2 percent speak a language other than English or Spanish. When compared to the rest of the United States, the cultural diversity of the communities surrounding the Gila NF is evident by the percentage of people who speak a language other than English although the State of New Mexico has a greater diversity of languages spoken as a whole.

Table 192. Language spoken at home in the area of influence, New Mexico, and the U.S.

Language	Area of Influence (%)	New Mexico (%)	U.S. (%)
Only English	71%	64%	79%
In addition to English	29%	36%	21%
Spanish	28%	29%	13%
Other Indo-European	1%	1%	4%
Asian & Pacific Island	0%	1%	3%
Other languages	1%	5%	1%
Speak English less than “very well”	5%	9%	9%

Source: US Census Bureau 2010-2014

Education

Educational attainment is a category where the State of New Mexico has historically struggled. New Mexico's population has become more educated during the last two decades. The portion of individuals age 25 or older with less than a 9th grade education decreased from 11 to 8 percent; the portion with some high school education but no diploma or GED decreased from 14 to 10 percent; and the portion with an associates or other advanced degree increased from 26 to 33 percent (UNM BBER 2014).

Although in 1990 the area of influence's population was less educated than New Mexico's population, now the two populations are similar in educational attainment (Table 193). Between 1990 and 2010, the portion of the area of influence population with less than a high school education declined from nearly 33 to 16 percent. During this same time period, the portion of the area's population with at least some college education increased from just over 33 to nearly 54 percent. The higher share for Grant County may be partly related to access to education since Western New Mexico University is located in Silver City (UNM-BBER 2007). The lingering effects of the Great Recession will likely continue to create an incentive for individuals to obtain higher levels of education (Carnevale et al. 2012). Therefore, it is expected that educational improvements will continue throughout the Gila NF associated counties (UNM-BBER 2014).

Table 193. Education attainment within the area of influence, New Mexico, and U.S.

Education/Population	Area of Influence (pop.)	New Mexico (pop.)	U.S. (pop.)	Area of Influence (%)	New Mexico (%)	U.S. (%)
Total population 25 years or older	36,158	1,360,013	209,056,129	--	--	--
Less than 9th grade	2,137	96,892	12,193,679	6%	7%	6%
9th to 12th grade, no diploma	3,361	121,093	16,394,069	9%	9%	8%
High school graduate (includes equivalency)	10,924	358,007	58,440,600	30%	26%	28%
Some college, no degree	9,127	324,492	44,241,558	25%	24%	21%
Associate's degree	2,442	104,758	16,580,076	7%	8%	8%
Bachelor's degree	4,489	201,686	38,184,668	12%	15%	18%
Graduate or professional degree	3,678	153,085	23,021,479	10%	11%	11%

Source: US Census Bureau 2010-2014

Employment

Prior to this century, New Mexico's unemployment rate typically exceeded that of the United States. The relationship changed after 2002, and since 2006 the New Mexico unemployment rate has been considerably below that of the rest of the Nation. Between 2000 and 2008, much of the growth in New Mexico nonfarm employment occurred in health and social assistance, local government, professional and business services, and construction. In 2008 to 2009 the economy crashed, resulting in what is now referred to as the Great Recession. More than 34,000 NM jobs were lost between 2008 and 2009. A large portion of these losses (nearly 10,000 jobs) occurred in the construction industry. Other areas of significant job loss during this time were manufacturing, administrative and waste services, retail trade, and mining. However, strength remained in the health care and social assistance industry as well as government (UNM-BBER 2014).

The gap between New Mexico and U.S. unemployment rates grew during the Great Recession, as the U.S. unemployment rate rose faster than New Mexico's. The gap between the two was greatest in 2009, when New Mexico had an unemployment rate of 6.8 percent, while the U.S. unemployment rate was 9.3 percent. In 2011, both the New Mexico and U.S. unemployment rates began to fall from their 2010 peaks. The U.S. rate fell more rapidly than the New Mexico rate, narrowing the gap between the two. As of 2011, the U.S. had an unemployment rate of 8.9 percent, while New Mexico had a rate of 7.4 percent. As the economy continues to recover from the Great Recession, unemployment rates are expected to continue declining (UNM-BBER 2014).

Since at least 1990, the area of influence has had an unemployment rate that exceeds that of New Mexico. In all but seven years between 1990 and 2010, Catron County had an unemployment rate higher than Grant, Hidalgo, and Sierra counties. At the other end of the spectrum is Sierra County, which has had an unemployment rate that has frequently been lower than that of New Mexico. The spike in unemployment caused by the Great Recession (after 2007) is evident in Figure 158. As the national economy continues to slowly recover, unemployment rates should gradually decline (UNM-BBER 2014).

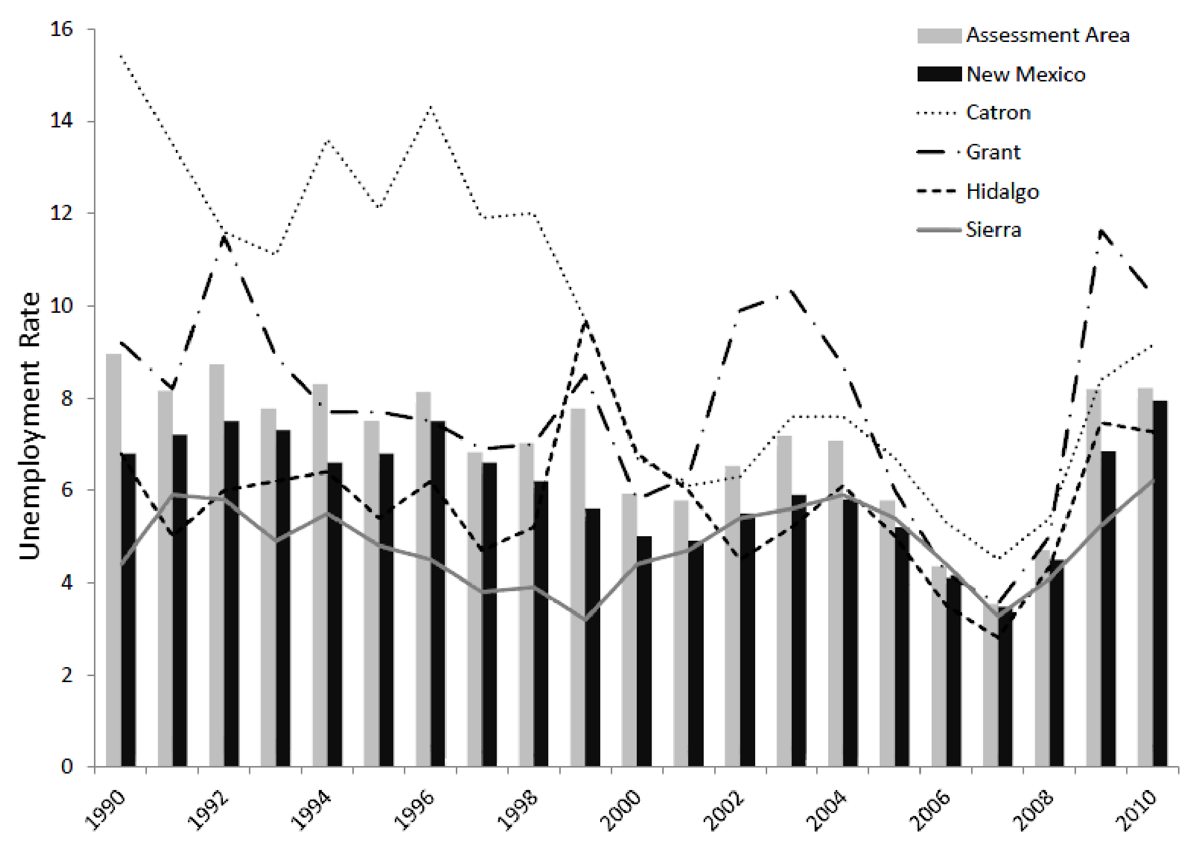

Figure 158. Unemployment rate in Gila NF Counties (1990-2010).
Please note that "assessment area" is the same as "area of influence." Figure from UNM-BBER 2014.

Sectors of the Economy

Table 194 depicts employment levels by aggregated job sectors within the area of influence. The table stresses the importance of the government, retail trade, health care and social assistance, mining, and agriculture job sectors (IMPLAN 2014). Together these industries provide 60% percent of the area's employment. The majority of area of influence jobs (more than 60 percent) are located within Grant County (UNM-BBER 2014).

Table 194. 2014 employment levels by industry classification for Gila NF area of influence.

Job Sector	Employment[a] In Area of Influence	Job Sector Employment as Percent of Total Employment
Agriculture	1,675	7%
Mining	2,034	9%
Utilities	121	1%
Construction	1,356	6%
Manufacturing	454	2%
Wholesale Trade	249	1%
Transportation and Warehousing	381	2%
Retail Trade	2,425	11%
Information	155	1%
Finance and Insurance	514	2%
Real Estate, Rental, and Leasing	776	3%
Professional, Scientific, and Technical Services	1,006	4%
Management of Companies	83	0%
Administrative, Waste Management, and Remediation Services	394	2%
Educational Services	279	1%
Health Care and Social Assistance	2,261	10%
Arts, Entertainment, and Recreation	636	3%
Accommodation and Food Services	1,671	7%
Other Services	1,017	4%
Government	5,129	23%
Total	22,617	100%

[a] Employment: jobs in IMPLAN are the annual averages of monthly jobs in each industry. Thus, one job lasting 12 months is equivalent to two jobs lasting six months each, or three jobs lasting four months each. A job can be either full-time or part-time - the job estimates are not full-time equivalents (FTEs).

Source: IMPLAN 2014

Income

New Mexico's aggregate household income grew by 41 percent between 1989 and 1999, and grew by 11 percent between 1999 and 2006-2010. In contrast, aggregate household income in the area of influence grew by 34 percent between 1989 and 1999, but subsequently shrank by 5 percent between 1999 and 2006-2010. It is expected that as the economic recovery continues the area of influence will experience more aggregate household income growth, although lingering effects of the Great Recession will likely limit growth for some time. Specifically, the low levels of population growth projected for the area (and in fact population declines for some area counties) will further dampen growth in aggregate household income (UNM-BBER 2014).

Table 195 lists the median household income for area of influence counties, the state, and the nation. All counties in the area have median household incomes below the state and nation. The un-weighted average of household income in the four-county area is approximately $10,000 below the state median and nearly $20,000 below the national median. These data suggest that area of influence residents are more likely to be on the economic margins of society. Economic changes (either positive or negative) may have a more pronounced effect the economic well-being of the area.

Table 195. Median Household Income

Location	Median Household Income (2011)
Catron County	$37,857
Grant County	$36,925
Hidalgo County	$35,532
Sierra County	$28,373
New Mexico	$44,631
United States	$52,762

Source: U.S. Census Bureau, 2012

Total personal income comprises labor and non-labor income. Labor income is the wage or salary received by an employee or sole proprietor. Non-labor income includes investments (e.g. rent, dividends and interest) and age-related transfer payments (e.g. Social Security) and hardship-related transfer payments (e.g. welfare). Table 196 identifies the division of labor and non-labor income in the area counties, the state, and the nation.

Table 196. Share of Labor and Non-Labor Income

	Labor Income (%)	Non-Labor Income (%)
Catron County	45	55
Grant County	46	54
Hidalgo County	56	44
Sierra County	41	59
AREA OF INFLUENCE	**47**	**53**
New Mexico	62	38
United States	65	35

Source: U.S. Bureau of Economic Analysis 2010, REIS Table CA30

The four-county analysis area is much more reliant on non-labor income than the state and the nation. Total personal income in New Mexico and the US is composed of approximately two-thirds labor income and one-third non-labor income. In contrast, three out of the four area of influence counties receive more non-labor income than labor income. Sierra County is particularly skewed toward non-labor income. From 1990 to 2014 in the four-county analysis area, labor income grew from $594 million to 767 million (in real terms; a 29% increase), while non-labor income grew from $487 million to $956 million (in real terms; a 96% increase) (Headwaters Economics 2015a). These data suggest that the area of influence has a growing concentration of retirees possibly attracted by high quality of life, mild climate, and affordable housing. The non-labor income is primarily from investments (35%), age-related transfer payments (35%), and hardship-related transfers (24%) (Headwaters Economics 2015a). The reliance on non-labor income may also indicate dependence on government transfer payments. Non-labor income may help to stabilize the economy, as it is not tied to employment status. However, non-labor income may fluctuate based on asset market performance (e.g., investments in stocks and bonds) or changes in government policy.

The distribution of household income for the area of influence shows that the portion of households with incomes of less than $35,000 has declined, while the portion with incomes greater than $50,000 has consistently increased (Figure 159). This trend is similar to what has occurred across New Mexico, and is expected to continue. Per capita income has also been rising in the area of influence, from $16,816 in 1989 to $18,320 in 1999 and $19,044 in 2006-2010. The portion of area of influence individuals living below poverty has declined somewhat from 22 percent during 1989 to 19 percent during 2006-2010. Although the distribution of households across income categories has improved in all area counties, poverty rates have not consistently improved in all counties. While the portion of the population living below poverty declined between 1989 and 2006-2010 in both Catron and Grant Counties, it rose in both Hidalgo and Sierra Counties. Changes in poverty rates have also varied by ethnicity and race. As the economy continues to slowly recover from the Great Recession, per capita income is expected to slowly increase while poverty rates are expected to continue to gradually decline (UNM-BBER 2014).

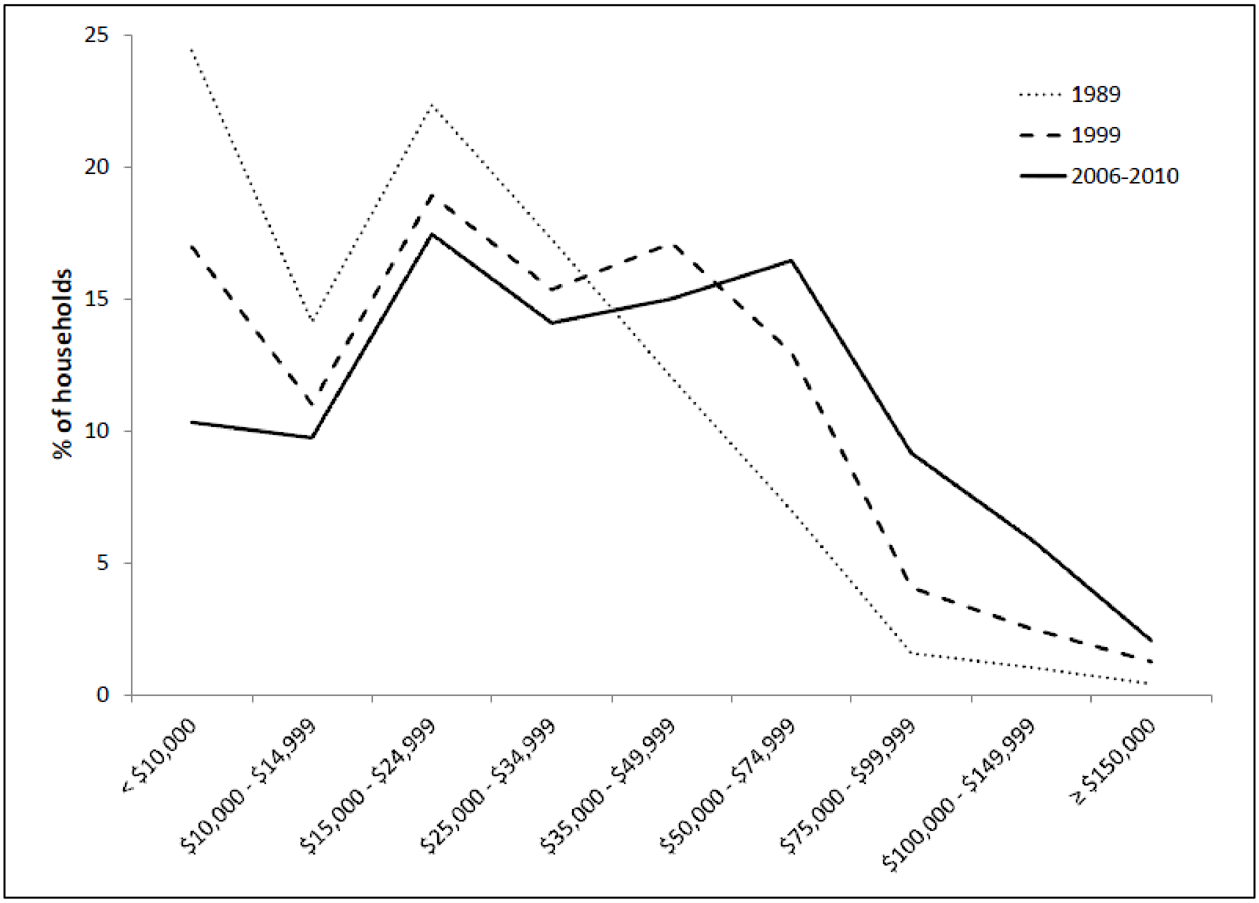

Figure 159. Household income distribution in the area of influence. Figure from UNM-BBER 2014.

Remoteness of Area of Influence

The area boosts many environmental amenities, such as scenery and recreation opportunities, that improve quality of life. However, one of the biggest economic challenges of all the counties in the area of influence is their remoteness. Often to capitalize on environmental amenities in the form of economic growth, an area also needs to have access to markets (via airports or highways), an educated workforce, and a diverse economy that welcomes newcomers (Rasker et al. 2008). The area of influence for the Gila NF is considered rural and isolated in terms of interstate airports (although Grant County does have a small airport with daily flights to Albuquerque) and driving time length to major cities. Isolated, rural counties in the West often have slower rates of growth in population, employment, and real income (Rasker et al. 2008). The area's ability to attract and retain people, businesses, and industry is limited by the lack of ready access to major population centers. Conversely, isolation may have some advantages in terms of slower pace of life and affordable housing.

Agriculture Patterns

Table 197 shows that the number of ranches and farms is increasing, but that the number of acres in farms and ranches and the average size of ranches and farms is decreasing. These trends suggest that private agricultural farms and ranches are being subdivided, and a portions are being converted to other uses including residential development. Private farms and ranches are important in contributing to local economic diversity, scenery, local culture, and community vitality. This conversion from agricultural use to residential development can also have implications for the Gila NF including growth of the wildland-urban interface (and the cost of protecting homes from wildfires), spread of invasive plants onto the Gila NF, the loss of access to public lands for recreation, the loss of wildlife habitat and wildlife movement corridors that cross private-public land boundaries, and the potential for conflict among user groups (Headwaters Economics 2015b).

Table 197. Agricultural statistics on the number and size of farms and ranches

Agriculture Statistics	Catron County	Grant County	Hidalgo County	Sierra County	Area of Influence	New Mexico
Number of Farms[a] 2007	259	327	162	265	1,013	20,930
Number of Farms 2012	351	407	171	256	1,185	24,721
Number of Farms (Percent Change 2007-2012)	36%	24%	6%	-3%	17%	18%
Land in farms (acres, 2007)	1,482,579	1,213,349	1,028,547	1,344,339	5,068,814	43,238,049
Land in farms (acres, 2012)	1,077,534	1,064,487	930,271	1,250,136	4,322,428	43,201,023
Land in farms (Percent Change 2007-2012)	-27%	-12%	-10%	-7%	-15%	0%
Average size of farm (acres, 2007)	5,724	3,711	6,349	5,073	5,214	2,066
Average size of farm (acres, 2012)	3,070	2,615	5,440	4,883	4,002	1,748
Average size of farm (Percent Change 2007-2012)	-46%	-30%	-14%	-4%	-23%	-15%

Source: USDA 2014

[a] Farm: This refers to all forms of agricultural production, including livestock operations. These data exclude leased public land from total land in farms.

Seasonal and Recreational Homes

The number of vacant seasonal and recreational homes in New Mexico steadily increased between 1990 and 2010, although growth between 1990 and 2000 was much more pronounced than that between 2000 and 2010. Ultimately, the number of such homes increased by 68 percent during the last two decades from fewer than 22,000 homes in 1990 to more than 36,000 homes in 2010. The number of vacant seasonal and recreational homes in the assessment area doubled between 1990 and 2010, with much of the increase occurring between 1990 and 2000. The slower increase between 2000 and 2010 is likely a result of the effects on the housing market during the Great Recession. The increase in the number of such homes within the assessment area was more pronounced than that within New Mexico (UNM-BBER 2014).

The largest assessment area increase (both absolute and relative) occurred in Catron County, where the number of such homes grew from 258 homes in 1990 to 1,120 homes in 2010 (a 334 percent increase) (Figure 160). Hidalgo County experienced a similar increase between 1990 and 2010, although the number of such homes in Hidalgo County (88 homes in 2010) is much lower than in Catron County. Sierra County has more vacant seasonal and recreational homes than other area counties, although between 2000 and 2010 the number declined by 15 percent, from 1,543 to 1,326 homes. The proportions of the vacant seasonal and recreational homes located within four-county area have shifted over time. Although the proportions in Grant and Hidalgo Counties have remained relatively stable, the proportion in Catron County has grown from 17 percent in 1990 to 36 percent in 2010, and the proportion in Sierra County has meanwhile declined from 64 percent in 1990 to 42 percent in 2010 (UNM-BBER 2014). Implications of this development for the Gila NF, if occurring near the Forest boundary or as an inholding surrounded by public land, are discussed further in the Wildland-Urban Interface section below and Chapter 17: Land.

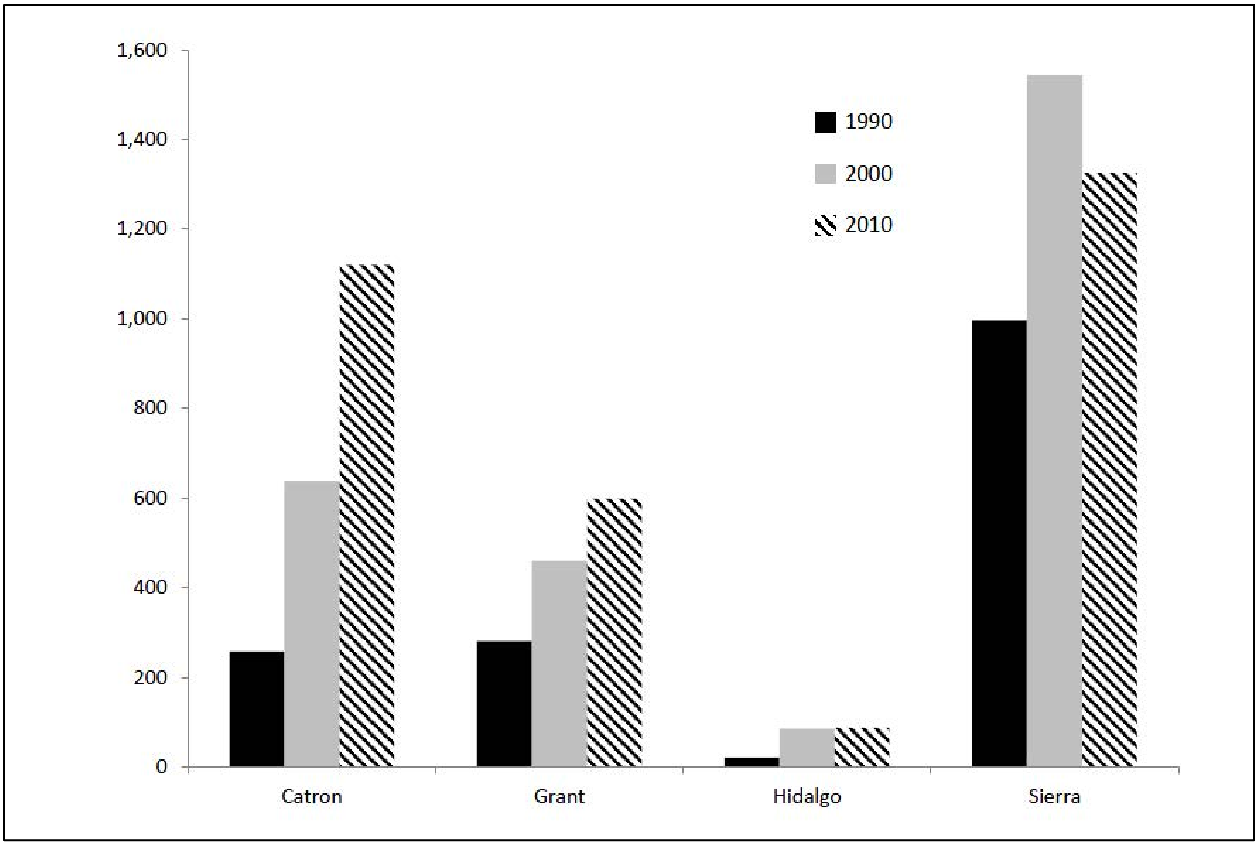

Figure 160. Vacant seasonal/recreational homes in the area of influence counties, by county Figure from UNM-BBER 2014.

Homes within the Wildland-Urban Interface

It is now common to have a large number of homes, second homes, and vacation homes bordering or surrounded by public lands in the western United States. Since wildfire is a natural disturbance on western public forests, these homes are especially vulnerable to the risk of wildfire, and are said to be within the wildland-urban interface (WUI). A WUI refers to the zone of transition between unoccupied land and human development. Communities that are within 0.5 miles of the zone may also be included.

Around 32 percent of U.S. housing units and one-tenth of all land with housing are in the WUI and housing growth is expected to continue (Stein et al. 2013). While the degree of risk may vary from one place to another, given the right conditions wildfire can affect people and their homes in almost any location where wildland vegetation is found. Even structures not immediately adjacent to wildland vegetation are at risk of damage from fire, because embers can be transported by wind and ignite vulnerable homes a mile or more ahead of the flame front (Stein et al. 2013). As more people live or work in the WUI, fire management becomes more complex and the costs to reduce fire risk, manage wildfires, and protect human lives and homes have risen sharply in recent decades (Stein et al. 2013). Today, the rising expense of wildland fire management on both public and private lands costs the Federal Government more than $3 billion per year.

Six percent of the homes found within the area of influence are located in the WUI (Table 198). It is estimated that 30 percent of those homes are second homes. In recent years, the Forest Service, including the Gila NF, has planned and implemented many projects that specifically decrease the potential undesirable effects of wildfires within these areas (e.g., prescribed burning and mechanical treatments to reduce fuels). Fire plays an important part in many wildland ecosystems. However, many years of fire suppression, much of it undertaken to protect private property, has resulted in fuel buildup, which in turn increases the probability of a large, severe fire. Warmer temperatures, less snowpack, and drier forests also result in longer and more intense fire seasons across the West (Headwaters Economics 2015a). See Chapter 2: Upland Vegetation for more information related to the fire regimes of the Gila National Forest.

Table 198. Total homes and wildland-urban interface homes in the area of influence and New Mexico

	Catron County	Grant County	Hidalgo County	Sierra County	Area of Influence	New Mexico
Total Number of Homes	3,289	14,693	2,393	8,356	28,731	901,388
WUI Homes	437	602	na	687	1,726	27,387
Second Homes in WUI	200	108	na	209	517	10,924
WUI Homes as % of Total Homes	13.3%	4.1%	na	8.2%	6.0%	3.0%
Second Homes as % of WUI Homes	45.8%	17.9%	na	30.4%	30.0%	39.9%

Source: Headwaters Economics 2015a

Note: The source material used “na” to describe the WUI statistics for Hidalgo County presumably because there currently are no homes in WUI areas in Hidalgo County.

Demographic Summary

The Gila NF is located in a rural area of southwestern New Mexico. For the assessment of social, cultural, and economic conditions, the Gila NF area of influence is comprised of the four counties that contain the Gila NF within their boundaries: Catron, Grant, Hidalgo, and Sierra counties. Although all the counties associated with the Gila NF are rural, their social and economic characteristics differ notably. The populations of all four counties were less than 30,000 in 2010, but the population of Grant County was ten times larger than that of Catron County. The area experienced moderate net in-migration between 1990 and 2000, but during the decade of the Great Recession net out-migration occurred in all counties but Catron. The area’s population is expected to be relatively constant for the next two decades. The ethnic composition of the area of influence has remained rather stable since at least 1990 – the area is approximately 58 percent non-Hispanic and 42 percent Hispanic, a composition that is similar to that of the state. The area of influence is not as racially diverse as the state; the area population is more predominantly White than that of the state, and has smaller portions of African-Americans, American

Indians, and Asians. The area of influence population is aging. Educational attainment has improved in all area counties.

In 2010, Grant County (home of Silver City, which is the area's largest urban area) provided the majority of the area's employment opportunities. The importance of Sierra County to the area's economy is increasing. Unemployment rates have historically varied greatly across the assessment area. Although the distribution of households across income categories has improved in all area counties, poverty rates have not consistently improved. As the economy continues to recover from the Great Recession, per capita income is expected to slowly increase, and unemployment and poverty rates are expected to gradually decline. Non-labor income, such as retirement and investment funds, now make up over half of total personal income. The number of ranches and farms is increasing, but the number of acres in farms and ranches and the average size of ranches and farms is decreasing. The number of seasonal and recreational homes has grown in all area counties, and most notably in Catron County, where the number of such homes more than tripled between 1990 and 2010. Six percent of the homes found within the area of influence are located in the wildland-urban interface.

The demographic and economic characteristics discussed in this report have been shown to affect forest use, volunteerism, environmental attitudes, preferences for site development, and opinions regarding forest management (UNM-BBER 2014). Understanding the unique characteristics, trends, history, and challenges of the area of influence communities is an important consideration for public land managers working to meet the needs of the public. The demographic characteristics can also help to identify how communication and outreach efforts could be tailored to different audiences.

Gila National Forest's Contribution to Social, Cultural, and Economic Conditions

Introduction

For over a century, communities have relied on the Gila NF as a source of sustenance. This has manifested through various means ranging from utilizing the natural resources on the Forest for livelihood; creating community synergy around issues and events; offering a place for groups to commune, work, and recreate together; to providing solitude, peace, and relaxation for individuals who want to get away from the social pressures and pace of their everyday world. While ways and means may have changed over time, people enjoy all manners of activities on the Forest. Firewood gathering is regarded as a traditional family activity, since many local residents still rely on wood to heat their homes during the cold winter months. Commercial woodcutters also sell firewood collected from the Gila NF. Recreational group sites are used by families and friends who come together and celebrate weddings, birthdays, life-changing events, family reunions, and holidays. Permitted livestock grazing on the Gila NF is a long-standing tradition. In addition, local residents rely on the Gila NF for parts of their livelihood, by capitalizing on the opportunity to provide outfitting and guiding, tourist activities, and other services on NFS lands. Forest management continues to bring communities together over issues that affect them or to foster involvement through volunteer work on their favorite part of the Forest. Others continue to engage in some of the more traditional uses. All of these uses help maintain social cultures and longstanding traditions.

This section will explore the relationship between the Gila NF and surrounding communities by examining the benefits the Gila NF offers its communities; the demands for Forest resources and ecosystem services placed on the Gila NF from local communities; how social and cultural conditions influence the Forest; and finally, how the Gila NF contributes to the economies of the area of influence, which is the multi-county analysis area of Catron, Grant, Hidalgo, and Sierra Counties. This section is based on what the Gila NF heard during 6 community conversations (March 2015), at 6 assessment community meetings (August 2015), and from emails and letters from stakeholders during the assessment phase. In addition, this section uses information from "Values, Attitudes and Beliefs Toward National Forest System Lands: The Gila National Forest"[49] (USDA FS 2006a).

Important Social, Cultural, and Economic Influences on the Gila National Forest

Benefits People Obtain from the Gila National Forest

The Gila NF is rich in unique New Mexico cultural and traditional heritage that has blended with modern uses. The Forest continues to provide (to varying degrees) benefits that have been historically significant, as well has offering modern benefits that present day New Mexico culture has come to desire, expect, or rely upon. From a cultural and social standpoint, the best source to identify these benefits comes from the people and communities who directly benefit from them. At 6 community meetings conducted for this assessment in August 2015 and via email and letters, stakeholders of the Forest had the opportunity to share what those benefits were (USDA FS Gila NF 2015a). Some of the stakeholder input included:

Traditional Benefits

- Gathering firewood
- Harvesting house logs for construction needs
- Livestock grazing
- Timber harvesting

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[49] Data collection for this 2006 report was accomplished by a combination of individual interviews and small group discussions within the assessment area.

- Hunting and fishing
- Irrigation systems

Natural Resource Oriented Benefits

- Clean water
- Wildlife habitat
- Fresh air

Nature Benefits

- Being away from civilization
- Solitude
- Natural Beauty/Scenery/Aesthetics

Recreation Activities

- Hiking
- Biking
- Camping
- Horseback riding
- Off-highway vehicle use
- Wildlife watching
- Sight-seeing
- Night sky viewing
- Hunting
- Fishing
- Rockhounding
- Driving for pleasure
- Recreational aviation

Wilderness Benefits:

- Enjoying wilderness values
- Quiet

Lifestyle Benefits:

- Providing business and income opportunities (e.g., commercial services such as outfitting and guiding) through special use permits
- Family bonding through outdoor activities
- Health (mental and physical)
- Exercise
- Spiritual connections
- Economic growth from tourism from people outside of the community visiting the Gila NF

Extraction Benefits

- Mining
- Sand and gravel collection
- Recreational prospecting and gold panning
- Decorative rock for personal use

These benefits will continue to be desired even with changing demographics, and the Forest will be expected to continue to provide these benefits into the future. While these are all benefits offered by the Gila NF, they are also considered to be ecosystem services. Ecosystem services are defined as the benefits people obtain from ecosystems. The four categories of ecosystem services are explained in the Introduction to the Assessment, Ecosystem Services Framework. All benefits obtained from the Gila NF fall into all four categories: provisioning (clean air, water, wood, forage, etc.), regulating (long-term carbon storage, climate regulation, flood control, water filtration, etc.), supporting (pollination, seed dispersal, soil formation, nutrient cycling, etc.), or cultural (spiritual and recreational experiences) services. Chapter 1: Ecological Integrity and Sustainability addresses ecosystem services from an ecological perspective. The following chapter on Multiple Uses will look at ecosystem services from a social, cultural, and economic perspective.

Concerns about the Gila National Forest

Participants at the community meetings and stakeholders that sent emails and letters discussed concerns as they relate to both the Gila NF and to natural resource management in general. These concerns are relevant in that they express underlying needs or demands that may need to be addressed in the future. Interestingly, many of the concerns expressed are also shared by the Forest. Many of the concerns expressed by stakeholders are summarized below (USDA FS Gila NF 2015a):

- How much use of the Forest is sustainable in various resources areas, such as water, timber, and mineral extraction? How are these uses impacting forest, wildlife habitat, and watershed health?
- People are worried about diminishing water supplies and water quality, which affect water available for irrigation, livestock, fish and wildlife, and domestic use.
- There is a general impression that restrictions have increased and not enough forest management is occurring.
- There is wide recognition of the overgrown condition of many of the forest types and juniper encroachment of the grasslands.
- There is concern about the increased risk of uncharacteristic wildfire, and threats to private property and adjacent communities.
- There is broad interest in fuel management strategies such as thinning and prescribed fire.
- Many people would like to see more timber harvesting and grazing to support local economies.
- To what extent should the Gila NF be used for local economic development?
- Can recreation activities on the Forest provide needed economic benefits to local communities? If so, what activities and to what extent?
- How to maintain the quality of recreational experiences while accommodating larger numbers of visitors?
- Some people feel the travel management process reduced motorized access by too much on the Gila NF, while others feel the transportation system should be further reduced.
- People perceive there is a decline in overall access resulting from the lack of right-of-ways across private land to get to portions of public land on the Gila NF.

- People want the existing trails and roads maintained, but how much investment and focus should there be on road, trail, and facility conditions and maintenance (including signage)?
- Some people want more wilderness areas, while others feel they are being locked out of the Forest by the addition of more wilderness areas.
- Some people would like to see less elk on the landscape to reduce competition for forage, while others believe there is an appropriate amount of elk for hunting opportunities.
- How should invasive plant and animal species be controlled to protect ecosystem integrity?
- How will climate change affect the Forest, forest health, and the surrounding communities that rely on the forest?
- Many stakeholders expressed the need for systematic and scientifically sound monitoring of forest conditions and management actions.
- Some people want to see more education, specifically on the cultural significance of the area, ecosystems (especially fire dynamics), and geology of the Forest.
- Some believe there is not enough enforcement of the rules and regulations on the Gila NF and want to see “bad behavior” that takes place on the Forest addressed. Others think there are too many restrictions and rules limiting their ability to use and access the Forest.
- There is a need for better communication and working relationships between the Forest Service, local communities and governments, stakeholder groups, and members of the public who are interested or affected by management activities on the Gila NF.
- Many people acknowledge the Forest Service is operating in a time of declining budgets and recognize the need and desire for more partnerships between the Forest Service, local governments and communities, and stakeholder groups.

More stakeholder perspectives are included in the “Stakeholder Input Received” section of each chapter.

Influence of the Gila National Forest on Local Social, Cultural and Economic Conditions

Relationship of the Gila National Forest to Local Social and Cultural Conditions

Since its inception in the early 1900s as the Gila Forest Reserve, the Gila NF has been the provider for many of the needs essential for settling this region of the southwestern frontier. It served Native American tribes, Spain, and Mexico long before it became a United States property and its borders were established. The heritage, culture, traditions, and values that grew from this time period were handed down over generations and still exist in New Mexico today. While those historical values are still prevalent, the social and cultural environment has evolved into the modern age. By this virtue, the Gila NF has the unique challenge of serving two different eras through present day management.

Aside from time steeped heritages and traditions, the Gila NF has a diverse community composition, where Native American, Hispanic, Anglo, and other cultures have combined to make New Mexico a multicultural center. All of these cultures have ties to the Forest through strong attachments to the land that may be generations old or a new found discovery. In addition to serving the local population, the Gila NF also offers visitors who travel to the region a unique experience in culture, exploration, wilderness, and other activities such as hunting and backpacking. Collectively, the area of influence and the Gila NF are strongly influenced and shaped by local time honored traditions, cultural diversity, and by those who wish to experience this unique setting from other areas around the country.

Traditions

Residents of communities surrounding the Gila NF have a strong connection to the land and its resources. There is also a strong sense of community across all of the diversity that exists within the area of influence. Both sentiments date back centuries, before the United States acquired this part of the country. Local passions continue to demonstrate these time honored connections to the land and culture, thereby giving long-lasting vibrancy to deeply rooted traditions and ways of life. The Gila NF has been an integral part of this history and continues to play a prominent role in the long-standing traditions and uses of the area of influence.

There is a strong sense of attachment to the land that is the Gila NF. There are three major components that characterize this sense of attachment. The first comes from traditional users having a sense of personal stewardship, based on historical associations with NFS lands (USDA FS 2006a). There is a significant generational element to this theme, which dates back to the time before the Gila NF was established. The second component is derived from historical practices around the use of natural resources. These traditional users believe their first-hand knowledge and self interest in management of Forest resources results in a culturally based understanding, and attachment to, Forest lands (USDA FS 2006a). The third component views the Gila NF as a sustainable legacy. It is viewed that this land is a unique resource that should be cared for, conserved, and passed down to future generations (USDA FS 2006a).

Likewise, these historical connections to the land have been instrumental in giving the Gila NF a large part of its character. They still influence the Forest in present day terms, through various means, especially through traditional uses.

Acequias are the historical ditches that bring water from rivers and streams to communities for irrigation purposes. They are generally community run through associations headed by the majordomo (ditch-master) and some date back to the time of Spanish settlement. These waterways are still in use today for the original purposes for which they were established. They are also a representation of how important water is in the arid Southwest and were instrumental in the settlement of the Southwest. Those who use and maintain these ditches serve to protect their historic values, as well as their utilitarian purposes. These values are also recognized by the State of New Mexico through the New Mexico Acequia Commission.

Acequias are considered political subdivisions of the state and are collaborated with as local governments. Acequias are vital in the production of crops and livestock, they are inherently special riparian areas for many species of wildlife and plants, and they provide spiritual and aesthetic value. Acequias are an integral part of the cultural and traditional heritage identified in the area of influence. The Gila NF plays a role in this heritage by working with acequia commissions or ditch associations to support ongoing maintenance, accommodate access, and assist with infrastructure improvements for the 30 historic ditches that originate on or cross the Gila National Forest.

Traditional uses as they relate to the Gila NF are uses that have strong cultural ties to New Mexico's heritage. They hold historic significance, since they were necessities for survival, and many uses defined a way of life. While their prevalence has diminished somewhat over time, those with cultural ties to the area of influence still engage in many of these uses and view them as a vital part of their heritage. Those who have a cultural investment in the traditional uses of the area look to the Gila NF to continue providing these opportunities as a matter of right. These uses consist of livestock grazing, hunting and fishing, medicinal herb gathering, firewood gathering, open forest access, and wood harvesting for commercial uses.

Transitions in the Social Environment

In the past, communities and families who lived within the area of influence relied on natural resources to get by. The main activities were logging, mining, grazing, ranching, and farming. Today, logging and farming especially are not as prevalent as they once were. The declines in traditional uses are generally due to market demands, regulatory changes, and other economic constraints such as the long distance to markets. The decline in traditional uses is still strongly felt in the local economies of some communities, and many people would like more opportunities for economic development.

For communities and counties reliant on the timber industry, the 1990s saw the decline of the amount of timber harvested and closure of the largest sawmill in Reserve. The primary reasons for the decline were related to new required practices for sustainable forestry, concerns for limited remaining old-growth, for management needs of the northern goshawk and Mexican spotted owl, litigation, economic constraints, and declining Forest Service budgets. The result of this sudden downward shift in economic activity caused a significant unemployment impact to the logging community and rippled throughout the community infrastructure (e.g., school, county road maintenance, government services, etc.) (USDA FS 1995a). Catron County unemployment and poverty rates rose to 15% and 25%, respectively (Wilson 2006). Many residents of these communities and adjacent areas had made their living for decades working in association with the timber industry. For many residents and businesses of these communities, the change in management seriously disrupted their traditional way of life (i.e., culture and lifestyle) and sense of well-being (USDA FS 1995a). Many families left the area in search of employment elsewhere impacting the community social fabric, supporting businesses, and county tax base to provide services such as road maintenance, law enforcement, and health care. School enrollment declined, and since the formula for receiving state education money is based on enrollment numbers, the Reserve School District budget was significantly reduced (Thal and Smith 1995). Social hardships grew with significant increases in social service and mental health caseloads, especially regarding family stability-related social problems (Thal 2003).

In addition to traditional uses that continue to weather the test of time, the Gila NF has also experienced a gradual progression more contemporary in nature. There has been a shift toward recreation and tourism, and when asked, some of the public view the Gila NF with a strong recreation emphasis especially hunting (USDA FS 2006a). The elk hunting season attracts hunters from across the country, and private outfitter guide companies provide a range of services to clients. Many other visitors come to experience the cultural distinctiveness, while others come to partake in various outdoor pursuits, and the beauty of the landscape is an attraction in and of itself. For these reasons, recreation and tourism have become focal points on portions of the Gila NF, incorporating its unique social and cultural setting. Approximately 514,000 people visit the forest each year with 73 percent of those visits being for recreational purposes (USDA FS 2011). However, some people doubt that recreation can replace the traditional uses as an economic base especially with lower average salaries in the service sector (USDA FS 2006a).

The four-county area and the Gila NF elicit a strong sense of connection that is not only traditionally based, but is also shared by those who are considered “non-traditional” users and live in the area or visit the Forest. Many of these connections are also based on interactions with the Forest and its resources, as well as personal experiences and values. Some users have special places on the Forest, while others speak of the inspiration, solitude, and appreciation they feel by being in the Gila NF. The diversity of wildlife, plants, landscape, and other resources is another important value of the Forest. There is a local environmental presence that has actively pursued implementing preservation values and beliefs about forest management and landscape conditions (USDA FS 2006a).

There is a perception that a transition is occurring within the social fabric of the area communities. This shift involves the exodus of younger people and the influx of newcomers. Younger people are believed to be leaving the area in search of jobs, which are limited within the area of influence. Despite a strong sense of attachment, many of these young people rarely make it back. It is also believed that newcomers are increasing in number attracted by the natural resources, rural lifestyle, and quality of life amenities. This influx has increased the diversity of lifestyles, most recently retirees and others who are not dependent on local economies for their income. Newcomers may not have the same appreciation for traditional uses, and may even view natural resource issues in different ways than longer term residents (USDA FS 2006a). These characteristics imply a mix of values and beliefs based on types of use, length of residence, and cultural background. These diverse views, especially those concerning polarized natural resource issues, have created some social tensions. These perceptions indicate a social scenario where communities are feeling a change, and possibly a loss of traditional ways of life.

The assessment input also reveals areas of broader agreement that could be the focus of future collaboration efforts. Restoration of forests, grasslands, and watersheds is a perceived need that could improve ecosystem function and offers potential economic benefits to local communities. Despite the contentiousness of past relationships, there appears to be a potential foundation for future collaboration with stakeholders throughout the area. Coordinating with stakeholders, such as other federal agencies, state agencies, local governments, organizations, and private landowners would not only improve efficiency and effectiveness of these restoration efforts, but could also bridge gaps between social differences and value conflicts within communities (USDA FS 2006a). There have been collaborative restoration efforts in the past, and this forest planning process is an opportunity to renew those relationships, and continue and expand this important work.

Gila National Forest's Contributions to Local Economic Conditions

Economic Contribution Analysis

The Gila NF makes up nearly 3.3 million acres or 7.9% percent of the area of influence, which is the multi-county analysis area of Catron, Grant, Hidalgo, and Sierra Counties, making it an important contributor to the local economies. These lands contribute a wide range of economic values to people. Market goods such as timber, forage for livestock, minerals, and recreation opportunities generate employment and income, as well as payments to local communities and revenue for the U.S. Treasury. Non-market goods, such as existence values of Gila trout or unique ecosystems and habitats, generate value everyone reaps, but do not necessarily pay for. Other forest benefits such as outdoor recreation and scenery are valued by the people who use them, but only a portion of this value is represented in market purchases. The economic contribution analysis considers only the market transactions that result from activities on the Gila NF. Numerous non-market social and economic values are associated with the Forest. The value of ecosystem services, such as clean air and water, are not captured in the economic contribution analysis. Therefore, this analysis should not be conflated with a representation of the total economic value of the Forest.

The economic role of the Gila NF in the area of influence was modeled with IMPLAN Professional 3.0 software using 2014 data (IMPLAN 2014). IMPLAN is an input-output model, which estimates the economic outcomes of activities, projects, and policies on a region. Input-output analysis represents linkages between sectors in an economy. For example, Forest visitors spend money on accommodation and food (a direct contribution). Accommodation and food service businesses buy supplies from other businesses (an indirect contribution). The employees of these firms spend their earnings on a variety of goods and services (an induced contribution). These transactions result in direct, indirect, and induced contributions in the analysis area economy, respectively. Definitions of terms used in the analysis are described below:

- **Direct contributions** are in the immediately affected industry, such as jobs on ranches with grazing allotments on the Gila NF.
- **Indirect contributions** are from linkages to other industries, not directly associated with the Gila NF.
- **Induced contributions** are generated as a result of spending new household income due to employment in industries with direct and indirect ties to Gila NF management. Their household spending results in demand for goods and services in the local economy, creating additional employment and output.
- All three types of impacts are measured in **employment**, **labor income**, **value added**, and **output**.
- **Employment** measures the number of jobs generated in the economy by the Gila NF. These numbers are in terms of number of jobs and not in terms of full-time equivalent employees.
- **Labor income** is income earned by the labor force because of the Gila NF's presence.
- **Value added** by the Gila NF is the total amount paid for all factors of production (inputs that are used in the production of goods and services) in the analysis area including labor. It is a measure of Gila NF's contribution to the local economy.

- **Output** is the value of industry production in the analysis area measured in producer's price. Producer's price is the amount received by a producer by selling one unit of goods or services produced minus any value added tax or other deductible taxes.

Forest Service data on expenditures and resource uses were used in IMPLAN to estimate the economic impacts of the Gila National Forest programs, resources, and uses (IMPLAN 2014). This economic contribution analysis includes recreation visitor expenditures, livestock grazing, mineral removal, forest product harvesting, payments to states and counties, and Forest Service expenditures. Quantitative inputs (e.g., animal unit months, recreation visits, and FS payments to counties) were averaged for fiscal year 2013 to fiscal year 2015 to lessen the effect of annual fluctuations[50]. The economic contribution analysis methods and data are described in detail in Appendix E. The Gila National Forest extends into four New Mexico counties – Catron, Grant, Hidalgo, and Sierra. These counties form the area economy for the economic contribution analysis. There are at total of approximately 22,617 jobs, and $882 million in labor income, and $3.1 billion in output in the four-county area. The five largest aggregated job sectors (out of 20), in terms of employment, in the area economy are: (1) government, (2) retail trade, (3) health care and social assistance, (4) mining, and (5) agriculture. When using the more detailed 536 possible job sectors in the North American Industry Classification System, the five largest job sectors in the area economy are: (1) state and local government, (2) copper mining, (3) cattle ranching and farming, (4) real estate, and (5) restaurants. The extraction and consumption of forest products (e.g., timber and forage), recreation visitors, and Forest expenditures (e.g., equipment and salaries) contribute to economic activity in the region. The total economic contributions (including direct, indirect, and induced) of these activities on the Gila National Forest are displayed by sector in Table 199.

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[50] Minerals data were averaged over the period 2011 to 2013, since more recent data were unavailable at the time of this analysis.

Table 199. Current Contribution of the Gila National Forest to the Area of Influence Economy

Sector	Employment [a]		Labor Income [b] (Thousands of 2014 Dollars)		Output (Thousands of 2014 Dollars)	
	Area Totals	FS [c]-Related	Area Totals	FS [c]-Related	Area Totals	FS [c]-Related
Agriculture	1,675	374	$68,331	$2,464	$178,441	$24,859
Mining	2,034	10	$152,595	$273	$758,530	$2,103
Utilities	121	1	$10,887	$164	$98,622	$939
Construction	1,356	12	$48,842	$418	$212,610	$1,654
Manufacturing	454	35	$15,408	$882	$121,787	$7,950
Wholesale Trade	249	9	$8,081	$498	$40,653	$1,291
Transportation and Warehousing	381	62	$12,054	$1,358	$155,209	$9,436
Retail Trade	2,425	51	$52,614	$2,435	$49,318	$3,654
Information	155	5	$7,313	$206	$74,849	$1,457
Finance and Insurance	514	64	$13,975	$1,622	$71,861	$10,492
Real Estate, Rental, and Leasing	776	24	$7,093	$337	$294,895	$4,054
Professional, Scientific, and Technical Services	1,006	52	$23,946	$1,024	$95,546	$2,753
Management of Companies	83	2	$3,698	$89	$11,713	$265
Administrative, Waste Management, and Remediation Services	394	8	$9,601	$241	$20,303	$420
Educational Services	279	2	$2,607	$40	$8,238	$74
Health Care and Social Assistance	2,261	13	$73,710	$560	$155,207	$942
Arts, Entertainment, and Recreation	636	4	$4,209	$36	$23,337	$142
Accommodation and Food Services	1,671	18	$28,977	$328	$88,853	$899
Other Services	1,017	10	$27,220	$364	$56,602	$670
Government	5,129	227	$311,060	$15,060	$560,898	$15,977
Total	22,617	981	$882,222	$28,700	$3,077,482	$90,031
FS as Percent of Total	--	4.3%	--	3.3%	--	2.9%

[a] Employment: jobs in IMPLAN are the annual averages of monthly jobs in each industry. Thus, one job lasting 12 months is equivalent to two jobs lasting six months each, or three jobs lasting four months each. A job can be either full-time or part-time - the job estimates are not full-time equivalents (FTEs).

[b] Labor income: includes employee compensation and proprietors' income - the wages, salaries, and benefits paid to employees and self-employed individuals.

[c] FS=Forest Service

Source: IMPLAN 2014

Market transactions attributable to activities on the Gila National Forest support an estimated 981 jobs, $28.7 million in labor income, and $90 million in output in the area economy. Activities on the Gila National Forest are responsible for approximately 4.3 percent of total employment, 3.3 percent of labor income, and 2.9% of output in the four-county area. The Gila National Forest contributions are largest in the agriculture and government sectors. Although activities on Forest Service lands in the plan area contribute the most jobs to the agriculture sector (374 jobs or approximately 20 percent of total employment in the sector), the contribution to labor income is comparatively minor ($2.5 million dollars or about 3.9 percent of total labor income in the sector). Most of the employment in the agriculture sector is attributable to livestock grazing on Forest Service lands in the plan area. Livestock grazing jobs are typically lower paid than other occupations. Additionally, many ranches rely on unpaid family labor. The modeling system counts unpaid family labor as a job, but these jobs would not contribute to labor income. Therefore, the relative importance of livestock grazing on Forest Service lands in the plan area shows the discrepancy between share of employment and labor income attributable to activities on Forest Service lands.

Table 200 displays the total economic contribution of Gila National Forest activities by program area. Livestock grazing and Forest Service expenditures contribute the most to employment in the area economy, each supporting about 400 jobs on an average annual basis. However, Forest Service expenditures provide approximately $13 million more in labor income compared to livestock grazing, despite similar levels of employment. This indicates that jobs related to Forest Service expenditures are more likely to be full-time and provide higher wages than jobs related to livestock grazing in the four-county area.

Table 200. Current Contribution of the Gila National Forest by Program Area

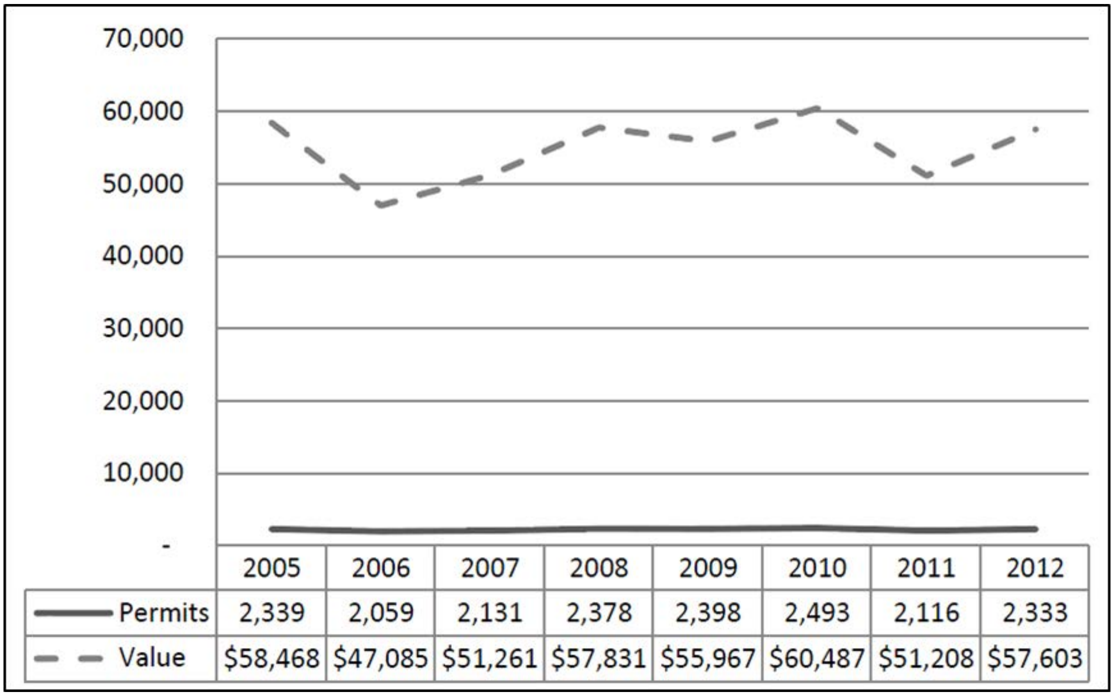
Program Area	Employment	Labor Income (Thousands of 2014 Dollars)	Value Added (Thousands of 2014 Dollars)	Total Output (Thousands of 2014 Dollars)
Recreation	71	$2,666	$4,784	$12,045
Grazing	434	$5,579	$12,972	$34,823
Timber	8	$314	$351	$2,274
Minerals	0	$0	$0	$0
Payments to Counties	69	$1,487	$2,933	$10,357
Forest Service Expenditures	400	$18,654	$21,496	$32,552
Total	981	$28,700	$42,536	$92,052

Grazing plays an important role in the local area economy. The forage provided by the Gila NF contributes approximately 434 jobs, $5.5 million in labor income, and $34 million in total output to the four-county area. These jobs and income are not only from direct grazing activities such as ranching, but also include indirect and induced contributions. When a rancher purchases machinery or veterinary services, these impacts are also included. In addition, when ranchers spend earned income in the local economy on food, this is accounted for in the induced effects. These estimates are based upon three-year averages of animal unit months (AUMs), by livestock category, to minimize the effect of short-term variations in authorized livestock grazing use. See Chapter 11: Multiple Uses section on grazing for more details on number of permits, acres, and range condition.

Although mineral extraction occurs on the Forest, the quantities of stone, sand and gravel removed are insufficient to result in measureable economic contributions to the four-county economy. In the four-county area, most of the active copper mines with large employment occur on private property, and mining employment generally follows copper prices.

Recreation visitors to the Gila NF support approximately 71 jobs, $2.7 million in labor income, and $12 million in total output to the four-county area. Growing populations in Albuquerque, Las Cruces, El Paso, and Tucson have led to more people seeking out the diverse recreation opportunities offered by the Forest. There are well-developed transportation links from these major population centers; however, the Forest is still relatively remote distance-wise. There were approximately 514,000 visits to the Forest during 2011 with 55% of these visits from local residents (USDA FS 2011). The area holds ecotourism potential, and there recently has been increased marketing by the state and local entities to generate more visitation.

The amount of employment in the timber industry is greatly diminished from the 1980s. See Chapter 11: Multiple Uses section on timber harvesting for more details. Fuelwood gathering on the Forest is still tied to livelihoods in some of the surrounding communities. Wood for fires continues to be widely used either aesthetically or as the primary heat source within homes. Approximately 48% of the housing units in Catron County rely on wood as the primary heating fuel type. In Grant, Hidalgo, and Sierra Counties, approximately 5 to 12% of the housing units use wood for heat (U.S. Census Bureau 2000b). The use of wood for heating homes may be tied to long-term customs, traditions, and culture of the community, but it may also provide economic savings over propane, natural gas and electricity. Figure 161 displays the quantity and value (in nominal dollars) of fuelwood permits on the Forest since 2005.



	2005	2006	2007	2008	2009	2010	2011	2012
Permits	2,339	2,059	2,131	2,378	2,398	2,493	2,116	2,333
Value	$58,468	$47,085	$51,261	$57,831	$55,967	$60,487	$51,208	$57,603

Figure 161. Quantity and Value of Forest Fuelwood Permits, 2005-2012.

Source: USDA FS Gila NF 2013c

In addition to fuelwood, piñon nuts, greenery, gravel, rocks, and other forest products are gathered on the Forest for both commercial and personal uses. Gathering habits have been part of the customs, tradition, and culture of the people for many years (USDA FS 2006a). The above analysis considers only the market transactions that result from activities on the Gila National Forest. Numerous non-market social and economic values are associated with the Gila National Forest.

Total Federal Land Payments

Counties containing federal lands have historically received a percentage of the revenues generated by the sale or use of natural resources on these lands. A steep decline in federal timber sales on national forests during the 1990s significantly decreased revenues received by counties from the Forest Service. Federal land payments are payments made by the federal government to state and local governments to compensate for non-taxable federal land within their borders. In the area of influence, the Forest Service makes contributions through both appropriations and revenue sharing via various programs, such as the appropriated Payment in Lieu of Taxes (PILT), and revenue sharing programs, such as the Secure Rural Schools program. However, dependency on these transfers exposes local services to changes in federal policy and spending decisions.

PILT are federal payments to local governments that help offset losses in property taxes due to nontaxable federal lands within their boundaries. PILT payments help local governments fund operations, such as emergency services and road maintenance. Payments are made annually for tax-exempt federal lands administered by the Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, USDA Forest Service, and for federal water projects and some military installations. Payments to counties are based on population, receipt sharing payments, and the amount of federal land within a county (Table 201).

Table 201. Payments in Lieu of Taxes (PILT) to the States and Counties, FY 2015

Location	Payment	Acres of Federal Land
Catron County	$619,691	2,717,893
Grant County	$2,078,740	1,161,528
Hidalgo County	$745,488	822,875
Sierra County	$1,205,512	1,301,253
State Total	$37,466,124	22,470,290

Source: USDI 2015

The Secure Rural Schools (SRS) and Community Self-Determination Act of 2000, reauthorized in April 2015, was enacted in part to stabilize payments to counties dependent on declining revenues from federal timber sales. This law ensures counties across the country can receive payments that provide funding for schools and roads and make additional investments in projects that enhance forest ecosystems. The SRS Act authorizes the use of Resource Advisory Committees as a mechanism for local communities to collaborate with federal land managers in recommending projects on federal lands that will benefit resources. The Secure Rural Schools payments to the area counties for fiscal year 2014 are in Table 202.

Table 202. Secure Rural Schools and Community Self-Determination Act, FY 2014 Payments

Location	Fiscal Year 2014 Payments
Catron County	$2,107,965
Grant County	$796,473
Hidalgo County	$5,184
Sierra County	$313,147
Total	$3,222,770

Source: USDA FS 2015f

Forest Service Gross Receipts from Commercial Activities

The Gila NF provides various economic opportunities to surrounding communities. These income producing opportunities for local businesses range including timber harvesting, ranching, and providing recreation services to the visiting public. Figure 162 shows the inflation adjusted total gross receipts from 1986 to 2015. Although before 2000 the receipts were not identified by source, historically most of the receipts collected in the Southwestern Region were from the sale of timber, and the significant decreases in the total receipts are apparent in the 1990s when timber harvesting declined as discussed in the "Transitions in the Social Environment" section. Figure 163 shows the gross receipts collected by source from 2001 to 2014 by the Gila NF and deposited into the National Treasury as fees collected from those who utilize such opportunities. Grazing currently generates the largest share of gross receipts, with land special use related activities (e.g. communication site leases) coming in second.

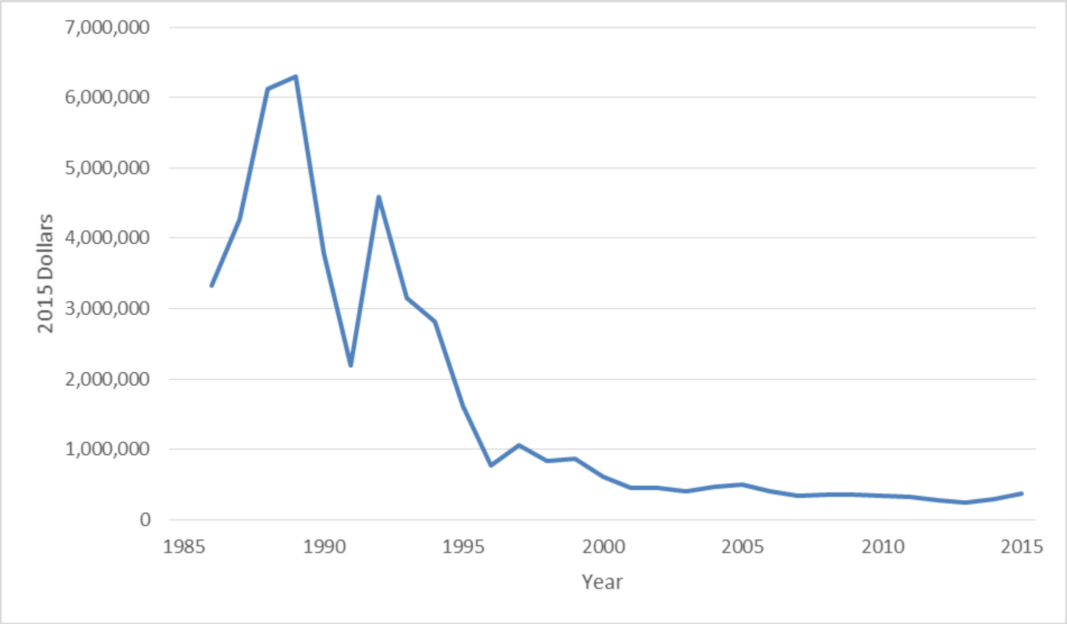


Figure 162. Gila NF inflation adjusted total gross receipts 1986-2015

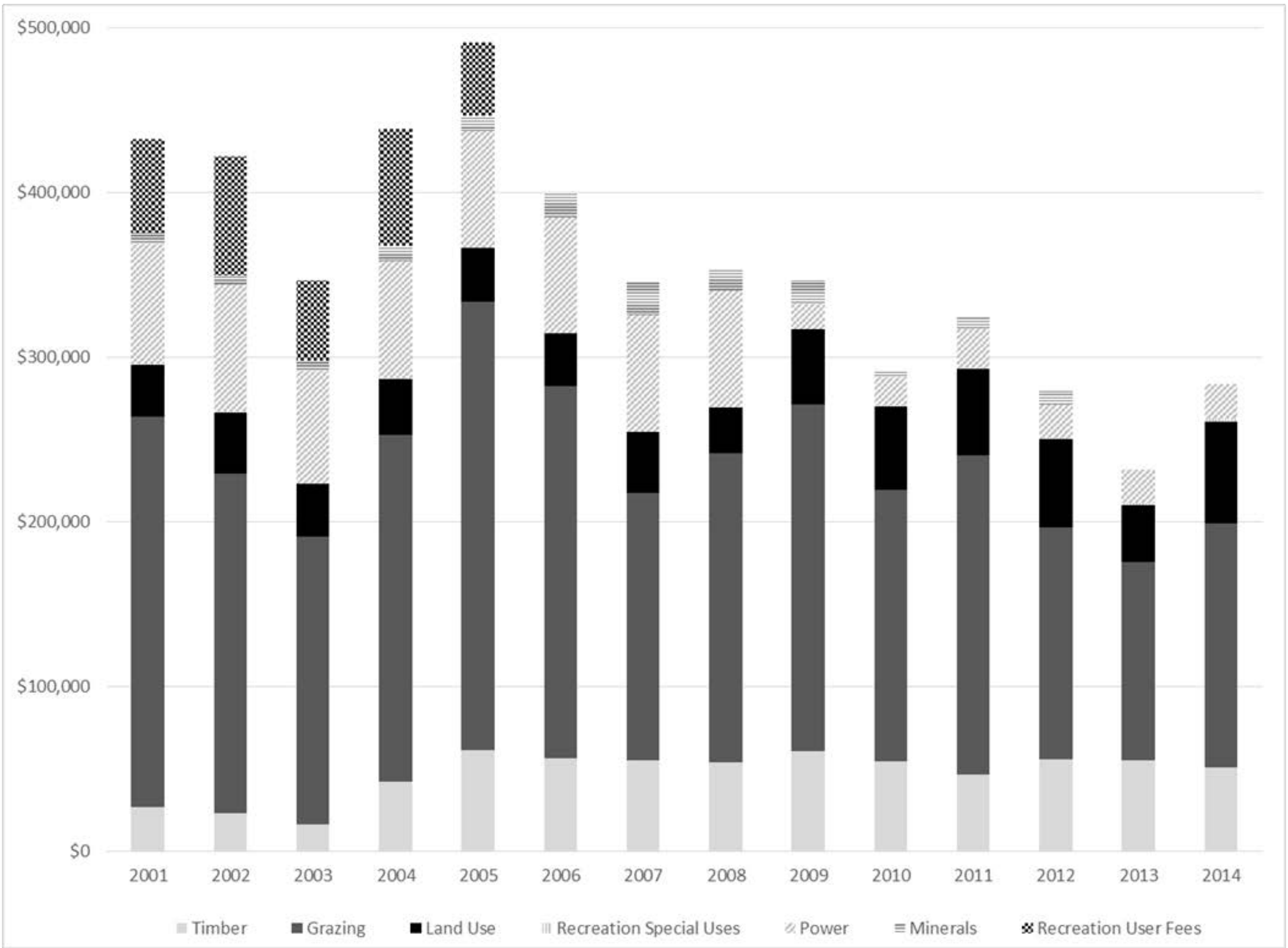


Figure 163. Gila National Forest gross receipts by source, 2001-2014

Aesthetics

Aesthetics and scenery are an important component of the Gila NF and the four-county area. The Forest is perceived as having a range of aesthetic resources that are valued by both local residents and visitors to the area. Scenery and other natural amenities are also believed to attract new residents to the four-county area (USDA FS 2006a). The opportunity to be away in an environment perceived to be vast, aesthetically pleasing, and readily accessible is an important characterization of Forest lands by longtime residents and visitors alike (USDA FS 2006a). The scenery and perceived beauty of the area contributes to the recreation and tourism industry in the area. For example, the Gila NF is a scenic back-drop to many communities within the area and influences the value of real estate. Property adjacent to or near the Forest boundary can sell for a much higher price than a similar property located further away. Scenery is discussed in more detail in Chapter 12: Recreation, which describes various parts of the Forest according to their scenic character.

Influence of the Gila National Forest on Social, Cultural and Economic Conditions in the Broader Landscape

Hunting

Culturally, hunting is an important activity for the people of New Mexico. Early inhabitants hunted and lived off the land. Many of the people in rural areas and small towns in southwestern New Mexico continue this traditional practice that provides food, is a bonding activity between parents and children, and is a way of teaching children about nature and the land around them. Recently, sport hunting has emerged as a recreational activity, which can involve larger groups, OHVs, and hunting camps. Sport hunting can be very social and many hunters return to the Forest annually for this activity. The growth of sport hunting has given rise to a community of commercial outfitters and guides. The Gila NF is known for its trophy animals, especially elk, which attract hunters from all over the country. Ranchers are taking advantage of the hunting opportunities by developing outfitting and guiding businesses. Outfitters and guides look to the Gila NF for special use permits that allow them to host tourist activities on Forest Service lands. Some rely on this as a main portion of their income. For more details on the economic contributions of hunting, please see Chapter 11: Multiple Uses.

Wilderness

Part of the Gila National Forest's niche is the freedom to explore vast expanses of backcountry. The fact that the Gila NF is home to the first wilderness area along with the strong ties to Aldo Leopold creates a national and international destination for visitors who seek a primitive natural experience. Popular activities within wilderness areas on the Gila NF include: hiking, backpacking, horseback riding, camping, hunting, fishing, and wildlife viewing. Additional discussion on wilderness can be found in Chapter 13: Designated Areas.

Stakeholder Input

Most of the feedback received on this draft assessment report chapter was concerning the economic contribution analysis. There were requests for additional clarification and information for the analysis terminology, methodology, interpretation, and discussion. Others felt that the timber harvest methodology is out of date and did not capture emerging wood product sectors (such as uses for woody biomass) and emerging carbon capture values that could integrate the benefits of thinning, economic development, watershed restoration, and carbon sequestration.

Other comments stressed the importance of transitions in the social environment be balanced with the preservation and protection of long-established uses, which are valued to the people that engage in them and the surrounding communities. It was also suggested that the Forest consider elements for forest management contained in Catron County's Wildlife Protection Plan (CWPP) as this plan looked at the wildland urban interface and forest conditions beyond the interface that could have downstream effects. There was also a comment for increased collaboration with forest restoration enterprises to achieve mutual goals.

Summary

In a social context, the Gila NF offers a unique setting in terms of history, diversity, and economic conditions. There is strong attachment to the land by the residents within the multi-county analysis area of Catron, Grant, Hidalgo, and Sierra Counties. There are also benefits derived from and demands placed on the Gila NF that the public and other stakeholders communicated during the course of this assessment. Many of these benefits are related to traditional uses, natural resources, nature, recreation, wilderness, and lifestyle. The demands were generally expressed as concerns or desires. In summary, the public's and stakeholders' main interests were related to (a) roads, trails, and facility maintenance; (b) support for economic development; (c) ecosystem sustainability; (d) recreation; (e) fire and fuels management; (f) diminishing water supplies; (g) wildlife habitat; (h) access and travel management; (i) invasive plants and animals; (j) drought and climate change; (k) wilderness; (l) more educational and volunteer opportunities; and (m) better communication with the Forest.

The social environment of the area has characteristics that influence values and beliefs about the Gila NF. These characteristics include: a multi-cultural heritage; traditional use economies transitioning to include tourism and amenity uses; a strong local environmental presence; a changing population mix with an increased presence of retirees and other newcomers; and an outdoor lifestyle. These characteristics imply a mix of values and beliefs based on types of use, length of residence, and cultural background. This social environment is also characterized by polarization about certain Forest management issues although there may be broader agreement on the need for restoration of forests, grasslands, and watersheds.

The demographics of the area also highlight some of the hardships people face, especially in terms of income and a struggling educational system. Most people in the four-county area work for the government or the copper mines, and average household income tends to be lower compared to New Mexico and the nation. Younger generations are perceived to be leaving the area in search of better economic opportunities. The Gila NF provides economic benefits to the four-county area in the form of direct, indirect, and induced economic contributions. Overall, the Forest contributes over 981 jobs and $28.7 million to the local economies. Grazing, timber, recreation, and Forest expenditures all provide economic contributions. The federal government also contributed more than $3.2 million to local counties for payments in lieu of taxes in 2015 and over $4.6 million to the Secure Rural Schools program in 2014. Also in 2014, the Gila NF received $288,350 in gross receipts from income generated by timber, grazing, and special uses, among other programs.

When considering the social context, the attachment people have, and the contributions the Gila NF makes, it is evident that the Forest is not separate from the communities it serves, but is an integral part of them. Reliance on Forest Service lands in some form or another is part of the culture within the area and will continue to be so for as long as the Forest remains in place.

Chapter 11. Multiple Uses and Their Economic Contributions

Introduction

The Forest Service is a multiple-use agency providing a range of benefits and services from the variety of resources provided by national forests and grasslands. The multiple-use mandate comes from the Multiple-use Sustained Yield Act of 1960 and the National Forest Management Act of 1976. The mandate is not exclusive to a single resource or use, and the sustained yield principle applies to all multiple-uses for which the national forests and grasslands are administered. Recreation, timber, range, water, and wildlife, fish and plant resources contribute to maintaining social cultures, maintain long-standing traditions, connect people to the land, and contribute to the quality of life for many Americans and communities.

This chapter describes the social and economic contributions from timber, range, water, and wildlife, fish, and plant resources. The Recreation description of social and economic contributions are included in Chapter 12: Recreation.

Timber and Special Forest Products

Plant products, including firewood, timber and other building materials, as well as special forest products (e.g., Christmas trees and transplants/wildings) are important resources available from the Gila NF. Firewood is the sole source of heat for the homes of many people within the area of influence, largely because it provides economic savings over propane, natural gas and electricity. Gathering firewood and Christmas tree cutting are often family events. Other wood products, such as lumber, posts, poles, and traditional building materials (e.g., latillas and vigas), are culturally and economically important as well. The Forest has increased the number of forestry treatments it implements, to improve forest health, reduce potential for uncharacteristic wildfire, and make forest products more available. This section discusses the current condition and trends of timber and special forest products on the Gila National Forest by identifying and evaluating:

- Ecosystem services from timber and special forest products
- Current condition of forested areas within the plan area
- How programs such as the Collaborative Forest Restoration Program, fit into the management of timber and special forest products
- Contribution of timber management to ecological sustainability
- Current timber and special forest product production in the plan area and broader landscape
- Trends influencing supply and demand of timber and special forest products coming from the plan area.
- Contributions the plan area makes to social, cultural, and economic sustainability
- Summary of timber and special forest products on the Gila National Forest

Ecosystem Services of Timber and Special Forest Products

The vegetation that contributes to timber, firewood and special forest products provides many ecosystem services on which humans and other life forms depend. Supporting ecosystem services of timber and forest products at the most basic level convert sunlight and carbon dioxide into oxygen and carbohydrates (primary production). Regulating ecosystem services of timber and forest products are key to soil formation and stability, thermoregulation (shading and evaporative cooling), nutrient and hydrologic cycling, carbon sequestration, and energy flow. Provisioning ecosystem services of timber and forest products provide wildlife habitat (cover, nest sites), food (piñon nuts for humans and other animal species, browse for wildlife), and fiber (lumber, paper, fuel). Cultural ecosystem services of timber and forest products (e.g., Christmas trees, botanical remedies, and aesthetics) are especially important to humans and society.

Current Conditions and Trends of Forested Areas

The Gila NF encompasses approximately 3.3 million acres, predominantly comprised of relatively dry ponderosa pine and mixed conifer forests, spruce-fir forest, piñon-juniper woodlands, and semi-desert grassland. Nearly 2,804,477 million acres (84%) are considered to be forested, of which about 432,361 acres (13%) are designated as suitable for timber production, where technology is available to ensure timber production, without irreversible resource damage (USDA FS Gila NF 1986). A periodic forest inventory of New Mexico's forests is conducted by the National Forest Inventory and Analysis (FIA) program[51]. FIA plot data were summarized using Forest Inventory Data Online (FIDO) standard reports from 2005 to 2013 inventory data[52]. According to these data, gross standing tree[53] volume on the Forest consists of about 877 million cubic feet (MMCF) and includes growth in the wilderness. These data from the 1997 inventory also indicate average annual mortality of 2.2 MMCF.

The Gila National Forest's 1986 forest plan (USDA FS Gila NF 1986) provides timber resource direction that generally prescribes a sustained yield from scheduled harvesting, while considering other resource needs. In 1996, the forest plan was amended to incorporate Regional guidance for northern goshawk habitat and Mexican spotted owl recovery. As a result, the Gila NF forestry program shifted emphasis from predominantly even-aged to predominantly uneven-aged forest management practices. In combination with waning budgets, the Forest gradually declined in forestry staffing, outputs, and accomplishments. The effects of this transition to the social environment are discussed in Chapter 10: Social, Cultural, and Economic Conditions. Although projects and activities addressing hazardous fuel loading had been a part of the vegetation management approach since at least the 1980s, the 2000 National Fire Plan[54] provided directional emphasis to reduce the impacts of wildfires on communities and to restore fire-adapted ecosystems to healthy conditions. The directive of the Gila National Forest's new forestry program was to further integrate with wildlife, watershed, and fuels management programs, subsequently providing wood products as a byproduct of other management objectives rather than a primary objective.

Table 203 displays annual average acres treated by Ecological Response Unit[55] (ERU) from 1996 through 2014. Management activities include harvesting, prescribed burning, non-commercial thinning and fuels treatments. Harvesting includes the sale of forest products to enhance the characteristics and health of existing stands. Non-commercial thinning is the thinning of material less than nine inches diameter at breast height (DBH) to reduce competition and increase health of a stand of trees. Fuels treatments are treatments that cut mechanically or by hand to reduce the amount of fuel within a stand; reduce the number of trees per acre; and to increase the amount of space between canopies. Material from all treatments except prescribed burning are usually made available for forest products including saw logs,

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[51] FIA data are publicly available from the national FIA Website at www.fia.fs.fed.us. This site includes data downloads, online tools that allow users to perform custom queries, and documentation of FIA's field inventory protocols, database structure, and publications.

[52] Available at: Forest Inventory Data Online Website.

[53] Tree species at least 5 inches diameter at breast height or diameter at root collar

[54] The report entitled "Managing the Impact of Wildfires on the Communities and the Environment", was released September 8, 2001. This report, and a set of corresponding agency strategies, formed the basis of what is now known as the National Fire Plan.

[55] The assessment of terrestrial ecosystem condition is stratified using the ERU classification system, which is a grouping of sites that are each similar in plant species composition, succession patterns, and disturbance regimes. See Chapter 2: Upland Vegetation for more details.

fuelwood, post and poles. The majority of management activities occurred within ponderosa pine and piñon pine / juniper ERUs because they are most prevalent on the Forest.

Table 203. Gila National Forest's average management activity treatment (acres) by Ecological Response Unit* from 1996 to 2014

Management Activity	PPE	MCD	MCW	SFF	PJW	MSG	CPGB	SDG	MMS	Total
Harvest-thinning	133	9	8	8	7	0	0	0	0	165
Harvest-uneven-aged	140	15	0	0	0	0	0	0	0	155
Burning-prescribed	6,469	372	23	5	3,902	253	91	13	198	11,326
Non-commercial thin	547	155	0	0	0	193	0	0	0	895
Fuels treatment	2,482	353	0	0	2,130	0	128	120	232	5,445
Total	9,771	904	31	13	6,039	446	219	133	430	17,986

*Ecological Response Unit - Ponderosa Pine Evergreen Oak and Ponderosa Pine-Forest (PPE); Mixed Conifer, with Frequent Fire (MCD); Mixed Conifer with Aspen (MCW); Spruce-Fir Forest (SFF); Piñon Juniper Woodland, Piñon Juniper Evergreen Shrub, Piñon Juniper Grass, and Juniper Grass (PJW); Montane Subalpine Grassland (MSG); Colorado Plateau Great Basin Grasslands (CPGB), Semi-desert Grasslands (SDG), and Mountain Mahogany Mixed Shrubland (MMS). (See Chapter 2: Upland Vegetation)

General management objectives for the Forest have largely revolved around forest ecosystem restoration, which includes improving forest resilience, watershed condition, and wildlife habitat, while reducing fire hazard (fuels) and providing wood products to local communities. From 1996 to 2005 the majority of products harvested on the Gila National Forest were fuelwood, posts, and poles. When timber sales were offered on the Forest during that time period, there were often no bids from local mills, due to their size and capacity, or from Arizona sawmills unless the sale was within an economic hauling distance.

In 2005 a new mill was built in Reserve, New Mexico that could handle more capacity and material from 9” to 24” in diameter. Since the mill's establishment, the number of acres treated mechanically and the volume of material removed from the Forest has increased dramatically. Treatments have included timber sales, commercial and personal use fuelwood sales, post and pole permits, and other forest product sales. Between fiscal year 2005 and 2015 approximately 37,000 acres were treated[56]. Sale volume associated with projects implemented on the treated acres averaged about 23.0 MMCF annually (Table 204). Fuelwood sales (personal and commercial) and sale of personal use forest products (posts, vigas, house logs, etc.) accounted for about 80 percent of the volume during this 11-year period.

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[56] This number includes fuelwood areas and non commercial thinning units that were not included in the table above.

Table 204. Volume sold on the Gila National Forest by product and fiscal year in million cubic feet (MMCF).

Product	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Yearly avg.
Saw Timber	0.2	13.5	2.5	0	0	2.1	0	6.3	4.5	0	18.0	47.4	4.3
Pole	0.2	0.2	0.5	0.5	2.5	0.3	0.1	0.2	0.1	0.4	1.0	6.0	0.5
Post	3.5	8.7	3.5	8.9	8.8	7.6	3.6	6.1	10.4	7.2	0.4	68.7	6.2
Fuelwood	5.5	4.6	4.9	5.8	5.6	6.1	5.1	5.8	5.5	5.8	8.0	62.7	5.7
Misc. Convertible	7.1	4.5	10.3	2.8	15.8	5.4	4.0	8.7	2.1	4.7	2.3	67.7	6.2
Total	16.5	31.5	22.0	18.0	32.6	21.5	12.8	27.2	22.6	18.0	29.8	252.4	23.0

Collectively, timber harvest from the Gila National Forest averaged 4.3 MMCF per year from 2005 through 2015 (Table 204). There were three active primary wood products facilities within Catron and Grant counties in 2012 (Sorensen et al. 2015), and wood products from these facilities include lumber, vigas, and latillas. There are several portable saw mills in the region that the Forest provides material to as needed by the purchasers. The demand from these operation is not consistent because these mills are operated on a part-time basis.

As implied by the amount of harvest activities, the timber base largely draws from the ponderosa pine evergreen oak and ponderosa pine forest (PPE) and mixed conifer with frequent fires (MCD) ecological response units (ERU) (Table 203). Ponderosa pine and mixed conifer with frequent fires ERUs are abundant on the landscape, but their age and size classes are departed from historical conditions, largely due to interruptions to the natural fire regime and/or influences from land management activities such as harvesting and lack of thinning to improve timber stands. These ERUs are vulnerable to widespread, high severity wildfire and susceptible to a variety of insect and disease mortality, due to changes in species age, size and density across the landscape. Widespread, high severity wildfire and insect and disease mortality can reasonably be expected to occur in these ERUs in the future, potentially exacerbating a current trend of even-aged, relatively young stands at a broad extent that did not exist in the reference condition. Large scale disturbance could potentially affect the availability of timber resources on the Forest, shifting harvest activities to other ERUs. Harvest activities from other ERUs would be far more challenging, as traditional use of species from within PPE and MCD ERUs is driven in part by ease of access (i.e., close proximity to communities, generally modest slopes, and higher road density). A more detailed analysis of ecological condition and trend by ERU can be found in Chapter 2: Upland Vegetation.

Timber and Special Forest Products Management on the Gila National Forest

Collaborative Forest Restoration Program

In 2000, Congress passed the Community Forest Restoration Act (Public Law 106-393, Title VI). The Act authorized the establishment of the Collaborative Forest Restoration Program (CFRP) in New Mexico to provide cost-share grants to stakeholders for forest restoration projects on public land designed through a collaborative process. These projects may be entirely on any combination of federal, tribal, state, county, or municipal forest lands, and must include a diverse and balanced group of stakeholders in their design and implementation. Each project must also address specific restoration objectives including: (1) wildfire threat reduction; (2) reestablishment of historic fire regimes; (3) reforestation; (4) preservation of old and large trees; and (5) increased utilization of small diameter trees.

Since 2001, 22 CFRP grants have been awarded on the Gila National Forest, totaling $6.9 million in funding and the treatment of 8,550 acres. There is currently one ongoing CFRP project on the Forest, which involves training members of the Alamo Band of the Navajo Nation to pursue careers in forestry or natural resource fields. These grants have also allowed businesses to purchase equipment that can utilize small diameter timber; assist in the completion of NEPA; and training people to pursue careers in forestry and natural resources. CFRP Grants on the Forest have also helped employ 105 people to harvest and manufacture forest products from the private sector as reported in the 2015 CFRP Grant Report (USDA FS 2015g). The most important part of the CFRP program has been the partnerships that have been established. Through these partnerships the Forest has been able to complete NEPA analysis and implement restoration projects on the ground. In addition to CFRP, the businesses that utilize material from the Gila NF have been successful in obtaining federal grants from the USDA, USDA Forest Service Forest Products Laboratory, Department of Energy and various grants from the State of New Mexico.

Contributions of Timber and Special Forest Products to Ecological Sustainability

Land managers are often concerned about a forest's resilience to disturbances like insect, disease, and wildfire. These concerns are commonly addressed by commercial or non-commercial thinning of forests, as tree density is the major factor that a forester can manipulate (Daniel et al. 1979). Tree vigor can increase the availability of defense mechanisms used to protect against insects and diseases (Oliver and Larson 1996). Thinning can increase tree vigor by reducing competition between individuals, and can improve overall stand vigor by removing less vigorous individuals. The greater the individual and stand vigor, the greater forest resistance and resilience to insect and disease outbreaks. Thinning also addresses wildfire hazards by reducing density of smaller trees in the under and mid-story (ladder fuels) and decreases the overstory canopy density. Ladder fuels can carry a surface fire into the overstory canopy. Overstory canopy density is the primary factor driving crown fire behavior. Reducing the overall number of trees and canopy density reduces the risk of crown fire in stands (Graham et al. 1999).

Forest restoration involves using uneven-aged cutting methods to conduct single tree and group selection treatments. Prescribed cutting as one of several methods that may include: free thinning, low thinning, single tree selection, group selection, or rarely even-aged regeneration methods. Prescribed cutting is a selective process, where undesirable characteristics can be selected against, and desirable characteristics can be retained or promoted. For example, prescribed cutting tactics can prescribe removal of weak, diseased, and dying individuals, or species and individuals with characteristics that are more susceptible to drought, fire, and/or insect mortality. Prescribed cutting strategies can prescribe preferential retention of disturbance resilient species, such as ponderosa pine. Prescribed cutting can allow for manipulation of species composition and stand structure, such that they promote natural disturbance regimes and ecological functions.

Recently, momentum has increased for a more holistic approach of forest restoration (Reynolds et al. 2013). Generally, the prescribed cutting methods used to accomplish restoration objectives place more emphasis on developing diversity in forest structure, age classes, and species composition akin to historic conditions. This approach generally includes selective cutting methods paired with prescribed burning, intended to develop and maintain uneven-aged forest conditions that are considered more resilient to natural disturbance, and thus more sustainable long-term. However, their extent covers only a small fraction of the landscape. Treatments are limited in part by workforce capacity and current forest plan standards that are very prescriptive, restraining management options across broad extents. The magnitude of prescribed burning accomplishments is affected by weather and other environmental factors that can be highly variable year to year, and is limited by air quality regulations, and to a lesser degree, workforce capacity and concerns over public safety and values at risk (i.e. water quality, wildlife habitat, soil productivity).

Impacts of Timber Harvest on Ecological Integrity and Species Diversity

Past management activities have altered stand structure, composition, and fire occurrence patterns on the Gila National Forest, as described in Chapter 9: System Drivers and Stressors. Current ponderosa pine and dry mixed conifer stands are overstocked, have an overabundance of shade tolerant species, and are often even-aged and multi-storied, with few examples of the historic open, fire-maintained stand conditions remaining.

Current stands contain more small trees, and fewer large trees than existed in the past, increasing the amount of ladder fuels. In each of the vegetation types described, forest fuels have accumulated from plant material that is dead and dying. Relatively drier climatic conditions and slow decomposition rates, combined with the interruption of historical fire return intervals, have resulted in large accumulations of burnable materials. Current tree growth rates are commonly slow, and stand vigor is declining as competition for water, nutrients, and growing space has increased as a result of higher tree density. The low level of tree and stand vigor makes trees more susceptible to insect attack and disease mortality, combined with increased density of vegetation and continuity of fuels coalesces in an increased probability of severe effects from wildfire.

Timber management activities on the Gila National Forest are trending toward targeting improvements to forest structure and function. Addressing mid- and overstory conditions is critical to these restorative efforts, as this affects overstory species composition, stand structure, potential crown fire starts and spread, stand density, and influences on understory conditions. Relying on other vegetation management methods, such as understory burning, does not necessarily have the same selective capacity, especially with regards to the overstory.

Short-term negative impacts to forest soils and hydrology can be expected from timber management activities. Limited soil compaction and waterway sedimentation may occur due to disturbances from logging equipment, skidding, landings and temporary road construction, and use. These effects are typically mitigated by limiting ground-based operations to relatively gentle slopes, as well as establishing limits to extent of disturbance and proximity to riparian and/or other sensitive areas. Long-term benefits to ecosystem resilience, disturbance regime, nutrient cycling, biodiversity and food webs, old-growth condition, overall hydrologic function, wood products, and aesthetics and recreation can outweigh short-term negative impacts (Reynolds et al. 2013).

Trends Driving Supply and Demand of Timber and Special Forest Products

The supply and demand for timber is driven by regional, national, or global forces. Local drivers are smaller in scope and scale, and generally have only minor effects on the overall market for timber and lumber products. Demand for woody material from the Forest is largely driven by fuelwood needs. This demand is made evident by the proportion of volume sold as fuelwood as discussed above (Table 204). Other local demand for woody material comes from mills that generate rough cut lumber, fuelwood, and other specialty products for use in local custom-built homes. The demand for firewood by families and communities has remained stable to slightly increasing over the last five years, primarily due to higher cost of natural gas and propane delivery versus the availability of wood in close proximity to the communities the Gila NF serves.

The Forest Service recently acknowledged the critical need to increase the pace of restoration to address a variety of threats including fire, climate change, and insect and disease outbreaks (USDA FS 2012c). Across the nation and in the Southwest, there is broad public support for actively managing forests to be more resilient to these threats. In response, the Gila National Forest is generally shifting planning and implementation efforts to encompass larger landscapes. This broad recognition is piquing interest in the feasibility of commercial use of traditionally sub-merchantable materials, such as small diameter dimensional lumber and wood-based energy production for forest product business located in eastern Arizona. The Gila NF will continue to work with other Federal, State, and local government agencies, as well as non-government organizations to build facilities and markets that will use this type of material.

The near-term potential for impacts to the Forest is probably low, as the haul distance to these facilities is long. Future projects/activities in the northwest portion of the Forest (Quemado Ranger District) could provide material for eastern Arizona business. What is clear is that the Forest intends to manage National Forest System lands such that species composition, structure, and function are more akin to historical conditions, and to do so at a broad scale. This work will be completed within the agency as well as with the assistance of partners that would include Federal, State, and local government agencies, conservation groups, businesses, and any other interested stakeholders. The Gila NF plans to work with these partners and build upon our past successes to use all available options to make more wood products available than current local manufacturing facilities can support. These options include but are not limited to the use of grants, agreements, contract options, and authorities allowed on National Forest System Lands.

Contributions of Timber and Special Forest Products to Social, Cultural, and Economic Sustainability

The Gila National Forest administers its lands for a variety of objectives that can generally be described as forest ecosystem and watershed restoration. Timber and woody material is largely derived as a byproduct of restoration and other activities. There has been a long-term historic demand for firewood, which continues to this day. The ability to access the Forest and gather firewood is very important for local communities. The Forest makes firewood available throughout the Forest as part of CFRP projects and designated areas for those with a permit to gather firewood. The ability to access the Forest and gather firewood is very important traditional use for families and communities surrounding the Forest. Often firewood gathering is a family event. The use of firewood for heating saves many families money over the cost of using utility sources for their heating.

The Forest is adjacent to the Cibola National Forest and Apache-Sitgreaves National Forests in Arizona, as well as Bureau of Land Management, state, and privately owned lands. Currently, the mill in Reserve, New Mexico employs eight people at the mill and up to ten people on timber sales. There are also approximately five active smaller mills that purchase timber to produce rough cut lumber and other forest products on a limited scale and at least seven fuelwood businesses based upon sales of permits. The number of employees in these businesses is not known and many may be self-employed businesses with no paid employees. In 2013, timber-related jobs accounted for less than one percent of private sector employment within the four counties: Catron, Sierra, Grant and Hidalgo; that the Forest is situated (Headwaters Economics 2016). Catron County has the largest percent of the total timber-related employment due to the number of permits sold and the location of these businesses.

There is a broad interest in increasing the pace of restoration activities, which may pave the way for potentially innovative wood facilities in the future. The efficient management and sustainable use of wood resources was identified as one of the Natural Resources policies within the Grant County Comprehensive Plan (2004). Sierra County identified opportunities to explore markets for harvested materials and sustainable wood product industry for wide spectrum of producers and local entrepreneurship (Sierra County 2006).

The relation of timber to the social and economic importance to Catron County are identified in the Catron County Comprehensive Plan (2007), which include:

- Per the Healthy Forest Initiative, continue to work with the US Forest Service in order to support efforts to revive the timber industry in the County with a focus on smaller diameter trees and wood products (Economic Development Goal 1; Objective 1d).
- Workforce development and training is essential for Catron County's future economic growth, especially given the lack of population. One of the biggest issues regarding business retention and attraction is the lack of training for people entering the workforce. Workforce development and training is especially important should the timber industry become viable again or to meet new opportunities such as potential growth in the construction industry.

- Targeted industries…need to be appropriate to Catron County and take into consideration existing County resources such as water and values…The following industries are reasonable for targeting for location in Catron County:
    - Specialty Retail consisting of smaller shops focusing on specific products such as woodcrafts, arts, crafts due to timber products being available.
    - Bio-Fuels due to availability of materials generated from forest projects.

Stakeholder Input

Many comments received from stakeholders were related to economic development and opportunities related to wood products. There is a desire to increase timber or wood product cutting to aid in economic development, create jobs, and establish or improve business and mill infrastructure. Employment is not just related to mills, but also crews for thinning and piling on logging operations or restoration projects reducing tree densities or reducing fuel hazards. It is felt that there needs to be more collaboration between the Forest Service and private sector to be successful.

The reduction of logging and thinning is thought to have resulted in overgrown forested areas, more fuel load to burn, and insect infestation. The lack of logging or removal of dead or dying trees resulting from fires are adding to the fire risk and more insect infestation. It is felt that there is a loss of economic opportunity by the lack of logging or cutting available materials; having fires consuming woodland and forest resources; and not harvesting burned dying trees shortly after fire events when material is still viable for use.

Comments expressed the need to have more proactive management of forests. There is a sentiment that effective tree reduction (management) would benefit communities, property owners, industry, and forest ecosystems.

Alternative opportunities were suggested for the use of smaller diameter trees, burned logs, slash material, or other products. This included such things as wood pellet or chip production or creating material for bio-generator use. Greenwood fuel wood cutting areas could be increased in size with easier accessibility and size restrictions on trees changed to promote more collection and reduction of juniper stands in grasslands.

Many comments expressed concern about the occurrence of illegal wood cutting on the Forest. Some examples of impacts identified with illegal wood cutting were damage to the land and resources from use of motor vehicles driving everywhere and cutting fences. It was articulated that there needed to be more management, restrictions, and law enforcement presence to address the concern of illegal wood cutting.

Summary

The Gila NF's primary contribution of timber and forest products is to local communities around the Forest for logs, firewood, and other forest products. An increased emphasis on land restoration projects should allow for the continued ability to contribute to this demand. The Forest should be able to continue to meet demand for the local mills which operate in or adjacent to the planning area. An increase in forest restoration projects will be vital to help sustain forest and watershed health, reduce potential for uncharacteristic wildfire, and improve or maintain wildlife habitat.

Range

Multiple use management on the Gila NF includes producing forage for wild ungulates and domestic livestock. The ranching culture and tradition in New Mexico is deeply rooted in history. The Forest Service began administering grazing on NFS lands in 1899, however rangelands were grazed long before then by earlier generations. Because settlers had utilized these lands for so long, raising livestock has become a very important part of the culture of the communities surrounding the Forest. As a result of historical use the plan area has inherited a legacy of ecological impacts from high numbers of livestock. As the majority of land ownership in the assessment area is either federal or state, many ranching operations still rely on public lands for livestock grazing. Maintaining the sustainability of ecological resources is important for sustaining this social, cultural and economic benefit for local communities. This section identifies and evaluates:

- Ecosystem services derived from grazing multiple use
- Current grazing and trends on the Gila National Forest
- Range condition and trends on the Forest
- Capability and productivity to support grazing
- Impacts of livestock grazing on ecological integrity and species diversity
- Contributions of livestock grazing to social, cultural, and economic sustainability
- Summary of rangeland and livestock grazing on the Gila National Forest

Ecosystem Services of Rangelands

Rangelands on the Gila NF provide a variety of benefits to local communities. Forage produced on rangelands has sustained ranching operations for generations; some of which would not remain viable without access to public grazing land. Not only does grazing generate income for the ranching families, but it also benefits the local economy by producing food and other products, providing local jobs, and commerce to local businesses for goods and services needed locally to manage livestock/ranching operations. Rangelands sustain cultures and traditions by contributing to the historical western way of life, and connect future generations to the land and livestock. Rangelands provide open space and opportunities for recreational activities such as picnicking, hiking, biking, OHV and horseback riding, hunting, etc. In addition, range improvements such as water developments benefit different species of wildlife.

Current Level and Trends

Currently 2.6 million acres of the 3.3 million acres of the Gila National Forest are managed for livestock grazing. As of March 2016, there were 138 active grazing allotments, 11 vacant (included in the active allotments) and 3 closed allotments on the Forest, all of which are administered by six different ranger districts (Table 205). Vacant allotments are included in the active allotments because they can be used as relief allotments, on an "as needed" basis by a valid permit holder although some range developments may be in disrepair. This case may occur as an adaptive management response to address resource concerns such as fire or drought. In other cases, vacant allotments or portions thereof may be included into the management of adjacent allotments.

For administrative purposes of livestock management, there are three units identified for distinct purposes:

1. **Head month (HM)** is a month's use and occupancy of rangeland by one weaned or adult cow, bull, steer, heifer, horse, burro, or mule, or five sheep or five goats. Head months are used for grazing fee calculation and collection purposes.

2. **Animal Unit Month (AUM)** is the quantity of forage required by one mature cow and her calf (or the equivalent, in sheep or horses), for one month.
3. **Permitted numbers** represent the total number of livestock pairs or individuals permitted on a given grazing allotment.
4. **Authorized numbers** are expressed in head months and represent the year to year actual stocking on the allotment, based on forage and water availability, condition of range improvements, climatic conditions, personal convenience for the permittee, or resource protection non-use.

Permittees or the Forest may place an allotment or their permitted numbers into partial or total non-use for either personal convenience (3 year limit), or for resource protection (longer term non-use associated with a Memorandum of Understanding between the permittee and the Forest). There are currently 13 allotments that have been placed in long-term non-use for resource protection due to circumstances such as drought, and/or inadequate infrastructure (i.e., fences, water sources, corrals) (Table 205). During the past 10 years, authorized numbers have been below those permitted, mostly due to adaptive management responses to drought (Figure 164). Figure 165 shows the long term trends in permitted Animal Unit Months on the Gila NF. The noticeable peak around 1920 is due to the Forest Service being requested by the Hoover Commission to increase livestock numbers to produce more meat, wool, and mohair during World War I, although these numbers led to significant range deterioration (Chapline 1980).

Table 205. Grazing allotments on the Gila National Forest by ranger district (2016).

Status / District	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
Active [1]	19	27	29	11	21	31
Vacant [2]	1	1	3	2	1	3
Non-use [3]	3	0	0	6	0	4
Closed [4]	0	0	0	0	0	3
Total Allotments	**23**	**28**	**32**	**19**	**22**	**41**

[1] Active includes long term non-use & vacant

[2] Vacant allotments are included in the active allotments because they can be used as relief allotments, on an “as needed” basis by a valid permit holder although range developments may be in disrepair.

[3] Long term non-use for resource protection or infrastructure needs

[4] Closed is closed by NEPA Decision

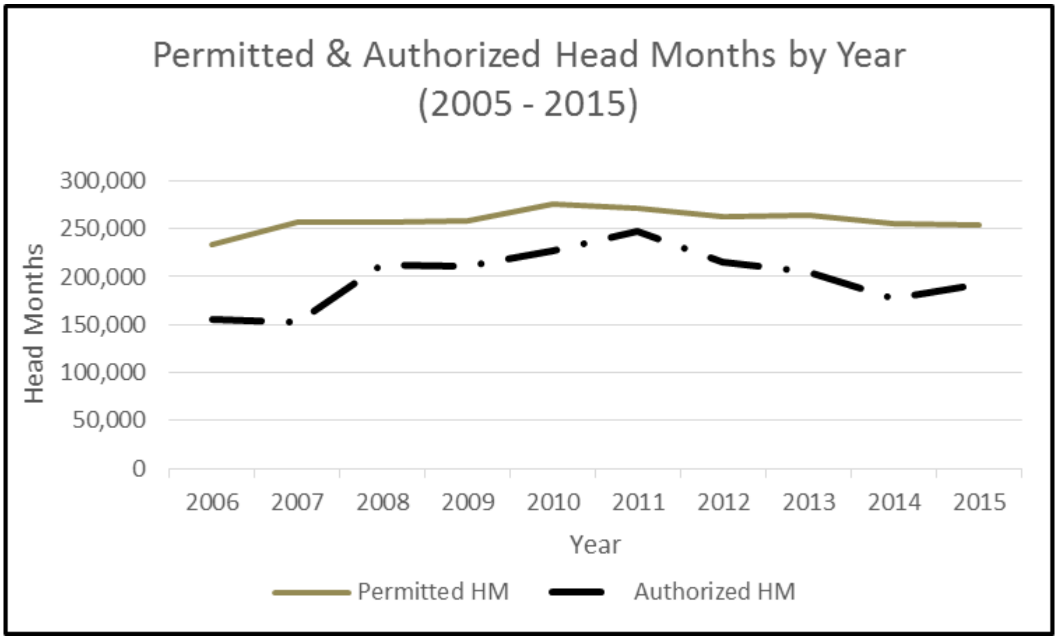


Figure 164. Permitted and authorized livestock head months (HM) on the Gila National Forest 2005-2015. Source: USFS Gila NF 2016b

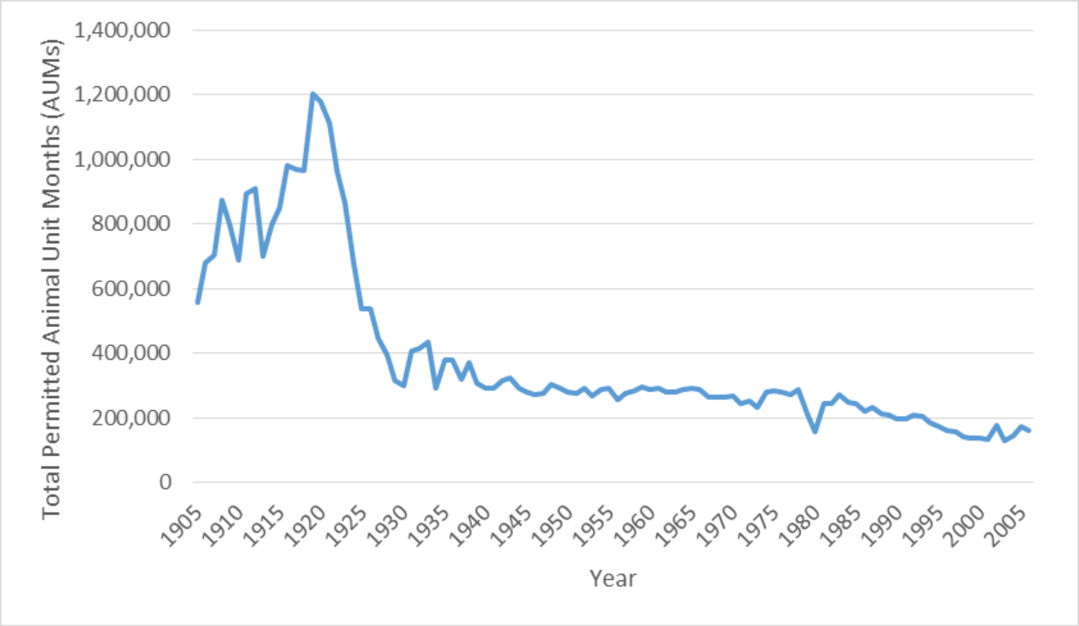


Figure 165. Total permitted animal unit months (AUMS), 1906-2007. (Apache National Forest allotments not included)

Grazing Management

Management direction under the current Gila Land Management Plan (USDA FS Gila NF 1986) states:

- Provide forage to the extent benefits are commensurate with costs without impairing land productivity and within the constraints of social needs.
- Provide cooperation with other agencies and private range landowners to reduce impacts of livestock grazing.

- Identify and manage areas that contain threatened and endangered species of plants and animals.

Grazing management for specific grazing allotments is determined through completion of the NEPA range analysis process under FSH 2209.13 – Chapter 90 Rangeland Management Decision-making. The Gila NF is continuing to work through a schedule for range analysis and preparing to initiate reviews of older decisions in accordance with NEPA. The Section 18 review process FSH 1909.15 section 18.2 – 18.4) reviews prior NEPA decisions in order to assess if grazing activity, associated permits, AMPs, and/or AOIs are consistent and within the bounds of the existing NEPA documentation. If as a result of the review, there are inconsistencies, a determination is made to make a correction, supplement or revision or initiate another analysis for continuation of grazing on range allotments.

Current grazing analysis and management includes adaptive management strategies which is 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. This allows management flexibility within the NEPA decision, such as changes in livestock number and season or length of use in response to variable resource or climatic conditions.

Range Condition

Range condition can be described as the “state of health” of the range. More specifically, range condition is an ecological measure of the current condition of the range as compared to the potential (often called “climax”) (McGinty and White 2016). The Gila National Forest Land Management Plan (USDA FS Gila NF 1986) states “Range condition as evaluated and ranked by the Forest Service is a subjective expression of the status or health of the vegetation and soil relative to their combined potential to produce a sound and stable biotic community. Soundness and stability are evaluated relative to a standard that encompasses the composition, density, and vigor of the vegetation and physical characteristics of the soil.” Range condition is evaluated for each allotment on the Forest through the project to plan analysis under the guidance of FSH 2209.13, Grazing Permit Administration Handbook, Ch. 90 Rangeland Management Decision Making.

Historical

Livestock grazing was introduced in the Southwest in the late 16th century by the Spanish and included cattle, horses, goats and sheep. Pueblos and Spanish-American villages practiced year-long grazing in the tradition of open range for several hundred years. By the early 1800s Spanish-Americans had developed large cattle herds in New Mexico. After 1870, the cattle industry expanded. It is estimated that on New Mexico rangelands there were 158,000 cattle in 1870 and 1,065,000 in 1886. Range conditions deteriorated and following the drought of 1886, thousands of cattle starved. This drought, range deterioration and competition for grazing lands brought about the fencing of private rangelands. Open-range grazing ended on all but Federal lands. By 1900, there were so many livestock on public lands that evidence of degradation was apparent even in “good” years (Baker et al. 1988).

The 1905 USGS report included a description of range conditions across the Forest. In the vicinity of the T Bar Grasslands, the report documents the grazing of sheep had produced “a barren desert, not a blade of grass to be seen and even the roots being entirely destroyed.” Conditions were similar, “but not so bad” over much of the Forest. The area around the East Fork Gila River and the Black Mountains was an exception, which Rixon described as having “a fine growth of grass” (Rixon 1905).

Based on decadal averages, from 1910 to 1960, livestock grazing on the Gila National Forest was reduced by 64 percent. Sheep and goat numbers began to decline and no longer grazed the Forest after the 1970s, although most of these animals were taken off the Forest long before. During the 1930s, many watershed structures were installed across the Forest in attempts to control gully and rill erosion. Many non-native perennial species were seeded in association with those structures to assist in stabilizing the soil. Most of these structures were never properly maintained for long and are either at capacity or otherwise non-functional.

Current Range Conditions

Range condition long term trend monitoring has occurred on the Forest since the 1950s, when the first transects were established using the Parker Three Step method. The majority of grazing allotments have undergone range analysis that determines overall range condition, directly relating to estimated capacity, permitted numbers, season of use, and grazing management. Many of these decisions date back to the mid and late 1990s. The Forest is scheduled to complete NEPA analysis on all allotments by 2025.

Range condition on the Gila NF is for the most part determined by using the Parker 3 step method which involves collecting data related to plant composition and vigor, and soil characteristics; then determining a “condition class” and trend to the specific area. These condition classes include very poor, poor, fair, good and excellent ratings and are associated with a trend of upward, downward or stable. The Parker 3 Step protocol contains valuable historical data and will continue to be used as part of the Forests rangeland analysis process. However, the Forest is in the process of transitioning from this method for assessing rangeland health to different types of assessments such as cover frequency and other types of assessment protocols. FSH 2209.13, Grazing Permit Administration Handbook, Ch. 90 Rangeland Management Decision Making provides recommendations for other assessment methods.

After centuries of grazing, overall rangeland conditions on the Forest have improved substantially over the past several decades. Review of past and current range analysis, photo records and personal communication with district range and Forest staff, indicate most rangeland areas within the plan area are in “fair condition” with stable to upward trends. There also remains some areas within the Forest that reflect “poor” conditions. However, as mentioned above, many allotments on the Forest are in need of NEPA review (Section 18 Review) to evaluate new information.

In addition to long term trend analysis and professional judgement, other indications of range condition can be inferred from riparian assessments such as Proper Functioning Condition, Watershed Condition Assessments and annual implementation monitoring outcomes for forage utilization, and overall grazing management compliance.

Riparian Areas

Streams on the Gila NF provide essential habitat for many aquatic, terrestrial and riparian species, and in some cases water for livestock. Some riparian areas on the Gila NF are inaccessible to livestock due to natural barriers (topography), or excluded by fencing due to resource concerns (see Chapter 9: System Drivers and Stressors for more details). Regardless of accessibility, streams are evaluated during range analysis using the Proper Functioning Condition protocol (Prichard et al. 1998). These assessments are accomplished during the range analysis process. Overall, these assessments depict improving trends across the Forest’s riparian areas (personal communication, M. Natharius). Please refer to Chapter 7: Riparian for more information about riparian conditions and functions.

Watershed Condition Framework/Classification As An Indicator of Range Condition

The Watershed Condition Framework (USDA FS 2004, FSM 25231.1) also gives us information about range condition, as several of the indicators relate directly to rangeland vegetation condition and the presence of invasive species. This classification uses 12 core national indicators to describe overall watershed health and function, three of which are informative for range condition: rangeland vegetation, invasive species and soil condition. These three indicators for the 6th code watersheds assessed showed functioning at risk (70%), and functioning properly (23%) for rangeland vegetation; functioning properly (99%) for invasive species; and functioning at risk (46%) and functioning properly (32%) for soil conditions. These three attributes do not alone indicate overall watershed condition. This framework is discussed in more detail within Chapter 6: Water.

The rangeland vegetation indicator was scored by District range specialists referencing available data collected at permanent range monitoring sites, the national ruleset provided in the technical guide (Potyondy and Geier 2011) and professional judgement to rate this indicator. Range condition data scores sites into very poor, poor, fair, good and excellent condition categories as identified by the Parker 3-step protocol. For the watershed condition assessment, ratings were averaged to each subwatershed with very poor and poor range condition categories being equated with Impaired Function indicator ratings, fair with Functioning at Risk, and good and excellent being equated with Functioning Properly indicator ratings. While the range data includes trend analysis, the watershed condition classification does not provide a means to report trends; therefore trends were not assessed at the watershed scale.

Although the indications of historic overgrazing cannot be reversed, adaptive management strategies have led to improved range condition in some areas, stabilized trend in others, and the identification of those areas still in poor condition. Monitoring data continues to accumulate, and the prospects are good for adaptive management to lead to further improvement even in the face of climate change.

Stressors to Rangelands and Grazing

Drought/Climate Change

Livestock ranching operations manage millions of acres of US rangeland ecosystems. These operations produce food and are increasingly important for providing ecosystem services as more rangelands are permanently converted to development. Droughts like the one that began in 2011 and affected huge areas of the central and western US can trigger undesirable ecological changes in rangelands, reduce livestock production and provision of ecosystem services and threaten ranching livelihoods (Kachergis et al. 2014).

In 2015, the Forest Service Southwestern Region prepared the Climate Change Vulnerability Assessment (CCVA) for the Gila NF (Triepke 2015). This is an ecosystem-based vulnerability assessment for all major upland ecosystems (Ecological Response Units) in Arizona and New Mexico based on the anticipated effects of climate change. Four vulnerability categories are reported: low, moderate, high and very high. These categories are accompanied by uncertainty categories to account for difference in climate model predictions and are also reflected as low, moderate, high and very high. This assessment describes the relative susceptibility of an ecological type conversion. Overall, the Forest falls into the moderate vulnerability and uncertainty categories. Given these predictions, rangeland managers must stay judicious in providing for flexibility in managing rangelands (e.g. ability to use multiple management options/adaptive management) for drought, which is imperative to ranching operations and range ecosystem sustainability. Please refer to the Drivers and Stressors section of this document for more information about the CCVA.

Although livestock managers have historically dealt with drought conditions (e.g. Dust Bowl year of the 1930s, the mid 1950s drought and the 1988 drought), current efforts associated with the dry years of the early 21st century demonstrate that there is a need for adaptive management to increase resiliency of the rangeland vegetation and sustainability of rural communities and economies. Adaptive management necessitates that 1) adjustments are made when temporally appropriate (both within and across years), 2) experiential and experimental knowledges blended to provide sufficient capacity for flexibility with predicted long-term droughts that are more intense/severe, as well as "flash" droughts like the one experienced across a wide swath of the US in 2013 and 3) spatial and temporal variability are embraced rather than looked at as negatives. Key for livestock managers is how to increase flexibility in management to adapt to increasing weather variability associated with a changing climate (Derner 2015).

Invasive Species

Invasive plant species within the Gila NF are not well established across the landscape when compared to other western United States National Forests. However, disturbances such as fire, drought, vehicle travel, herbivory and possible adjacent land owner infestations increase the risk of invasive species introduction, establishment and spread on rangelands. The majority of invasive species are unpalatable to livestock and their presence reduces the overall quantity and quality of palatable forage to sustain livestock. When established, invasive species disrupt the structure and stability of native plant communities, degrades native wildlife habitat by out competing and replacing native plant species, changes soil characteristics, all of which threaten overall rangeland ecosystem health. For more details refer to Chapter 9: System Drivers and Stressors.

Management Challenges for Rangelands and Grazing

Fire Effects to Grazing

Wildfire, managed fire and prescribed fire, can provide long term benefits to maintaining the ecological integrity of grasslands and preventing woody species encroachment. However, fire management activities do pose short-term management challenges for rangeland managers and livestock operators. These challenges often include the need to rest areas from grazing after fire to provide forage recovery, which can cause the permittee to change pasture rotations, find other allotments to graze, or move livestock off the National forest to deeded land.

Threatened & Endangered Species

The presence of species listed as threatened or endangered under the Endangered Species Act can also present management challenges for managers and operators on many allotments in the Gila NF. The presence of listed fish species in some cases restricts watering areas for cattle or requires fencing and related fence maintenance. Mexican wolf-livestock conflicts and depredations are a major concern to permittees. Depredations, managing around den or rendezvous areas increases the intensity and cost of livestock management.

Capability and Productivity of the GNF

The Gila has supported public grazing for many years. As stated above, livestock numbers have been greatly reduced since the early 1900s. The past 20 years have seen minor fluxes in authorized grazing use mostly due to drought and/or personal convenience non-use. Summaries from range analysis and professional judgement depict an upward trend in range condition overall; utilization monitoring in general is within or below established utilization standards, other than in isolated areas; and other range assessments such as upward trends in riparian conditions indicate that the Forest is capable of supporting livestock grazing. These observations combined with adaptive management strategies that allows grazing management to respond to changing resource or climatic conditions, further demonstrates that the Gila NF rangelands are able to provide the needed forage and resource productivity to support public grazing as a multiple use.

Impacts of grazing on Ecological Integrity and Species Diversity

Impacts from unmanaged livestock grazing can result in adverse impacts on ecological integrity and species diversity. The effects of poor grazing management are well documented. Reductions in vegetative cover and soil compaction can lead to decreased water infiltration, increased runoff and accelerated erosion (Belsky and Blumenthal 1997; Smith et al. 2009; Holechek et al. 2010) depending on the degree and extent to which they occur. Where decreases in herbaceous biomass occur, the ability of frequent fire ecosystems to carry low intensity fire can be reduced (Belsky and Blumenthal 1997; Holechek et al. 2010). It also reduces the risk of moderate and high intensity fire. Decreases in fine fuels can also lower fire severity when fires do occur. Additionally, decreases in the herbaceous component reduces competition by grasses with woody species, allowing those woody species to expand or encroach into grasslands and woodland and forest openings (Allen 1984; Moore and Huffman 2004). While there is evidence that heavy grazing can degrade arid rangelands (Todd and Hoffman 1999; Loeser et al. 2007 among others), there is also evidence that properly managed grazing can be sustainable (Pieper 1994; Loeser et al. 2007; Holechek et al. 2006, Holechek et al. 2010; Davies et al. 2011, among others).

According to Holechek et al. (2010), heavy stocking (51%-60% utilization) consistently caused a downward trend in ecological condition, light stocking (0%-30% utilization) caused an upward trend, and a slight improvement occurred under moderate stocking (41%-50%). “Conservative” grazing is defined by Holechek et al. 2004, as a level of grazing between light and moderate which optimizes ranching risk, financial returns, and livestock productivity. This equates to an average of 35% utilization (range of 31%-40% utilization). Unless other management objectives are stated for specific areas, such as dormant season grazing, or cases in need of a lesser degree of utilization, in order to promote upward trend in range condition, this conservative level is the standard adhered to on the majority of the grazing allotments administered by the Gila NF. Also according to Holechek it has been known for some time that certain degrees of utilization can increase plant productivity. Removal of apical dominance by grazing or browsing has been long understood as one means of increasing productivity. However, this can be highly variable depending on species, climate and intensity of grazing. In addition, the presence of livestock on the rangelands can result in positive outcomes, such as invasive plant detection, in the sense that livestock managers are continually monitoring for invasive species during their presence on the landscape, reduction of fine fuels (grasses and forbs) through grazing where spread of fire is a concern, and supplementary water developments that benefit wildlife permitting use of areas from which wildlife were previously excluded due to lack of water.

Competition for forage between livestock and elk is an ongoing concern for livestock producers within the plan area. Livestock grazing has been considered detrimental to wildlife by some; however, livestock grazing and diverse and productive wildlife populations can coexist provided good management is in place for all species. It is difficult to generalize the impact of livestock grazing on wildlife because of the uniqueness of each grazing situation and varying habitat requirements of different wildlife species. Improperly managed grazing of livestock, or wildlife can have negative impacts to ecological integrity and species diversity. This would include poor distribution, grazing numbers above ecological capacity, and over populated wildlife. However, there are potential benefits to wildlife habitat from managed livestock grazing. Livestock grazing can improve forage quality by removing coarse grasses and allowing for nutrient-rich regrowth (NMSU 2016). According to Vavra (2005), managed livestock grazing programs, have the potential to maintain habitat diversity and quality for wildlife. In addition, the indirect advantages of livestock on the landscape include additional water developments and invasive species detection.

According to Westoby et al. (1989), “Vegetation changes occur as a result of many factors other than grazing, and disturbance is a natural feature of plant communities. Grazing is not necessarily a primary driver of vegetation change and even when grazing has been the cause of vegetation change, current levels of grazing may be inconsequential and even completely removing grazing will not always result in return to historical conditions." Within the Gila NF, areas of forage reduction (i.e., denser forests, infill, meadow encroachment); poor distribution of livestock for various reasons and lack of water in upland areas during drought periods are the primary reasons for localized overgrazing of both terrestrial and riparian habitats.

Although the legacies of historic overgrazing cannot always be reversed, more intense management and adaptive management strategies have led to improved range condition in some areas, and stabilized trend in others. With ongoing range analysis and new monitoring technologies, the prospects are good for adaptive management to lead to further improvement of rangeland ecosystems as a whole. See Chapter 9: System Drivers and Stressors for more information.

Contributions of grazing in the plan area to Social, Economic, and Ecological Sustainability (on Forest and in outlying communities)

Grazing plays an important role in the local area economy. The Gila National Forest grazing program contributes approximately 434 jobs, $5.5 million in labor income, and $34 million in total output to the four-county area (see Chapter 10: Social, Cultural, and Economic Conditions). These jobs and income are not only from direct grazing activities such as ranching, but also include indirect effects. For instance, when a rancher purchases machinery, veterinary services, or groceries, these economic contributions also occur. See Chapter 10: Social, Cultural, and Economic Conditions for more details of economics in the plan area.

Almost all ranching operations in New Mexico are family businesses, and also the socio-economic baseline for many communities in the state (Table 206). There are approximately 6,800 beef and sheep producers in New Mexico. Among the beef producers, approximately 67% own less than 50 head of cows. However, there are nearly 200 ranches that have greater than 500 head. Ranching has been a relatively stable economic and cultural foundation for the majority of New Mexico communities (NMSU 2016).

Table 206. Number of cattle, farm and ranches, and cash receipts from cattle/calve production from the New Mexico Agricultural Statistics (2012-2014) for New Mexico and counties which include the Gila National Forest (USDA 2014).

	Cattle Number	Farm & Ranches	Cash Receipts from cattle/calves ($1000's)
New Mexico	1,340,000	24,721	$1,092,753
Catron County	26,000	351	$21,203
Grant County	26,500	407	$21,610
Hidalgo County	26,500	171	$21,610
Sierra County	18,600	256	$15,168
Total	**97,600 (7.3%)**	**1,185 (4.8%)**	**$79,591 (7.3%)**

Note: Values shown in ( ) are percent of the four counties in relation to entire state values.

Ranching historically has been a part of the base traditional social and economic structure of the counties encompassing the Forest. Maintaining and protecting the traditions of ranching and associated economic contributions to families, communities, and counties is important to all of the counties encompassing the Forest (Grant County 2004, Sierra County 2006, Catron County 2007; Hidalgo County 2011). Ranching provides an opportunity for Catron County (2007) and Sierra County (2006) to consider an existing resource within the Counties to potentially develop a tourism industry related to the life of a cowboy by driving cattle, building fence, or branding.

The Gila National Forest has one of the largest grazing programs in Southwestern Region. Since a substantial amount of the four county assessment area is federal land (see Chapter 17: Land), grazing on federal land is vital to the economic sustainability of the surrounding communities of the Gila NF. Many members of rural communities have historical ties to ranching, and many families continue to carry on this profession both for livelihood and to retain cultural/traditional values. Ranching is a long-term commitment of investment capital and personal devotion that also provides economic stability to the State of New Mexico.

Stakeholder Input

There are often many points of view regarding grazing cattle on the Forest. One is to graze more cattle, including sheep, goats, and horses; and another is to vacate all or some allotments and rest the land. There are also those who want to continue managed cattle grazing but have protection and improvement of resources, including streams, riparian habitat, watershed condition, and grasslands.

It is a concern that past reduction of cattle numbers has impacted the lifestyle and tradition of ranching for families and contributed to the loss of revenue to both ranchers and counties. Overall there is desire to graze more and improve economic revenue.

The capacity to graze livestock is impacted by encroachment of juniper and piñon pine tree species grasslands on the Gila NF. The reduction in the availability of grass is impacting both cattle and wild game including elk. It was suggested to utilize livestock in improving ecosystems by allowing grazing to assist in the reduction of grass, brush height, and density therefore reducing fuel loading. There were concerns expressed that elk are contributing to impacts to resources and contributing to the reduction of livestock numbers. Comments expressed the need for the Forest Service and New Mexico Department of Game and Fish do more coordination and work on a grazing management plan to manage forage, wildlife numbers, and cattle.

Regulations, including NEPA, threatened and endangered species, and cultural clearances are seen as too stringent or restricting and time consuming, impacting the permittee and management of livestock on the ground. There are concerns that changes cannot be made to management decisions until new NEPA is completed, which may be a long time to wait. There is a sentiment that allotment permittees, especially long-term permittees, should be listened to and allowed to manage the livestock because they have more knowledge about the area.

Other concerns are the impacts of feral cattle affecting riparian habitat and the lack of action to address the problem.

Water

This section briefly describes the water resources, uses and trends on the Gila National Forest and surrounding counties, in addition to looking at the contribution of water resources to social and economic interests. Chapter 6: Water provides more detail on the ecological characteristics of water resources within and surrounding the Gila NF. Aquatic ecosystems provide a variety of ecosystem services and economic benefits to society, ranging from products such as safe drinking water to healthy and abundant fish populations that provide food and recreational opportunities (USDA FS 2012d).

Ecosystem Services of Water

Water resources on the Gila NF provide many ecosystem services from which society derives enjoyment or benefit. It provides supporting ecosystem services such as primary production, soil formation and nutrient cycling, and for sustaining all life. Water resource features contribute to provisioning and regulating services by contributing to erosion control, flood regulation, water purification, domestic and agricultural uses, the production of forage, livestock, and game animals taken for meat, and other products. They also provide many cultural ecosystem services to society as they provide opportunities for recreation, personal enrichment, education, and research.

Water Rights

All natural waters flowing in streams and water courses and found underground in New Mexico are declared to be public and subject to appropriation for beneficial use. In New Mexico, beneficial use includes the following: domestic use, livestock and wildlife watering, irrigation, prospecting and mining, and construction of public works, highways and roads. Water for fish culture is not nor are instream flows considered a beneficial use. The four basic rules that govern New Mexico water law are as follows:

1. **“First come, first served”.** Water in New Mexico is governed by the "doctrine of prior appropriation". The fundamental principle of this doctrine is that the first person to divert water from a stream has the right to continue his or her use of water in times of shortage.

2. **Water must be applied to a beneficial use.** "Waste" of water is prohibited under New Mexico water law.

3. **Water rights are freely transferable.** In New Mexico, water rights may be bought, sold, and moved around rather freely within the basin. Users may change both their "point of diversion" and type of use.

4. **“Use it or lose it”.** Unlike other property rights, simple failure to use water for a period of time may result in a permanent forfeiture of the right to use the water in the future.

Water Rights on Forest Service Lands

Surface water and groundwater is administered by the New Mexico Office of the State Engineer through a permitting process. This applies to new appropriations, transfers of location, changes in beneficial use, changes in point of diversion, or enlargements. Stream systems and underground basins as outlined by the State Engineer determine which rules and regulations each water right claim fall under. Spring developments and stock tanks fall under surface waters which are regulated by stream system, while wells fall under groundwater, which is regulated by declared groundwater. Approximately 75% of the Gila NF lies within the Gila-San Francisco stream system and its associated groundwater basin. The remainder of the Forest lies within the Little Colorado, Rio Grande, Lordsburg, Animas, and Mimbres stream systems and their associated groundwater basins. Maps of the New Mexico stream systems and groundwater basins can be found on the State Engineer’s website at:
http://www.ose.state.nm.us/HydroSurvey/index.php and http://www.ose.state.nm.us/GIS/maps.php.

While similar in many cases, the map boundaries are not the same as the NHD watersheds currently used by the Gila NF and coordination is always necessary to ensure that State Engineer maps are used for water right claims.

The Gila-San Francisco (GSF) stream system has been adjudicated (i.e. court has determined water rights), and is considered fully-appropriated, with no new appropriations permitted by the Office of the State Engineer. Transfers of water from surface to ground, changes in points of diversion, and places and purposes of use are common. Any new developments that the Forest constructed within the GSF after July 3, 1978, where the Gila NF did not claim a reserved right, would have to be transferred from some other development within the basin that had been filed upon or declared with the State Engineer.

Other adjudications that have been completed that pertain to Gila NF lands include the Animas and Mimbres stream systems. The only active adjudication that affects the Gila NF is the ongoing Lower Rio Grande stream system, which was initiated in 1997.

In those stream systems that are not adjudicated (Rio Grande, Lordsburg, and Little Colorado), the Forest routinely files on and constructs spring developments, drills wells in declared groundwater basins, and constructs stock tanks for small amounts of water. A permit is required to impound surface water, including surface water for livestock.

There are 29 declared groundwater basins in New Mexico, of which the Gila NF occupies portions of eight, with the largest of these being the Lordsburg, Mimbres and Gila-San Francisco declared underground basins. Most of the eight basins within which the Forest is located were declared between 1960 and 1965, with the remaining being declared in 2005.

Reserved rights are water rights that accompany land that was reserved or withdrawn from the Public Domain under the authority of the Organic Administrative Act of 1897 to establish a National Forest. Sufficient water to satisfy the needs of the purposes of the reservation was also withdrawn through implication. The principle also holds that the priority date for the withdrawn water is the date of the land withdrawal, even though the water may not be put to beneficial use for years. The Gila NF has exercised reserved water rights for (A) continuous supply of timber, including water for such things as administrative sites, road construction for timber, forest fires, etc. and (B) favorable conditions of waterflow which includes water impounded by earthen dams to stabilize gullies and retain sediment. The intent of these is not to impound water, but to minimize the quick blast of water that the gully system may produce.

The Gila NF has entered into a number of agreements with other water right holders to utilize water on National Forest System lands for varying uses. The three types of agreements currently in place currently on the Forest are the following:

- Water Use Agreements – There are multiple water use agreements on the Gila NF. These agreements provide for the use of privately held water rights to be used on National Forest System lands. These agreements, to date, have only occurred between a range permittee and the Gila NF.
- Lease Agreements – The Gila NF currently has one lease agreement in place with Freeport-McMoRan Inc., a neighboring natural resource mining company. This lease agreement provides water to be used for livestock and wildlife purposes on the Silver City Ranger District over a 10-year period.
- Emergency Water Use Agreements – The Gila NF currently has entered into one emergency water use agreement. This agreement covers the use of Bear Canyon Reservoir, which is located on private lands immediately adjacent to National Forest System lands on the Wilderness

Ranger District. The use is limited for firefighting emergencies and coordinates the use between the Forest Service, New Mexico Department of Game and Fish, and irrigators.

In 2009, the Gila NF, in collaboration with the Office of the State Engineer developed the Mimbres River Conservation Plan for the 10 year period of 2009 – 2019. This plan is one of the first programs of its kind in New Mexico that allows water right holders in the Mimbres River basin to place their rights into non-use for the purpose of protecting habitat for the Chihuahua chub. Most notably, participation in the program will not require any change in place of use, purpose of use, point of diversion, or ownership for any water right entered in the program. All water rights will remain exclusively tied to the owner of the right.

Water Resources and Uses

Water resources on the Forest include streams, wetlands, riparian areas, lakes, ponds, reservoirs, and numerous stock ponds and tanks. Most of these resources are used for consumptive purposes such as livestock watering, drinking water, and agriculture or irrigation; while some provide recreational, fishing, wildlife viewing, or other opportunities of use and enjoyment. Water originating on the Forest flows southwest into the Gila River basin; northwest into the Little Colorado River, east into the Rio Grande, and southeast into the Rio Grande basin.

Approximately 957 miles of perennial streams and 546 miles of intermittent streams are within the Forest boundary. There are 30 acequias (irrigation ditches) which rely upon water diverted from some of these stream systems that are permitted by the Gila National Forest. In 2011, the New Mexico Environmental Department, Surface Water Quality Bureau, designated all perennial rivers and streams located in wilderness areas as outstanding national resource waters (eighty streams ~368 miles) that would be beneficial to the State of New Mexico and contribute to special trout waters or other area designation, or have exceptional recreational or ecological significance. These specially designated waters within the State are given the highest level of protection against degradation.

The Forest manages one lagoon wastewater system near the Gila Cliff Dwellings National Monument which receives all sewage pumped from the nearby area (vault toilets, RV dumps, etc.), and multiple leach field / septic type wastewater systems. There are estimated 2,369 earthen tanks on the Forest for livestock and 344 wells, most of which provide water for livestock and wildlife. Fifteen of the wells provide water for Forest recreation and administration facilities. More information can be found on these uses in Chapter 6: Water.

Water Demand

Surface and groundwater withdrawals supply water for various uses across the four counties in which the Forest is located. The main water use in Catron, Grant, Hidalgo and Sierra Counties is irrigation for agriculture purposes (Longworth et al. 2013). Other water uses include livestock, public water supply, mining, commercial, and domestic uses. Water is important in supporting current and future economic development in the counties, but also sustaining and supporting communities including future development and population growth.

Lake Roberts, Quemado Lake, Bear Canyon, Bill Evans Lake, and Snow Lake are waterbodies included in New Mexico Department of Game and Fish, Wildlife Management Areas program. Fishing is the main management purpose of these lakes, but also provide opportunities for such things as wildlife viewing, photography, and hiking. These lakes are located within or adjacent to the Forest. In Sierra County, Caballo Lake and Elephant Butte, which are part of the Rio Grande, are managed by New Mexico State Parks and provide fishing and other water related recreational activities. Bill Evans Lake, Bear Canyon Reservoir, Caballo Lake, and Elephant Butte provide recreational opportunities, but were primarily developed as part of water conveyance systems for consumptive uses such as mining, irrigation, municipal, and industrial.

Fish and wildlife also have demand and need for water within and outside the Forest. Fish and wildlife use of water and water bodies include habitat for some or all life stages (such as fish and amphibians), water sources for drinking, and habitat for species' food sources.

Current Conditions and Trends of Water

Watershed condition describes the status of the physical and biological characteristics and processes within a watershed that affect hydrologic and soil functions supporting aquatic ecosystems. Watersheds that are functioning properly have the following characteristics (Potyondy and Geier 2011):

- They provide for high biotic integrity, which includes habitats that support adaptive animal and plant communities that reflect natural processes.
- They are resilient and recover rapidly from natural and human disturbances.
- They exhibit a high degree of connectivity longitudinally along the stream, laterally across the floodplain and valley bottom, and vertically between surface and subsurface flows.
- They provide important ecosystem services, such as high quality water, the recharge of streams and aquifers, the maintenance of riparian communities, and the moderation of climate variability and change.
- They maintain long-term soil productivity.

Table 120 in Chapter 6: Water displays watershed condition for the Gila NF. The assessment for the Forest's watersheds are 28% Functioning Properly; 69% Functioning at Risk; and 3% Impaired Function.

The watershed condition provides information on the ecological condition of a watershed. Knowing the condition of the watersheds, provides what needs to be done and where to change the watershed condition. The Forest uses this information for planning restoration projects; assisting in prioritizing work; and identifying watersheds where there are risks to domestic water use and consumption, agricultural use, and recreation use.

Across the southwest, the trends in water demand are increasing, and water quantity decreasing. This is a concern given New Mexico is experiencing drought conditions for the last several years. Climate change is increasing hydrologic uncertainty and may reduce available supplies and increase demands (USDA FS 2012d). The assessment of the larger Southwest is likely to face the challenge of bringing water demand more in balance with water supply. The projected levels of vulnerability suggest that drier areas will continue to experience pressures to mine groundwater and deplete streamflow (USDA FS 2012d). Chapter 6: Water provides more detail pertaining to the ecological aspects of impacts and trends of water resources in the plan area and the broader landscape. Chapter 9: System Drivers and Stressors further discusses climate, climate change, and water supply and demand.

State and regional water plans forecast increases in population levels across the counties associated with the Forest. The concern for providing water for the potential increase in demand is what the source might be since a majority of the watersheds are fully appropriated (see Water Rights section), so there is little to no "new" water available to meet future demands.

Contributions of Water to Social, Cultural, and Economic Sustainability

Water is considered an ecological resource and an important life sustaining requirement. The social concern regarding adequacy of water was one of the elements for which the Forest Service was created. The headwaters of major river systems have played influential roles in the history of the counties and communities in and around the Gila National Forest. These systems have provided and continue to provide critical water resources for agriculture and ranching, and assist in sustaining a quality of life for communities. The integrity of these upper watersheds is important in supporting the delivery of quality water to users and uses below. The Gila NF has a role in supporting this need through management, protection, and restoration activities. The management of the Forest to ensure a sustainable supply of clean water will continue to be a major consideration into the future.

Social Concerns Regarding Water within the Assessment Area

Issues surrounding water, socially and legally, have been at the forefront for a long time. Water is an important commodity, especially in the desert southwest where the Gila NF is located. The most prominent of these issues within the assessment area are:

- Projected population growth creates an increase in the demand for water, putting pressure on water supply. Also, there is a concern for having a water supply in or near communities for the purpose of fire suppression.
- Climate change is projected to continue to decrease water supply and to contribute to drought impacts.
- Impacts to water quality from both natural and human threats will continue. State and regional water plans identify some of the human threats as dilapidated or aged water infrastructure and the cost to maintain or upgrade those systems; and individual wastewater disposal / septic systems contaminating individual wells or groundwater sources.

Economic Contributions of Water

Determining the economic value of water is often the topic of economic research studies, since the value of water is more than just a consideration of price. Cost can be determined by the cost per acre-feet multiplied with a measured amount from surface and ground water uses. The value of water is based on the social context it serves. Values such as cultural attachment to historic uses of water, recreation, domestic use, agricultural uses, and the value of water rights provide examples of water value considerations. This has not been studied, to date, on the Gila NF.

The economic and general welfare of people and communities in and around the Forest are dependent on maintenance of adequate supplies of good quality water. The assurance of water for residential, commercial, industrial, and local government uses are in the interest of sustaining current and future economics and interests.

Stakeholder Input

Watersheds and water resources are of great concern to the Gila NF and stakeholders. From stakeholder input received during the assessment, the importance of water to the overall health of the Forest, aquatic and riparian species, and recreational and economic value of the Forest were frequently visited topics.

The availability, reliability and quality of upland water resources are a concern. These concerns are common to all communities which include observations of poor watershed conditions and water quality, altered streamflow, reduced streamflow and water availability in uplands springs and earthen tanks. Altered streamflow and associated reduction in water quantity are attributed to climate change, drought, changes in channel shape and function related to post-fire and livestock grazing, increased densities of upland woody vegetation, as well as native and non-native riparian vegetation. The importance of the ecosystem services provided by groundwater, in terms of livestock management and contributions to stream flow are recognized and declining groundwater tables are a concern. These concerns are largely attributed to climate change and declining snowpack.

There is great concern about interstate water compacts, future impacts to water resources, and therefore riparian and aquatic ecosystems on the Forest. There are also concerns about possible implications any Forest management decisions, or lack thereof, might influence the ability of streamflow to continue to support ecological values or interfere with the State's administration of water rights and local economies dependent on water use. These concerns are mostly specific to the Arizona Water Settlement Act and the proposed diversion of the Gila River and San Francisco rivers.

Summary

Water is one of the important resources of the Gila NF, ecologically and socially. Water is a key ecosystem resource as described in Chapter 6: Water. It is a key component in the cultural development and settlement of the assessment area. Water is important economically for the development and maintenance of industry, ranching, and agriculture including their associated benefits to the communities, counties, and state revenues and employment. Also, there is additional social and economic benefits of water associated with recreational opportunities as described in the Wildlife, Fish and Plants section and Chapter 12: Recreation. But ongoing and future concerns for water quality and quantity will continue to be an issue considering ecological pressures and increasing demands.

Wildlife, Fish, and Plants

The Gila National Forest is rich in wildlife, plants, trees, and other resources that are enjoyed by people in a variety of ways. Based on the 2011 National Visitor Use Monitoring report, *viewing wildlife* (57%) and *hunting* (20%) were near the top of the list of activities that Forest visitors participated in (USDA FS 2011). *Fishing* and *gathering forest products* were also identified activities, but participation levels were lower, 11% and 4% respectively. When visitors were asked to identify their primary activity or purpose of visiting the Forest, *hiking/walking* (21%), *hunting* (20%) and *viewing natural features* (12%) were the top three activities. *Fishing* and *viewing wildlife* were in the top ten primary activities listed (USDA FS 2011). This section will cover the more common hunting and fishing species; forest products; and wildlife viewing in relation to condition and trends; impacts to ecological integrity and species diversity; and social and economic contributions.

Ecosystem Services of Wildlife, Fish, and Plants

Wildlife, fish, and plant resources have long been used for practical uses such as food, clothing, and tools, as well as for economic purposes such as trading or providing goods. Wildlife, fish, and plants play important roles in nutrient cycling, seed dispersal, and pollination. Over the past several decades, there has been a shift in the way people regard the values and uses of natural resources. The change is tied to diversifying to other services including ecotourism, wildlife viewing, outdoor recreation, cultural or spiritual inspiration, and ecosystem function and health.

Condition and Trend of Commonly Hunted Species

The Gila National Forest provides habitat for a wide variety of wildlife species and is a popular hunting destination. Many of the species managed by the New Mexico Department of Game and Fish for hunting and trapping can be found within the Forest boundary or on adjoining lands.

Elk – Elk use a variety of different habitat types. They typically utilize higher elevation meadows and forest with grass understories in the summer and migrate to lower elevation piñon-juniper woodlands and shrub lands in the winter. Elk forage predominately on grass, but rely on denser areas of shrubs and trees for cover. Elk are common species in the Gila National Forest (USDA FS 2008b). Elk herds statewide are stable with some regional differences. Populations statewide are estimated to be between 70,000 and 90,000 (NMDGF 2015b). Population within the Greater Gila Elk Herd, which encompasses the majority of the Gila NF in Game Management Units 15 and 16A-16E, is estimated between 20,700 – 21,900 animals (NMDGF 2014a). Within the Greater Gila Elk Herd, population trend appears to be stable.

Mule Deer – Mule deer are statewide in distribution and occupy most habitats. Populations have declined throughout New Mexico in recent decades. New Mexico Department of Game and Fish has identified the mule deer as a "Species of Greatest Conservation Need" due to habitat loss, habitat fragmentation, ecological succession, and drought impacts to populations (NMDGF 2006). The statewide population is estimated at 90,000 to 110,000 (NMDGF 2015b). New Mexico's climate and weather patterns are extremely important to deer survival. Periods of significant rainfall produce ample forage and vegetative cover, which improves fawn survival. However, harsh winters or prolonged periods of drought can have devastating effects on fawn survival and overall deer numbers. Other limiting factors are changes in habitat composition, lack of water, predation, and competition with other species.

On the Forest, mountain mahogany and oak are important nutritional forage species for mule deer. Low lying shrubs or branches and regeneration of new growth of these browse species is decreasing due to mixed mountain mahogany shrublands and ponderosa pine evergreen oak woodlands moving towards more tree dominated cover versus a mosaic of shrubs and trees (See Chapter 2: Upland Vegetation for more details). Fire historically maintained vegetation types in a mosaic of differing seral stages (USDA FS Gila NF 2012). Past management activities including wildfire suppression have contributed to a decrease in browse for mule deer.

Winter surveys conducted from 1987-2011 indicate that mule deer numbers on the Gila National Forest vary widely and parallel fluctuations seen at the state level. During the 1990s, fawn to doe ratios were very poor which corresponded with the decrease in deer populations. In the 2000s, fawn to doe ratios increased, but populations were so low that the increased recruitment only led to a small change in the overall population. Recent observations show a slight decline due to poor recruitment related to drought conditions (USDA FS Gila NF 2012).

Pronghorn – Pronghorn are inhabitants of plains and meadows of short grass from the deserts to the grasslands of the high plateaus up to the piñon-juniper zone. They prefer areas of grasses and scattered shrubs or dissected hills or mesas (BISON-M 2016). New Mexico's pronghorn population has declined in recent years because of habitat loss due to woody species encroachment, fire suppression, predation, fencing, and drought. Pronghorn are fairly common on the Gila National Forest (USDA FS 2008b). The regional and national population trends have generally been increasing (USDA FS Gila NF 2012). The population statewide is estimated at 40,000 to 45,000 (NMDGF 2015b).

Black Bear – Black bears are typically found in nearly all forested habitat types including mixed conifer, ponderosa pine, piñon/juniper, oak woodland, and spruce fir (BISON -M 2016). They typically feed on mid-seral fruit-producing shrubs and plentiful grasses and forbs (BISON-M 2016). Black bears have been identified by New Mexico Department of Game and Fish as a "Species of Greatest Conservation Need" and threats to the species include habitat conversion/loss, drought, and human conflicts (NMDGF 2006). Black Bears are a common species in the Gila National Forest (USDA FS 2008b). The population statewide is estimated at 8,000 to 9,000 (NMDGF 2015b).

Mountain Lion – Mountain lions are a wide-ranging species and can be found in a variety of habitat types. In New Mexico, they are found in areas of abundant prey, rough terrain, and adequate vegetation to provide hunting cover (NMDGF 2011). Deer are considered their staple diet (NMDGF 2011), therefore trends in deer populations may affect mountain lions. Although not often seen due to their secretive behavior, mountain lions are a fairly common species in the Gila National Forest (USDA FS 2008b). The population statewide is estimated at 3,123 to 4,269 (NMDGF 2015b).

Condition and Trend of Commonly Fished Species

The majority of the stream and lake fishing opportunities in the southwest corner of New Mexico are found within the Gila National Forest and the New Mexico State Parks along the Rio Grande (http://www.wildlife.state.nm.us/download/fishing/maps/New-Mexico-Public-Fishing-Waters-Map.pdf). There are opportunities for either or both cold (e.g. trout) and warm water (e.g. bass) species.

In 2015, the New Mexico Department of Game and Fish stocked across the state more than 3.5 million triploid rainbow trout and more than 500,000 each of channel catfish, Rio Grande cutthroat trout and striped bass. To a smaller degree, largemouth and smallmouth bass, Gila trout, bluegills, and tiger muskie were stocked (NMDGF 2015b). The stocking program allows for the persistence of these species to occur throughout the plan area, and provides the availability of angling in these areas. The stocking and management of the state's streams and lakes/reservoirs is outlined in the 2016 Statewide Fisheries Management Plan (NMDGF 2016a).

Special Trout Water Fishing

The New Mexico Game and Fish Department ceased stocking nonnative rainbow trout in streams and rivers within the Gila Watershed in the early 2000s due to conflicts with native fish populations but continues to stock rainbow trout seasonally in lakes. Gila trout are listed as threatened under the federal Endangered Species Act and the New Mexico Wildlife Conservation Act. Restoration efforts are ongoing to recover the species within its historical habitat. Many of the streams that had populations of wild Gila Trout on the Forest experienced severe resource damages from wildfires which negatively affected Gila Trout populations. Currently, there are two wild populations of Gila trout that are open to angling in New Mexico: a segment of Mogollon Creek within the Gila Wilderness and a segment of Black Canyon extending from FSR 150 into the Aldo Leopold Wilderness.

The population of Gila trout in Mogollon Creek is in good condition. The Black Canyon population was impacted by the 2013 Silver Fire and subsequent flooding. Habitat conditions are beginning to rebound. In 2015, over 3,500 Gila trout, 4" in length, were stocked throughout Black Canyon, with an additional 1,105, 6" in length, being stocked in March 2016.

There are also opportunities to fish for stocked Gila trout. Gila trout are stocked in Sapillo Creek below the Highway 15 bridge, Willow Creek, West Fork of the Gila River, Gila Forks area, and Lake Roberts. Trout populations in Willow Creek were eliminated by the 2012 Whitewater Baldy Fire and subsequent flooding. Approximately 19,000 Gila trout have been stocked in these streams and lake between 2014 and 2016 (NMDGF 2016d). Recovery efforts for the native Gila Trout could lead to reductions in the ability to fish for non-native trout species in some waters, but would increase angling opportunities for the Gila Trout over time as the population increases.

Tiger Muskie

Tiger muskie are a sterile hybrid (i.e. cannot produce fertile offspring) between northern pike and muskellunge. Approximately 147,000 tiger muskie fry and fingerlings were planted in Quemado Lake between 2003 and 2012 as a biological control to assist with reducing goldfish numbers. Goldfish were estimated to be in excess of 70,000 mature fish in 1999 contributing to the decline of trout population in Quemado Lake. The 2014 population estimate of tiger muskie in Quemado Lake was 639 fish. Population continues to be stable and surveys show the fish to have good condition indices and size distribution (NMDGF 2014b). Currently the daily bag and possession limits allow one tiger muskie 40 inches or longer to be taken at Quemado Lake.

The introduction of tiger muskie assisted in reaching fishery management goals in Quemado Lake. Goldfish numbers have been drastically reduced and rainbow trout numbers have stabilized. A survey in 2014 gives indication that rainbow trout have improved in health and range in size from 7 to 18 inches

(NMDGF 2014b). The angling opportunities in Quemado Lake has been enhanced with the improvement in conditions for rainbow trout and the addition of tiger muskie. The challenge for management is maintaining the balance of the number of tiger muskie to continue providing control over unwanted fish, providing the unique angling experience for tiger muskie, and maintaining or expanding other angling opportunities including trout in the lake (NMDGF 2016a).

Habitat Stamp Program

The New Mexico Habitat Stamp Program is a joint venture between sportsmen, the New Mexico Department of Game and Fish, the Bureau of Land Management, and the U.S. Forest Service implemented under authority of the Sikes Act (16 U.S.C. 670a) and the New Mexico State Game Commission. Since statewide implementation in 1991, all licensed hunters, anglers, and trappers are required to purchase the $5.00 Habitat Stamp, if they will be hunting or fishing on federal lands, in addition to the normal license. Revenue is dedicated to wildlife conservation and rehabilitation projects on public lands within the state of New Mexico.

The Gila National Forest has been receiving an average of $115,000 per year to assist with project implementation including contracts for work or other services. Projects on the Forest include development and maintenance of water sources, road access, fencing, and aquatic and terrestrial habitat improvements. In the last four years, wildlife habitat projects have included restoration of grasslands for pronghorn and thinning and/or burning to stimulate grasses, forbs, and browse for deer.

Condition and Trend of Commonly Used Plant Species

The collection of various plant species for pigments, medicine, food, tools, and building structures in and around the Forest has been a traditional and cultural practice for many generations. These resources have been and continue to be of Tribal importance (see Chapter 18: Tribal Areas of Importance).

The Gila National Forest provides opportunities for the gathering of various plant species for personal and commercial uses. Some of the products currently permitted on the Forest are: Christmas trees, fuelwood, piñon nuts, pine cones, house logs, vigas, poles, posts, stays, and wildings. The most common activities are the collection of:

Piñon nuts – Piñon nuts or seeds have been a key dietary staple to people of the southwest and are still a popular food item available both in grocery stores and at road-side stands. The piñon is a source of pride with the piñon tree being New Mexico’s state tree and that the New Mexico legislature in 1978 passed the Piñon Nut Act that required labeling standards on products and instituted genetic research for piñon in the state.

The public may gather piñon for personal use without a permit. Those interested in harvesting for commercial use (harvest more than 25 pounds of nuts) must obtain a permit from the Forest Service. Piñon nuts take approximately two years to mature on the tree, so production amounts can be greatly influenced by drought and rainfall patterns. During the past decade, the southwest has been in drought conditions, which has been impacting the health and resistance of the trees and subsequently the seed production.

Firewood – Firewood gathering is important to many people who live within or adjacent to the Gila National Forest. For some, it is part of their heritage and tradition and for some it is an important fuel for winter heating. Many communities rely on fuelwood for economic well-being. Approximately 46% of the housing units in Catron County rely on wood as the primary heating fuel. In Grant, Hidalgo, and Sierra Counties, approximately 5 to 20% of the housing units use wood for heat (U.S. Census Bureau 2000b). Commercial and personal firewood permits are issued on the Forest. A firewood permit on the Gila National Forest allows the gathering of two cords of wood. From 2011 to 2015, issuance of permits for fuelwood ranged from 2,107 to 2,503, averaging 2,316 permits per year. The Forest has been and will continue to utilize commercial and personal gathering of fuelwood as a tool for assisting in implementing vegetation treatment projects.

Christmas trees – Christmas tree cutting is a popular winter pastime for many. The following species are commonly collected: piñon pine, juniper, ponderosa pine, Douglas fir, white fir, and Engelmann spruce. A Christmas tree tag or permit is required for each tree. The public is asked to cut trees as close to the ground as possible and to not just take the tops of trees. The Forest averages approximately 1,100 permits per year.

Wildlife Viewing Opportunities

Wildlife viewing or watching refers to individuals or groups whose primary interest or purpose is viewing of wildlife around their homes or at another location at least 1 mile from their home of natural settings. Activities include such things observing, trying to identify birds or other wildlife, or photography. Around the home it can include creating and maintaining natural areas; planting shrubs, flowers, etc. that benefit wildlife; and putting out feeders for birds, hummingbirds, or wildlife.

Bird Watching Locations

Southwestern New Mexico Birding Trail

The *Southwestern New Mexico Birding Trail* is product developed through the efforts of: New Mexico Department Game and Fish, New Mexico Audubon Society and Council; New Mexico Department of Transportation, U.S. Department of Interior, National Park Service, The Nature Conservancy, U.S. Forest Service, and New Mexico Rural Economic Development through Tourism. There are currently 41 sites listed in the guide (http://www.wildlife.state.nm.us/recreation/birding/); with 15 being located within the Forest boundary. The birding trail was developed to provide locations for people to get out and enjoy New Mexico's diversity and abundance of bird life, as well as learn more about the locations.

Important Bird Areas (IBA)

The Audubon Society in partnership with BirdLife International, has been identifying and working to conserve a network of Important Bird Areas (IBAs) throughout the United States. The Important Bird Area program is an effort to identify and conserve areas that provide essential habitat for one or more species of bird and that include breeding, wintering, and/or migration habitat.

There are 62 IBAs in the state of New Mexico with 13 located within Catron, Grant, Hidalgo, and Sierra Counties (http://netapp.audubon.org/IBA/State/US-NM). Four of which are located entirely or in part within the Forest boundary:

- **Emory Pass** is located at the top of the Black Range Mountains at an elevation of approximately 8,500 feet, providing opportunities to observe high elevation bird species.
- **Gila Bird Area** is located along the Gila River lined with southwest riparian vegetation where over 200 species of birds have been recorded.
- **Mimbres River** extends from the lower Mimbres Valley extending 30 miles into the Forest and described as being an excellent example of a riparian gallery forest.
- **Gila-Cliff** is located along the Gila River in the Cliff-Gila valley. Much of upstream end is Nature Conservancy property and/or Gila National Forest (includes much of Mogollon Creek) and includes sycamore dominated riparian forest.

Wildlife Viewing Locations

Watchable Wildlife

Watchable Wildlife areas are considered prime wildlife viewing areas (http://www.wildlife.state.nm.us/recreation/). There are five identified in the Gila region of southwestern New Mexico. All five provide both wildlife viewing and bird watching opportunities. All except the Lower Gila Box are within the Gila National Forest boundary. The Lower Gila Box is located on Bureau of Land Management west of the Burro Mountains. The five *Watchable Wildlife* sites are:

- Fort Bayard – Watchable Wildlife Site #48
- Heart Bar – Watchable Wildlife Site #47
- Lower Gila Box – Watchable Wildlife Site #72
- The Road to the Cliff Dwellings – Watchable Wildlife Site #46
- San Francisco Hot Springs Area – Watchable Wildlife Site #42

New Mexico Department of Game and Fish – Wildlife Management Areas and Gaining Access Into Nature Program

Wildlife Management Areas (http://www.wildlife.state.nm.us/conservation/wildlife-management-areas/) are properties owned or managed by the New Mexico State Game Commission. Many Wildlife Management Areas (WMAs) are being opened to additional wildlife-associated recreation activities beyond traditional uses of hunting and fishing through the Gaining Access Into Nature (GAIN) program (http://www.wildlife.state.nm.us/recreation/g-a-i-n/). Depending on the WMA, these new activities include wildlife viewing, photography, hiking, bicycling, skiing, snowshoeing, and horseback riding. The following are near or within the Gila National Forest:

- Bear Canyon Reservoir (GAIN)
- Bill Evans Lake (GAIN)
- Glenwood State Fish Hatchery
- Heart Bar Wildlife Area (GAIN)
- Lake Roberts (GAIN)
- Mimbres River Tract (GAIN)
- Quemado Lake
- Snow Lake

Impacts of Hunting, Fishing, or Plant Collection on Ecological Integrity and Species Diversity

Hunting, trapping, and fishing permits and regulations are used for the management objectives of the species developed by New Mexico Department of Game and Fish. These are methods to control species population numbers which has beneficial impacts to the health of the species, habitat conditions, and species diversity. The New Mexico Department of Game and Fish objectives are to have sustainable wildlife management practices and continue to provide opportunities for continued hunting, trapping, and fishing.

The majority of users of the outdoors are good stewards of the land, but impacts do occur. They include activities like trampling of vegetation (habitat alteration), noise disturbance, improper disposal of trash, establishing unauthorized user-created routes, and introducing or spreading non-native plants or animals.

These activities are not widespread, but there are isolated areas where signs of such impacts are evident across the Forest.

Freshwater systems are particularly affected by the introduction of nonnative species (USDA FS 2012d). Hybridization, depredation, and competition from stocking non-native fish for sport fishing or by accident through bait bucket transport have contributed to diversity and distribution declines of native fish species and may also affect macroinvertebrate and aquatic plant species. The continued stocking of non-native fish is very important for supporting sport fishing, but limits opportunity for the reintroduction of native fish species.

Contribution of the Use and Enjoyment to Social and Economic Sustainability

Wildlife, fish and plants on the Gila National Forest contribute to social sustainability by promoting recreational and educational opportunities. They also provide for cultural aspects of social sustainability such as preservation of traditions, history, art, and traditional uses in the plan area. Many tribes rely on resources within the plan are for cultural, traditional and religious uses. These are *cultural* ecosystem services which contribute to social wellbeing and quality of life.

These resources contribute to the economic sustainability as well by added tourism, employment opportunities, support of small businesses, and federal receipts shared with local governments. In 2013, New Mexico Department of Game and Fish commissioned a study of hunting, fishing, and trapping to estimate county-level and state-wide contributions to the state's economy (Southwick Associates 2014). The study found 248,334 New Mexico residents and nonresidents hunted, fished, or trapped in New Mexico in 2013 (Table 207). Of these participants, 24% (59,751) hunted, trapped and fished in the four counties encompassing the Gila National Forest (Table 207), expending approximately $46,595,774.

Table 207. Sportsmen participation and expenditures statewide and by county by activity in 2013.

Location	Hunters	Economic Value	Trappers	Economic Value	Anglers	Economic Value
New Mexico	**86,384**	**$342,368,654**	**1,639**	**$3,493,874**	**160,311**	**$267,717,023**
Catron County	12,406	$15,018,759	109	$71,283	7,328	$1,841,330
Grant County	6,802	$8,902,764	161	$114,044	10,141	$6,452,871
Hidalgo County	2,281	$1,619,381	29	$16,107	153	$112,231
Sierra County	5,329	$4,357,758	29	$16,090	14,983	$8,073,156
Four County Total	**26,818**	**$29,898,662**	**328**	**$217,524**	**32,605**	**$16,479,588**

From: Southwick Associates 2014

A source of income for landowners is through the Antelope Private Lands Use System (A-PLUS) or the Elk Private Lands Use System (E-PLUS) programs. The A-PLUS and E-PLUS programs were created in recognition of the important benefits that private lands make to the pronghorn antelope and elk populations and hunting opportunities in New Mexico. Through both programs, the New Mexico Department of Game and Fish distributes a portion of the state's pronghorn antelope and/or elk hunting opportunity to private landowners. For the 2016-17 Season approximately 146 landowners within the four counties encompassing the Gila National Forest were listed as participating in one or both programs. Landowners receive private-land pronghorn antelope and/or elk authorization certificates from the Department which can be bartered, sold, or traded to hunters. The certificates are then used by hunters to buy private-land pronghorn antelope or elk licenses.

The New Mexico Department of Game and Fish conducted a review of the eleven state owned dams and the economic contribution of associated lakes to the state. The estimated economic contribution to the state by anglers is approximately $21 million (NMDGF 2014c). Four of the lakes are located within the Gila National Forest boundary (Lake Roberts, Bear Canyon, Snow Lake, and Quemado Lake). The economic value to the state from these four lakes totals approximately $6.6 million.

The expenditures of hunters, trappers, and anglers support jobs and garners additional tax revenues. Statewide, approximately 7,936 full- and part-time jobs, providing approximately $268 million in labor income and adding $106 million in tax revenue (Table 208). In the four counties, there was approximately 620 full- and part-times jobs, providing approximately $12 million in labor income.

Table 208. Total number of jobs, income, and taxes statewide and by county from hunting, trapping, and fishing in 2013.

Location	Jobs	Labor Income	Local, State & Federal Taxes
New Mexico	**7,936**	**$267,920,790**	**$106,493,369**
Catron County	259	$3,703,806	$2,675,882
Grant County	187	$4,760,746	$2,514,814
Hidalgo County	21	$502,401	$278,245
Sierra County	153	$3,370,197	$1,506,065
Four County Total	**620**	**$12,337,150**	**$6,975,006**

From: Southwick Associates 2014

Outfitting and Guiding

New Mexico has several different outfitting and guide industry segments including river rafting, backcountry skiing, river and lake fishing trips, and big game hunting. The hunting and fishing industry in the state of New Mexico is well established and has been creating a livelihood for outfitter and guides for many decades (NMCOG 2014).

On a state-wide level, the New Mexico Council of Outfitters & Guides 2014 report estimated the annual economic contribution to the state from guided fishing industry to be $50,000,000 and from outfitting for big game hunts more than $44,000,000. The vast majority of outfitter and guides conduct hunts for elk (94%), mule deer (79%), pronghorn (67%), and bear (46%) (NMCOG 2014).

In 2013, there were 1,511 outfitter/guides registered in the state (NMCOG 2014). On the Gila National Forest, an average of 139 permits are issued to outfitters and guides per year (Table 209). Based on Forest Service annual revenue collected, it is estimated that an average $2,159,000 in gross revenue is generated annually from outfitter and guide activities on the Forest (Table 209).

Table 209. Number of outfitter and guide permits issued annually from 2010 to 2015 on the Gila National Forest and total reported revenue.

Fiscal Year	No. of Permits	Reported Revenue
2010	131	2,188,274.00
2011	143	2,159,373.67
2012	132	2,357,139.33
2013	128	1,778,180.33
2014	131	2,350,166.00
2015	125	2,118,501.33
Average	**139**	**2,158,605.78**

Source: USDA FS Gila NF 2016c

Wildlife Watching

In 2011, 566,000 people participated in wildlife watching activities of feeding, observing or photographing (USDI-USDC 2014). Most of the participants (82%) stayed at or close to home and 46% traveled more than a mile from home to watch wildlife. Bird watching was the most participated activity by both at-home and away-from home wildlife watchers. Wildlife watchers spent $327 million in the state of New Mexico in 2011 on equipment and travel (USDI-USDC 2014).

Stakeholder Input

Stakeholders describe the Forest as having high quality hunting areas, especially for elk. Hunting by individuals and outfitter and guide trips is identified as a major economic contribution to the local communities and counties in the area. Wildlife viewing, ecotourism, and utilizing the resources of the Forest to draw tourists to the area were identified as potential sources of economic development for local communities.

Comments expressed concern in the decline of recreational fishing opportunities and associated economics due to ash, debris, and sediment impacts to streams from fires and Gila trout restoration activities. The restoration of Gila trout has resulted in not stocking or the removal of rainbow, brown, or brook trout from specific areas. For some this reduces fishing satisfaction and economic benefit, while others feel restoring Gila trout would provide a unique fishing opportunity attracting sportsmen into the area.

Summary

The public derives substantial social and recreational, especially hunting, value from wildlife, fish, and vegetation resources on the Gila NF. Aquatic ecosystems also provide a variety of ecosystem services and economic benefits to society, such as safe drinking water and healthy and abundant fish populations that provide food and recreational opportunities (USDA FS 2012d). Economically, participation in activities focused on wildlife and fish provide considerable contribution to within and beyond the area of influence.

Game animals for hunting are prevalent on the Forest and most demonstrate increasing or stable populations. Habitat conditions for game species face threats from woody species encroachment, uncharacteristic wildfire, drought, and invasive plant and fauna species. Overall, the Gila NF will continue to be important for hunting and sport fishing and provide opportunities to harvest plants and other flora for traditional and cultural uses.

Multiple Use Stakeholder Input

Comments received from stakeholders generally fell into two clusters regarding the concept of multiple-uses. First, many comments expressed that the concept of multiple uses on the Gila National Forest has greatly diminished or is not the primary direction currently being followed. Commenters felt the Forest needs to return to more multiple use management and find opportunities to maintain or increase employment, industry (i.e. timber, cattle grazing, recreation), and economic development in local communities and counties. Concern was expressed that resources are being preserved rather than conserved. Also, there was a feeling that regulations, threatened and endangered species, and litigation has limited or even eliminated opportunities for multiple use management, and therefore decline in economics and opportunities and causing an impact to cultural and traditions of the local areas.

The other perspective is that the forest resources are being over-utilized. Some felt that political influence is involved in the level of resource utilization, resulting in impacts to such areas as watersheds, listed species, and other wildlife habitat. It was suggested that the use of the land by logging, recreation, mining, and grazing should be removed or greatly reduced to improve and maintain ecological conditions for future generations.

Chapter 12. Recreation

Introduction

The purpose of this chapter is to assess aspects of recreation on the Gila National Forest (Gila NF) as it relates to recreation settings, opportunities, access, and scenic character. Current conditions, trends, and risks will be the main the focus along with influences (both environmental and social from within and beyond the planning area) with the consideration of future sustainability.

This chapter is divided into the following sections:

- Introduction
- Ecosystem services of recreation
- Recreational setting
- Recreational Opportunity Spectrum
- Trends in recreation
- Types of recreation opportunities
- Compatibility of different recreation activities
- Emerging recreational trends that may affect future recreation demand
- Recreation fees
- Nature, extent, and condition of trails, roads and other transportation and other infrastructure to provide recreational access
- Opportunities to foster greater connection between people and nature
- Scenic character
- Conditions and trends affecting the quality of recreational settings
- Sustainability of recreation opportunities and scenic character
- Influences outside of the planning area that affect the demand for recreation
- Recreation opportunities on other lands within the broader landscape
- Stakeholder Input
- Summary

Multiple studies, reports, and databases were utilized to compile information in this chapter. The National Visitor Use Monitoring survey (NVUM) is conducted every five years on every national forest. The Gila NF has conducted three separate surveys in 2001, 2006, and 2011 (USDA FS 2006b, 2011). The most recent survey is currently being implemented in 2015-2016 although results will not be available until 2017. Due to a difference in survey methodology, results from the 2001 NVUM study are not used in this assessment because trends and comparisons would not be consistent with the 2006 and 2011 survey methodologies and results.

Other documents utilized include, but are not limited to, the Gila NF Sustainable Recreation Strategy Action Plan (USDA FS Gila NF 2015c), Gila NF Travel Management Recreation Specialist Report (USDA FS Gila NF 2013c), Gila NF Recreation Opportunity Spectrum draft report (USDA FS Gila NF 2016d), and New Mexico Statewide Comprehensive Outdoor Recreation Plan (2010 – 2014) (NM EMNRD 2009, 2015a). Data was extracted from various Forest Service Natural Resource Manager Databases (INFRA and SUDS), Gila NF Geographic Information Systems (GIS) corporate data, and New Mexico Game and Fish Department databases.

Ecosystem Services of Recreation

Outdoor recreation contributes to ecosystem services in a variety of ways. From a cultural and social perspective the Forest offers a variety of opportunities for recreation, scenic viewing, and places to connect with nature. It also offers rejuvenation and escape from urban environments and lifestyles, while providing an opportunity to experience solitude to connect to nature. Recreation contributes greatly to the physical, mental, and spiritual health of individuals, and bonds family and friends. Outdoor recreation on the Gila National Forest also contributes to tourism and the economies of the local communities. Recreational gathering of firewood and plant materials provide products from the Forest for people's enjoyment and use. Hunting and fishing are two recreational activities that have regulating functions for ecosystems by helping to manage wildlife populations.

Recreation Setting

The Gila NF consists of approximately 3.3 million acres, and offers spectacular scenery, ranging from high, cool mountains of aspen and Douglas fir to warm semi-arid lowlands with juniper, oak, and cactus. It remains one of the most remote, uniquely continuous, and least developed national forests in the southwest United States. Twenty-four percent of the Forest's land mass consists of congressionally designated wilderness to be managed for primitive and semi-primitive non-motorized use. The Gila NF is home to the first designated wilderness and has a proud history of wilderness management in the Gila, Aldo Leopold, and Blue Range Wilderness Areas. Along with the previously mentioned Wilderness Areas, there are a variety of specially designated areas, trails, and byways on the Gila NF (see Chapter 13: Designated Areas for more details). Local communities' quality of life and economic opportunities are interwoven with the Forest's future. This is best summarized in the Gila National Forest Recreation Facility Analysis (USDA FS Gila NF 2007), which identified the Gila NF's niche and desired condition as follows:

> "From wilderness to western heritage, visitors to the Gila National Forest have the opportunity to 'find themselves' in the wildness of the forest. The essence of the Gila is the freedom to explore vast expanses of backcountry. Heritage and cultural connections allow local communities, Native Americans, and recreationists to establish long-term bonds with the forest. Traditional gathering of forest products and hunting bring visitors from near and far. Rivers and lakes, uncommon in the Southwest, provide relief from heat across the forest."

Recreational Opportunity Spectrum

Since the early 1980s, the Recreation Opportunity Spectrum (ROS) has been used as a framework to identify, classify, plan, and manage a range of recreation settings for both existing and desired conditions. The ROS defines recreation setting based on physical, social, and managerial attributes. The physical setting is defined by the absence or presence of the sights and sounds of people, size, and the amount of environmental modification caused by human activity and authorized uses. The social setting reflects the amount and type of contact between individuals or groups. It indicates opportunities for solitude and interactions with a few individuals or large groups of visitors as one moves across the spectrum. The managerial setting reflects the amount and kind of restrictions placed on people's actions by the administering agency or private landowner which affects recreation opportunities. ROS provides a range of recreation opportunities that can be enjoyed in diverse settings. ROS remains the best available framework for recreation planning (McCool et al. 2007).

ROS is divided into six different classes as defined below:

Primitive areas are characterized by essentially unmodified natural environment 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 the area are not permitted.

Semi-Primitive Non-Motorized 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 areas are managed in such a way that minimum on-site controls and restrictions may be present but are subtle.

Semi-Primitive Motorized 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 areas are managed in such a way that minimum on-site controls and restrictions may be present but are subtle. Motorized use is permitted.

Roaded Natural areas are characterized by predominantly natural-appearing environments with moderate evidences of the sights and sounds of people. Such evidences usually harmonize with the natural environment. Interaction between users may be low to moderate, but with evidence of other users prevalent. Resource modification and utilization practices are evident, but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities.

Rural areas are characterized by 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. A considerable number of 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. Moderate densities are provided far away from developed sites. Facilities for intensified motorized use and parking are available.

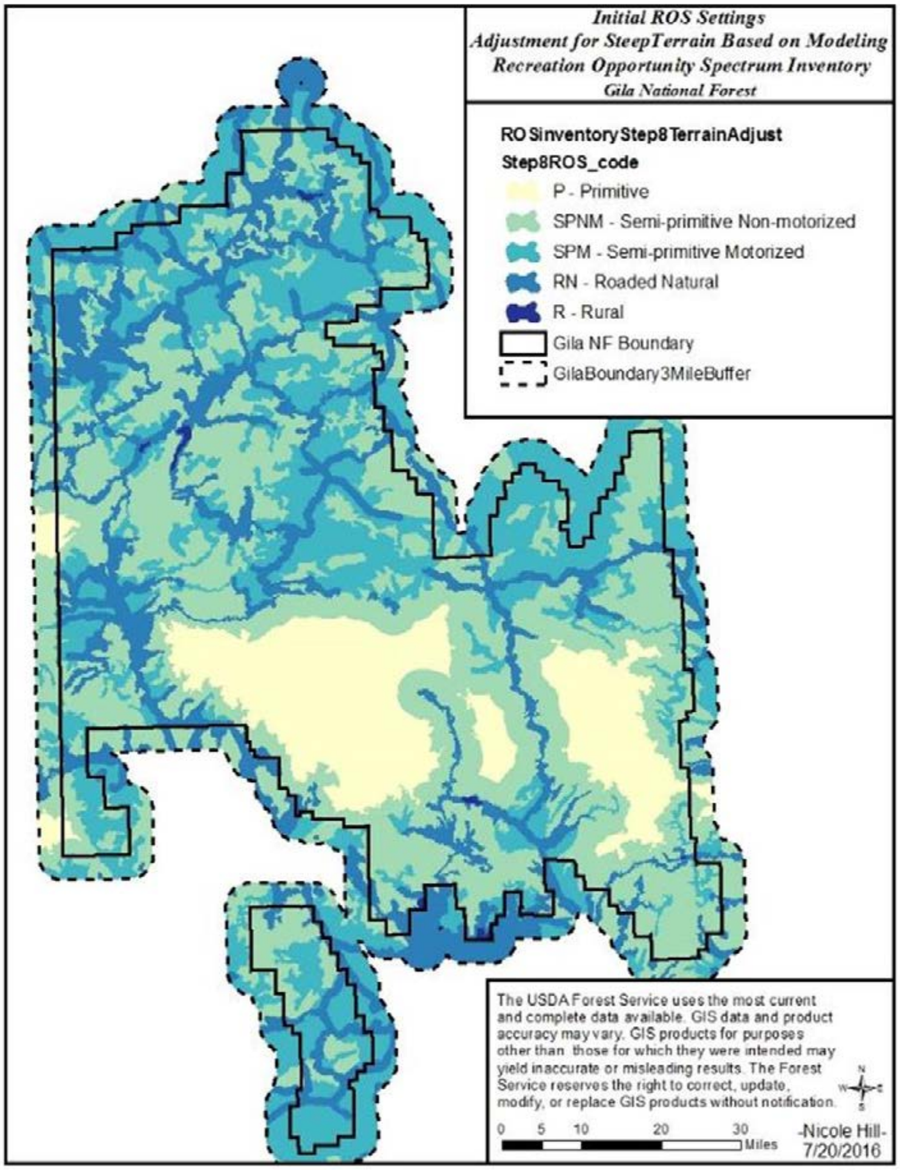
Urban areas are characterized by a substantially urbanized environment, although the background may have natural-appearing elements. Renewable resource modification and utilization practices are to enhance specific recreation activities. Vegetative cover is often exotic and manicured. Sights and sounds 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.

The Gila National Forest visitors have opportunities to experience solitude at one end of the spectrum within wilderness areas and more remote sections of the Forest; or to experience more of social opportunity in Forest locations near communities and major travel routes within the Forest. Campers also have a range of recreation opportunities, from developed campgrounds with electrical hook ups to user-developed dispersed camping sites located in remote areas. Water based recreation opportunities include more highly developed facilities located near one of the lakes located on the Forest, or nearby a stream in close proximity to a major travel route, to a challenging experience at one of many remote streams accessible only by trail. Another popular recreation opportunity on the Gila NF is hunting, which varies from utilizing an outfitter and guide to a more self-reliant “on your own” hunt at a remote location within or outside of a designated wilderness area.

When ROS classes were first delineated for the Forest, they were incorporated as part of the 1986 Gila NF Forest Plan. As part of the current Forest Plan Revision process, a new ROS inventory is in the process of being completed (USDA FS Gila NF 2016d). Due to differences in the inventory methodology from the 1986 Gila ROS to the draft 2016 Gila ROS including terrain adjustment, trends and comparisons are not possible, and only data from the draft 2016 Gila ROS Inventory will be summarized for this assessment. As presented in Table 210, approximately 16% of Forest lands offer recreation opportunities in the primitive setting, 44% in the semi-primitive non-motorized setting, 24% in the semi-primitive motorized setting, 16% in the roaded natural setting, and 0.1% in the rural setting. Currently there are no lands administered by the Gila NF managed under the urban class. Refer to Figure 166 for the graphic portrayal of current ROS settings.

Table 210. Recreation Opportunity Spectrum (in acres and percentage) on the Gila NF

ROS Class	Acres	Percentage of Gila NF
Primitive	512,644	16%
Semi-Primitive, Non-Motorized	1,435,262	44%
Semi-Primitive, Motorized	787,979	24%
Roaded Natural	531,294	16%
Rural	4,780	0.1%
Urban	0	0%
Total Evaluated for ROS	3,271,959	100%



The USDA Forest Service uses the most current and complete data available. GIS data and product accuracy may vary. GIS products for purposes other than those for which they were intended may yield inaccurate or misleading results. The Forest Service reserves the right to correct, update, modify, or replace GIS products without notification.

Figure 166. Draft Gila NF ROS Inventory 2016

*Note - lighter colors represent more primitive classes while darker colors represent more urban classes

Trends in Recreation

The results of numerous studies indicate that outdoor recreation has become a major component of many Americans' lifestyles (Roper 2004, Cordell 2008), and participation in outdoor recreation activities has been on the increase since the Great Depression and World War II. However, studies differ on whether participation in outdoor recreation activities has been increasing or decreasing since 2001. Some reports show a decline in recreation participation nationally beginning in 2001. Suggested reasons for this trend include the general state of the economy, personal security concerns associated with transportation following the September 11th, 2001 terrorist attacks, and increased interest and availability of computer games, the Internet, and television (Roper 2004). Alternatively, other studies show an overall increase in outdoor recreation participation, but a change in the mix of outdoor activities and their relative popularity. For instance, participation in some traditionally popular outdoor activities (such a hunting and fishing) has been on the decline, replaced by other activities such as driving for pleasure, wildlife or bird watching and photography (Cordell 2008).

The goal of this section of the Recreation Assessment is to assess visitation to the Gila NF, identify trends and changes with visitation, and identify possible causes and implications of changes in visitation. The visitation statistics were developed by compiling and analyzing information from several sources, including Forest visitation numbers, recreation site visitation data, trip specific data, and economic information. This information was obtained from Gila National Forest National Visitor Use Monitoring (NVUM) data collected from surveys conducted during Fiscal Years 2006 and 2011. It should be noted that more recent information from the most recent NVUM survey collected in FY 2016 was not yet available for purposes of this assessment. It is possible the 2016 NVUM will contain data that reflects changes to past trend due to events that have occurred since the 2011 data was collected, such as the effects of recent large-scale wildfire, flooding, or changes in economic conditions.

The NVUM data differentiates recreation sites by the following categories:

- **Day Use Developed Site**: a site that is designed for recreation use, which has some sort of development that restricts overnight camping. Examples of these sites include picnic areas, the Catwalk National Recreation Trail, and interpretive sites.
- **Overnight Use Developed Site**: a site which allows overnight / multi-day stays that has infrastructure to support this use. Examples of these sites include campgrounds, some trailheads, and livestock corrals.
- **General Forest Area**: National Forest lands that are considered undeveloped with the exception of roads and trails. These areas are typically associated with dispersed recreation. Examples of uses on general forest areas are dispersed camping, Off Highway Vehicle (OHV) riding, hunting, backpacking, and horseback riding.
- **Designated Wilderness**: an area designated by Congress for preservation and protection in their natural condition and may also contain ecological, geological, or other feature(s) of scientific, educational, scenic, or historical value. The Gila NF has three designated wilderness areas – Gila Wilderness, Aldo Leopold Wilderness, and Blue Range Wilderness.

Gila NF Visitation Numbers

Total visitation to the Gila National Forest increased by 69%, or from 305,000 to 514,000 visitors between 2006 and 2011 based on the NVUM survey results. Figure 167 represents the estimated annual visits to the Gila NF between 2006 and 2011 by site category. Each site type had an increase of visitation, with General Forest Areas (78% increase) having the largest growth and with Designated Wilderness (17% increase) having the least amount of increase.

The current level of visitation within the Forest is considered to be at manageable levels. The risk posed by a significant increase of visitation above current levels include possible overcrowding, resource damage, and conflicts between differing types of recreation user groups. Since the largest increases in visitation occur in General Forest Areas, which tend to have different uses spread out across the Forest, to date there have been minimal issues with overcrowding or conflicts between user groups. Areas of concentrated use is a concern especially in popular areas and trails near Silver City and at frequently used sites like Sapillo and Forks Campground. In the Silver City area, there is risk of overcrowding especially during holiday weekends and a risk of user conflicts between equestrians and dog walkers, and the Forest is monitoring these risks and trends.

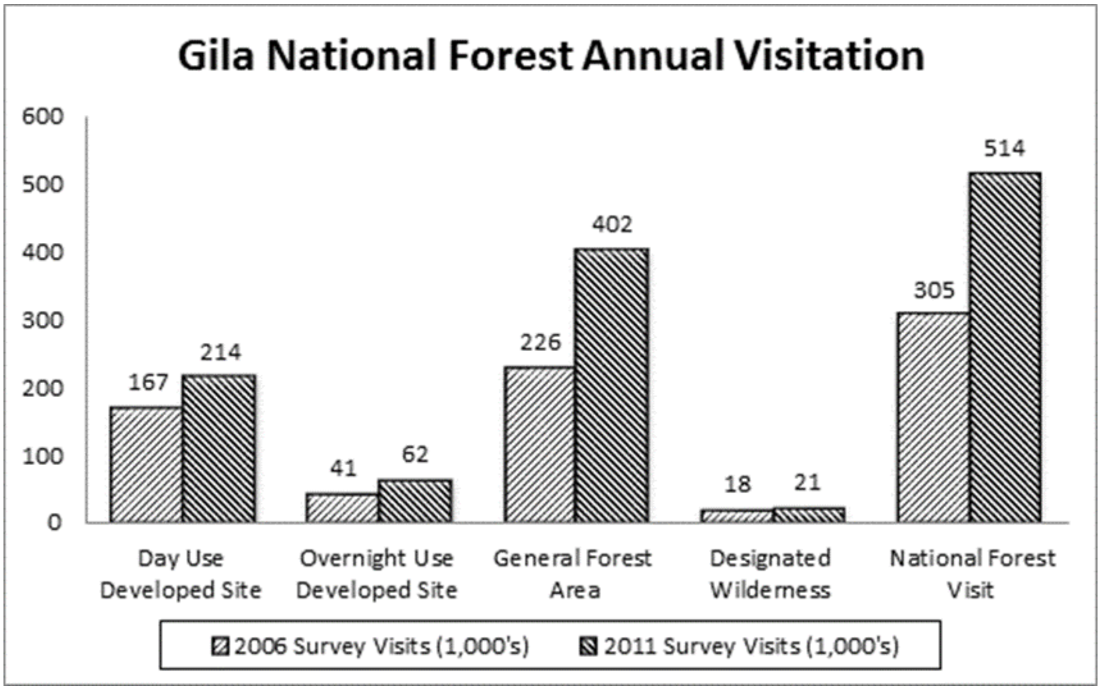


Figure 167. Gila NF Annual Visitation Numbers between 2006 and 2011

When assessing the proportion of site type used from 2006 to 2011, the biggest changes were in Day Use Developed sites (decreased by 6%) and General Forest Area (increased by 7%). Table 211 shows that while total visitation has increased, the type of site utilized is quite similar between 2006 and 2011. There is a noticeable trend of visitors shifting from utilizing developed sites to dispersed sites. A large percentage dispersed site use is associated with hunting and utilization of backcountry areas including trail use. The risks associated with an increase of dispersed recreation use include resource damage within riparian areas due to concentrated recreation, increased litter, and the possibility of greater conflicts among visitors.

Table 211. Distribution of Site Type Used between 2006 and 2011

Site Type	2006	2011
Day Use Developed Site	36.9%	30.6%
Overnight Use Developed Site	9.1%	8.9%
General Forest Area	50.0%	57.5%
Designated Wilderness	4.0%	3.0%
Total	100.0%	100.0%

Figure 168 represents the average duration of visit by site type (i.e. hours spent at any given site per visit) between 2006 and 2011. Site types that experienced longer duration per visit include General Forest Area (increase by 19.3 hours per visit), Overnight Use Developed Site (increase by 17 hours per visit), and Designated Wilderness (increase by 1.8 hours per visit).

This trend of longer duration per visit may be an indication that a significant number of Forest visitors are now staying for three-day visits as compared to two-day visits. Day Use Developed Sites were the only site type that experienced a shorter visitor stay duration, by 1.4 hours. The overall duration of a National Forest Visit has increased by 2.4 hours per visit. Risks associated with this trend could be competition for access to, and overuse at popular recreation sites.

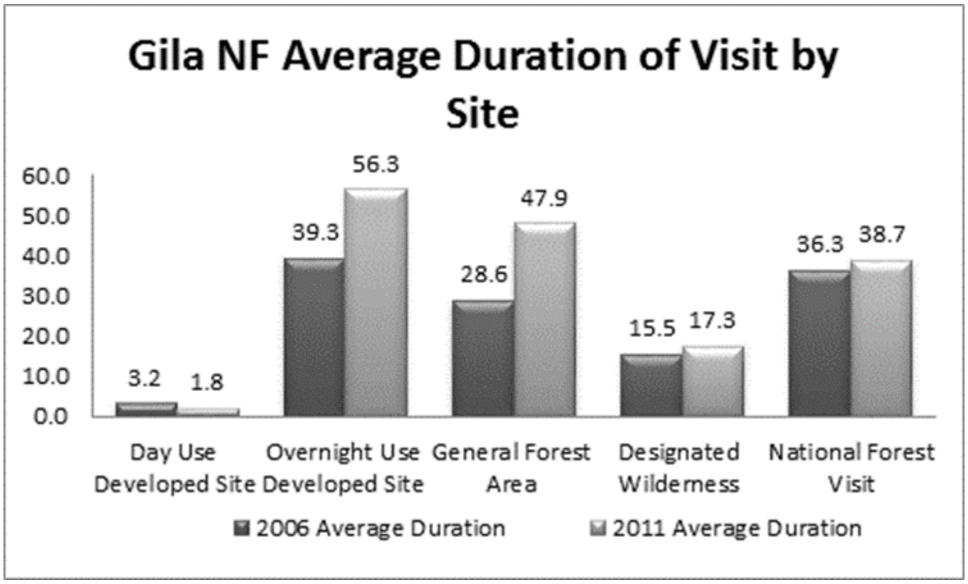


Figure 168. Gila NF Average Duration (hours) of Visit by Site Type between 2006 and 2011

Table 212 examines the visitor’s main activity (i.e. why they are visiting the Forest) comparing Gila NF visitation data from 2006 and 2011 along with the 2012 national average on National Forest System administered lands. Hiking/walking is the largest draw for Forest visitors on the Gila NF (both in 2006 and 2011) and nationally.

From 2006 to 2011 the three recreation activities that showed the greatest increase on the Gila National Forest were OHV use (increased 125%), hunting (increased 121%), and horseback riding (increased 100%). The risks posed by these increased recreation uses may include conflicts with other users, and exceeding the capacity of permitted outfitter/guides in certain areas. The Forest will need to monitor for these risks and develop mitigation actions as needed. Ecological risks associated with increased user conflicts could involve increased resource damage in new areas as users spread out attempting to find areas with less use while these new areas may not be able to support that specific use. This could lead to such things as more user created roads and trails, new dispersed camping sites, and utilization of areas near water that historically have not been used recreationally.

During that same time period, the three recreation activities showing the greatest decrease in use included nature study (decreased by 100%), nature center activities (decreased by100%), and visiting historic sites (decreased by 92%). This data references only the main activity that visitors cite as the reason for their Forest visit. It is a common occurrence that visitors may actually participate in many other recreation activities within a given visit. For example, hiking may be the main reason cited by a user for visiting the Gila NF, however they may also utilize a developed recreation facility for a picnic after their hike. This is an important factor to take into consideration when assessing existing and potential future recreational use trends.

When comparing the 2011 Gila NF main activities by percent to 2012 national average, the three activities above the national average by the greatest percent are: hunting (240%), horseback riding (186%), and picnicking (173%).

Differences from the national average could be due to the Gila NF's status as a premiere big game hunting destination for elk and mule deer, the abundance of available wilderness and backcountry trails for horseback riding, and prevalence of secluded, open spaces that provide respite from the heat of the arid desert for picnicking. These differences from the national average for these recreational activities serve to help to define the Gila NF's niche while emphasizing what makes it a special place for visitors.

Table 212. Main activities by percent for the Gila NF compared to the National Average

	Percent of Total		
	Gila NF		National Average
Main Activity	2006	2011	2012
Hiking / Walking	17.4	21.4	19.3
Hunting	8.9	19.7	5.8
Viewing Natural Features	12.8	12.1	13.4
Driving for Pleasure	10.6	12	4.7
Relaxing	8.1	7.6	5.7
Fishing	13.8	7.3	7
Some Other Activity	0.3	6.7	3.8
Picnicking	6.1	4.1	1.5
Viewing Wildlife	3.4	3.9	1.9
Horseback Riding	1	2	0.7
OHV Use	0.8	1.8	1.4
Developed Camping	2.2	0.8	3.1
Visiting Historic Sites	9.8	0.8	0.3
Backpacking	1.1	0.3	0.7
Other Non-Motorized	3.1	0.3	2.2
Bicycling	1.1	0.2	2.6
Non-Motorized Water	0	0.1	1.2
Primitive Camping	0.8	0.1	0.6
Gathering Forest Products	0.9	0.1	1
Nature Center Activities	0.3	0	0.3
Nature Study	0.2	0	0.3

Gila NF Trip Specific Data

Figure 169 shows the percent of visitations by the distance travelled from the visitor's home to the Gila NF. The NVUM summary report defines Forest visitors traveling 50 miles or less to the site as local, and those travelling from more than 50 miles from the Forest as a non-local visitor. From 2006 to 2011, local visitation grew from 30.8% to 54.8%, which is a 43.8% increase. The largest percent decrease in visitation was within the group that traveled 500+ miles from home to the Forest. In 2006 the percentage of visitors traveling from more than 500 miles was 20.3% as compared to 7.1% in 2011, which is a decrease of 185%.

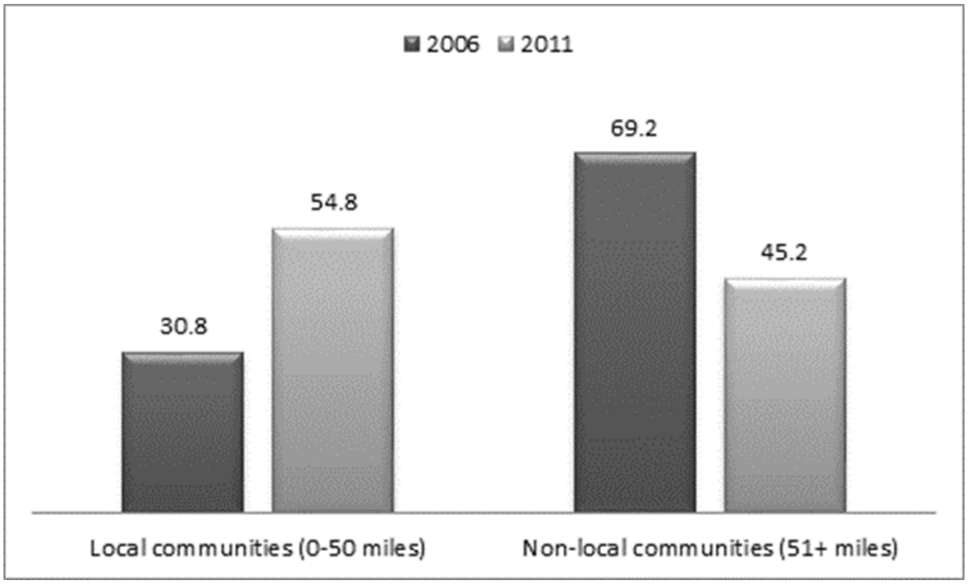


Figure 169. Percent of Visitation by Distance Traveled between 2006 and 2011

Table 213 represents the total number of visits by individuals to the Gila NF within a given year from 2006 to 2011 surveys by percent. Since 2006, the number of individuals visiting the Gila NF 21-30 times, 51-100 times, and 101-200 times annually within a one-year timeframe has seen a dramatic increase. There have been decreases in the number of visits for 1-10 times and 31-40 times within a calendar year. Analysis of these trends may assist in assessing and prioritizing information needs regarding available recreation opportunities to existing constituents while identifying outreach to future visitors that may be unaware of the opportunities on the Gila NF.

Table 213. Number of annual visits by individuals to the Gila NF between 2006 and 2011 by percent.

	Number of Annual Visits								
	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 100	101 - 200	201 - 300	300+
2006	77.1%	8.8%	2.7%	4.3%	3.8%	1.9%	0.1%	0.2%	1.1%
2011	59.2%	9.1%	5.3%	2.4%5	4.5%	9.8%	9.4%	0.3%	0%

Combining the Table 213 results with the distance traveled results from Figure 169, emphasizes the trend of local visitation with multiple annual visits increasing significantly in that five-year period. The risks of increased local visitation are over utilized popular sites and activities near communities and an increased possibility of user conflicts especially at sites that serve multiple recreational users. Currently, many sites around Silver City experience user concentration impacts and litter. Many other communities that are adjacent to the Forest experience increased visitation by local citizens. The common activity near these communities are hiking local trails nearby their community, and often these people will informally monitor trail conditions and pick up litter. The Forest is evaluating the possibility of implementing an adopt-a-trail program that would formally recruit local citizens as volunteers to maintain and patrol local trails.

Figure 170 is a comparison of visits from various age groups as a percentage of the total visitation. Groups that demonstrated the most increases in visitation are aged 30-39 years (20% increase), aged 60-69 years

(42% increase), and aged 70+ years (72% increase). The largest decreases in visitation are within the age groups under 16 years (50% decrease), aged 16-19 years (142% decrease), and aged 20-29 years (55% decrease). This trend aligns closely with current demographics of neighboring communities. Southern New Mexico is a popular retirement destination, while a significant percentage of the population between the ages of 18 to 29 years is known to relocate in search of better economic opportunities. The Forest will need to assess available recreation opportunities in light of these demographic trends to suit the needs of the local populations. Currently, the Forest has limited accessible recreation sites and trails for those with disabilities. Accessible facilities will be important for accommodating a diverse and aging recreating public. However, many system trails have limited potential to be upgraded to become accessible due to rugged topography.

The risk of the decreasing trend of users under the age of 30 represents a potential loss of connection between younger people to their public lands. If this trend continues, it may lead to a decrease in visitation by younger visitors (and/or future generations), or a loss of the appreciation for the resource of public lands as a whole. This trend emphasizes the need for pursuing opportunities to foster greater connection between people and public lands, especially with the younger generations.

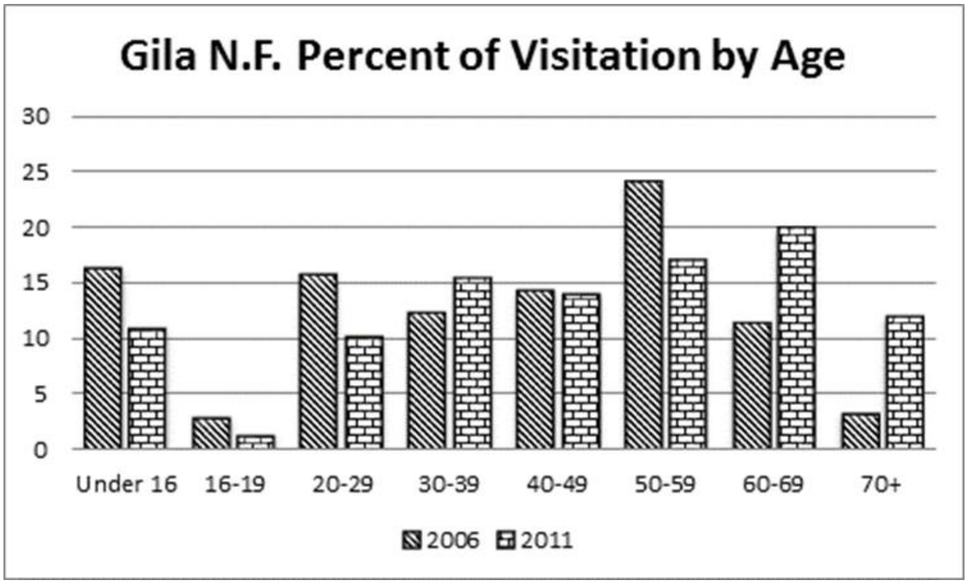


Figure 170. Gila N.F. Percent of Visitation by Age

Social, Cultural, or Economic Conditions Impacting Recreational Participation

New Mexico is known for its multicultural population including Hispanic, Native American, and Anglo influences. This rich diversity is ever-changing, and from 2000 to 2011, the Hispanic population in New Mexico increased by 28 percent (Brown and Lopez 2013). According to the 2006 and 2011 NVUM survey data (Table 214), the percentage of Hispanic visitors has increased by 24.8% during this time period. The increase of Hispanic visitors is close to the rate of the Hispanic population. Efforts by the Gila NF to increase awareness and visitation by diverse and underserved populations (e.g. bilingual brochures) is showing progress, although continued work on this front will be needed.

Table 214. NVUM survey data for visitation to the Gila NF by Race/Ethnicity

Visitation by Race/Ethnicity	2006 Forest Visits (%)	2011 Forest Visits (%)
American Indian / Alaska Native	1.9	3.7
Asian	0.3	0.2
Black / African American	0.3	0.2

Hawaiian / Pacific Islander	0	0.1
White	68.5	59.6
Hispanic / Latino	29	36.2

According to the New Mexico Statewide Comprehensive Outdoor Recreation Plan (NM EMNRD 2009), over 30 percent of New Mexico residents earn below $25,000 a year, and approximately 43 percent earn less than $35,000 per year. This large percentage of New Mexico residents with limited incomes may impose limitations on the types of recreation residents can participate in due to travel and equipment costs. This could also result in local residents that live closer to the Gila NF choosing to recreate on the Forest rather than other locations outside of the assessment area. Additionally, recreating locally may be considered more cost effective because there are a limited number of fee sites on the Forest.

Gila Visitation Summary

Visitor data can be used to assess current and future trends across the Forest to determine potential future impacts of increased or decreased use to developed and dispersed recreation sites. The likely future trend on the Gila NF is an increase in visitation (both in terms of site visits and duration of stay) although the most recent NVUM data collected is not yet available to verify more recent visitation numbers. The risks associated with increased visitation include overcrowding of popular sites or resource damages to sites that regularly exceed site capacity (this includes the urban trail system around Silver City, Emory Pass, popular campgrounds during holiday weekends, and popular trailheads). If visitation trends continues to increase, these issues could be more widespread across the Forest and occur more frequently at popular sites.

Another significant trend is an increase of local visitors. This may be at least in part as the result of a downturn in the economy and higher gas prices during the time the 2011 NVUM survey was conducted. It is unknown at this time if the most recent NVUM survey will demonstrate if this trend continues, or if it is a likely effect of changing economic conditions. This trend may also be due to other factors, such as residents choosing to live in communities nearby to the Forest for the quality of life benefits of nearby forest recreation opportunities.

Survey data shows that recently more visitors to the Forest have been utilizing dispersed recreation opportunities as compared to developed recreation sites. The risk associated with increased dispersed recreation use is that undeveloped Forest areas could experience resource damage due to high levels of use. OHV use has increased largely due to the growing popularity of UTVs that make motorized access to some remote areas of the Forest possible. The Gila NF has a small percentage of the existing trail system that continues to be open to motorized use, and has contributed to resource damage due to increased use with limited opportunities. The Forest is currently in the process of implementing the Travel Management decision, which may reduce resource damage by diverting existing motorized use onto trails and roads that continue to be open to motorized use. As the Travel Management decision is implemented, and as motorized recreation use continues to be monitored and assessed, future planning may be focused to align opportunities while mitigating any resources concerns.

The Gila NF has also experienced a significant increase of visitors older than 60 years old. Southern New Mexico has gained popularity as a retirement location due to a relatively low cost of living and mild climate, resulting in a higher percentage of visits from this particular age group. In direct contrast to this trend, there is a corresponding decrease of younger visitors to the Forest. The risks associated with a decline in visitation by younger demographics include is a loss of connection between younger people and management of public lands. While outreach efforts are ongoing, and the percentage of Hispanic visitors has increased close to the percentage of the population, the Forest will need to continue work outreaching and including underserved communities.

Types of Recreation Opportunities

Dispersed Recreation

Dispersed recreation activities occur outside and completely independent of designated recreation sites or developed recreation facilities. The large size of the Gila NF and contiguous Forest land ownership provide a unique opportunity for dispersed recreationists to experience solitude outside of designated wilderness areas. Dispersed recreation includes a variety of both motorized and non-motorized activities, and may occur throughout the year.

Motorized dispersed recreation activities may include, but are not limited to, OHV driving, scenic driving, and car camping. Most dispersed motorized recreation use occurs on existing Forest roads or motorized trails, which vary in condition and level of development (see Chapter 14: Infrastructure).

Many Forest system roads are backlogged for maintenance, and have been degraded by flooding and erosion. Some motorized recreation visitors seek out these types of driving conditions, and consider them to be a challenging 4x4 experience. However, the risk of continued erosion will limit the use of these roads at the development level for which they are classified as well as lead to further resource damage.

The trend of use for OHV recreational use has shown an increase over the five-year period from 2011 to 2016. Many of the roads and trails across the Forest are user created that later became system roads/trails during a roads inventory process in the 1990s. The trend of user created travel routes creates a situation where many of these routes are in need of design features to minimize resource damages. Implementation of the Travel Management decision will reduce the number of user created roads and trails by identifying routes that are open for motorized travel and limit cross country motorized travel to specific areas for specific purposes. These specific routes and areas identified for motorized travel have been selected to provide motorized access to areas while limiting resource damages.

Non-motorized dispersed recreation activities include, but are not limited to, hiking, backpacking, climbing, mountain biking, horseback riding and packing, some forms of dispersed camping, fishing, hunting, boating, exploring caves, geocaching, and nature viewing. Forest visitors engaging in these forms of dispersed recreation experiences often make use of the Gila NF's extensive single-track developed trail system. For conditions, trends, and risks associated with the developed trail system, see the trails section later in this chapter.

Hunting while dispersed camping on-forest is a very popular recreation activity on the Gila National Forest. There are many popular user-developed dispersed campsites distributed throughout the Forest. Most of these sites are in excellent condition. Many visitors that utilize existing user-developed campsites have been observed to be conscientious in maintaining a clean camp and minimizing any resource damage they may cause. Some common risks associated with dispersed campsites include litter, wheel ruts in the ground during wet conditions, and unattended campfires.

According to the 2011 NVUM survey, hiking/walking is most popular primary recreation activity of Forest visitors. The Forest has limited opportunities for day hiking due to distances to trailheads, limited loop opportunities, and closures of popular trails following flooding and wildfire events. As a result of these conditions, there is a trend of increasing use at many popular day hiking trails. The risk associated with increased use at a limited number of trail opportunities include user conflicts, limited opportunities to experience solitude, and overcrowding during high use times.

Equestrian use (horseback riding and backcountry stock-packing) are also popular forms of non-motorized recreation on the Forest. This type of use primarily occurs within wilderness and less-developed Forest areas adjacent to communities. Backcountry horseback riders visiting wilderness areas use vehicles and stock trailers to access trailheads and areas throughout the Forest. It is common for some of these users to pull stock trailers for 3 to 5 hours to reach a trailhead. Many of these backcountry trips are multi-day in duration, and involve the use of both pack and saddle stock. Day use equestrians are more likely to make use of Forest trails located immediately adjacent to local communities. Conflicts between user groups are more likely to occur on these popular trails located nearby to population centers.

Although not observed as being popular recreation activities, it is known that to some degree rock climbing and spelunking (cave exploration) do occur on the Gila. One limiting factor to the popularity of rock climbing has been the poor quality of the rock at many locations within the Forest boundaries, compared to better quality locations nearby but outside of the Forest boundary. However, there are some locations where rock climbing has been known to occur, sometimes with "bolted" routes, but more often less formal climbs using existing, natural anchors. Some better-known rock climbing locations include the Cherry Creek area in the Pinos Altos Range, Purgatory Chasm in the Mimbres area, Chloride Canyon in the northeastern Black Range, some of the cliffs in the Jordan Spring area of the Gila Wilderness, and Saddle Rock in the northeastern area of the Burro Mountains. Similarly, cave exploration is also known to occur on the Gila, primarily in locations of the Black Range District, but is not a significantly popular activity. See the Caves section in the following pages for more details on caves. There is no direction in the current forest plan for management of either of these activities, inside or outside of designated wilderness. The risks associated with both of these activities include: if not accounted for in project planning, these activities could be inadvertently impacted, and without appropriate oversight they may be a potential threat to wildlife, heritage, cave, or other Forest resources.

Although the Gila National Forest is located within a semi-arid landscape, fishing and water-based recreation opportunities are available on approximately 957 miles of perennial streams and rivers, as well as on three reservoirs: Quemado Lake (112 acres), Lake Roberts (68 acres), and Snow Lake (72 acres). Some of the more common sport fish found in these waters include rainbow and brown trout, large and small mouth bass, as well as channel and flathead catfish. Quemado Lake is one of only two lakes in New Mexico that have a population of tiger muskie, which is a draw that attracts anglers from all across the region.

Many native fish are also found in the streams on the Forest, some of which are federally listed as threatened or endangered under the Endangered Species Act. A particular draw attracting fishermen to the Gila Forest region is the opportunity to fish for the threatened Gila trout. Many of the streams that had populations of wild Gila trout on the Forest have experienced severe negative effects from wildfires to fish habitat. The Gila NF is partnering on several projects with the New Mexico Game and Fish Department with the goal of restoring Gila trout habitat and fish populations.

The available recreation facilities associated with the three lakes located on the Forest have been steadily improved, including new boat ramps installed at Lake Roberts and Quemado Lake, improving access to for watercraft use on these waters. Several developed campgrounds are located near these bodies of water.

Current fisheries improvements along with increased stocking levels has created an increase of fishing based recreation. Access to many of the rivers and streams located on the Forest is by way of system trails. Fishing and other water-based recreation activities are dependent upon current water quality conditions. One of the most significant risks to water conditions is negative effects from wildfire to vegetation and soils. Another risk to fisheries on the Forest is the effects of prolonged severe droughts limiting the availability of water and affecting the amount of stream flow. Many lakes and streams rely on winter snow pack runoff, are spring feed, or some combination of both. For more detailed information about stream and lake conditions, see Chapter 6: Water.

Developed Recreation

Developed recreation is defined as recreation that requires facilities and results in concentrated use of an area (Gila Forest Plan 1986). The Gila National Forest currently has 33 developed campgrounds (including 2 group sites), 6 picnic sites (including 3 group sites), 98 developed trailheads, 3 public target shooting ranges on the Glenwood, Silver City, and Reserve Ranger Districts, an observation site, and an Interpretive Visitor Center near the Gila Cliff Dwellings National Monument. Developed sites and areas experience greater use during the summer and fall seasons and on holidays, although several facilities (primarily on the southern and lower elevation portion of the Forest) remain open and receive use year-round.

The Gila NF conducted a Recreation Facility Analysis (RFA) process in 2007 (USDA FS Gila NF 2007). Through this process, Forest recreation staffs analyzed all recreation facilities and evaluated how they might operate and maintain these sites and facilities more efficiently. The product resulting from the RFA process was a document that outlined a five-year program of work that included all of the tasks required to bring the Forest's recreation infrastructure into alignment with the resources available to operate and maintain it to standard. These tasks included such actions as a seasonal closure of some facilities after hunting season, suspension of trash removal services at several sites, a change in visitor capacity at some facilities, installation of new signs, repairs and renovations, decommissioning of some sites, establishing fees at some facilities, and increasing them at other current fee sites, and increasing the recruitment and use of volunteers to help maintain facilities.

Many of the tasks identified by the RFA were completed within the five-year time period which streamlined the management of many of the facilities. Revisions to the fee structure across the Forest have not yet been accomplished at the time of this analysis. Additional opportunities for fee sites have been explored since the RFA was completed. These opportunities are currently being evaluated and initial planning is being conducted, including some site improvements required to be completed prior to implementation. One such opportunity currently being evaluated is to implement a cabin rental program on the Gila NF.

All recreation facilities are scheduled for a recreation facility condition assessment to be conducted and the results entered into the INFRA Recreation database at least once every five years. The inspections result in the documentation of all completed deferred maintenance requirements. An analysis that compares the between completed and deferred maintenance costs to the replacement value for each asset is known as the facility condition index (FCI). The FCI correlates to a facility condition rating of good, fair, or poor (Table 215). A good condition rating describes a recreation site that is fully functional and poses little to no safety concerns to the public and agency personnel. A fair condition rating indicates that there is room for improvement, but overall function of the site is acceptable. An FCI rating of poor typically indicates the need for major repairs, replacement, or decommissioning of the facility.

The majority of the Gila National Forest developed recreation facilities are currently rated as in good condition (Table 215). Annual and deferred maintenance needs and costs are identified and tracked in the INFRA Recreation database. The trend for many Forest developed recreation facilities are declining condition due to the growing backlog of deferred maintenance, age of infrastructure, cost of maintenance or replacement, and vandalism (e.g., graffiti, litter, physical damage to facilities, etc.). The risks associated with developed recreation facilities not being maintained to a minimum acceptable condition include threats to public safety by such hazards as poor condition of infrastructure, deficiency of hazard tree mitigations, non-accomplishment of improvements to limit damages from flooding and other environmental conditions, and health and safety issues associated with vault toilets. Other risks include a limitation on services provided at some facilities, site closures, imposing seasonal closures at more locations, or longer timeframes for seasonal closure periods.

Table 215. Recreation buildings on the Gila National Forest, with their facility condition ratings

Ranger District	Number of Structures	Good	Fair	Poor
Black Range	7	6	1	0
Quemado	26	16	6	4
Glenwood	16	14	0	2
Wilderness	54	28	5	21
Reserve	16	12	2	2
Silver City	25	20	5	0
TOTAL	144	96	19	29

Many of the risks to developed recreation facilities are posed by environmental conditions and natural disaster events such as fires, flooding, and prolonged drought, as well as insect and disease outbreaks. Any of these natural events may impact and create hazard trees within and surrounding developed recreation sites. Additionally, the presence of dead and dying trees within and near recreation facilities will have negative effects to the visual qualities of the area. Dead and dying hazard trees also result in decreased shading and increased risk to public safety due to dead trees falling on roads, trails, or facilities. To mitigate safety risks to the public, developed recreation sites are continuously evaluated for hazardous conditions and appropriate mitigation actions are taken as needed. Where appropriate, signage is posted within recreation sites and at trailheads warning of risks from falling trees.

There are several developed recreation sites that are currently closed due to damage from recent wildland fires and/or flooding. There are other sites that have instituted some type of seasonal closure or restrictions due to seasonal threat of flooding (e.g. monsoon season). Many of the Forest’s developed recreation sites are located within floodplains which increases of the risk of flooding related damages. Since these sites are within riparian areas and floodplains, there are many limitations on what type of improvements can be implemented due to resource and public safety concerns. This creates a management challenge because terrain often limits moving these sites immediately outside of floodplains. The Forest is attempting to balance meeting the visitor needs for developed recreation sites near water and providing for public safety concerns.

A trend on the Forest is increased seasonal closures of some developed recreation sites. The risks associated with implementing additional seasonal closures include limiting availability of recreation opportunities, possibility of increased vandalism, and decreased visitation to these sites.

Vandalism that is known to occur on the Gila NF includes graffiti to structures within sites, destruction of government property, theft and damage to signs, and cutting of vegetation within the developed recreation sites. The Gila NF has been implementing the use of building materials that are more durable and resistant to environmental factors and vandalism. The disadvantage to using these materials is that they tend to be expensive, which places financial limitations on how many sites are able be upgraded each year.

Special Uses

All uses of NFS lands, improvements and resources are considered “special uses” except for noncommercial recreational activities and certain activities governed by other regulations such as mining, timber, grazing, or road use (36 CFR 251.50). The Forest Service Special Uses Program authorizes use of National Forest System lands and resources through the issuance of a permit. Permit terms and conditions protect public and natural resource values while affording the permit holder the opportunity to conduct business on the national forest, or private recreation opportunities in limited circumstances (such as recreation residences). Under various laws and regulations set by Congress, the Forest Service collects land use rental fees for special use authorizations. While most land use rental fees are returned to the US Treasury, some fees are retained by the Forest. Certain recreation special use authorizations, such as outfitter/guides and recreation events, generate revenue for the Forest, which is directed to improve visitor services and address upgrades or deferred maintenance of recreation facilities.

The Gila NF recreation program manages a variety of special use permits including outfitting and guiding, tours, trail guides, special events, photography and filming, and various other types of uses. Currently the Gila NF manages 112 outfitter and guiding permits, 3 recreation residence permits, 1 marina permit, 2 target range permits, 6 recreation events, 1 visitor center / museum permit, and 2 church group event permits along with many single occurrence type events. Some the single occurrence type events that typically occur on the Forest are weddings, family reunions, field schools, school-related field trips, and many others.

The demand for outfitter / guides to operate big game hunts on the Forest is currently being met, although this situation may change over the next few years as competition for trophy big game animals continues to increase. The Gila NF needs to complete a capacity analysis for all special use permits to ensure there is an appropriate number of permits issued for any given activity within certain location perimeters.

To date, there have been few reported conflicts among those currently permitted to operate on the Forest. The relatively large land base of the Gila allows competing outfitter/guides to disperse, and limits the likelihood of them coming into conflict over specific locations.

There have been a small number of conflicts known to occur between outfitter/guides and the general public related to use of specific areas to hunt or establish a campsite. Most of these reported conflicts are resolved between the two parties when they occur. Typically, if conflicts occur repeatedly by a certain permittee, appropriate actions may be taken through the administration of their permit. Many outfitter/guides have been operating on the Forest for many years, and they have gained the knowledge of where other guides typically operate along with popular areas where the general public tend to hunt. Because of this accumulated knowledge of use patterns, many permittees will choose operate in areas where there is little potential for competition and conflicts with other hunters. Some outfitter/guides utilize private property to base hunting operations from, but many other special use permittees will locate their camps on Forest. Proper permit administration, including regularly conducted field inspections, serve to ensure there are little to no impacts to resources on the ground.

With New Mexico becoming more popular within the film industry for film production due to tax credits, the demand for additional special use permits for commercial filming may increase as well. Often film permits require additional time to administer due to the complexity and duration of many filming productions. Large film productions could impact many different resources on the Forest.

Some common challenges across the Forest with administering special use permits include a lack of personnel and training available to properly issue and administer permits. Due to many vacancies within the recreation program within the past five years, administration of special use permits has been completed by other staff areas that have not received proper training. This has resulted in an inconsistent approach on how new and existing special use permits have been administered. A risk of not properly administering permits often results very few, if any, inspections to ensure there are not conflicts, overuse of popular sites, and resource damages. With the Gila NF recreation program becoming more organized across the Forest and vacant positions being filled, these issues should be addressed and resolved in a unified approach across the Forest. A current condition of many special use permits on the Gila NF is that many of the long term priority use permits are due to expire within the next couple of years. As permits are renewed, proper NEPA clearances will be completed which will identify resource concerns and proper mitigation actions. The Forest has experienced a trend of more permit requests for special events, endurance races, and a variety of guiding operations. This risk of this trend is an increase of possible user conflicts and a possibility of the Forest exceeding the capacity of use in popular areas.

Caves

The Federal Caves Resources Protection Act of 1988 directs the Secretary of Agriculture to prepare and maintain a list of significant caves. The criteria for listing are found in 36 CFR part 290.3(c). The Forest Service policy is to identify and manage significant caves, although under certain circumstances the location of significant caves can be withheld.

The Gila National Forest has several different known cave systems within administrated lands. Cave resources include wildlife habitat, most notably for bat populations such as Pale Townsend’s big-eared bat. Risks to bats include activities known to impact habitat, such as mining, vandalism, and recreational caving, as well as disease such as White Nose Syndrome. White Nose Syndrome has not been reported in New Mexico to date, but the disease has been spreading west from places where it is currently documented. At present, the Forest recommends a few precautions to limit the spread of the disease, such as sanitizing gear and clothing before entering a cave. There are six caves on the Gila National Forest that have either been evaluated for significance, or currently are being evaluated, but at this time no caves have yet been designated as significant. When designated, all significant caves will be managed to protect and maintain the caves and cave resources.

The Gila National Forest does not yet have a forest-wide cave management plan. The Forest has utilized partnerships with local grotto groups, along with the Lincoln NF cave specialist, for assistance in the management of caves. Two caves are currently being managed for recreational purposes with minimum development, and the other caves require further evaluation for development of an appropriate management strategy. All of the caves being evaluated for significance are also being monitored for resource concerns.

Coffee Cave is the only gated cave on the Forest, and a key can be checked out by the public to allow controlled access to the cave. Road access to the cave has been damaged by flooding from the Silver Fire which currently limits access to the entrance. The condition of Coffee Cave is considered good, with limited occurrences of resource damage. Robinson Cave is the other cave being managed for recreational purposes, although this cave regularly experiences problems with littering and graffiti. Currently, there is no restricted access or registration requirements to access this cave. The Forest is presently monitoring the litter and graffiti damages, and undertaking clean up actions as required. There is no road or system trail access to Robinson Cave, so cross country travel and knowledge of the location are required to locate the cave.

Further cooperation from our partners will be necessary to help with the identification and exploration of additional caves located within the Gila NF. It is possible there are many more caves eligible as significant located on the Gila NF, but are not yet known to Forest personnel. There is limited data available on visitation trends to caves on the Gila NF. Most of the available information is from Coffee Cave, which consists of records of when the key is checked out. The amount of use of Coffee Cave has been steady to slightly increasing each year as this cave becomes better known. There is potential to grow and expand the cave program across the Forest with the cooperation and assistance of partner organizations and recruitment of volunteers.

Night Sky

Boasting some of the darkest nights in the Southwest, the Gila National Forest offers many visitors the chance to view and admire the natural night sky, a glittering dome peppered with stars, planets, and passing meteors. Much of the Gila National Forest lies within the darkest category on the Clear Sky Chart light pollution map (Figure 171), and on the Bortle scale rates a 1 or a 2 as being in the range of excellent to typical truly dark sky.

The Cosmic Campground on the Glenwood Ranger District has gained the recognition as an International Dark Sky Sanctuary by the International Dark Sky Association. This is the first International Dark Sky Sanctuary located on National Forest System lands. International Dark Sky Sanctuaries are lands possessing an exceptional or distinguished quality of starry nights. The Cosmic Campground offers a 360-degree, unobstructed view of the night sky, and often hosts “star parties” in cooperation with the partner group Friends of the Cosmic Campground. Having this designation will help further protect and raise awareness for the value for dark skies. This site is situated where there is little light pollution and low development. The greatest threat to this dark sky resource is increased development in the immediate area that could cause light pollution. However, design for the campground will ensure light pollution controls will be in place for the immediate area.

With trends of more and more people residing in expanding urban and suburban areas, the experience of viewing the natural night sky is becoming rarer and more unique This opportunity to view the natural night sky is relevant not only to astronomers, but also stargazing recreationists. The trend of recreationists utilizing the Cosmic Campground for stargazing will increase as awareness about the designation and as opportunities to view the natural night sky become rarer across the United States. Currently there are limited islands of areas that have these qualities across the region (Figure 171), and they will be increasingly rare as more development occurs.

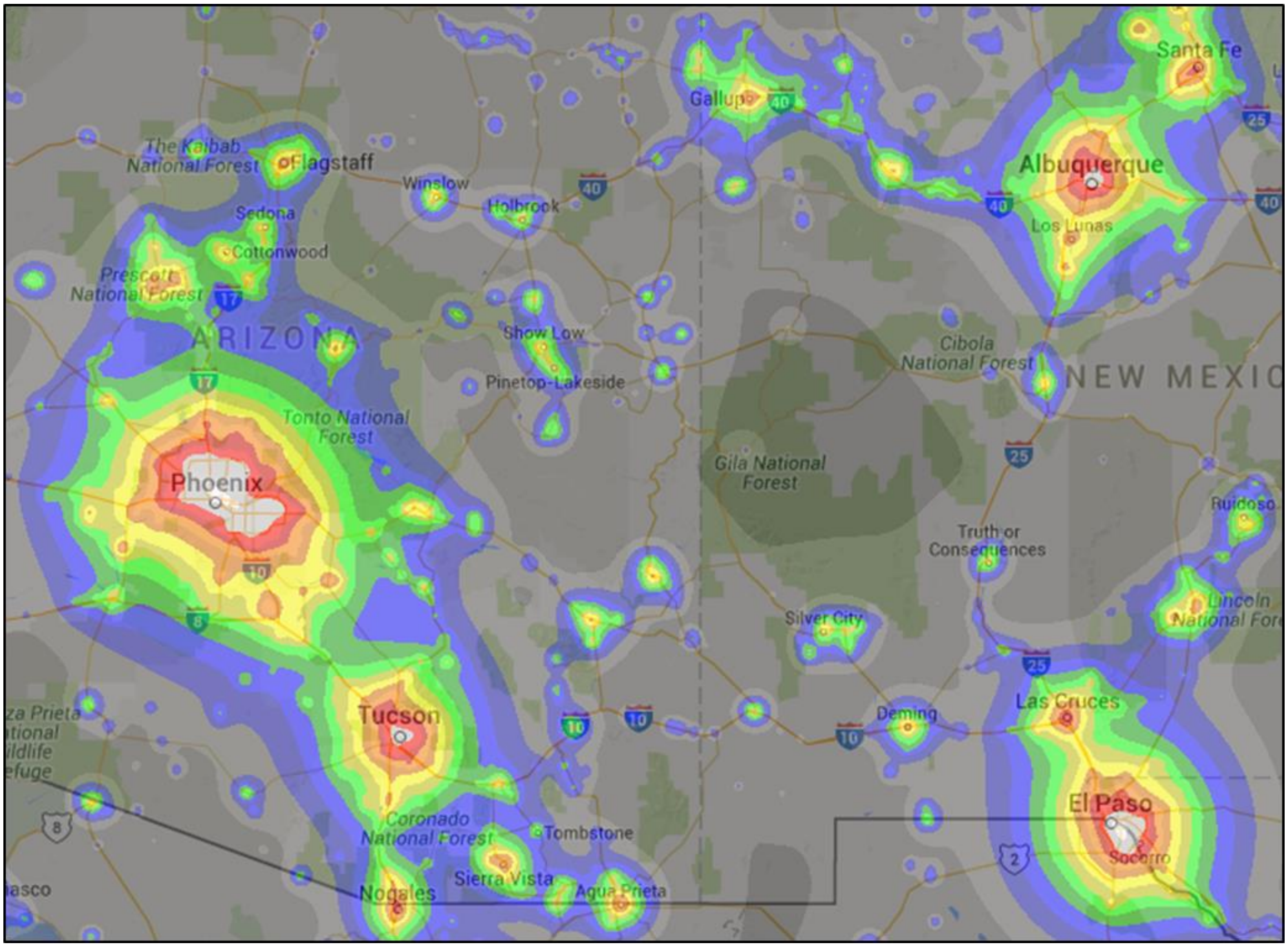


Figure 171. Map of light pollution in the region surrounding the Gila National Forest.

Note: Warmer (lighter) tones indicate more light pollution and cooler (darker) tones indicate less light pollution.
From the Light Pollution Atlas (Lorenz 2006)

Compatibility of Different Recreation Activities

Participants in the Values, Attitudes and Beliefs (VAB) Survey for the Gila NF (USDA FS 2006a) discussed increasing demand for limited recreational resources, which results in the increased potential for one type of use to conflict with another (USDA FS 2006a). Participants in the VAB were concerned about conflicts between motorized and non-motorized uses. Participants also believed that many of the "problem users" simply lacked information about appropriate Forest rules and regulations. Unauthorized routes continue to appear and are created by both motorized and non-motorized activities, such as OHVs, horses, and hikers. Mountain biking is becoming an increasingly popular activity on the Forest. There is a variety of opportunities for bikers on the Gila NF, but there is potential for conflict with other trail users, in addition to impacts to the resource if bikers travel off designated routes.

On the Gila NF, many visitors tend to use the Forest for multiple types of recreation purposes in a single visit. For example, a visitor to the Forest for big game hunting is also likely to camp either in a dispersed site or in a developed campground, using Forest roads and trails, viewing scenery and wildlife, or driving an OHV or using pack stock. A visitor enjoying a scenic drive viewing wildlife may also picnic, day hike, or visit an interpretative area.

Since most visitors to the Gila NF enjoy multiple recreation uses within a single visit, and are typically seeking solitude, conflicts amongst different user groups are minimal. The Gila NF being is a large uninterrupted area of public lands, providing ample opportunities for recreationists to find less crowded areas. Additionally, different user groups use the same locations but at different times of year. Where the majority of user conflicts occur are at developed recreation sites and areas where the Forest is near communities, and are more likely during popular weekends and holidays when there is increased visitation.

A trend of increasing conflicts has been observed between hikers, equestrian users, and mountain bikers on the Gila NF trail system. These types of conflict are most commonly known to occur in the area near Silver City, and are increasing as the area becomes more popular and receives more visitation by a range of recreation users. The risk associated with user conflicts on the Forest trail system include impacts to trail conditions, and negative interactions between user groups adversely affecting all trail users' recreation experiences. Examples include horses being spooked by dog walkers, and mountain bikers passing hikers at high speeds, creating an impression of unsafe conditions.

Another common and increasing conflict occurs between motorized and non-motorized recreationists. This conflict is typically limited in location due to the few areas where these activities overlap. One example is where motorized trail use is encroaching on sections of the Continental Divide National Scenic Trail (CDNST) where roads cross the trail. The risks associated with this conflict include increased user conflicts, impacts to trails not designed for motorized use, and resource impacts associated with the formation of user created trails that split off of the system trail.

Increased visitation to the Forest is one of the biggest factors contributing to the risk of conflict amongst different user groups. As visitation numbers rise, the likelihood of user conflicts also increases. Competition between user groups for more desirable recreation sites also increases the risks for user conflicts.

Emerging recreational trends that may affect future recreation demand

There is a growing interest in adventure races and similar events such as boot camps, mud events and endurance races. These events are usually held under a special use permit by "for profit" organizations, although some are conducted as fundraisers. The activities associated with these recreation events may include: running, bicycling, paddling, climbing, orienteering, and other activities that require endurance, strength and agility.

One such event that occurs on the Gila NF is the "Ride the Divide" mountain bike race. This race follows as close as possible to the CDNST, and participants attempt to ride the entire CDNST unsupported. Another Gila NF recreation event is the "Tommyknockers 10" race that occurs within the Fort Bayard trail system near Silver City. This event is a 10 hour endurance mountain bike race that makes use of multiple trails to create a loop that participants complete as many laps as possible. The first official event occurred in February 2016, and was very popular.

Other recreation activities that may contribute to the demand for recreation within the Gila National Forest plan area include the growing interest in zip lines, use of drones, and geo- or eco-tourism. Depending on where these activities may occur, if not managed they could exacerbate environmental and social stressors described throughout this chapter. If managed appropriately, these activities attract visitation to the area and contribute to the local economies without undesirable impacts.

Recreation Fees

The Federal Lands Recreation Enhancement Act (FLREA) was signed into law by President Bush in 2004. It permits federal land management agencies to establish, modify, charge and collect modest recreation fees at campgrounds, rental cabins, and at day use sites that meet specific facility criteria. Recreation fees provide crucial resources that allow the federal agencies to respond to increased recreational demand on federal lands. The goal is to provide visitors with a quality recreation experience through enhanced facilities and services.

The Forest charges use fees at some of the developed recreation areas including the Catwalk Recreation Area, Dipping Vat Campground, Juniper Campground, Mesa Campground, Piñon Campground, and Upper End Campground. A majority of the revenue generated from these fee areas stays on the Forest and supplements appropriated dollars to maintain and enhance recreation opportunities and amenities. However, the revenue that is generated by the fee areas is not sufficient to address all deferred maintenance needs.

The Catwalk National Recreation Trail is a tourist destination which experiences high visitation levels. This site contributes significantly to the local economy of the town of Glenwood. Due to the location of the trail within lower Whitewater Canyon, it is susceptible to damage from flooding, and has experienced periodic closures for cleanup and repairs. The risk associated with these periodic closures of the trail include impact to the economy of Glenwood and surrounding areas, while the loss of FLREA fee revenue affects future maintenance and enhancements. When significant damages occur to the trail, repairs are prohibitively expensive, causing strain to the Forest recreation budget.

Since the Dipping Vat, Juniper, Mesa, Piñon, and Upper End Campgrounds all collect fees and generate revenue used in their maintenance and improvement, these facilities are currently in good condition. These sites typically have volunteer campground hosts to assist with collecting fees, distributing information, and performing routine maintenance. As unforeseen events occur and maintenance issues arise, having a campground host on-site to address or report them to managers helps to minimize the extent of damage and likelihood of closure for repairs.

Visitation to these fee sites has been increasing, as observed by total fees collected. Total revenues increased from $57,758 in FY 2014 to $63,488 in FY 2015. Dipping Vat Campground is located at Snow Lake, Mesa and Upper End Campgrounds are located at Lake Roberts, and Juniper and Piñon Campgrounds are located at Quemado Lake. Since all of these Forest campgrounds are located near lakes, drought and associated lower lake levels are among the greatest risks to visitation numbers for these campgrounds. Other risks that could affect visitation include quality of fishing opportunities, occurrence of nearby wildfires, condition of access roads, and negative impacts to the view shed of the surrounding Forest.

Compared to adjacent national forests, the Gila NF has very few sites that charge fees. Many campgrounds and developed recreation sites are provided at no cost to the visitor. . While providing many campgrounds and other developed sites without user fees allows Forest visitors from all economic backgrounds the opportunity utilize these sites, it does strain the recreation budget to continue to operate, maintain, and improve these sites. The risk as associated with lack of user fees include a lack of maintenance funding as appropriated funding stagnates or declines. In order to mitigate impacts from these trends, the Forest may need to consider alternative management actions that may include increasing the number of facilities that charge fees, increasing existing fees; reducing services at non-fee sites; implementing seasonal closure of sites during lower-use times of the year; and seeking assistance from outside partners.

Nature, Extent, and Condition of Trails, Roads, and Other Transportation and Other Infrastructure to Provide Recreational Access

This section will assess the conditions, risks and trends as it relates to transportation access for Forest recreation opportunities and trails. The Gila NF is located the southwestern portion of New Mexico and is nestled north of Interstate 10 and west of Interstate 25 (Figure 172). These two interstates provide the primary access to the federal and State Highways that pass through or near the Forest and surrounding communities. For more detailed information related to roads, see Chapter 14: Infrastructure.

Access to Recreation Opportunities

Most of the State Highways located on the Gila NF are paved (with the exception of State Highway 163 and portions of State Highways 159 and 59). The paved State Highways are suitable for passenger vehicles, and are typically open for use year round unless closed due to weather events. The majority of these highways are suitable for motorhomes and trailers. Portions of several State Highways passing near or through the Gila NF may be challenging driving situations for larger vehicles and vehicles towing trailers due to sharp curves and steep grades. A high percentage of the Gila NF developed recreation sites (excluding trailheads) are located off of State Highways. Typically county and National Forest System (NFS) roads accessing campgrounds adjacent to highways are well-maintained and are accessible most of year. The biggest risks to use of these highways are during periods of inclement weather such as heavy snow or rain. Another risk to all roads in and around the Gila NF is the threat of wildfires and flooding. Roads may be closed for safety during fires or floods, and for longer periods depending upon the amount of damage to their condition. There are a number of developed campgrounds that are only accessible by NFS roads, and are considered to be remote.

Compared to developed recreation sites, the majority of trailheads tend to be located in remote areas accessible only by NFS roads. Many of these roads accessing Forest trailheads are classified as Maintenance Level 2, and are recommend for high clearance vehicles only. These roads typically have little to no improvements and receive only minimal maintenance. The condition of the Level 2 roads may vary across the Forest, depending upon the time of year, location, and recent weather conditions. During the drier times of year, most of these roads tend to be in good condition. When the Forest receives precipitation, many level 2 roads become very difficult to travel and vehicles may become stuck and/or create ruts in the road during wet conditions. Other risks to Level 2 roads include damage from wildfires and flooding.

There is a current backlog of maintenance to many roads within the Gila NF due to declining budgets and a limited number of personnel and equipment available to perform maintenance. The risks of a limited maintenance budget and a backlog of road maintenance include safety concerns for visitors, a loss of utility for roads as deteriorating conditions could make them unusable while creating a high risk of resource damage as vehicles create new routes to bypass impassable sections of roads. Resource damages from user created routes include loss of vegetative groundcover from the creation of ruts, soil compaction and increased soil erosion on steep slopes. For additional information on road conditions, risks, and trends please see Chapter 14: Infrastructure.

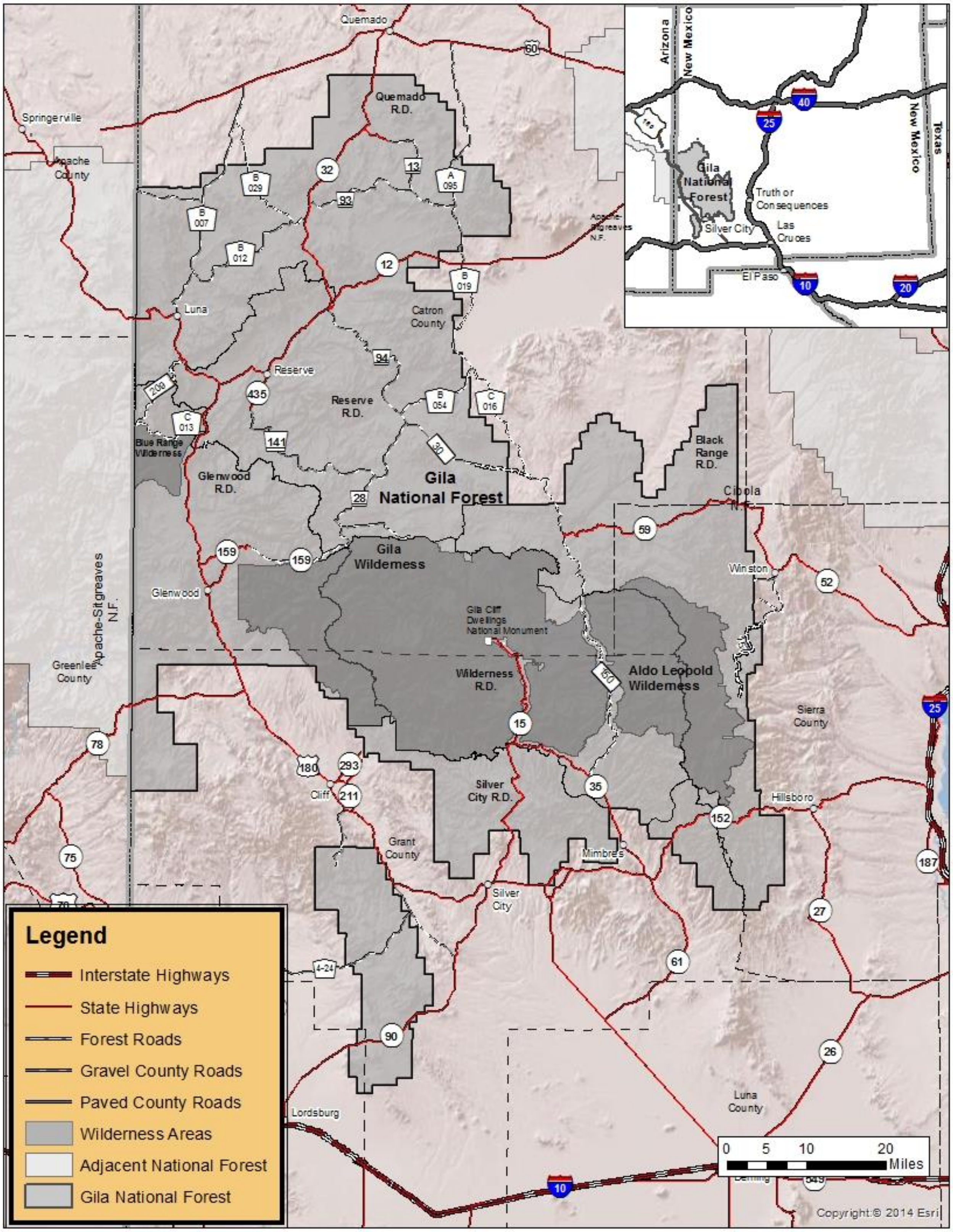


Figure 172. Major access routes in and around the Gila National Forest

The current quality of road access to water features (Figure 173) on the Forest varies depending on the body of water. Quemado Lake, Lake Roberts, and many trailheads that provide access to the Gila River (including the West, Middle, and East Forks) are accessible by paved roads that are in good condition. Snow Lake is accessible by NFS roads that are well-maintained but not paved, and during wet seasons or periods of heavy snow, accessibility may be difficult.)

The boat ramps at Quemado Lake and Lake Roberts have recently been extended and resurfaced. These boat ramps are in excellent condition. Many of the major streams located on the Gila NF are accessible by State, county, and NFS roads with the majority of streams being accessible by non-motorized trails. Many of these trails are located immediately adjacent to or in the streambeds in the case of low water crossings. Due to their location in flood prone areas, the majority of trails near streams are in fair to poor condition. The tendency of deteriorating trail conditions is common across the Forest, with an accelerated pace of deterioration along streams due to regular flooding.

Three lakes (Bill Evans Lake, Wall Lake, and Bear Canyon) are located near the Gila NF but are not administered by the Forest Service.

Trails

The most popular recreation activity for visitors to the Gila NF is hiking, and the Gila NF contains several large wildernesses, numerous inventoried roadless areas, an abundance of undeveloped backcountry, and limited motorized access. Trails are not only important for recreational use, but are a vital component of the Forest transportation system. Many of the trails on the Gila NF also provide access for range or wildlife improvements, livestock management, lookout towers, and for fire management.

Many of the trails within the Forest were established by past users of the land prior to the establishment of the Gila NF. The location of many of the trails is terrain influenced, along with providing direct access to water resources. Since water availability is limited, system trails located near or to water resources are very popular with recreationists. These same trails typically are vulnerable to damage from frequent flooding and may contribute to resource damage. Often, existing trail slope grades and the location of their alignment are not ideal for addressing problems associated with drainage and erosion. Improper trail design often requires the installation of numerous drainage structures to address erosion issues that require frequent maintenance and creates conditions that are a challenge to sustainability.

Currently the Gila NF has a total of 1,927 miles of system trails. There is a total of 179 miles of motorized trails and 1,752 miles of non-motorized trails, with 861 miles of trails located within designated wilderness. Under current and projected funding of the trails program, it is likely that there are more miles of existing trail than that can be maintained by the Forest. There are several options that managers are currently exploring to address this issue.

One option is to complete a travel analysis with possible decommissioning of less-used trails or trails that receive so little use or maintenance that they no longer exist on the ground. Other options include teaming with partner organizations, volunteers, and special use permittees to assist with trail maintenance, including an “adopt a trail” program. With limited funding and fewer personnel available to maintain the existing trail system, it will be necessary to develop a sustainable trail system that meets the needs of the trail users but is manageable with available resources. Additionally, trails designed and designated sustainability and dedicated use by specific user groups may help minimize user conflicts in certain areas.

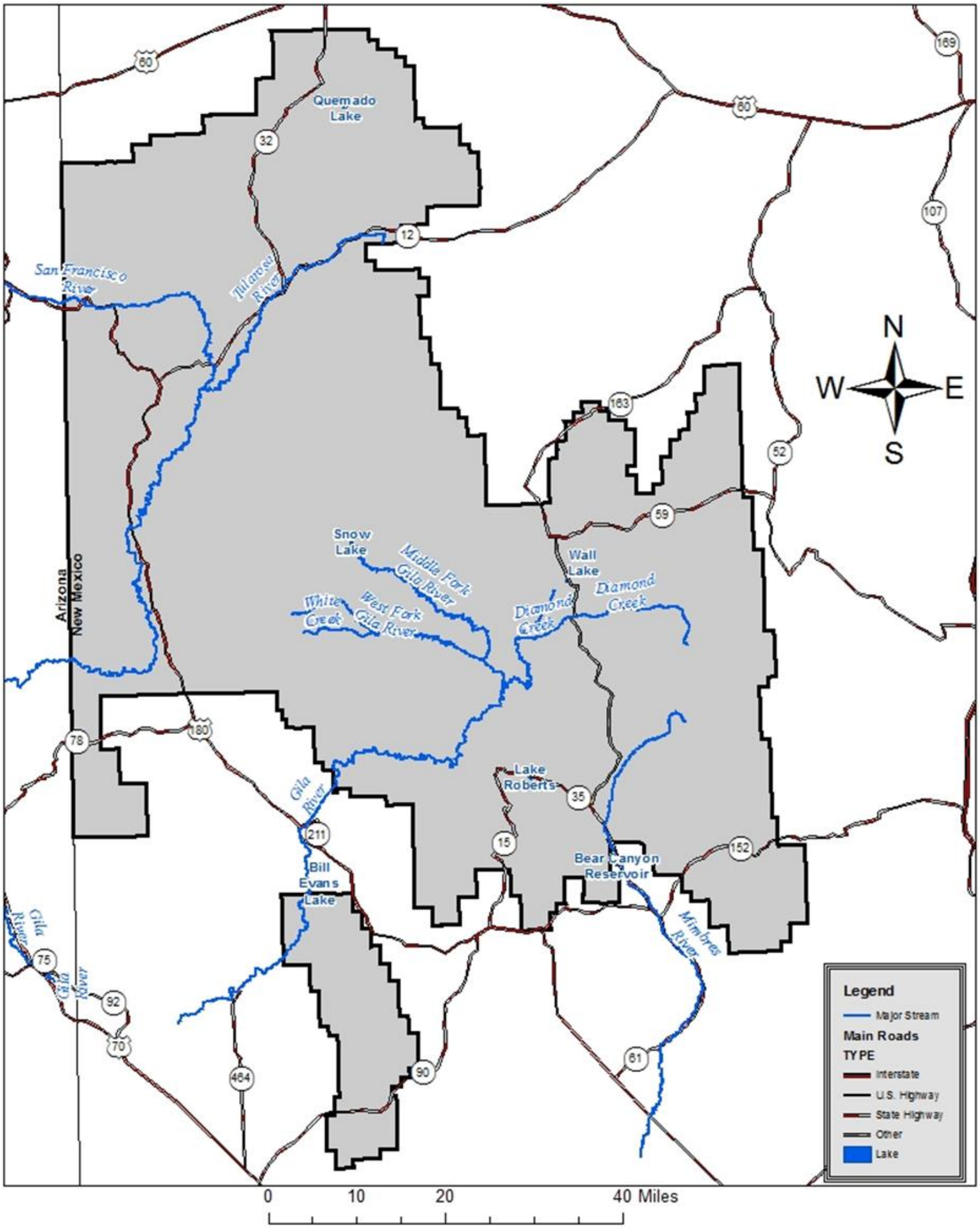


Figure 173. Major bodies of water on the Gila National Forest

Trail conditions vary throughout the Forest. The trails in the best condition are usually the most popular trails, associated with access to water, access lookout towers, nationally designated trails, popular day hikes, and interpretative trails. Because of regular use by the public, these trails are typically better maintained, and when there are condition issues, they are reported and addressed by Forest personnel. However, the majority of system trails are less used and have deferred maintenance issues to the point that they are difficult to locate and travel.

Many trails are missing signs and many existing signs are unreadable due to weathering. There is a lack of accurate maps of the trail system available to the public, and there is often limited information available on current trail conditions. The risk associated limited information can lead to frustrated, disappointed recreational users, or the possibility of increased Search and Rescue incidents due to visitors becoming lost.

Major disturbances such as high severity wildfires and flooding have resulted in an accelerated rate at which trails are experiencing damage across the Forest. While the Forest has prioritized maintenance of popular trails within the disturbed areas, many secondary trails within the disturbed areas and other trails outside of them are neglected, which further compounds maintenance issues.

There are many risks to the condition of trails. The effects of wildfires and floods tend to cause immediate and long lasting threats. Damage includes soil loss, vegetation loss, erosion, debris and fallen trees blocking trails, and encroachment of nuisance vegetation on trails following disturbances. Vandalism and theft of trail signs are a threat to the navigability of the trails. Another risk to the trail system across the Forest is an increasing trend of user created trails. In many cases, these trails lack proper sustainable design and are in locations that can create resource damages and lack erosion control design features.

Opportunities to Foster Greater Connection between People and Nature

Participation in outdoor recreation is the most common way that most Americans come to know their National Forests, making recreation an important portal for understanding the meaning, history, and relevance of all public lands. Connecting with nature reminds people of the resources that sustain life and helps them understand and care about those resources. It is also vitally important that we work to connect youth and underserved communities, who represent the future of our constituencies, with their public lands as well.

The Gila NF trails, picnic grounds, campgrounds, wilderness areas, group use areas, and interpretive displays/sites present countless opportunities for visitors to connect with nature. Other opportunities for visitors to get connected with the Gila NF include:

- **Volunteering** can provide a meaningful connection with nature and benefit management of the Gila NF resources. Volunteers are typically engaged in a variety of activities, including maintaining and constructing trails, maintenance of recreation sites, maintenance and construction at administrative facilities, staffing interpretive facilities, serving as campground hosts, and presenting interpretive/conservation education programs. Currently, there are a number of volunteers working across the Forest during different times of year. The Gila NF continues to explore opportunities to expand the volunteer base. There is a need to reach out to different volunteer groups to help develop relationships, which will help with coordinating current and future partnerships to complete projects. With a limited workforce, the Forest continues to emphasize the importance and value of volunteers.

  Currently there is an increased emphasis on growing volunteer opportunities to foster a greater connection between people and nature while supplementing a limited agency workforce to complete necessary work. The current trend on the Gila NF is increased interest from the public to volunteer. The Forest has not been able to accommodate many volunteer requests due to the limited capacity within the recreation program to manage volunteers. A risk of not being able to utilize willing volunteers to their desired capacity could result in losing potential volunteers that eventually seek opportunities elsewhere or lose interest. This could potentially result in fewer individuals connecting to the natural environment. Growing the volunteer program along with increasing capacity to more effectively manage volunteer projects could result in a more sustainable workforce, increased opportunities for the public to connect to the natural environment, enhanced partnerships, and increase the public perception of the importance of natural resource management and public lands.

- **Fee Waiver Days** waive recreation day use fees at most federal recreation areas to promote and encourage increased public interest and use. The Forest Service participates in five fee waiver days: Martin Luther King, Jr. Day; President's Day weekend; National Get Outdoors Day; National Public Lands Day and Veterans Day Weekend. The only site on the Gila NF that qualifies for Fee Waiver Days is the Catwalk Recreational Area.
- **Conservation Education/Interpretation** on the Gila NF includes a variety of conservation education and interpretive programs including Smokey Bear Fire Prevention, Junior Rangers, career fairs, nature hikes and programs for schools on and off site. Several youth groups and summer camp programs also use the Gila NF as a setting for their programs. Charter schools like the Aldo Leopold Charter School in Silver City routinely make use of the Forest as an outdoor classroom to connect students to nature. The National Outdoor Leadership School (NOLS) runs seven to ten backpacking courses on the Gila NF each year to develop outdoor skills, environmental studies, and leadership education. The Forest has been experiencing an increased trend of requests for environmental education presentations. A trend with youth in many local communities is a growing disconnect with the natural environment. The risk of having a limited environmental education program on the Gila NF is not being able to properly meet the increasing requests for educational presentations, as well as missing out on crucial opportunities to connect with youth and underserved communities.
- **Agreements** with youth development programs such as the Southwest Conservation Corps, Youth Conservation Corps, Rocky Mt. Youth Corps and Arizona Youth Corps provide meaningful outdoor work opportunities for young people between the ages of 14 and 25. Conservation Corps trail crews have completed trail rehabilitation projects on several Districts across the Forest. There are several Youth Conservation Corps partnered with the Forest to complete trail work, maintain recreation facilities, and construct recreation signs. With limited budgets to hire seasonal temporary employees, the Forest has increased the use of agreements with different conservation groups. There has been a trend in recent years in the southwestern United States of fewer conservation corps crews that are available for agreements. A risk of fewer available crews is more competition for crew availability during a short field season. Within the past five years, there have been three different conservation groups that have been utilized on the Forest, due to long travel times to work locations and the skill sets required to complete work within designated wilderness areas. As the Forest continues to utilize agreements, there will be a need to have a Forest liaison to work with these partners to set up agreements, coordinate prior to implementation of projects, and provide an educational component to conservation crews about the history and legacy of the Gila NF. Increasing the use of conservation crews on the Gila NF will help increase the awareness and knowledge of the Forest and its legacy with the youth, especially to crew members from other states.
- **Special Use Permits** allow private individuals and businesses to provide valuable services for visitors that may not possess the skills, equipment, or knowledge of the area to be able to

participate in some recreation activities on the Gila NF independently. Privately provided recreation services provided under Special Use permits may include, but are not limited to, outfitting and guiding for hunting and fishing, tours, guided hikes or equestrian trail rides, and special recreation events. See the section on Special Uses for more detailed information relating to the Special Uses program on the Gila NF.

- **Forest Product Permits** allow the public to gather firewood, cut Christmas trees, and harvest other types of timber products for personal, non-commercial use. Many people use wood-burning stoves or furnaces to heat their homes, and gathering firewood on the Forest has become a tradition for the entire family. The number of timber product permits sold has been steadily increasing during the past several years. The Forest recently removed restrictions on the maximum amount of fuelwood permits that an individual may purchase in a calendar year, which has increased the number of permits sold. Availability, accessibility, limitations on numbers of new green fuelwood areas combined with remoteness of location (distance needed to travel to remove products) are risks to future forest products use. Other forest products besides firewood that are typically gathered by the public include rocks, minerals, and piñon nuts. If a permit is required to harvest a forest product, they are administered under the authority of the Timber Program Manager or the Lands and Minerals specialist. A significant risk to continued availability of many forest products is climate change.
- **Scenic Byways / Scenic Highways** offer opportunities to drive for pleasure, view natural features, and view wildlife. There are two National Scenic Byways on the Gila NF: the Geronimo Trail and Trail of the Mountain Spirits. See Chapter 13: Designated Areas for more detailed information.

Scenic Character

This portion of the chapter provides background information on scenic character, evaluates the existing and potential conditions, and trends affecting scenic character.

People are concerned about the quality of their environment, including aesthetic values of the landscape, particularly scenery and spiritual values (USDA FS 1995b). Located in New Mexico, the Gila National Forest features an abundance of spectacular scenery, ranging from high cool mountains forested with aspen and Douglas fir to warm semi-arid lowlands of juniper, oak and cactus. Forest Service lands that provide the scenic backdrop to adjacent communities offer a sense of place and contribute to the identity of those communities, while benefiting the local and regional economies. It is important to manage scenic resources to provide natural appearing landscapes that ensure quality sightseeing and other recreation opportunities for the public, as well as maintaining natural landscapes for communities adjacent to the Forest.

Natural appearing scenery provides the basis for high quality recreation experiences on the Forest. In other words, scenery is an integral component of all Forest settings, and contributes to the quality of visitors' recreation experience. Scenic resources or natural settings are recognized as a central component of the recreation niche of the Forest.

When the Gila National Forest Plan was developed and approved in 1986, it identified Visual Quality Objectives and Recreation Opportunity Spectrum (ROS) classes by management area. However, electronic maps for analysis purposes are unavailable of that data. The Visual Management System (VMS) provided the framework for inventorying the visual resource and providing measurable standards for managing it. The Forest Service replaced the VMS in 1995 with the Scenery Management System (SMS) for the inventory and analysis of the aesthetic values of National Forest System lands. The SMS is described in Agriculture Handbook 701, Landscape Aesthetics: A Handbook for Scenery Management (USDA FS 1995b), which provides a systematic approach for determining the relative value and importance of scenery in National Forest lands.

The 2012 Planning Rule defines scenic character as: "A combination of the physical, biological, and cultural images that gives an area its scenic identity and contributes to its sense of place. Scenic character provides a frame of reference from which to determine scenic attractiveness and to measure scenic integrity." (36 CFR 219.19). Forest Service agency policy (FSM 2382.3) mandates that the Gila National Forest will update scenery inventory using the SMS with the initiation of the current Forest Plan Revision.

There are many ecological and physical considerations that factor into the scenic character assessment of the Gila National Forest along with considerations for management of specially designated areas. The diversity of vegetation across the landscapes of the Forest is a key attribute of scenic character. Species composition across the various elevation zones and ecological settings, existing conditions, and distribution all contribute to scenic character conditions.

The Gila NF is home to many diverse landforms and landmarks that enhance scenic qualities. Landform types found on the Forest include steep rugged mountains, rolling hills, valleys, steep canyons, water features, and vast open grasslands. Where multiple and/or unique landforms occur in a single location, it tends to create unique landmarks that enhances scenic opportunities within the Gila NF. Figure 174 is an example of steep, rugged mountains and canyons meeting, and combined with a variety of vegetative species create a unique scenic opportunity. The management of specially designated areas require additional considerations to protect and enhance the scenic character that contributes to the designation. For additional information refer to Chapter 13: Designated Areas.

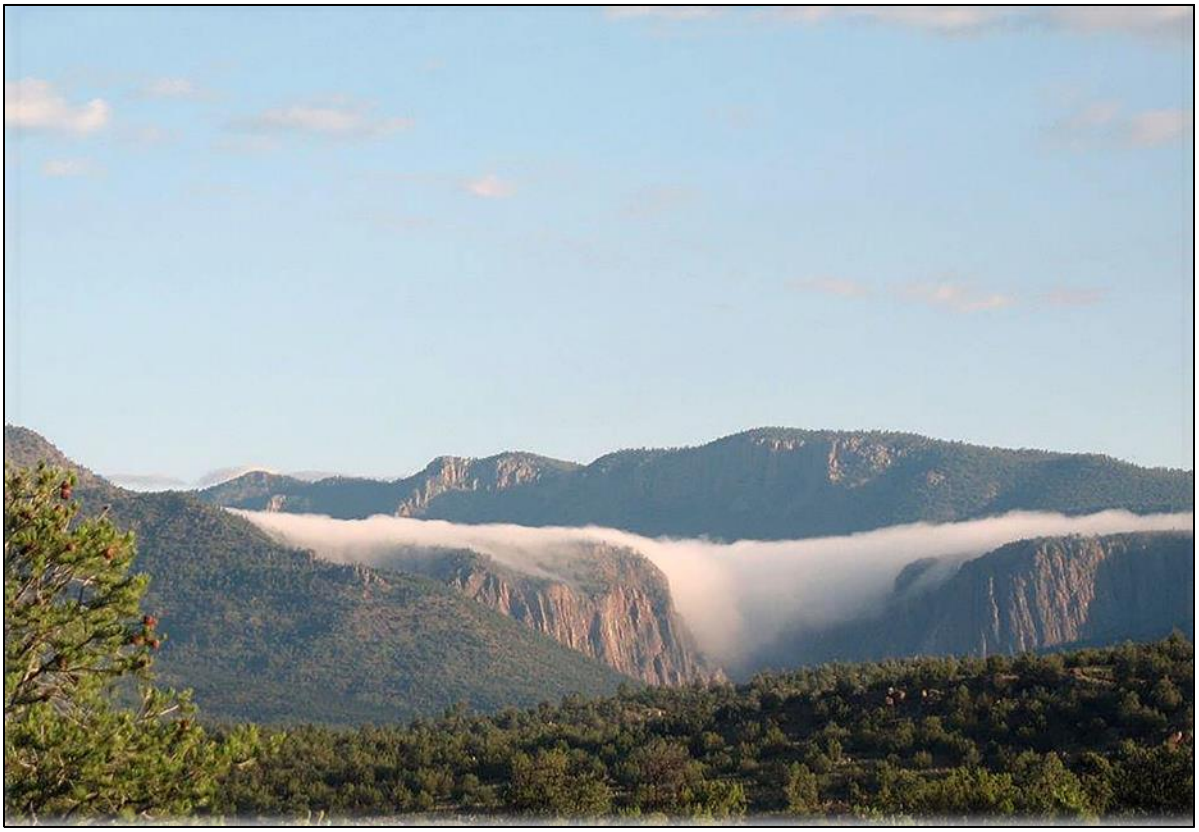


Figure 174. San Francisco Box Landform

Existing Scenic Character

A variety of landscapes across the Forest are managed to appear natural. This is done through a variety of management scenarios including providing semi-primitive non-motorized recreation settings. Approximately 45 percent of Forest lands are either designated wilderness areas or are inventoried roadless areas. Together these areas of the Forest provide an abundance of natural appearing landscapes. Refer to Figure 175 for a map depicting these natural landscapes.

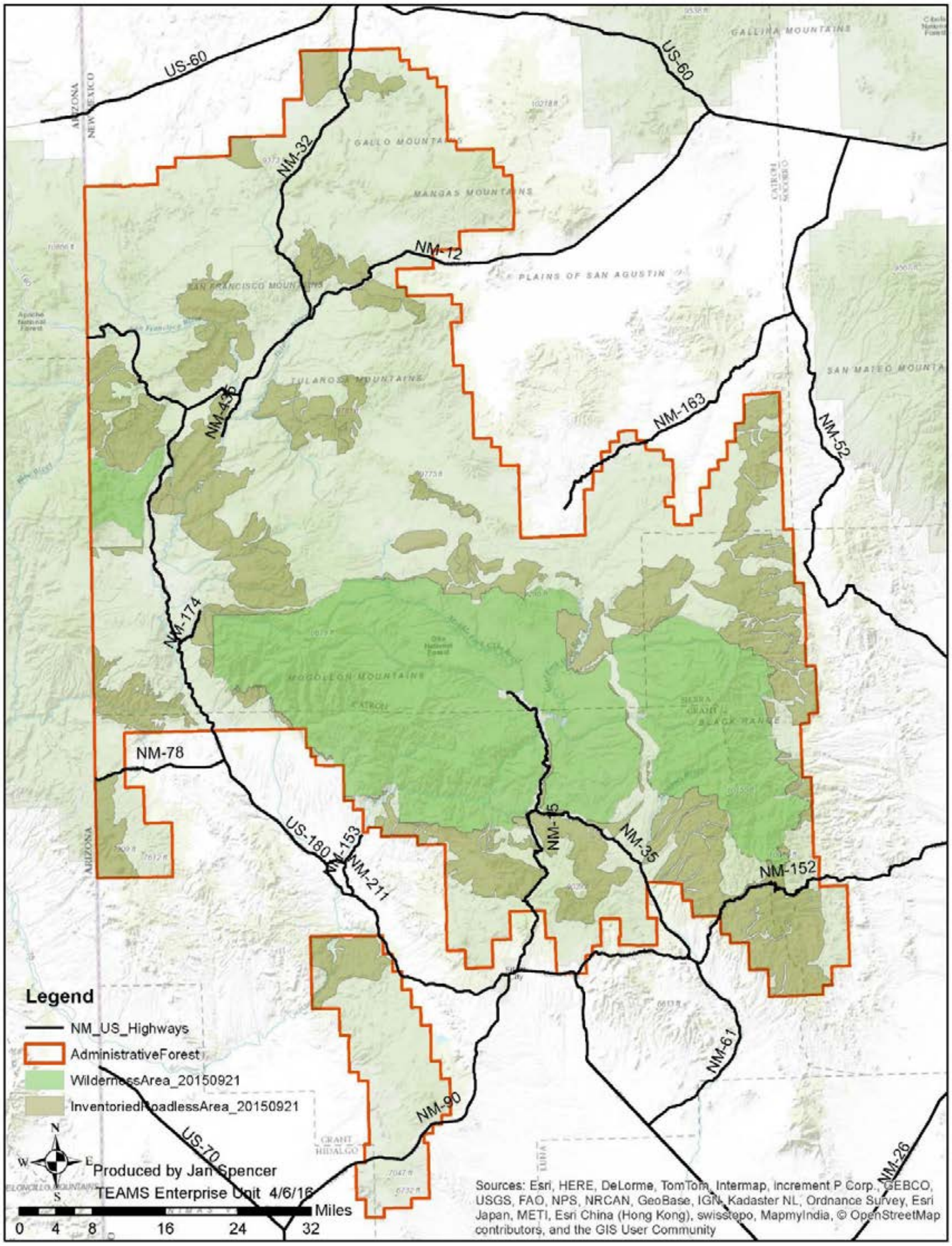


Figure 175. Map of areas that are natural appearing based on wilderness and inventoried roadless areas

The landscapes identified as suitable for timber harvesting may range from appearing slightly altered (but still natural appearing) to heavily altered depending upon implementation of planned management activities. Timber harvesting records from 1945 to 1993 show that 8 percent of the Forest had been managed for timber. During this time period timber production could be very noticeable in the landscape over several years. Although timber harvesting is one of the most noticeable activities on the landscape besides mining activities, because activity is site-specific and limited in scale, the majority of the scenic characteristics of the landscape were intact.

Natural disturbances affect Forest landscapes to varying degrees. Typically the events that create the most notable changes in the landscapes are insect and disease infestations, and fires that burn outside of the range of historic variability. The section “Trends Affecting the Condition of Scenic Character” has detailed information on how different disturbances affect current and future scenic conditions.

Potential Scenic Character

Natural appearing scenic character is a key component of recreation settings that attract outdoor recreation participants from all walks of life. The Forest has recognized the important contributions that scenic character plays by emphasizing it in the Forest recreation niche. Management of scenic character is intended to be planned in concert with the various multiple-uses that occur across the Forest to sustain the natural appearance of the landscape.

As shown in Figure 175, almost half of the Forest is managed to provide natural appearing landscapes. As long as the Forest continues to implement management activities that meet Scenic Integrity Objectives under the SMS, and react to natural disturbances such as insect epidemics and uncharacteristic wildfires in ways that would reduce the impacts to scenic character, natural appearing landscapes should continue to dominate the Forest. When recreation facilities are updated or newly constructed, efforts should be made to ensure the facilities meet the visual quality objectives and the Forest Service Built Environment Image Guide.

Factors Affecting the Condition of Scenic Character on the Gila National Forest

Landscape characteristics of scenery have been modified over the last century by implementation of management activities such as timber harvesting, prescribed burning, fire suppression, grazing, wildlife habitat improvements, utility corridor development, and recreation developments. These management activities typically impact scenic resources, but not to the same extent for all activities. This section will discuss the effects of the individual disturbances to scenic character.

Natural Disturbance Regimes

A wildfire that burns outside of the natural range of variability is likely to dramatically impact scenic resources over a long period of time. In contrast, localized patches of insect epidemics may cause tree mortality in a random pattern across a landscape level area. The mortality would impact scenic character, but may not be a dramatic effect to scenic character at the landscape level. These natural disturbance drivers combined with drought cycles have played a role in creating the current vegetative mosaic.

Fire

A current Gila NF priority is to restore and maintain ecosystems that are adapted to fire. In an attempt to use naturally-occurring wildland fire to reduce fuel levels along with achieving various resource benefits, the Gila NF manages natural fire starts if climatic conditions, private property, safety, and other conditions are favorable without risk of uncharacteristic fire for the vegetation type. Restoring the natural role of fire to these ecosystems has a very positive, long term effect to ecosystem resiliency. The reduction of the risk of large, high intensity, uncharacteristic fires occurring also contributes to the sustainability of scenic character in the future. When these resource areas benefit from using fire as a management tool, so does the scenic characteristics of vegetation.

Wildfire, whether human caused or a natural ignition, can heavily alter the vegetative component of scenic character. Forested areas that once had a closed canopy can rapidly become an open canopy with few live trees. This can have dramatic effect on the experiences of Forest visitors that have an attachment or sense of place about an area that has experienced high levels of tree mortality following a fire event.

The size of the majority of wildfire occurrences on the Gila NF is typically very small, ranging from 2 acres to less than 100 acres. In recent years drought conditions have contributed to an increase in wildfire size and intensities (see Chapter 9: System Drivers and Stressors). Impacts to scenic character from wildfires vary across the Forest from having little impact to drastically impacting large areas.

Although many factors (naturally occurring and human caused) contribute to fire severity and frequency, impacts from fires can have both negative and positive impacts to scenic character. An example is a stand replacement fire (i.e. high severity fire) in a mature mixed conifer vegetation type. Immediately after the fire event, the area have negative impacts to scenic character due to the amount of dead blackened trees, the presence of ash on the ground, and an overall lack of vegetation in that area. While the majority of these impacts initially have negative impacts to scenic character, the view from within the affected area to adjacent areas are increased. As the area recovers from the immediate effects of the fire event, wildflowers and ground cover increases along with a possible increase regeneration of aspen trees to provide a colorful setting to the area. The following figures are examples of effects from recent large fires with high severities. See Chapter 2: Upland Vegetation for more information on the fire regimes of the different ecosystems.

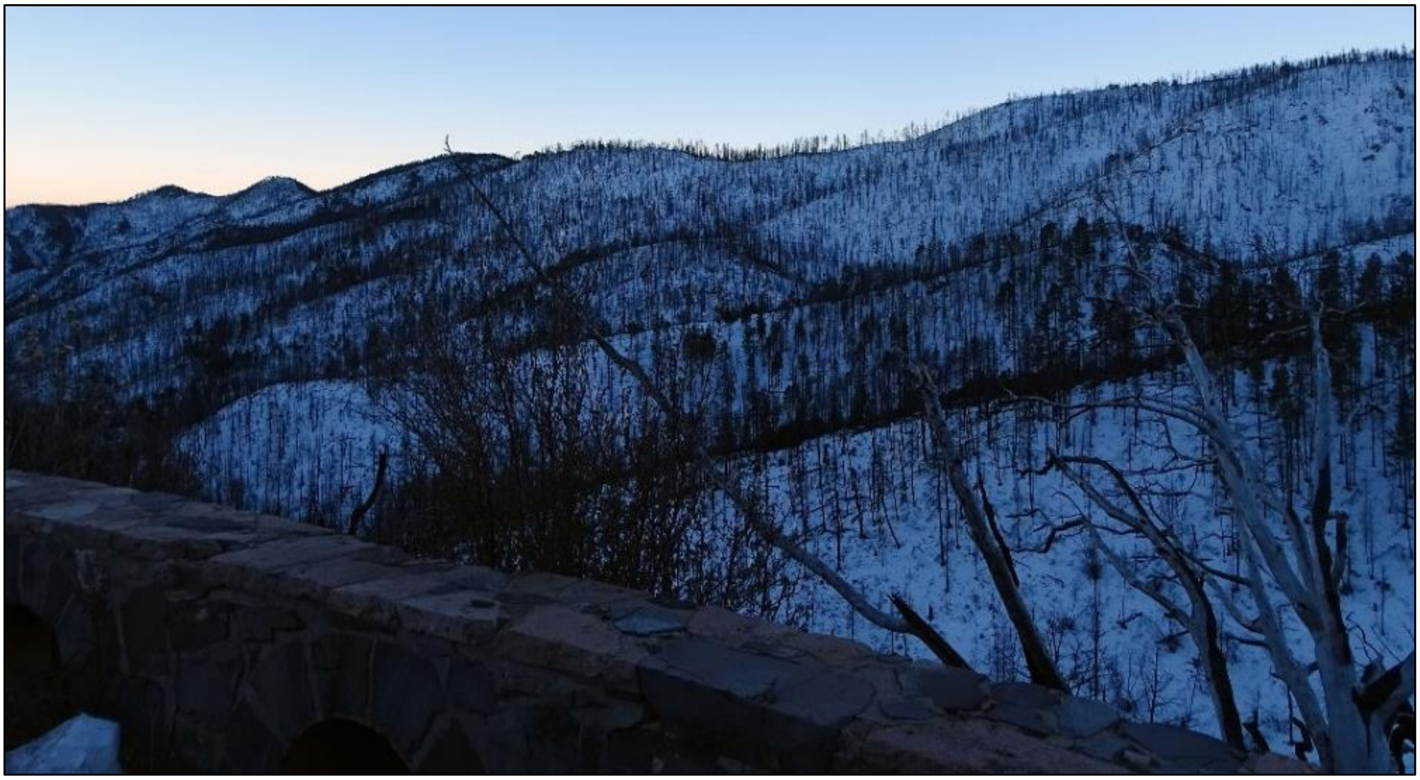


Figure 176. Effects from the Silver Wildfire of 2013 seen from Emory Pass Vista

Figure 177. Effects from the 2006 Bear Fire

Insects and Disease

Insects and diseases are natural components in forest ecosystems. The cyclic nature of endemic and epidemic levels of each have played a role in the historic vegetative patterns across the landscape, and will continue to influence the vegetative mosaic of the future. Both positive and negative changes to vegetation can arise from insect and disease presence. Positive changes may include, but are not limited to, variable openings creating diversity in the forest or woodland canopy, increased heterogeneity of species type, and structural age class. Large scale epidemics may negatively impact scenic characteristics of the landscape, such as a bark beetle epidemic that kills hundreds of acres of ponderosa pine. Historical records show no clear changes in outbreak patterns of native insects and diseases on the Gila NF. Refer to the Insects and Disease discussion in Chapter 2: Upland Vegetation and Chapter 9: System Drivers and Stressors for further information.

Human-Caused Disturbance

A variety of management activities have occurred over a century across the landscape of the Gila NF. Some of these activities have included timber harvesting to support the railroad industry, grazing, mining, and fire suppression. Spread of nonnative species and noxious weeds has occurred in various locations. These historical activities have contributed to the vegetative mosaic influencing the current scenic characteristics. Suppression of fire has led to stands to becoming overstocked, creating a higher risk of wildfire. Grazing has been taking place since before the establishment of the National Forest. Other activities include, but are not limited to, communication site development, utility lines, and mining.

Fuels Reduction Treatments

Fuel reduction treatments, including mechanical methods and prescribed burning, help contribute to a natural appearing landscape and reduce the risk of high intensity fire which would negatively impact scenic character.

The following activities, accomplished in 2010 and 2011, are reflective of typical fuel reduction treatments on the Gila National Forest. In 2010 the Forest treated a total of 23,400 acres through the use of prescribed fire and mechanical removal. The majority of acres were treated with prescribed fire. In the five years prior to 2016, mechanical treatments have focused on the wildland urban interface (WUI) areas. Vegetation treatments in WUI and other areas that promote the natural role of fire across the landscape also serve to enhance the vegetative components of scenic character.

Timber

Prior to 1996 the Gila NF emphasis for timber management was to conduct even-age management treatments. In an effort to comply with the Mexican spotted owl and northern goshawk guidance, the Forest transitioned to emphasizing the use of uneven-aged management techniques. The uneven-aged management treatments result in more natural appearing landscape characteristics. In the last decade the majority of treatments occurred in ponderosa pine and piñon pine/ juniper stands. This shift in management practices enhances scenic character by reducing the likelihood of uncharacteristic wildfires. Refer to the Timber section of Chapter 11: Multiple Uses for additional details regarding these practices.

Vegetation management activities can have variable impacts to the scenic characteristics of the vegetative component of scenery management. Some activities may be more dominant in the surrounding natural appearing landscape than others. The permanent land clearing that was done for the Tucson Electric Power Company electric transmission line corridor is in direct contrast to the surrounding natural landscape characteristics and would be considered as very low scenic integrity. It is recognized that some deviations must necessarily be allowed for some uses and under certain circumstances, such as establishment of a new powerline ROW, but there may also be required mitigations assigned to reduce impacts. Shelterwood establishment cuts, wildlife habitat regeneration cuts, and fuel breaks usually also have a low scenic integrity. The thinning and mastication shown in Figure 178 and the prescribed burn in Figure 179 have a moderate scenic integrity level/slightly altered appearance.

Figure 178. Thinning and Mastication around Poverty Creek

Figure 179. Prescribed Fire at Indian Peaks

Developed Recreation

Developed recreation facilities on the Forest should be designed to complement and blend into the landscape. This is true of both Forest Service facilities and facilities operated under special use permit. The 1986 Forest plan, along with national policies for developed recreation sites, have provided direction as to what visual quality objectives needed to be met for developed recreation facilities on the Forest. Under the new plan, the Scenery Integrity Objectives for these areas will be managed under Scenery Management System.

The Gila NF has a range of developed recreation facilities, including day use sites, trailheads, campgrounds, and boat ramps. The facilities vary in the degree that they blend into the surrounding landscape characteristics. Figure 180 and Figure 181 display examples of developed recreation facilities.

Figure 180. Quemado Lake Recreation Area

Figure 181. Campsite in the Mesa Campground blending into the surrounding landscape

Utilities

Installation and maintenance of utilities rights of way on Forest lands usually create long-term modifications to the landscape. Powerline corridors are by necessity managed to keep vegetation at a minimum height over the width of the corridor to ensure reliable electrical service and human safety. The following photo taken on the Quemado District illustrates the contrast of the surrounding Forest and a maintained utility corridor. The distinct edge of the corridor is defined by lack of vegetation on the hill in the middle of the photo.

Figure 182. Powerline Utility Corridor in the Foreground Distance Zone

Conditions and Trends Affecting the Quality of Recreational Settings

External factors affecting the opportunity and condition of recreation related activities primarily involve wildfire. In the previous 15 years, the Gila NF has experienced many large, high severity wildfires that have drastically changed landscapes across the Gila NF. These large wildfires have directly and indirectly impacted many recreation facilities and trails on the Gila NF. Although there have been many large scale prescribed fires and managed fires for resource benefit on the Gila NF, typically care was taken to minimize effects from these types of fires to values such as recreation opportunities, trail opportunities and scenic character. In the previous five years, there have been a total of 1,208,354 acres of wildfires at a minimum of 1,000 acres in size occurring within or immediately adjacent to the Gila NF. During this same time period, there were four fires over 85,000 acres each, and in three consecutive years (2011, 2012, and 2013), the Gila NF had a fire over 100,000 acres in size each of these years.

The current trend shows a likelihood for higher severity fire and flood events to occur in the future, along with more frequent intervals of these events. There are many common impacts from the aforementioned wildfires to recreation facilities and trails. Some of the impacts include: temporary recreation area and trail closures during the incident and post-fire effects of infrastructure damage and visual impacts to the landscape. Typically impacts from large, high severity wildfires may cause greater damage with a longer duration of effect. Areas within and surrounding large fires typically experience more intense and frequent flooding. Other impacts/damages include landslides, dead trees falling on or within facilities and trails, encroaching nuisance vegetation, erosion, extended closures due to hazardous conditions, and silting in of available water sources. Rehabilitation and restoration projects may take several years to fund and complete, which could delay other planned projects from being addressed.

Climate Conditions

The Southwest has recently experienced an extended drought, and climate predictions indicate drought conditions are likely to reoccur on a cyclical basis. As fire danger increases, restrictions may be put in place to reduce the risk of human-caused fires. Depending on the severity of conditions, restrictions typically range from a ban on open campfires to Forest closures. These restrictions limit access to recreational settings and opportunities.

Extended periods of warm weather may also lead to a longer "summer" recreation season, starting earlier in the spring and extending later into the fall. A longer recreation season may necessitate the need to extend employment for seasonal staff, while incurring additional operation and maintenance costs.

Extended droughts directly affect available water sources for hikers. Across the Forest, there is already limited water sources, and in many areas the distance between water sources limits the opportunities for trail users. The Forest has experienced loss of previously reliable water sources from extended droughts, damages from wildfires, and a lack of maintenance to remote water developments. The risk associated with the loss of water sources is limitations to user experiences due to lack of reliable water and an increasing need to carry larger amounts over longer distances.

In addition to water sources, these same stressors affect water levels of the streams and lakes located within the Gila NF. As stream and lake levels decrease, the diversity of recreational opportunities become more limited. This results in concentrated use of streams that continue to have flowing water conditions, and adds pressure to streamside trails. The flow rate, along with depth, can determine the quality of fishing, navigability by watercraft, and suitability for swimming or bathing in hot springs. At lakes, decreasing lake levels affect access along shorelines, practical utility of boat ramps, and may result in lower visitation numbers.

Sustainability of Recreation and Scenic Character Opportunities

The goal of sustainable recreation is to:

- Provide a diverse range of quality natural and cultural resources-based recreation opportunities, and protect the natural, cultural, and scenic environment for present and future generations to enjoy
- Partner with public and private recreation benefit providers to meet public needs and expectations
- Perform and plan by implementing systems and processes to ensure effective decisions, sound investments and economic efficiencies.

National forests can no longer depend solely upon appropriated funding to meet constituents' needs, and must unite diverse interests and focus scarce resources to sustain and expand the benefits of outdoor recreation. To sustain these benefits, the recreation program must achieve a sustainable balance among the three spheres of environmental, social, and economic conditions (USDA FS 2010h).

The current trend observed on the Gila NF is of increasing demand for services and levels of recreation use, in conjunction with flat or declining budgets and fewer staff. These factors make it increasingly difficult to maintain and operate the existing recreation and trails program infrastructure to standard. In addition, recreation facilities, particularly older sites, may no longer align with the capacity or use for which they were originally designed. The risk associated with not implementing a Forest-wide sustainable recreation strategy is that the program will continue to struggle to provide quality recreational and trails opportunities to the public.

The Gila NF has created a Sustainable Recreation Strategy Action Plan to enable the recreation program to meet the needs of the public and protect resources, while being more efficient, effective, and sustainable within the current budget environment. The Forest expects this action plan to be an evolving document based upon stakeholder input both internally and externally.

Influences Outside of the Plan Area Affecting Demand for Recreation

There are many factors and influences outside of the planning area that affect the use of and demand for recreation on the Gila NF. Examples of these influences include the preferences of New Mexico residents and out of state visitors for recreation opportunities, economic conditions, statewide and national recreation activity trends, and current / future recreational development within New Mexico.

Approximately every five years, the New Mexico State Parks with cooperating agencies and partners produce a comprehensive outdoor recreation plan. These documents compile data of trends and influences that affect recreation along with objectives and actions for New Mexico State Parks and partners. The two most recent plans were published in 2009 and 2015.

According to the 2015 Plan (NM EMNRD 2015), the favorite outdoor activities across the state of New Mexico are as follows:

• Walking, hiking, and running	41%
• Hunting, fishing, shooting, and wildlife viewing	17%
• Camping	10%
• Visiting parks, lakes, and sightseeing	6%
• Team and individual sports	6%
• Biking and equestrian	5%
• Swimming and boating	4%
• Other activities	9%

These numbers are comparable to the NVUM data collected on the Forest and show that the trend of preferred activities on the Gila NF and within the State of New Mexico are similar. This information emphasizes the importance of meeting the desired activities of visitors.

The Viva New Mexico plan identifies five key themes in which objectives and action items were identified to increase benefits that outdoor recreation can provide within New Mexico. The five themes are as follows:

- Community Livability
- Trails
- Health
- Economic Vitality
- Environmental Health

It is important that the Gila National Forest reference this plan when developing strategies for forming new partnerships or strengthening existing partnerships. These plans provide useful information such as the availability of alternative funding sources that could be taken advantage of to assist with completing future projects. Wherever the goals and actions of these plans align with those of the Gila NF recreation program, coordinated efforts could result in improved recreational opportunities within the Gila NF to future potential visitors.

Currently there is an emphasis by the Gila NF to coordinate and partner with the State of New Mexico, local communities, chamber of commences, and other government agencies. Coordination with these partners helps to develop a common vision for needs and desires of the recreating public, and to make the most of developing new opportunities and improving existing ones. The Forest is already working with local communities to emphasize recreation opportunities that could attract visitation and provide benefit to local economies. The biggest risk associated with insufficient communication with these partners is a possible difference of priorities and vision.

Recreation opportunities on other lands within the broader landscape

There are a number of recreation opportunities available adjacent to and nearby the Gila National Forest. The Gila Cliff Dwellings National Monument, administered by the National Park Service, is located near the center of the Gila NF; and to the west of the Gila NF and across the border in the state of Arizona are the Apache-Sitgreaves NFs; and to the northeast are segments of the Cibola NF. Both of these Forests offer many similar recreational opportunities to ones that may be found on the Gila NF. Differences from opportunities with these two nearby forests are the Gila NF has significantly larger wilderness areas and less development, while the Apache-Sitgreaves NFs tend draw more visitors for snow related activities, and have more fishing opportunities.

There are several New Mexico State Parks in the area surrounding the Gila NF that offer hiking and camping. Two nearby State Parks are located on some of largest lakes in New Mexico (Elephant Butte Lake and Caballo Lake), offering a variety of water related recreation opportunities as well as camping and hiking. Two other state managed lakes in the area that are popular fishing destinations are Bill Evans Lake and Bear Canyon Lake. City of Rocks State Park offers camping and hiking opportunities.

There are a number of BLM developed recreation sites in the Gila NF region that offer hiking, camping, visitor center activities, and other opportunities. Additionally, many adjacent BLM lands (and New Mexico State Lands) allow both hunting and dispersed camping. The primary difference between many of these aforementioned areas (except for the Apache-Sitgreaves NFs) is that they feature a semi-arid desert environment with limited forested areas as compared to the Gila NF.

There are several National Wildlife Refuges administered by the U.S. Fish and Wildlife Service located within the broader area, including the Bosque Del Apache, Sevilleta, and San Andres National Wildlife Refuges. These refuges all provide excellent opportunities for wildlife viewing, including large bird migrations.

Many of the recreation opportunities adjacent to the Gila NF have a minimal impact on the demand for recreation services provided by the Forest. In many situations, visitors to nearby opportunities will make use of recreation sites on the Forest as well. The majority of adjacent recreation opportunities offer a different recreation experience (either in a different ecological setting or unique activity not offered on the Gila NF), which allows visitors to southern New Mexico a variety of experiences in diverse settings. A common trend observed among visitors to southern New Mexico is that when visiting their planned destination, they discover other recreation opportunities found within the area.

Stakeholder Input

There were a number of comments received relating to the personal value of recreation on the Gila NF. Some common values identified included: opportunities for hunting and fishing, trails and roads for access and recreation, opportunities for developed and dispersed recreation, open access to the Forest, the need for current information, development of the Cosmic Campground, protection of wilderness and primitive areas, economic benefits to local communities, and opportunities for future generations to use the Gila NF.

There were also comments received that questioned the validity of the analyzed NVUM data that was collected in 2006 and 2011 in light of recent events and circumstances, such as changes in economic conditions, and fire and flooding events, that have occurred since that data was collected. There was a desire expressed for considering more recent data that may show these effects. Comments also questioned future trends in use by the Baby Boomer generation. These comments proposed that as they aged, some of the activities this demographic engaged in would no longer be physically possible, and so there may be downward trend popularity of those activities. Comments also speculated that implementation of the Travel Management Rule may reduce future numbers of OHV recreation on the forest, with a similar effect to dispersed camping, although 3,334 miles of road and 174 miles of trail are currently open to motorized travel, and camping is allowed in 36 approved areas, and within 300 feet of 1,316 miles of dispersed camping road corridors.

Comments related to current recreation conditions on the Gila NF were similar. There were many comments about the need to update and improve existing campgrounds. People felt that there is a need for additional opportunities for camping. It was also identified that there is lack of interpretive and environmental education services offered by the Forest.

Many comments noted that the majority of trails were in poor condition, and that many popular trails were currently closed to the public. Other comments also mentioned the impact of flooding and wildfires on trail conditions, and noted that declining budgets affected the amount of maintenance being completed. There were concerns expressed that new, realigned, or reconstructed trails should be of a sustainable design. Comments also noted that many trail signs are unreadable or completely missing, and the need for updated trail maps.

Many trends were identified through public comments. An increase of litter and trash scattered throughout the Forest has been observed. Conflicts amongst different user groups have been increasing. The trend of decreased budgets and emphasis of the recreation program affecting the conditions of facilities and trails was observed. Limiting access, closing roads / trails, and closing existing campgrounds was also a common comment. One stakeholder suggested identification of gaps in providing sufficient public access for recreational use to important areas of the Gila NF and how strategic access points could be created through land acquisitions, access easements or other tools.

Comments also identified several risks to the recreation program. Risks of declining visitation and use of the Gila NF due declining conditions of facilities and trails will have negative impacts to local economies. Lack of outreach about recreational opportunities will result in future visitors overlooking the Gila NF as a destination. The risk of extended and seasonal closures of developed recreation sites and trails will lead to overcrowding of open sites, increased user conflicts, and an increase in resource damages.

Summary

The Gila NF features a unique and diverse range of recreational opportunities as compared to other national forests within the Southwest Region. Opportunities for solitude, either as part of a wilderness experience, or even when pursuing more developed recreation experiences is one of the strengths of the Gila NF. This opportunity for experiencing large areas of undeveloped wilderness combined with the Gila NF's association with Aldo Leopold creating of the world's first designated wilderness area make the Forest a national and international destination.

Demand for recreational opportunities on the Gila NF is increasing, while many in-demand opportunities have limited availability on lands adjacent to the Forest. Effects to the recreation program are increasing by more frequent, uncharacteristically severe intensity wildfires, post-fire flooding, drought, insects and disease, and an increasing backlog of deferred maintenance for recreation facilities and trails. These impacts negatively affect the quality of recreation settings, opportunities, seasons of use, and visitor experiences. Management of Forest recreation opportunities with stagnant or declining budgets, limited staffing, conflicting user group demands, and resource impacts will continue to be a challenge. It will be vital for the Forest recreation program to work internally with other program areas and externally various partner groups, currently underserved communities, and volunteers to develop and implement a sustainable recreation program.

Chapter 13. Designated Areas

Introduction

Every National Forest has areas that contain special, exceptional, or unique values. Many of these areas meet the criteria to be considered special places and can be designated special status. This status can be on a national, regional, or local scale. Designated areas are specific areas or features within the plan area that have been given a permanent designation to maintain its unique special character or purpose. Designation of these areas undergoes rigorous scrutiny and study that can last years, depending on individual circumstances. Official designation of areas may be established by statute (statutorily designated areas or often called congressionally designated areas) or by administrative processes (administratively designated areas).

Designated areas within the Gila NF by type of designation include:

- Statutorily Designated Areas
    - Three wilderness areas
    - Two wilderness study areas
    - One national scenic trail
- Administratively Designated Areas
    - 29 inventoried Roadless areas
    - One research natural area
    - Two scenic byways
    - Three national recreation trails
    - Critical habitat for six threatened and endangered species

Areas within the Gila NF eligible or recommened for designation include:

- Eight eligible wild and scenic rivers (eligibility is completed administratively, official designation is completed through Statute)
- Four proposed research natural areas

Some benefits of designated areas may include connecting people to their natural and cultural heritage, providing unique recreational opportunities, preserving intact natural systems, and protecting special or unique features.

This chapter will discuss:

- Ecosystem Services of Designated Areas
- Descriptions of Existing Designated Areas located within the Gila NF
- Current Conditions, Uses, and Trends of Designated Areas Within the Gila NF
- Designated Areas located adjacent and near the Gila NF
- Potential Need or Opportunity for Future Designations
- Contributions of Designated Areas to Social, Economic, and Ecological Sustainability
- Synopsis of Stakeholder Input received on designated areas
- Chapter Summary

The chapter will not address the separate but required inventory and evaluation process which is governed by Chapters 70 and 80 of the 2012 Planning Rule. This separate process requires the Gila NF to identify and evaluate lands which may be suitable for inclusion in the national wilderness preservation system (see FSH 1909.12, Chapter 70) or the wild and scenic rivers system (see FSH 1909.12, Chapter 80). The Gila NF will conduct inventory and analysis through a separate public engagement process following the assessment but prior to the development of alternatives during the formal plan development process as governed by the National Environmental Policy Act.

Ecosystem Services of Designated Areas

Ecosystem services of designated areas provide some level of protection for the values they were designated for. This allows regulating services, such as storage of carbon, water filtration, climate regulation etc. to function with some level of protection. For example, designated areas often provide high-quality water, soil, and air resources (DellaSala et al. 2011). Designated areas can play a role in conserving biodiversity and facilitate connectivity (Loucks et al. 2003). In addition, designated areas can provide important social and economic services, including significant recreational and scenic opportunities, places to connect with nature and spirit, and contribute to the local tourism industry (Rasker 2006). They also offer the ability to connect with history and provide places for research.

Wilderness

The concept of managing some areas within the National Forest System as wilderness was first applied in 1924, with the administrative designation of the Gila Wilderness at the urging of the conservation pioneer Aldo Leopold. The Gila Wilderness became a part of the National Wilderness Preservation System when Congress passed the Wilderness Act of 1964. The definition of wilderness from the 1964 Wilderness Act is:

> “A Wilderness in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.”

In the 1964 law, Congress acknowledged the immediate and lasting benefits of wild places, by passing landmark legislation that permanently protected some of the most natural and undisturbed places in America. The Wilderness Act established the National Wilderness Preservation System "...to secure for the American people of present and future generations the benefits of an enduring resource of wilderness.” In 1980, the Blue Range and Aldo Leopold Wilderness Areas became part of the National Wilderness Preservation System with the passage of the New Mexico Wilderness Act. The three wilderness areas together total around 792,584 acres, or approximately 24 percent of the Gila National Forest (Figure 183).

The Wilderness Act prohibits permanent roads and the use any form of motorized or mechanized transport within wilderness areas. The Wilderness Act requires management of human-caused impacts and protection of the area's wilderness character to insure that it is "unimpaired for the future use and enjoyment as wilderness."

The Wilderness Act describes wilderness using the following four qualities of “wilderness character”:

- Untrammeled – free from modern human control or manipulation
- Natural – where the natural condition of the land, its plants, wildlife, water, soil, air and the ecological processes are managed, protected and preserved
- Undeveloped – retaining its primeval character and influence, as is essentially without permanent improvements or human occupation
- Outstanding opportunities for Solitude or Primitive and Unconfined Recreation – opportunities for solitude or primitive and unconfined recreational experiences

There is sometimes a fifth quality of wilderness character called "Other Features of Value," which are ecological, geological or other features of scientific, educational, scenic, or historical value that are truly unique and essential to the character of a particular wilderness, but this may not be applicable to all wilderness areas.

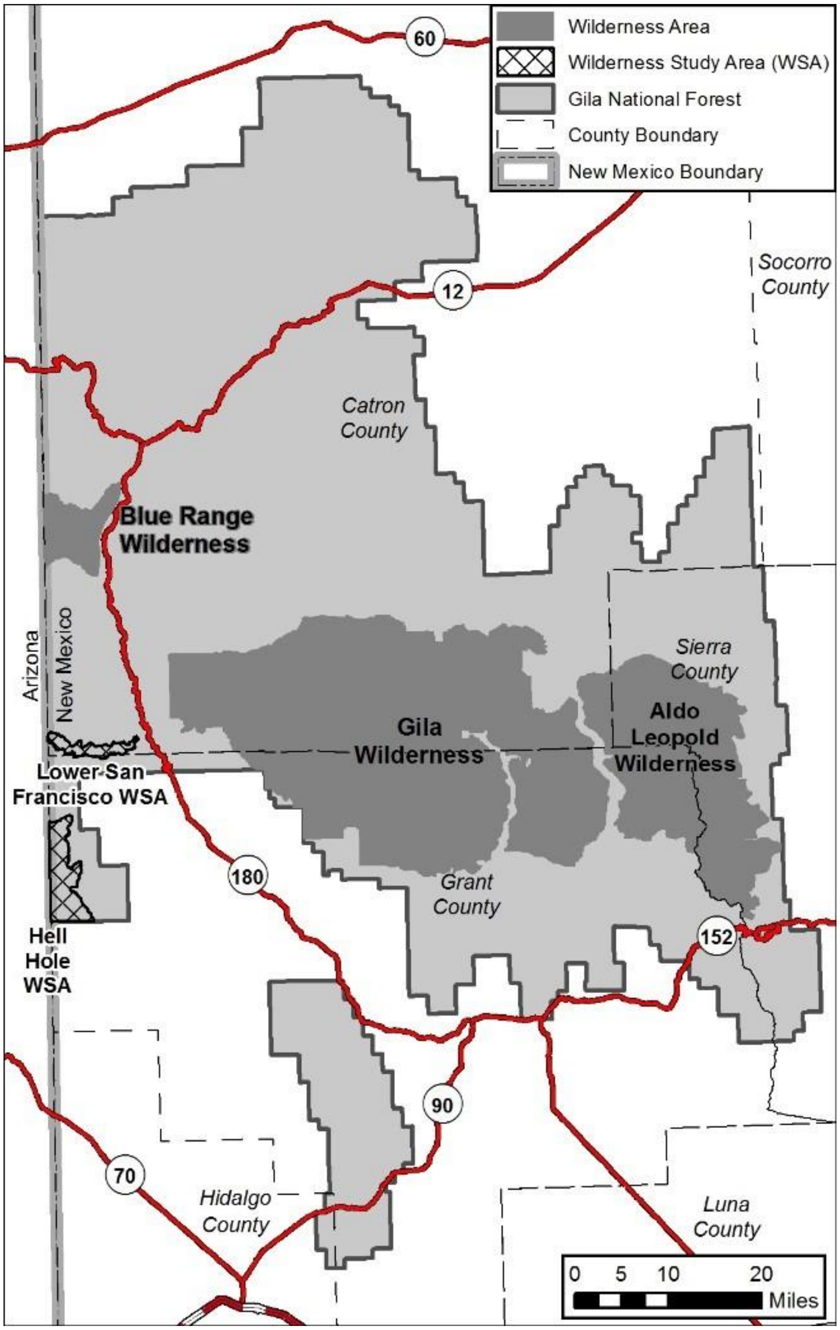


Figure 183. Wilderness and Wilderness Study Areas, Gila National Forest

All of the Gila NF's wilderness areas have the following characteristics in common:

- Popular activities within wilderness on the Gila NF include: hiking, backpacking, horseback riding, camping, hunting, fishing, and wildlife viewing.
- Many of these activities provide opportunities to seek solitude in a natural primitive setting.
- Current overall recreational use of the wilderness on the Forest is considered relatively low as compared to other wilderness areas located nearer to large metropolitan areas. However, each wilderness area has popular trails and specific that may experience periods of high use and associated concerns for impacts to resources and the solitude component of wilderness character.
- There are significant numbers of documented intrusions by motorized vehicles in all of the wilderness areas. This tends to mostly occur where gentle terrain intersects the boundaries of wilderness areas, and additional undocumented intrusions may be occurring in remote locations of the wilderness boundaries. Implementation of the travel management decision (including the prohibition on cross-country travel and designation of a motorized route system) may reduce the recurrence of motorized trespass and help protect wilderness character.
- A significant backlog of trails maintenance currently exists forest-wide, and particularly within fire-affected areas of wilderness. This situation can create issues with resource damage due to erosion, more concentrated use in unaffected areas and poorly located user-created trails, which may have a detrimental effect to overall wilderness character.
- Although most commercial uses are prohibited, Outfitter/Guide (O/G) use is permitted to the extent allowable under the Wilderness Act. However, adequate O/G program oversight is essential to ensure that O/Gs are in compliance with the terms of their permit to protect wilderness character, and that they are following appropriate Leave No Trace practices and interpreting wilderness values to their clients.
- The sights and sounds of military overflights have a negative effect on opportunities for solitude in wilderness across the Forest.
- The 1986 Gila Forest Plan mandates the management of the wilderness resource for quality wilderness experiences and to protect and preserve the unique wilderness character of each wilderness area. The plan provides a number of standards and guidelines for the purpose of achieving this desired condition.
- The 1986 Forest Plan also provides direction for allowing wildfire to be managed for resource benefit within wilderness. Managing fires for resource benefit can be challenging due to public concerns, adjacent private land issues, and the effects of fuel loading, slope, aspect, terrain, and/or seasonality on fire intensity. Use of prescribed fire presents challenges dealing with fuel loadings, threatened and endangered species restrictions, and mimicking the timing of naturally occurring fire. Although wilderness resource benefits may be a positive secondary effect, by agency policy prescribed (agency ignited) fire may only be used in wilderness for fire management objectives (i.e., to reduce the possibility of future wildfires moving onto adjacent private property, or to reduce fuel loading and the likelihood of high intensity wildfires outside the natural range of variability).
- The 1986 Forest Plan provides the following management direction specific to wilderness areas:
    - Maximum group size of 25 persons and/or 35 head of pack and saddle stock
    - Organized recreation events either competitive or non-competitive (for example: runs, games, trail endurance events, etc.) will not be allowed within designated wilderness areas
- To meet the requirements of law, policy and regulation, the Forest must undergo a Minimum Requirements Analysis (MRA) prior to undertaking any management action within congressionally designated wilderness. The MRA is a process to determine what is the least intrusive tool,

> equipment, device, force, regulation, or practice determined to be necessary to accomplish an essential task that will also achieve wilderness management objectives. The management tool that is most commonly used to conduct an MRA process is known as the Minimum Requirements Decision Guide (MRDG).

According to National Visitor Use Monitoring (NVUM) data that was collected on the Gila NF in 2006 and 2011, there has been an increase of visitation to wilderness areas from 18,000 reported visits in 2006 to 21,000 visits in 2011 on the Gila NF. In addition to the trend of increased number of visits, the average duration of a visit to wilderness areas on the Gila NF has increased from 15.5 hours per visit to 17.3 hours per visit. The risk of increased visitation is that popular areas may be experiencing periods of high use which could decrease the quality of a solitude experience. This risk may be a contributing factor to the trend of longer average duration of a single visit, due because of a need to visit more remote areas to experience solitude.

Gila Wilderness

The cache of being the world's first formerly designated wilderness, combined with the associated ties to legacy of conservationist Aldo Leopold, makes the Gila Wilderness a national and international destination. However, the Gila is also a draw for visitors who seek a primitive natural experience, regardless of its place in the history of wilderness management. At 559,688 acres, the Gila is New Mexico's largest wilderness, with an extensive trail system providing access. High mesas, rolling hills, and deep canyons distinguish the eastern portions, as do piñon and juniper woodland and a few grassland areas. Ponderosa pines blanket the central portion, with sheer cliffs outlining the Gila River. The west and southwest portions boast high mountains with spruce-fir forests, particularly within the Mogollon Range, with elevations up to 10,895 feet at Whitewater Baldy. The headwaters of many important rivers and creeks originate in the Gila Wilderness.

Of all the wilderness areas on the Gila NF, the Gila Wilderness receives the majority of recreational use. Most of this use occurs from early spring through late fall. Popular recreation activities within the Gila Wilderness include backpacking, day hikes, horse / pack trips, and big game hunting. Current visitation is generally light, with minimal user conflicts. Some areas within the Gila Wilderness do experience periods of high use, in particular the East, Middle, and West Forks of the Gila River and trails located near Gila Cliff Dwellings National Monument. When water levels in the rivers are high enough, rafting and kayaking does occur on the Gila River from Grapevine Campground to Mogollon Box. The popularity of these areas are due to proximity to water sources and access to the wilderness boundary.

The Gila Cliff Dwellings National Monument (administered by the National Park Service) is a popular destination, and many visitors to the monument also take time to hike on one of the nearby trails that lead into the Gila Wilderness. This contributes to the trend of high visitation to these areas of the Gila Wilderness during summer months. The risk of increased visitation includes over-crowding which could limit the opportunity for visitors to experience solitude.

Other risks of popular areas and trails are increased opportunity for user conflicts, resource damage from overuse of popular trails and campsites, and increased user-developed trails. There are many areas within the Gila Wilderness that experience very light visitation. These areas include trailheads located away from populated areas with difficult access, areas within the Gila Wilderness that are greater than 10 miles from the nearest boundary, and many locations within the wilderness that have limited water sources. The risk to these areas is that without regular use, many remote trails are a low priority to receive maintenance and tend to be declining in condition. Many trails in these less-visited areas are difficult to find and to follow. Poor trails can limit recreational opportunities and create social trails into ecologically fragile areas which diminish wilderness character.

Grazing and grazing improvements are expressly authorized under the1964 Wilderness Act, which states "The grazing of livestock, where established prior to the effective date of this Act, shall be permitted to continue subject to such reasonable regulations as are deemed necessary by the Secretary of Agriculture." Therefore grazing continues within the Gila Wilderness, although significant grazing reductions on the Gila NF within wilderness and non-wilderness alike occurred in the 1950s and then again in the 1990s. Since then, grazing numbers within the Gila Wilderness have remained fairly stable, with some decline for at least the past 10 years. There are a number of grazing allotments within the Gila Wilderness that are currently in non-use status, or grazing less than the administratively permitted numbers.

Grazing management activities that occur within the Gila Wilderness on active allotments includes maintenance to range improvements such as fences, water structures, gates, and holding pens. Some visitors to the Gila Wilderness have expressed that the existence of grazing does have a negative effect to their wilderness recreation experience. There is a risk that these activities could impact visitors' solitude experience during implementation and consequential negative visual effects. However, to mitigate any visual effects from fences and structures, the location is preferred to be out of the view of existing trails. Additionally when possible, materials and designs that blend in with the surrounding area are utilized to minimize impacts that can detract from a wilderness experience.

There are many existing or potential management activities that occur within the Gila Wilderness. The risk of nonnative species establishment and expansion within the Gila Wilderness has profound negative impacts to the natural quality of wilderness character, particularly in riparian/aquatic areas where many nonnative species may outcompete native species. The short-term negative effects to untrammeled quality during nonnative control activities are considered against the long-term positive effects to the natural quality of the wilderness character in the Minimum Requirements Analysis process.

The Gila NF routinely partners with the New Mexico Game and Fish Department along with the US Fish and Wildlife Service to complete a variety of habitat improvement and species management activities within the Gila Wilderness. The trend of these activities has remained constant in recent years. Most of these activities occur on an annual basis, and after being analyzed by the Minimum Requirements Decision Guide are found to have minimal impacts to wilderness character in comparison to positive effects. The risk of these projects include negative effects to the untrammeled quality of wilderness character, short term disruptions in location-specific areas while work is conducted that could affect opportunities for solitude. However, the risk if these projects are not completed would have a negative effect to the natural qualities of wilderness character.

Other activities that may impact wilderness character and visitor experiences include trail maintenance/construction, administrative cabin maintenance, and fire lookout tower operations. Many times, the risk of affecting wilderness character has a short duration during the activity, but has a long-term benefit overall. When these activities occur, the design of the features attempts to blend them into the natural environment when possible.

The ecological condition of the Gila Wilderness is dependent on many environment factors. During periods of prolonged drought, decreased water levels in streams, springs, and rivers within the Gila Wilderness have been observed. Drought and reduced water levels may limit recreational opportunities, affect wildlife, impact aquatic species, and affect vegetative health, increasing susceptibility to insect and disease outbreaks and increased likelihood of uncharacteristic wildfires outside the natural fire regime for specific ecosystems (see Chapter 9: System Drivers and Stressors).

Fire management activities that occur within the Gila Wilderness include actions related to fire suppression and management of naturally ignited fires. The Gila NF has trended towards managing naturally ignited fires within the Gila Wilderness across the landscape since the 1970's when conditions are favorable. Risks associated with managed fire include short term negative effects to air quality, potential for areas experiencing high severity fire effects, and possible temporary area closures. However, the risk of not managing these fires leads to continued fuel loading and a higher potential for uncharacteristic fire severity in the future negatively impacting the ecosystem. Restoring the natural role of fire to the ecosystem has a very positive, long-term effect to wilderness character and ecosystem resiliency. In contrast, large areas of uncharacteristic fire may be detrimental to wilderness character and cause significant ecological impacts such as erosion, stream sedimentation, vegetation loss, and negative impacts to certain wildlife and aquatic species (see Chapter 9: System Drivers and Stressors).

During the past ten years there have been several large fires that have occurred within the Gila Wilderness, see Figure 184. The majority of these large fires have occurred in the central and western portions of the Gila Wilderness. Fire severity is dependent on weather conditions, fuel loading / type, and when the area has last experienced fire. Many fires within the Gila Wilderness burn in a mosaic pattern with lower severities in locations where recent fire has occurred to high severity where there has been minimal fire in recent history.

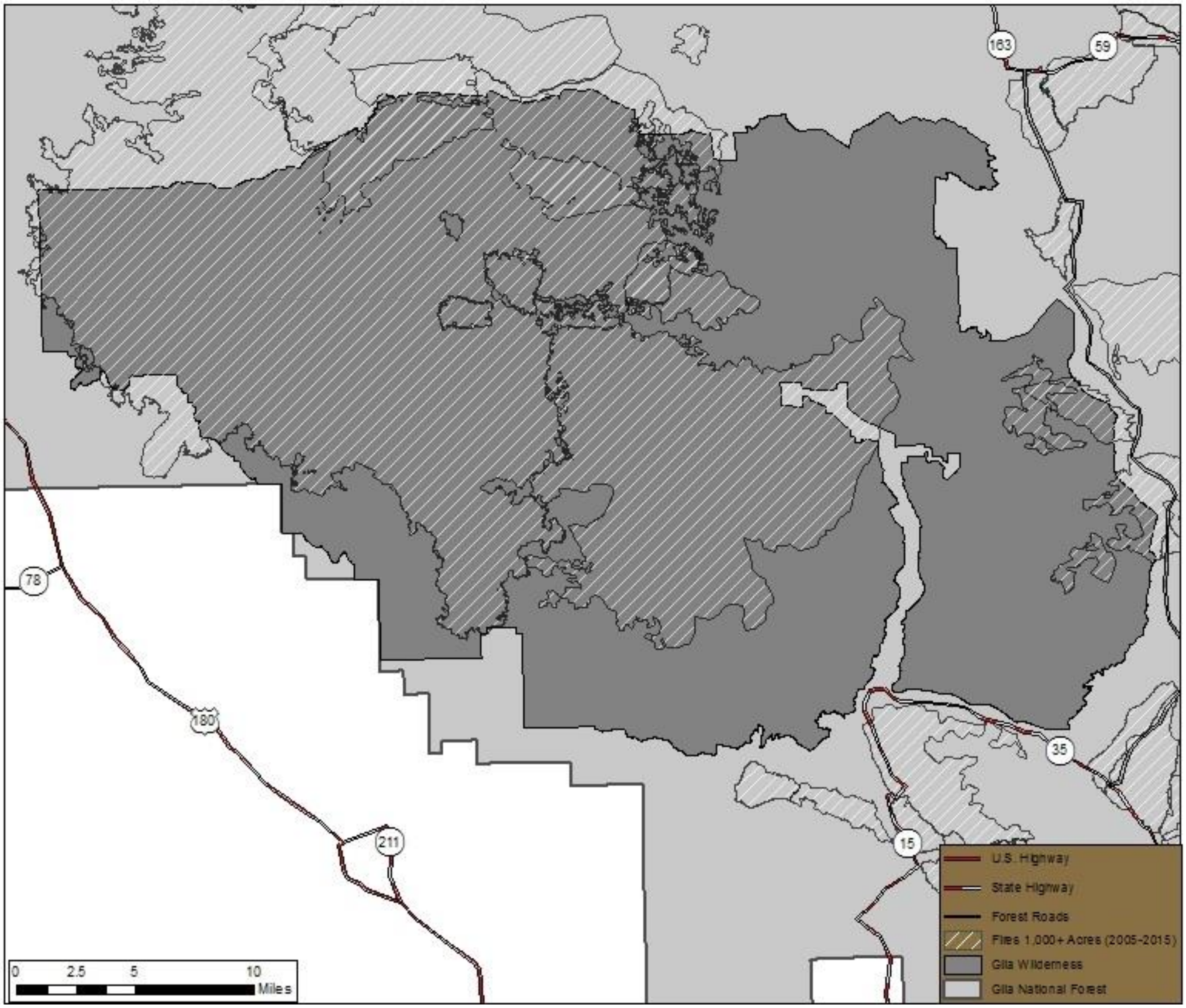


Figure 184. Fires 1,000+ acres within the Gila Wilderness 2005 – 2015

The Gila Wilderness is the only class 1 airshed within the Gila National Forest (see Chapter 5: Air). Currently, air quality within the Gila Wilderness is very high quality, with minimal impacts from pollution. The long distances from large urban areas contributes to the increased air quality along with minimal impacts from air and light pollution. A risk to the air quality of the Gila Wilderness is smoke impacts from fires burning within and adjacent to the wilderness. When planning for prescribed fire project implementation near the Gila Wilderness, potential impact from smoke to air quality is a significant consideration for implementing the project. With many prescribed fire projects, implementation is planned when wind conditions are favorable to have a minimal impact to the class 1 airshed.

Aldo Leopold Wilderness

The Aldo Leopold Wilderness is 203,797 acres (New Mexico's third largest), and straddles the crest of the Black Range. Containing some of the most rugged portions of these mountains, the crest of the range overlooks a series of east-west trending steep and narrow stream valleys, one thousand or more feet deep. The Continental Divide cuts across the center ridgeline of the Wilderness, and a section of the Continental Divide National Scenic Trail (CDNST) is present. Hiking and backpacking are the major recreational activities, but scarcity of water inhibits many potential visitors as most streams and springs are seasonal and unreliable. The Aldo Leopold Wilderness is often considered New Mexico's "wildest wilderness" with low use and excellent opportunities for solitude. Only Forest Service Road 150 separates the Aldo Leopold Wilderness from the even larger Gila Wilderness. Prior to construction of this road, the area that is now the Aldo Leopold Wilderness was part of the original administratively designated Gila Wilderness. Hunting is another popular activity within the Aldo Leopold Wilderness. Rugged terrain and limited access points reduce the amount of hunters that are able to utilize remote areas within the wilderness.

Access into the Aldo Leopold Wilderness is limited, and many trailheads are in remote areas and accessed by forest roads that require high clearance vehicles. Most trailheads are located off of paved roads and require hiking several miles before entering the wilderness boundary. This limitation on direct access is a contributing factor to lower visitation numbers than the neighboring Gila Wilderness. The majority of visitors to the Aldo Leopold Wilderness stay for multiple days, likely due to the remoteness of the area. During recent years, there has been an increasing trend of visitors requesting trail information for the Aldo Leopold Wilderness. Many of the information requests are for areas to experience solitude, but also inquiring about water availability. Visitors often report that during their trip they did not see another person the entire time.

Existing or potential management activities that may affect wilderness character have occurred within the Aldo Leopold Wilderness. As with all management actions in wilderness, these activities are analyzed with a Minimum Requirements Decision Guide to determine the minimum requirements to accomplish wilderness management objectives. These management activities include native fish reintroduction within Diamond Creek, South Diamond Creek, and Animas Creek. These three systems are typically some of the only streams in the area that consistently have water throughout the year. Impacts to wilderness character from these activities are outweighed by long-term benefits to natural quality, and offset somewhat by use of primitive tools and pack stock to transport needed supplies to accomplish these projects.

Trail maintenance routinely occurs within the Aldo Leopold Wilderness. The majority of trail work occurs on the CDNST and the Black Range Crest Trail. There are minimal impacts to the wilderness character due to the use of primitive tools, and interactions between trail crews and hikers seldom occur.

Grazing is an existing use the Aldo Leopold Wilderness. Maintenance of fences and range improvements do occur, however the majority of maintenance work is with primitive tools, and much of the range infrastructure is located away from popular trails. The risk of grazing related activities include possible interactions between wilderness visitors and cattle. Very few occurrences result in negative interactions although some of the interactions could detract from a wilderness experience. Since water is a limited resource within the Aldo Leopold Wilderness, cattle and other ungulates could cause impacts to riparian areas (see Chapter 7: Riparian).

Environmental disturbances include drought, insect and disease outbreaks, and fire. Since the Aldo Leopold Wilderness has limited sources of water, the risk of a long duration drought has the potential to have significant impacts to wildlife and vegetation condition. The Wilderness has experienced trends of increased length and severity of droughts during the past 10 years. There have been many annual below historic average measures of snowpack and monsoonal moisture events in recent years. Along with below average snowpacks, snow has typically melted off earlier than normal. The risk of snowpacks melting earlier in the year increases the potential for water sources to become dry during the summer months and for less moisture to remain in the soil throughout the year (see Chapter 6: Water and Chapter 9: System Drivers and Stressors).

During the mid-2000s, there was an outbreak of bark beetles associated with drought that affected large stands of ponderosa pine throughout the Aldo Leopold Wilderness. As many ponderosa pine trees died, this elevated the risk of wildfire. As many of these dead trees began to fall, it increased the amount of fuel loading in these stands, which would also increase the intensity and severity of wildfire. See Chapter 9: System Drivers and Stressors for more details on insects and diseases on the Forest.

Since the mid-1990s, the Aldo Leopold Wilderness has experienced a number of large-acreage fires (see Figure 185). The majority of these fires have occurred along the crest of the Black Range mountains within mixed conifer and ponderosa pine stands. The Silver Fire in 2013 burned a large part of the south half of the Aldo Leopold Wilderness, including large areas of high severity. Risks associated with large contiguous areas of high severity fires (as opposed to a mosaic of different fire severities) include a reduction of mature, late successional stands of forests across extensive areas leading to reduction of shade and increases in temperatures and drying of these sites. Soil erosion and large scale flooding often follow these large, high severity fire events, and due to the steep terrain found throughout the Aldo Leopold Wilderness the magnitude of these fire effects can be more severe than other parts of the Forest.

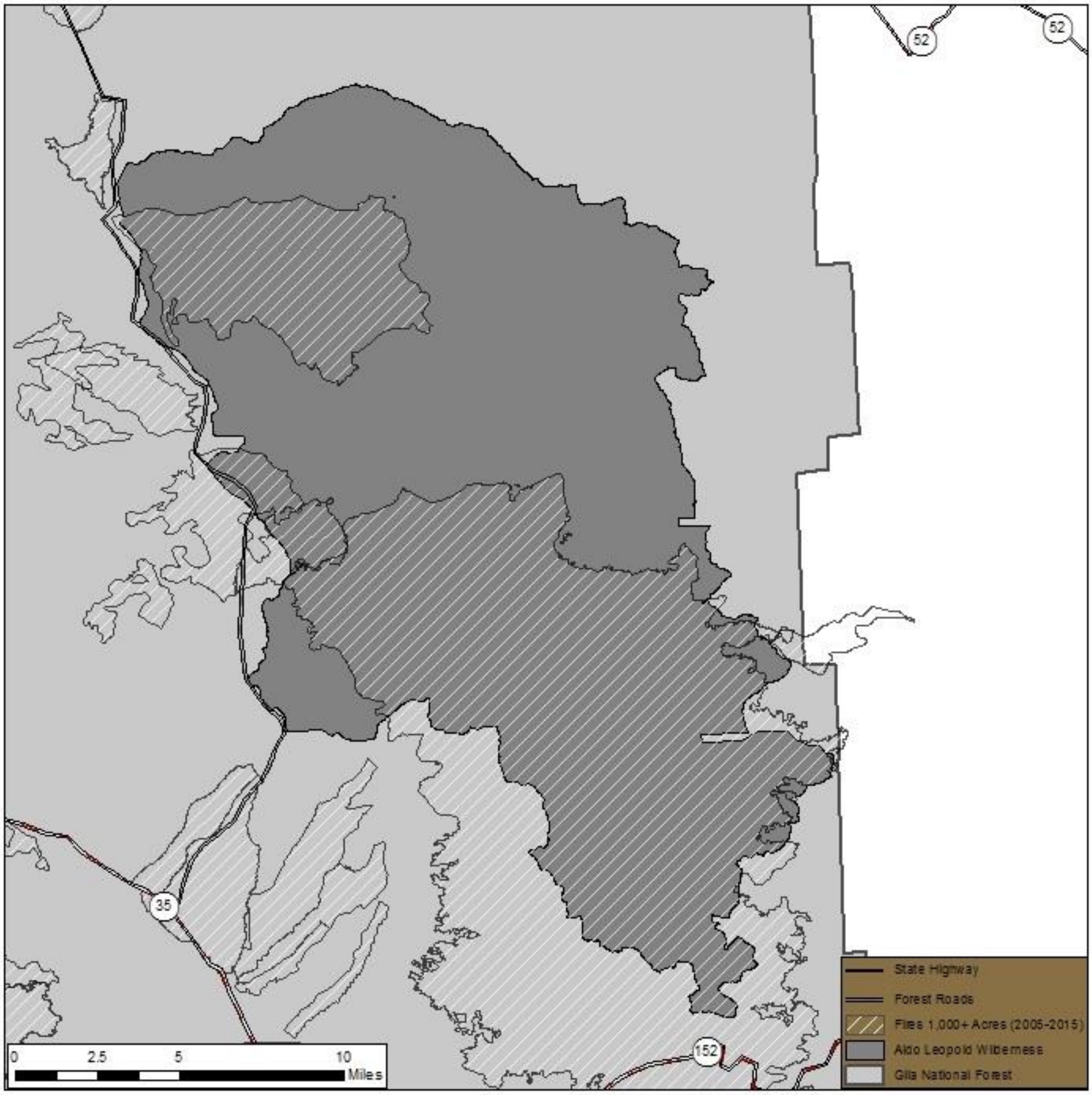


Figure 185. Fires 1,000+ acres within the Aldo Leopold Wilderness 2005 – 2015

Blue Range Wilderness

While the Blue Range Wilderness is the smallest wilderness area on the Gila NF at 29,099 acres, it is also located immediately adjacent to the Blue Range Primitive Area (199,505 acres) of the Apache-Sitgreaves National Forests in Arizona. The state line is all that separates the two areas, with New Mexico's Wilderness tucked into the Blue Range Mountains and halved by the Mogollon Rim, a dramatic edge of the Colorado Plateau that runs east to west. The Blue Range Wilderness is managed with an emphasis on the primitive end of the Recreation Opportunity Spectrum (ROS) (USDA FS 1986b). There are six trails located in the Wilderness, two of which may only be accessed from the Arizona side of the boundary. All have higher degrees of difficulty to follow, and there are no dependable water sources available. There is minimal visitation to this area by hikers and in the fall by hunters, offering excellent opportunities for solitude. However, many visitors to the area seeking opportunities for solitude tend to visit either the Gila

Wilderness or Blue Range Primitive Area in Arizona, because of more trail opportunities and available sources of water, which contributes to low visitation of the Blue Range Wilderness. The risk of a trend of low visitation is becoming a low priority for trail maintenance. This may further limit opportunities for trail users, while enhancing the experience for visitors that are seeking a primitive wilderness experience.

There are concerns about a permitted powerline located immediately adjacent to the wilderness boundary affecting wilderness character. Also, within the Blue Range there are semi-precious minerals (including agate, bytownite, chalcedony, labradorite, hypersthene, and rhyolite) at well-known locations that are relatively accessible in close proximity to both the wilderness boundary and the trailhead Pueblo Park Campground. The visible ground disturbance caused by concentrated gathering and removal of minerals from the area by amateur enthusiasts, known as rock-hounds, is a threat to wilderness character. There are additional concerns of motorized intrusions within the lower elevations on the eastern and southern wilderness boundaries.

The ecological condition of the Blue Range Wilderness is currently within a late seral successional regime due to limited disturbances in the area. This area has not had large fire events or insect and disease outbreaks during the last 25 years. Periods of drought have affected the Wilderness, reducing water levels and flow rates, impacting vegetation and wildlife, and limiting already scarce water sources for visitors.

Wilderness Study Areas

When the New Mexico Wilderness Act was passed in 1980, it designated two areas, the Hell Hole and Lower San Francisco Wilderness Study Areas (WSAs) for review to determine if they feature wilderness characteristics to make them worthy of designation by Congress as wilderness (Figure 186). The Forest Plan (USDA FS Gila NF 1986) evaluated the Hell Hole and Lower San Francisco Wilderness Study Areas for wilderness suitability as directed by Congress and the New Mexico Wilderness Act, and recommends that these areas not be designated as wilderness. Until such time that Congress acts on this recommendation, the Forest Plan calls for managing these lands to maintain existing wilderness character. However, no baseline monitoring data has been collected for the Wilderness Character within these WSAs.

Hell Hole Wilderness Study Area

The Hell Hole WSA (18,860 acres in size[57]) is located south of Mule Creek, New Mexico with the boundary running along the Arizona State line. Access is from the north via Highway 78 west of Mule Creek. A county road heading south from Mule Creek forms the eastern boundary of the WSA.

The landscape of the southern portion of the WSA is dominated by topographic features including deep, rugged canyons, rocky peaks, and steep cliffs. The northern portion of the WSA is primarily rolling hills. Vegetation varies greatly with elevation and aspect. The presence of ponderosa pine in the WSA is somewhat unusual, as it is rather scarce in surrounding areas. The area lends itself to a variety of primitive recreation activities. The degree of difficulty and variety of conditions found in the WSA provide an adequate level of challenge regardless of user’s skills. Current recreation activities are primarily hunting and viewing scenery and wildlife. There are no developed recreation sites or designated trails within the area. The present and expected future use of this area is low.

According to the Record of Decision for the 1986 Gila Forest Plan, the Hell Hole WSA was originally part of a larger Roadless Area Review and Evaluation (RARE) II area that extended into Arizona. The Arizona portion contained an ecosystem that was under-represented in the Wilderness System. As a result, the entire area was designated a Further Planning Area in the RARE II process. When the New Mexico Wilderness Act was passed, the area was designated a Wilderness Study Area. Since that time, the Arizona

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[57] Acres as listed in the New Mexico Wilderness Act

Wilderness Bill in 1984 released the Arizona portion for other multiple uses. Since this was the portion that contained the under-represented ecosystem, and because existing wilderness on the Gila NF already contained vegetation similar to the New Mexico portion of Hell Hole WSA, the 1986 plan decision determined that wilderness designation of the area would not contribute significant ecological diversity to the Wilderness System. The 1986 Gila Forest Plan manages this WSA to maintain semi-primitive recreation opportunities, and no fuelwood, timber, or forest products harvest is permitted.

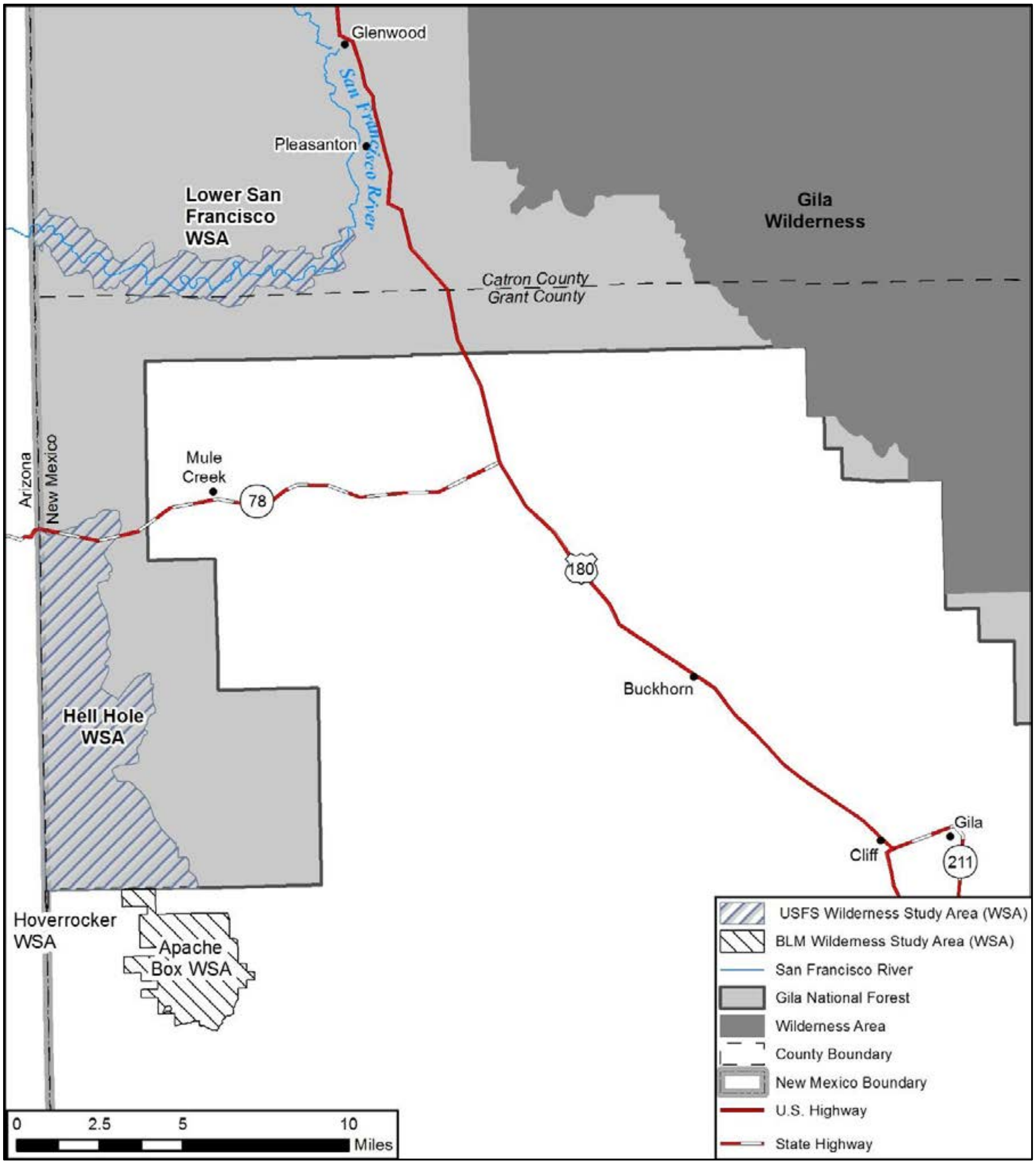

Figure 186. Forest Service and BLM Wilderness Study Areas

There are very few internal roads in the Hell Hole WSA –most roads associated with this area are on the perimeter. With the implementation of the Travel Management decision (USDA FS Gila NF 2014b), the total number of roads and mileage of roads will be reduced, along with impacts from dispersed recreation associated with motorized use. The TMR decision also prohibits cross-country travel. Implementation of the Travel Management decision should enhance the area’s wilderness characteristics particularly the opportunities for solitude. Travel management implementation in this area will be challenging due to the prevalence of illegal firewood gathering and an extensive network of user-created routes occurring on the east side of the WSA. Traces of the undesignated routes will likely remain visible for a long time, especially those occurring on steep slopes subject to erosion and poor plant establishment.

The ecological condition of the WSA is similar to the Blue Range Wilderness. There have not been any large scale disturbances within the WSA. Under the current ecological classification system used in this assessment, all of the Fremont Cottonwood/Oak riparian Ecological Response Unit acres on the Gila NF are located within this WSA (see Chapter 7: Riparian). Non-native species may be present, but no surveys have specifically been conducted in the area. More information on the ecological condition of local unit (Mogollon Front) can be found in Section I: Ecological Integrity and Sustainability.

Lower San Francisco Wilderness Study Area

The 8,800-acre Lower San Francisco WSA is located north of the Hell Hole WSA, west of Highway 180 and the town of Glenwood, NM and extends to the Arizona/New Mexico state boundary. Popular recreation activities include accessing the San Francisco River at Big Dry Creek to picnic, fish, and hunt. There are no NFS system trails located within the WSA. In spring when the river is high enough, rafting and kayaking occur. Rafters typically put in above the San Francisco Hot Springs south of Glenwood and take out at Martinez Ranch on the Apache Sitgreaves NF in Arizona.

Prior to the Travel Management decision, there were 8.2 miles of NFS roads located within the Lower San Francisco WSA. During Travel Management planning, motorized use in the San Francisco River corridor was very controversial. Opinions expressed by the public ranged from a total closure of the entire River corridor to reduce impacts to riparian and aquatic habitat, to keeping the entire corridor open to motorized vehicle use to maintain access for fishing, camping, bird watching, and traditional family outings. This is only one of very few public access points to this section of the San Francisco River. This wide range of opinion and the concerns raised were considered in developing the Travel Management proposed action, alternative development, environmental impact study, and final decision.

The Travel Management decision (USDA FS Gila NF 2014b) maintained public access via Big Dry Creek, to continue the parking and camping opportunities currently available near the San Francisco River, but closed motorized routes along the river to reduce the impacts to riparian and aquatic resources. Implementation of the Travel Management decision are expected to enhance the WSA’s wilderness characteristics. Reduced motorized access within the WSA has the likelihood to reduce intrusions and the influence of modern human activities, which would improve the undeveloped qualities of the area. Fewer intrusions would reduce resource damage and improve visual quality objectives, improving natural qualities. In the Lower San Francisco WSA, periodic flooding events are expected to physically remove the routes located in the river bottom within 10 years.

The San Francisco River within the Lower San Francisco River WSA is designated as critical habitat for both the loach minnow and spikedace species of fishes. Currently, the native fishery within this reach of river has been severely degraded due to the dominance of nonnative fish (J. Monzingo pers. obs.). Known infestations of saltcedar (*Tamarix* spp.) are scattered through-out the San Francisco River corridor from the confluence of Whitewater Creek downstream to the border of Arizona/New Mexico (K. Brown pers. obs).

The Tucson Electric Power (TEP) powerline right- of-way (ROW) is located in the Lower San Francisco WSA. The ROW is periodically maintained per the terms and conditions of the special use permit, including helicopter access, use of roads, and vegetation management within the corridor, all of which may be audible or visible to the recreating public.

Inventoried Roadless Areas

Inventoried Roadless Areas (IRAs) were established under the 2001 Roadless Area Conservation Rule (36 CFR Part 294). The "inventoried" part of the name comes from two Roadless Area Review and Evaluation (RARE) national forests conducted in the 1970s (RARE) and 1980s (RARE II). Approximately 22 percent of the Forest's land mass (733,836 acres) is located within 29 individual Inventoried Roadless Areas (Figure 187). The following are characteristics considered under RARE II for IRA designation:

- Natural - being substantially free from the effect of modern civilization.
- Undeveloped - having little or no permanent improvements or human habitation.
- Outstanding opportunities for solitude or primitive and unconfined recreation.
- Special features and values, or the potential to contribute to unique fish, wildlife and plant species and communities; outstanding landscape features; and significant cultural resource sites.
- Manageability, meaning the area is at least 5,000 acres in size.

The Roadless Area Conservation Final Rule prohibits road construction, reconstruction, and timber harvest, except under certain circumstances, in Inventoried Roadless Areas because they have the greatest likelihood of altering and fragmenting landscapes, resulting in immediate long term loss of Roadless area values. Some roads and motorized trails may be present within IRAs. The Roadless Rule does not prohibit travel on existing roads or motorized trails.

Inventoried Roadless Areas provide opportunities for dispersed outdoor recreation, opportunities that diminish as open space and natural settings are developed elsewhere, however, most of the IRAs on the Forest attract little attention by the public. Management direction for existing IRAs is provided by direction of the 2001 Roadless Rule and the Gila NF's 1986 Forest Plan for Management Areas with semi-primitive and primitive recreation opportunities. Since the implementation of the Forest Plan in 1986, existing roads and trails on the boundaries of and within IRAs have continued to be maintained. Trails within IRAs are also regularly maintained to prevent resource damage and preserve recreation opportunities. Grazing, outfitter/guide, communication site and utility right-of-way special uses permittees all use existing roads within IRAs for access.

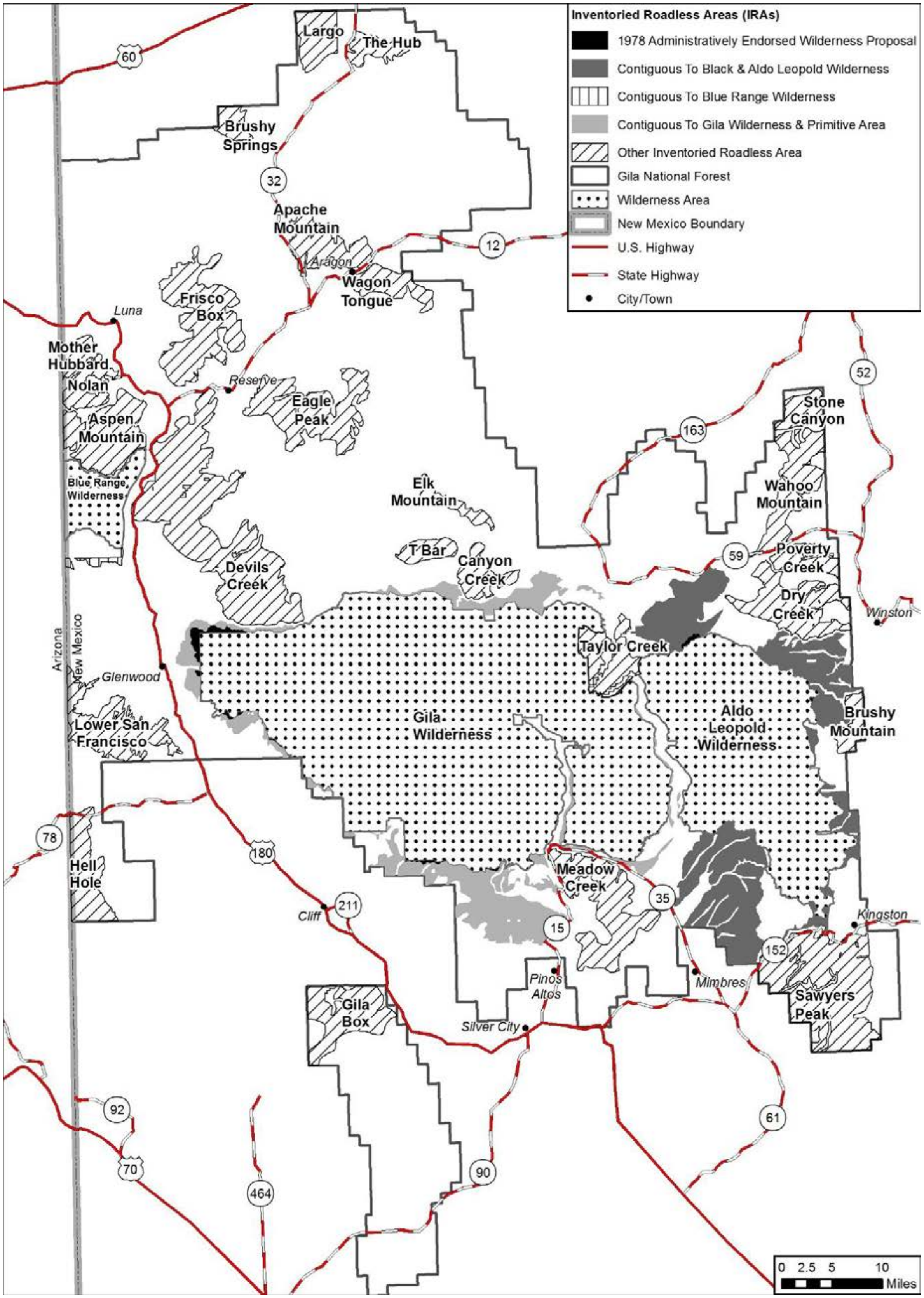

Figure 187. Inventoried Roadless Areas, Gila National Forest

Table 216 below lists acres of each IRA and associated local unit(s) located on the Forest.

Table 216. Inventoried Roadless areas, Gila National Forest

Inventoried Roadless Areas	Official Acres (Albers)(1)	Local Scale unit
1978 Administratively Endorsed Wilderness Proposal	4,286	Black Range, Little Colorado-San Agustin Fringe, Lower Gila River, Mogollon Front, Upper Gila River
Apache Mountain	17,506	Apache
Aspen Mountain	23,783	Mogollon Front
Brushy Mountain	7,199	Black Range
Brushy Springs	5,735	Little Colorado-San Agustin Fringe
Canyon Creek	9,824	Little Colorado-San Agustin Fringe, Upper Gila River
Contiguous to Black & Aldo Leopold Wilderness	111,811	Black Range, Little Colorado-San Agustin Fringe
Contiguous to Blue Range Wilderness	1,980	Mogollon Front
Contiguous to Gila Wilderness and Primitive Area	79,048	Little Colorado-San Agustin Fringe, Lower Gila River, Mogollon Front, Upper Gila River
Devils Creek	89,915	Apache, Mogollon Front,
Dry Creek	26,719	Black Range, Little Colorado-San Agustin Fringe
Eagle Peak	34,016	Apache
Elk Mountain	6,550	Little Colorado-San Agustin Fringe, Upper Gila River
Frisco Box	38,977	Apache
Gila Box	23,759	Lower Gila River
Hell Hole(2)	19,553	Mogollon Front
Largo	12,730	Little Colorado-San Agustin Fringe
Lower San Francisco(2)	26,459	Mogollon Front
Meadow Creek	34,167	Black Range, Lower Gila River
Mother Hubbard	5,895	Apache, Mogollon Front
Nolan	13,050	Apache, Mogollon Front
Poverty Creek	8,770	Black Range
Sawyers Peak	59,743	Black Range
Stone Canyon	6,801	Black Range
T Bar	6,823	Upper Gila River
Taylor Creek	16,639	Little Colorado-San Agustin Fringe
The Hub	7,498	Little Colorado-San Agustin Fringe
Wagon Tongue	11,411	Apache, Little Colorado-San Agustin Fringe
Wahoo Mountain	23,121	Black Range
TOTAL	**733,836**	

(1) The official acres are calculated using Albers from 2001 Roadless Area Conservation rule, 36 CFR Part 294.

(2) The Hell Hole and Lower San Francisco IRAs encompass the Hell Hole and Lower San Francisco Wilderness Study Areas (WSAs).

The condition of the IRAs across the Forest are variable, and influenced by the local unit within which they are located (Table 216). Invasive species are threats to Roadless characteristics, due to negative effects to soil resources, diversity of plant and animal communities and the overall naturalness associated with the area's landscape character (USDA FS Gila NF 2013d). Invasive species treatment, vegetation projects (of the specific type allowable under the Roadless Rule), ongoing trail maintenance and reconstruction, and fire management activities all have the potential to improve the areas' Roadless characteristics. Additional information on the ecological condition of local units can be found in Section I: Ecological Integrity and Sustainability.

Threats to the IRA characteristics mandated for protection by the Inventoried Roadless Rule include the occurrence of new and existing unauthorized user-developed motorized routes. However, current trends are for increased management actions under implementation of the Travel Management decision to rehabilitate and reduce existing unauthorized routes, and prevention of the occurrence of new ones.

As part of the current forest plan revision process, areas potentially suitable for wilderness across the planning area will be inventoried and evaluated using criteria consistent with the 2012 Planning Rule. All IRAs located within the Gila National Forest will be included as part of the potential wilderness inventory process, however, existing IRA boundaries are not being reconsidered via the plan revision process.

Eligible Wild and Scenic Rivers

None of the eligible streams or rivers on the Gila National Forest are currently designated as Wild & Scenic Rivers. The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. For a River to be eligible for Wild & Scenic River (W&S) designation it must be free flowing and (with its adjacent land area) must possess one or more Outstandingly Remarkable Values (ORVs). ORVs are specific to each river segment and may include scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values.

The Gila National Forest Plan 1986 as amended in 2002 incorporated direction to identify and protect eligible Wild & Scenic Rivers for their ORVs, and preserve their character pending determination of suitability for inclusion in the National Wild & Scenic River System. The following Rivers were included in the eligibility findings: Whitewater Creek, Spruce Creek, Middle Fork Gila River, West Fork Gila River, Diamond Creek, South Diamond Creek, Holden Prong, and Las Animas Creek (Table 217; Figure 188).

Table 217. Eligible Wild and Scenic Rivers on the Gila NF

River	Outstanding Remarkable Values	Total Miles	Classification[1] (# of miles)
Diamond Creek	Fish, Historic	31	Wild (26 miles), Recreational (6 miles)
Holden Prong	Fish	8	Wild (8 miles)
Las Animas Creek	Fish, Historic	9	Wild (3 miles), Scenic (6 miles)
Middle Fork Gila River	Scenic	27	Wild (27 miles)
South Diamond Creek	Fish	9	Wild (9 miles)
Spruce Creek	Fish	5	Wild (5 miles)
West Fork Gila River	Scenic, Historic	26	Wild (26 miles), Recreational (1 mile)
Whitewater Creek	Recreation, Historic	14	Wild (11 miles), Recreational (3 miles)

[1] *Wild*: Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watershed or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

Scenic: Those rivers or sections of rivers that are free of impoundments, with shorelines or watershed still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Recreational: Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Most of these eligible rivers occur in the Gila or Aldo Leopold Wilderness areas. The recent travel management decision provides management direction to implement management actions intended to address unauthorized routes within Wild & Scenic River corridors outside of Wilderness. Past management activities implemented near eligible Wild & Scenic Rivers include upland vegetation thinning, herbicide application of saltcedar (*Tamarix* spp.), and fire management activities. Discussion on the condition, trends, and stressors to water resources on the Gila National Forest can be found in Chapter 6: Water.

Threats to Eligible Wild and Scenic Rivers generally include any change in condition, or lack of appropriate management response to a change in condition, that puts the ORVs of that river segment at risk. Factors that could affect a change in ORV conditions on the Gila NF include unauthorized, user-developed motorized routes within the river corridor, non-native invasive species, drought, wildfires that burn outside of the range of historic variability, and post-wildfire flooding and erosion.

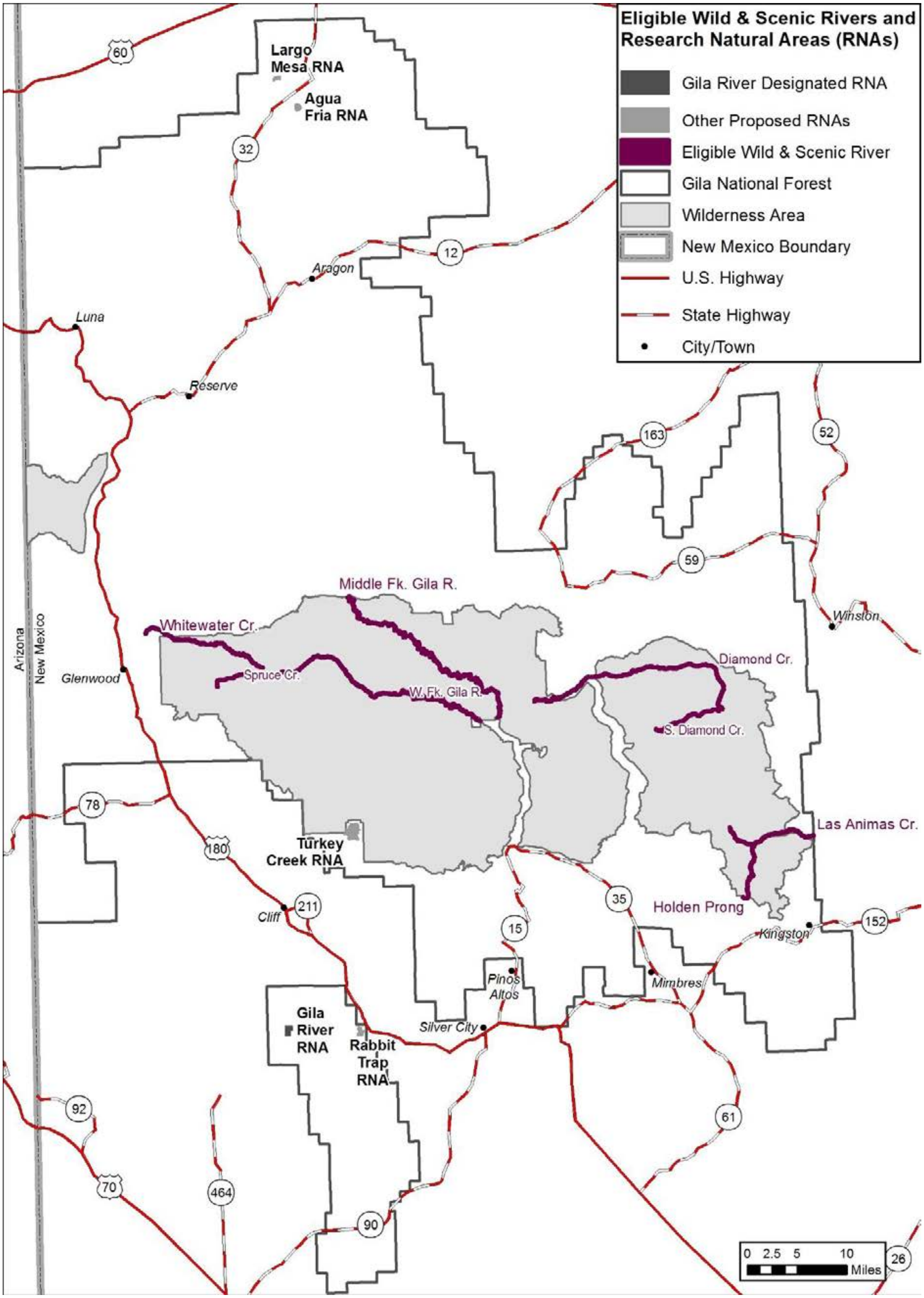

Figure 188. Eligible Wild and Scenic Rivers and Research Natural Areas, Gila National Forest

Research Natural Areas

Forest Service research natural areas (RNAs) are designated for the purpose of permanently protecting and maintaining natural conditions for the conservation of biological diversity, conducting non-manipulative research and monitoring, and fostering education. They are designated to "maintain a wide spectrum of high quality representative areas that represent the major forms of variability found in forest, shrub land, grassland, alpine, and natural situations that have scientific interest and importance that, in combination, form a national network of ecological areas for research, education, and maintenance of biological diversity" (FSM 4063.02). Included in this RNA network are:

- High quality examples of widespread ecosystems
- Unique ecosystems or ecological features
- Rare or sensitive species of plants and animals and their habitat (USDA FS RMRS 2016)

RNAs are managed to maintain the natural features for which they were established and to maintain natural processes. Because of the emphasis on natural conditions, they are excellent areas for studying ecosystems or their component parts and for monitoring succession and other long-term ecological change. The Gila NF has one established research natural area (Figure 188). Previously proposed RNAs are discussed in the Potential Need or Opportunity for Future Designations section towards the end of this chapter.

The Gila River RNA was established in 1972 and consists of 402 acres near the Gila River Bird Area in the northern Burro Mountains on the Silver City District. The area provides a well-developed example of the riparian ecosystem in New Mexico, and provides habitat for rich and unique birdlife. 231 species of birds, 43% of the bird species verified in NM, have been detected in the adjacent Gila River Bird Area (Shook 2015). Some of these species are at the northern edge of their natural range in southwestern New Mexico. Federal or State threatened or endangered species using the area include bald eagle, common blackhawk, peregrine falcon, Gila woodpecker, southwestern willow flycatcher, Bell's vireo, and Abert's towhee (Shook 2015). The Gila River in the Cliff-Gila Valley (including the Gila River RNA) is an important habitat area for native fish, including endangered loach minnow and spikedace. The ecological condition of the RNA is affected by the local unit where it is located (Lower Gila River), and the ecological response units (ERUs) it consists of. More information on the ecological condition, trends, and risk of the riparian ERUs can be found in Chapter 7: Riparian. Under direction of the 1986 Forest Plan, the RNA is managed to maintain the natural features for which it was established.

The Burro Mountains are known to be rich in copper, and to the north and along the east side of the Gila River nearby the location of the RNA there are existing mineral claims. Because of this possible conflict with mining, the Research Natural Area was located below the optimum habitat for the birds and riparian vegetation and withdrawn from mineral entry. However, none of these mining claims in the immediate vicinity of the RNA have been developed into operational mines.

Less than an hour drive from Silver City, the Gila River Bird Area is becoming more popular for recreational uses such as hiking, birdwatching, river access, and dispersed camping, although most those activities take place near the access road. Recreational use in the RNA itself is light, although there is a developed trail that travels 3 miles from the end of the bird area access road to the RNA. This trail passes partly within the RNA, and may be in conflict with Forest Plan direction for this designation by introducing a source of human-caused environmental disruptions. Cross country motorized travel in this area has been restricted since 1986. The riparian area is closed to grazing. Non-native species may be present, but no surveys have been conducted in the RNA since the 1972 establishment report. A restoration project in the Gila River Bird Area was completed in the early 1990s that restored over a 100 acres of dense riparian area (Boucher et al. 2003), which likely improved the connectivity of the riparian habitat at the RNA.

There are plans for future water development projects within the Cliff-Gila Valley that may negatively affect conditions within the RNA. The existence of the trail passing through part of the Area, is a threat to the purposes for which it was designated. Because there is a lack of recent survey data, the presence of invasive species are unknown, but may be an additional threat to the area.

Scenic Byways

The National Scenic Byways Program is administered by the U.S. Department of Transportation, Federal Highway Administration. It was established to help recognize, preserve, and enhance selected roads throughout the nation. The U.S. Secretary of Transportation recognizes and designates these designated roads based on one or more intrinsic qualities — archaeological, cultural, historic, natural, recreational, or scenic (DOT FHA 1995).

Two scenic byways travel through the Forest; the Trail of the Mountain Spirits traces a loop in the southern half of the Forest, while the Geronimo Trail creates a longer tour encompassing portions of the eastern edge of the Forest along with large tracts of land outside the Forest boundary (Figure 189). The primary uses along the Scenic Byway routes are driving for pleasure, cycling, sightseeing, birdwatching, and developed recreation sites. Most of the roads comprising the national scenic byways on the Gila NF are managed by the New Mexico Department of Transportation.

The Trail of the Mountain Spirits National Scenic Byway is a 93-mile route connecting Silver City, the Gila Cliff Dwellings National Monument, Sapillo and Mimbres valleys, the mining district, and many points of interest in between. This route is also used during the Tour of the Gila, an annual multistage international cycling competition. The routes this Scenic Byway follows through the National Forest are State Highways 15 and 35. This byway receives moderate use year-round, from both visitors as well as travel by residents and local commuters.

A National Scenic Byway corridor management plan provides guidance and direction for the conservation and enhancement of the byway's intrinsic qualities, as well as promotion of tourism and economic development. The Trail of Mountain Spirits Corridor Management Plan (Trail of the Mountain Spirits Scenic Byway Committee 2004) supports efforts to strengthen volunteer participation, explore alternative sources for project funding, increase membership, leverage business support, and identify project managers for the implementation and completion of byway projects. Among the implementation items included in the plan are providing interpretive materials and media, protecting an archeological site adjacent to the byway, and promoting and marketing regional tourism. These projects benefit byway traveler experiences by developing, enhancing, and interpreting existing sites along the byway corridor.

The Geronimo Trail National Scenic Byway, designated in 2005, typically begins in Truth or Consequences, NM. From there, one can explore the northern route (82 miles) or southern route (56 miles). Each route ties together many charming locales and traverses many life zones from the creosote and cholla-swept sands of the Chihuahuan Desert, to the piñon-juniper woodlands and ponderosa forests of the Gila National Forest. The routes through the National Forest are State Highway 152 to San Lorenzo along the southern route, and State Highways 52 and 59 to the Beaverhead workstation along the northern route. The North Star Mesa Road (FR150) is listed as a “side trip”, connecting the two routes to form a loop, but a 4-wheel drive vehicle and knowledge of road conditions are needed. The portions of the Forest along the byway receive low (northern route) to moderate (southern route) use year-round by visitors.

Geronimo Trail National Scenic Byway has a Corridor Management Plan (Geronimo Trail Advisory Committee 2008) that strives to showcase and preserve the corridor area for its historic multi-cultural heritage and natural resources. Some of the goals of the plan are to market the byway as a unique tourism opportunity, develop interpretive signs and other amenities along the byway, ensure services provided along the route meet travelers' needs, and preserve the byway's resources so the route is a sustainable tourist and recreation attraction. The city, county, state, and federal agencies with management responsibilities along the byway work in concert with the Geronimo Trail Advisory Committee to achieve these goals. There are concerns about the viewshed and land development along the scenic byway.

Because the primary visitor experience and purpose of the byways are scenic in nature, primary threats to these types of designated areas are associated with scenic values. One of these threats is excess or incompatible development along Scenic Byways; however, most of this type of development occurs on private, rather than NFS Lands. Other threats to the scenic values of byways include those that apply to scenic values throughout the Forest. For detailed information on current conditions, trends and threats to scenic resources across the Gila National Forest, please refer to the Scenic Character section of Chapter 12: Recreation.

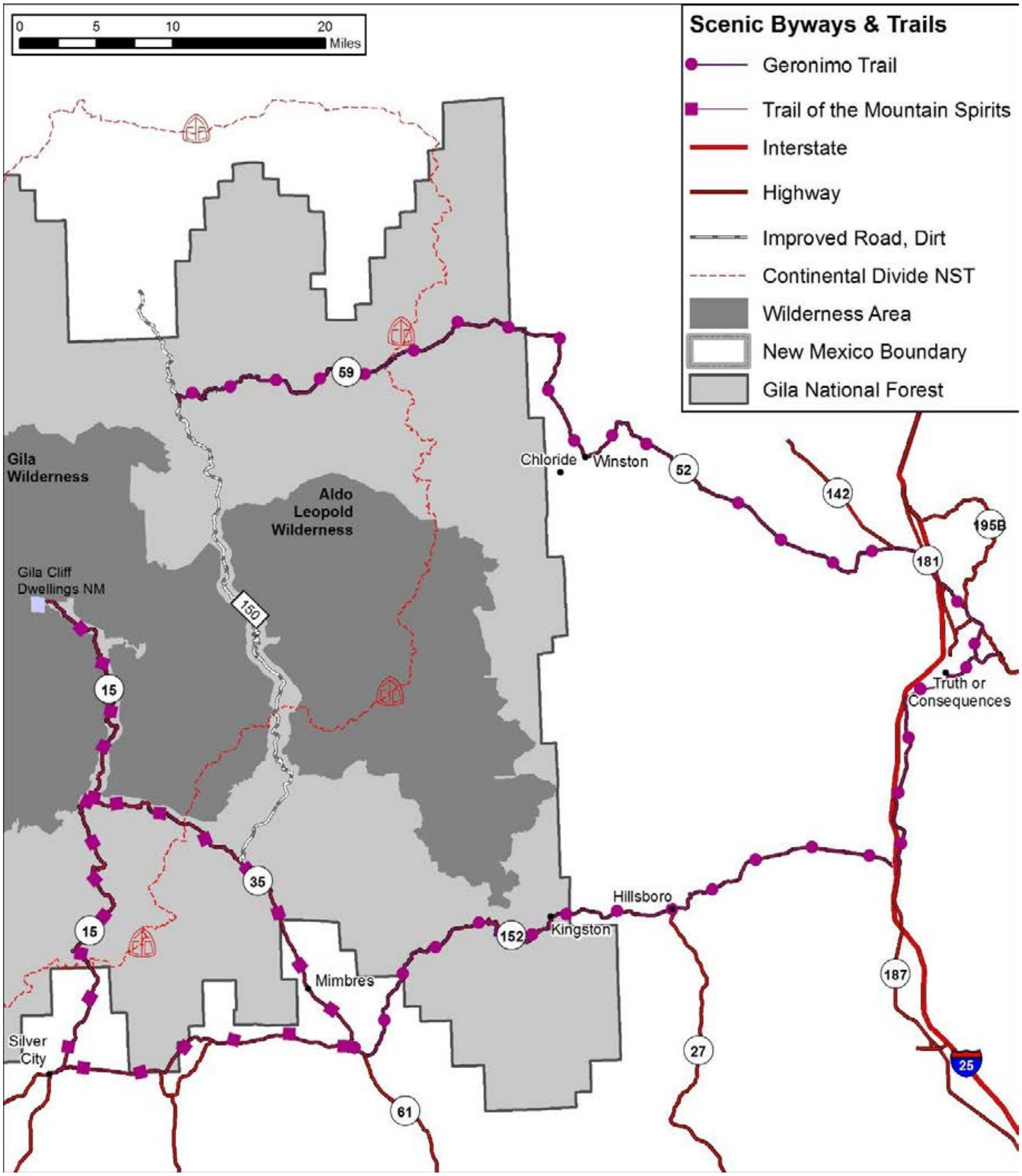

Figure 189. National scenic byways through the Gila NF

National Scenic and Recreation Trails

A nationwide trails study led to publication of a 1966 report entitled "Trails for America." The report called for federal legislation to foster the creation of a nationwide system of trails. The report heavily emphasized national scenic trails and the role they should play in meeting the nation's needs for trail-dependent outdoor recreation. The Appalachian Trail was to be the first designated National Scenic Trail. The report also proposed three other national scenic trails, including the Continental Divide Trail, a section of which crosses through the Gila NF. Congress passed the National Trails System Act in 1968. The Act authorized creation of a national trail system comprised of national scenic trails, national historic trails, and national recreation trails. National Scenic and Historic Trails are statutorily designated through laws passed by Congress, and National Recreation Trails are an administrative designation instituted by the agency. The Gila NF administers one national scenic trail (Continental Divide National Scenic Trail) and three national recreation trails (Catwalk National Recreation Trail, Sawmill Wagon Road National Recreation Trail and Woodhaul Wagon Road National Recreation Trail) (Figure 190).

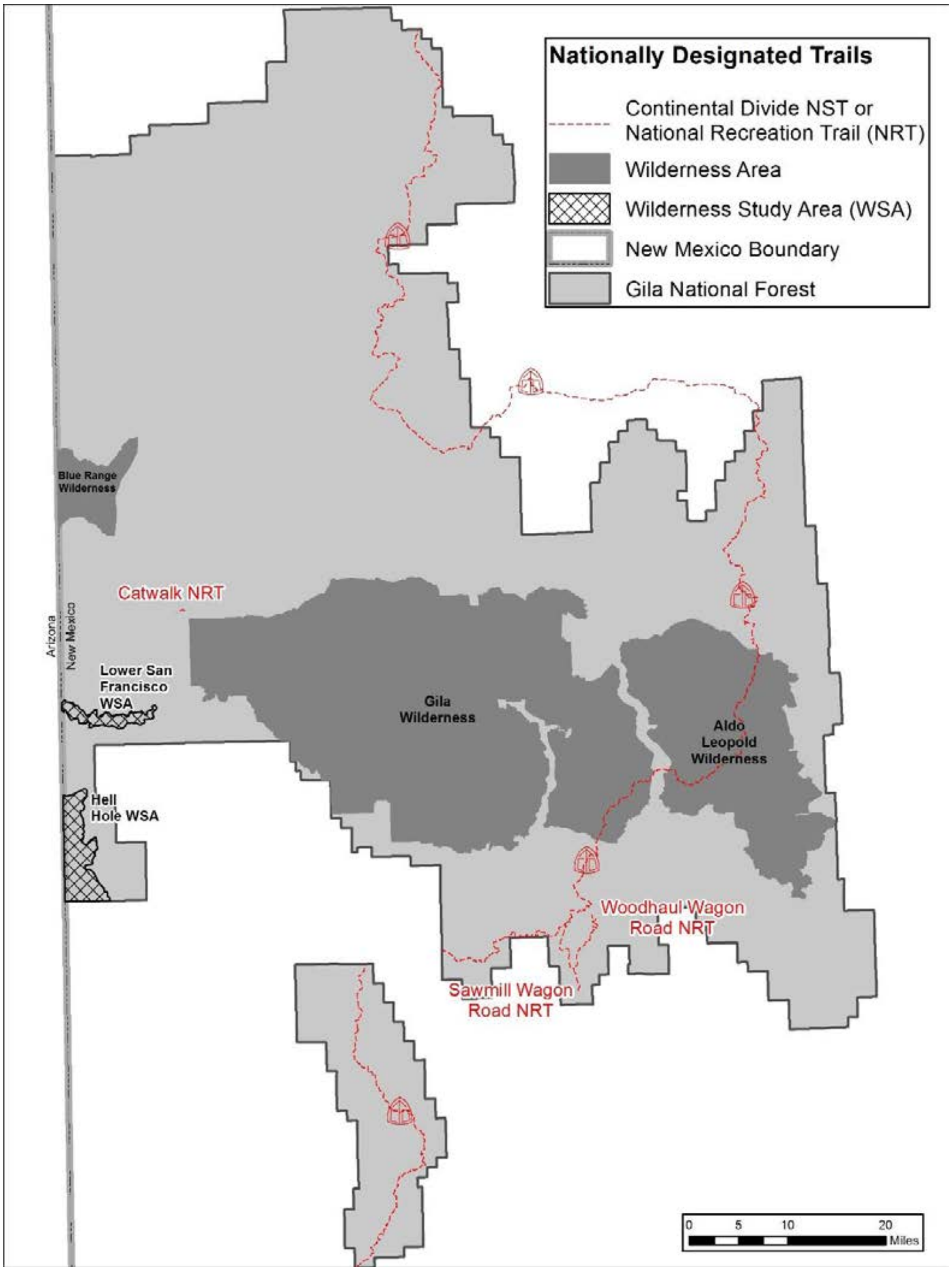

Figure 190. Map of the National Scenic Trail and National Recreation Trails on the Gila NF

National Scenic Trails

As envisioned in "Trails for America," national scenic trails are to be very special: "A standard for excellence in the routing, construction, maintenance, and marking consistent with each trail's character and purpose should distinguish all national scenic trails (USDA FS 2015h). Each should stand out in its own right as a recreation resource of superlative quality and of physical challenge." According to the Act, national scenic trails "will be extended trails so located as to provide for maximum outdoor recreation potential and for the conservation and enjoyment of nationally significant scenic, historic, natural, and cultural qualities of the area through which such trails may pass" (American Trails Website). National scenic trails are located so as to represent desert, marsh, grassland, mountain, canyon, river, forest, and other areas, as well as landforms that exhibit significant characteristics of the physiographic regions of the nation. The corridor will be normally located to avoid established uses that are incompatible with the protection of a trail in its natural condition and its use for outdoor recreation.

The Continental Divide National Scenic Trail (CDNST) traverses the Rocky Mountains from Canada to Mexico for approximately 3,100 miles (USDA FS 2015h). It travels through portions of 20 national forests, 3 national parks, one national monument, 13 BLM field offices, as well as various State and private lands in Montana, Idaho, Wyoming, Colorado, and New Mexico. It was established by Congress in 1978 to provide high-quality scenic, primitive hiking, and horseback riding opportunities, and to conserve natural, historic, and cultural resources along the CDNST corridor. The CDNST navigates dramatically diverse ecosystems through mountain meadows, granite peaks, and high-desert surroundings. It is one of the most renowned trails in the United States for its scenic beauty, recreational opportunities, elevation gains, and primitive character. The Gila NF manages 254 miles of the CDNST according to direction provided in The Continental Divide National Scenic Trail Comprehensive Plan (USDA FS 2009).

The CDNST is a significant draw to hikers and other trail users; attracting a significant number of visitors to the Gila NF. The trail is managed and maintained on the ground by five different Ranger Districts across the Forest. There are many sections of the CDNST that pass through areas with limited water sources available, creating a challenge for long-distance trail users. In the area near where the trail enters the Forest at the northern boundary, a significant number of trail users opt to not follow the designated route, instead crossing private property, creating conflict with property owners. Some sections of the trail are impacted by past wildfires, making the trail difficult to follow in certain areas.

The alignment of the trail across the Forest is a meandering route, entering the Forest at the northwest corner, following east along the Black Range Crest, then travelling southwest towards Silver City (see Figure 190). The trail leaves the Forest for a number of miles west of Silver City, but re-enters the Burro Mountains segment of the Forest just west of Mangas Springs. From the point it re-enters the Forest, the trail takes a slightly meandering southerly route, crossing NM Hwy 90 and exiting the Forest for a final time in the area of Walker Mountain at the south end of the Forest.

The bulk of the CDNST is located in remote regions within the Gila NF, and long sections have limited road access points, which reduces visitor use and limits resupply options for thru hikers. Along with other factors, including poor trail conditions, a desire minimize mileage crossing the Forest, access to better water sources, types of travel being restricted within designated wilderness, motivates many CDNST users to follow alternative routes using other trails to cross the Gila NF.

Trail conditions vary, but tend to be better maintained than other Forest System Trails (see Chapter 14: Infrastructure for discussion on trails). The Continental Divide Trail Coalition partners with the Forest to organize volunteers to assist with trail maintenance. The segment of the trail outside the Forest boundary between the Bear Mountain trailhead northwest of Silver City to Mangas Creek in the Burro Mountains does not have a route on the ground designated or constructed.

Currently, the trail corridor makes use of some motorized routes as it passes through the Forest, however any motorized use within these shared rights of way is not an identified National Scenic Trail use as stipulated by the Act. Future plans include moving the trail onto strictly non-motorized routes when it becomes practicable.

Some of the most common users to the CDNST are thru-hikers, mountain bikers, and horseback riders. The most popular times of year are in spring and fall when thru-hikers are travelling north and south respectively. Other types of uses occur year round. The purpose of the CDNST is to provide for high-quality scenic, primitive hiking and horseback riding opportunities and to conserve natural, historic, and cultural resources along the CDNST corridor. The intent of the National Scenic Trail pursuant to the National Trails System Act of 1968 is for non-motorized use. Currently, the CDNST follows open motorized trail for 2.4 miles and open motorized road for 30.9 miles on the Gila NF. Public comments received in travel management and forest planning expressed concerns that concurrent motorized use is incompatible with National Scenic Trail objectives, and detrimental to recreation experiences sought by hikers and horseback riders on the CDNST. Specific areas identified included the Burro Mountains and Sapillo Campground, with motorized intrusion an issue on the Quemado District.

As opportunities have occurred, trail routes have been realigned to move the CDNST from roads to better meet the intent of the trail. The implementation of the Travel Management decision is likely to reduce the occurrence of motorized trespass of the trail, improving the qualities associated with intended uses of the Continental Divide Scenic Trail. For condition, trends, and risks to the trail system on the Gila NF, see Chapter 12: Recreation.

National Recreation Trails

National Scenic and Historic Trails may only be designated by an act of Congress, but National Recreation Trails may be designated by the agency to recognize exemplary trails of local and regional significance. These trails receive status as part of America's National System of Trails, and provide trail-based outdoor recreation activities in a variety of urban, rural, and remote areas. The Gila NF manages the Catwalk National Recreation Trail and Whitewater Picnic Area, the Sawmill Wagon Road National Recreation Trail and Woodhaul Wagon Road National Recreation Trail.

The Catwalk National Recreation Trail (NRT) is a very unique trail incorporating a hanging walkway suspended from cliff walls above Whitewater Creek. The trail attracts a significant numbers of visitors to the area, contributing to the local economy, and provides an important social connection as people have been visiting the Catwalk for generations connecting them to the Forest.

Due to the trail’s location in a narrow canyon, it is inherently at-risk to flooding impacts, and the walkway and trail have been damaged and rebuilt several times after devastating floods, most recently following the 2012 Whitewater Baldy Fire. The Catwalk Recreation Area is a FLREA fee area that generates revenue for the Forest to help fund maintenance expenses.

The Sawmill Wagon Road and Wood Haul Wagon Road National Recreation Trails were both designated l in 1979. The 7-mile Sawmill Wagon Road Trail was an integral part of the original Fort Bayard Military Reservation in the late 1800s (see Chapter 17: Cultural and Historic Resources). Soldiers used the trail to transport fuelwood and construction timber from the high ponderosa pine forests of the Pinos Altos Mountain Range to the military reservation.

The Wood Haul Wagon Road Trail is also part of the trail system close to Silver City, and travels from the Gila NF Fort Bayard Administrative Site to the popular destination “Wagon Wheel Ruts.” These Wood Haul Wagon Ruts are a result of the tireless passing of supply wagons hauling construction and fuel wood to the Fort Bayard Military Reservation. Mule and oxen drawn wagons were used to haul the heavy loads. Over time the hard wagon wheels cut into the volcanic cap rock leaving a testament to the endurance of these early settlers. The 11.5-mile route to the Wagon Wheel Ruts follows primitive roads (double track) that pass over land that was once part of the Military Reservation.

The Fort Bayard area trails are in moderate to good condition with a stable trend, although there are a few areas in need of maintenance. The trails are heavily used by hikers, mountain bikers, and equestrians, in part due to their close proximity to Silver City. The Aldo Leopold Youth Conservation Corps has adopted the trail maintenance for this area. For condition, trends, and risks to the trail system on the Gila NF, see Chapter 12: Recreation.

Former Designated Areas

Wild Horse and Burro Area

The Deep Creek Wild Horse and Burro Territory was established under Forest Service regulations promulgated under the Wild and Free-Roaming Horses and Burros Act of 1971. The horse herd in this area originally numbered approximately 15-25. By the 1980s the horse herd had dwindled to zero due to lack of reproduction and predation by mountain lions. The 1986 Forest Plan formally discontinued the Deep Creek Wild Horse and Burro Territory.

Designated Critical Habitat for Threatened and Endangered Species

Critical habitat (USDI FWS 2015c) is defined under the Endangered Species Act as a specific geographic area that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. Critical habitat may include an area that is not currently occupied by the species, but will be needed for its recovery. Critical habitat does not preclude activities within its borders; however, conservation of the habitat for the identified species is an important consideration when planning or allowing activities in these areas.

The US Fish and Wildlife Service has analyzed species needs and designated critical habitat within the Gila NF boundary for the Mexican spotted owl (*Strix occidentalis lucida*), southwestern willow flycatcher (*Empidonax traillii extimus*), Chiricahua leopard frog (*Lithobates chiricahuensis*), Gila chub (*Gila intermedia*), spike dace (*Meda fulgida*), and loach minnow (*Tiaroga cobitis*). There is also proposed critical habitat for the narrow-headed garter snake (*Thamnophis rufipunctatus*), Northern Mexican gartersnake (*Thamnophis eques megalops*), and yellow-billed cuckoo (*Coccyzus americanus*). Table 218 displays the area of critical habitat on the Gila NF by species. See Chapter 8: At-Risk Species for more details.

Table 218. Critical habitat area on Gila National Forest, by species

Species	Acres
Chiricahua Leopard Frog	2,488
Gila Chub	764
Loach Minnow	11,673
Mexican Spotted Owl	1,122,802
Narrow-headed Gartersnake (proposed)	52,430
Northern Mexican Gartersnake (proposed)	8,717
Southwestern Willow Flycatcher	1,547
Spikedace	9,968
Yellow-billed Cuckoo (proposed)	1,680

Adjacent Designated Areas, National Monuments, and National Parks

In addition to the specially designated areas found within the Gila NF, there are specially designated areas managed by other government agencies near and adjacent to the Forest. These areas add recreation values, scenic values, wildlife opportunities, and other resources values complementing those of the Gila National Forest.

Forest Service –Apache-Sitgreaves National Forests

In 1933, the Secretary of Agriculture proclaimed that the Blue Range Primitive Area, at that time located on the Apache National Forest in Arizona and New Mexico, should be managed for primitive uses to maintain the wildness of that area, and administratively designated it as a Forest Service Primitive Area. In 1971, the President of the United States forwarded a recommendation by the Forest Service for a Blue Range Wilderness in New Mexico and Arizona to Congress, who acted in 1980 on a portion of it, designating the Blue Range Wilderness in New Mexico, located on the portion of the Apache National Forest now administered by the Gila NF. The remaining Blue Range Primitive Area on the Apache-Sitgreaves NFs (A-S NF) is the last designated primitive area in the National Forest System, all others having been designated as wilderness by Congress through the Wilderness Act of 1964 and other subsequent wilderness legislation.

The remaining Blue Range Primitive Area, along with presidential recommendation additions from the 1971 recommendation to Congress, together total 199,505 acres, and by law, agency policy, and the 2015 Apache-Sitgreaves Revised Forest Plan continue to be managed with the same mandate as congressionally designated wilderness to protect wilderness character . The Gila NF borders the Blue Range Primitive Area along the Arizona/New Mexico state boundary for approximately 8 miles of adjoining designated Blue Range Wilderness and 7 miles of non-wilderness Forest lands on the New Mexico side.

During their forest plan revision effort, the Apache Sitgreaves NFs deferred the decision whether to recommend the Hells Hole, Nolan, and Mother Hubbard potential wilderness areas (a total of 26,023 acres) for wilderness designation until the Gila National Forest completes its potential wilderness evaluation and forest plan revision (USDA FS A-S NFs 2014a). These potential wilderness areas are composed of inventoried Roadless areas that straddle the Arizona/New Mexico state boundary, partially located on both the Gila and Apache-Sitgreaves National Forests. The Hells Hole, Nolan, and Mother Hubbard potential wilderness areas continue to be managed to protect wilderness characteristics until a decision is made during the Gila NF Forest Plan revision process as to whether or not to recommend these areas for wilderness designation (USDA FS A-S NFs 2014a).

The Lower San Francisco IRA located in Arizona on the Apache-Sitgreaves NFs lies to the west of the Lower San Francisco WSA and IRA located in New Mexico. As part of their forest plan revision, the Apache Sitgreaves NFs evaluated (West Blue/San Francisco Potential Wilderness[58] PW-03-01-052; USDA FS A-S NFs 2012b), but did not recommend as wilderness the Lower San Francisco IRA located in Arizona (USDA FS A-S NFs 2015). Instead, these areas will now be managed as Natural Landscape management areas under the A-S NF Revised Plan. These are generally undeveloped areas that are natural appearing and provide primitive and semi primitive recreation opportunities. Management activities are allowed but are primarily focused on ecosystem restoration. This management area includes most of the inventoried Roadless areas (IRAs) that were identified in the 2001 Roadless Area Conservation Rule. IRAs are managed to protect and conserve their Roadless character.

The Apache Sitgreaves NFs also has identified three Eligible Wild and Scenic Rivers with the potential to be influenced by Gila NF management decisions because portions of each are located across shared forest

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[58] The West Blue/San Francisco Potential Wilderness included 3,577 acres on the Gila NF

boundaries. The San Francisco River's headwaters are located on the A-S NFs west of Alpine, AZ but it flows through Gila NF administered and private lands in New Mexico before reentering Arizona and the A-S NFs.

The upper San Francisco River from its headwaters and across the Gila NF administered lands is not currently designated as an Eligible or Suitable Wild and Scenic River.; However, the lower portion of the river located on the Apache- Sitgreaves NFs is currently administratively designated as an Eligible Wild and Scenic River. The Gila NF also contains small portions of Coal Creek and Campbell Blue Creek, both of which are also administratively designated Eligible Wild and Scenic Rivers by the Apache-Sitgreaves NFs (USDA FS A-S NFs 2014b).

National Park Service
Gila Cliff Dwellings National Monument is a 533-acre National Park Service administered designated area surrounded by National Forest System lands (including the congressionally designated Gila Wilderness) managed by the Gila National Forest. Gila Cliff Dwellings National Monument offers visitors the opportunity to visit interpreted archeological sites originating from the Mogollon culture (see Chapter 17: Cultural and Historic Resources). From 2008 through 2011, an average of 37,000 people visited the Monument per year (Mitchell et al. 2014). Many of these same visitors also likely recreated on the Gila NF as well, including visiting one of many scenic overlooks, developed campgrounds, trails, and interpretive signs along the way. The Gila Visitor Center located near the monument is operated jointly by the National Park Service and the US Forest Service (see Chapter 14: Infrastructure). The revised management plan for the Gila Cliff Dwellings National Monument will be finalized soon (Hugh Hawthorne, Park Superintendent, pers. comm.).

Bureau of Land Management
The 7,161-acre Apache Box Wilderness Study Area (WSA), located on lands administered by the Bureau of Land Management (BLM) is contiguous for one mile of the southern boundary of the Hell Hole WSA, located on NFS lands administered by the Gila NF.

Another BLM administered unit, the Hoverrocker WSA, is located west of the Hell Hole and Apache Box WSAs (Figure 186). The Hoverrocker WSA is a 22-acre area that remained after the adjacent Arizona portion was released from wilderness review in 1990, but continues to be managed as a WSA in New Mexico pending congressional action.

The BLM Continental Divide WSA consists of 68,671 acres, encompassing parts of Pelona Mountain and a portion of the Continental Divide National Scenic Trail. This WSA is adjoins non-wilderness lands administered by the Gila National Forest for two miles.

All three of these BLM WSAs await congressional action, by either designating the area as wilderness or releasing it to be managed by the agency for other purposes. The WSAs are managed to protect wilderness qualities, so as not to impair the suitability of such areas for wilderness designation by Congress, according to the appropriate Resource Management Plan and BLM Manual 6330 Management of BLM Wilderness Study Areas.

The 840-acre Gila Middle Box Area of Critical Environmental Concern (ACEC) is immediately adjacent to the Gila NF. ACECs are areas "where special management attention is required...to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes" 43 U.S.C. § 1702(a).

State of New Mexico

The State of New Mexico has several areas in the vicinity of the Gila National Forest area that are designated for public outdoor recreation use and for wildlife habitat. The state also has historical markers distributed throughout all of the assessment area counties. The recreational sites, state parks, and wildlife areas located near or in the forest plan assessment area are listed below:

Recreational Sites and State Parks

- Caballo Lake State Park
- City of Rocks State Park
- Elephant Butte State Park

Wildlife Areas

- Glenwood State Fish Hatchery
- Heart Bar Wildlife Area
- Mimbres River Tract
- Quemado Lake[59]
- Snow Lake[59]
- Lake Roberts[59]
- Bill Evans Lake
- Bear Canyon Reservoir

The Gila NF works in partnership with all of these state and federal agencies to maintain communication and seek shared management objectives.

Potential Need or Opportunity for Future Designations

The Gila NF is not aware at the time of this report of any published documents or county, state, or tribal plans that identify the need or potential for additional designated areas within the plan area, with the exception of previously mentioned proposed critical habitat for narrow-headed garter snake, Northern Mexican gartersnake, and yellow-billed cuckoo. The 2012 Planning Rule and the directives associated with Forest Plan Revision require an inventory and evaluation for lands that may be suitable for inclusion in the National Wilderness Preservation system, and inventory of eligibility of rivers for potential inclusion in the Wild and Scenic Rivers System. These inventory and evaluation processes will occur in the next Plan Revision phase with significant public engagement.

Other potential special designations, such as special interest areas (e.g. botanical, geological areas) and RNAs will also be further considered and evaluated as part of the Forest Plan Revision process. There may be opportunities to establish additional Research Natural Areas (RNAs), including previously proposed RNAs, as well as new areas. The Gila NF currently has four proposed Research Natural Areas: Agua Fria (350 acres featuring mountain grassland), Largo Mesa (300 acres of piñon-juniper woodland), Rabbit Trap (297 acres featuring scrub grassland), and Turkey Creek (1,335 acres of riparian hardwood) (Figure 188). These proposed research natural areas are currently managed to maintain their present natural condition. Areas previously recommended can be re-recommended (and would need joint Regional

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[59] While the dams for these lakes are owned and maintained by the New Mexico Game and Fish Department, they are at least partially located on lands administered by the National Forest. See Infrastructure Chapter for more details.

Forester/Research Station Director approval to designate), or can be made available for other kinds of management.

The 1986 Forest Plan provided direction to inventory the following areas to determine if they should be considered for RNA designation:

- Eagle Peak (aspen; mixed conifer; common juniper forest)
- Lower San Francisco (riparian ecosystem)
- Mineral Creek
- Mule Creek (riparian ecosystem)
- Pinos Altos Mountain (Arizona pine)
- Rocky Canyon (Arizona pine)
- Tillie Hall Canyon (mixed one, two, and three needle piñon pine and associated desert scrub)

It should be noted that selection of these ecosystem types were based on an earlier ecosystem stratification and were recently updated to the Ecological Response Units (ERUs) currently referenced in the ecological assessment of this report (see Chapter 2: Upland Vegetation).

A region-wide assessment of RNA ecological representation has been conducted to help identify ecosystems and vegetation types that are underrepresented among the region’s currently established RNAs. This may lead to previously proposed or new potential RNAs being identified on the Forest that may meet regional needs for ecological representativeness.

Table 219 shows the proportion of Ecological Response Units (ERU) located within designated areas on the Gila NF. All of the Ecological Response Units identified on the Gila National Forest currently occur within designated areas except for Little Walnut-Ponderosa Pine.

Table 219. Proportion of Ecological Response Units (ERU) located within designated areas (Wilderness, Wilderness Study Area, Inventoried Roadless Areas, and RNAs) on the Gila NF.

ERU	ERU Acres within Designated Areas	Total ERU Acres on Gila NF	% ERU within Designated Areas on Gila NF
Arizona Alder - Willow	2,620	3,222	81%
Arizona Walnut	459	1,325	35%
Colorado Plateau/Great Basin Grassland	13,678	89,033	15%
Desert Willow	741	8,929	8%
Fremont Cottonwood - Oak	85	85	100%
Fremont Cottonwood / Shrub	818	2,059	40%
Gambel Oak Shrubland	44,898	51,106	88%
Herbaceous Wetland	270	2,485	11%
Juniper Grass	29,991	114,396	26%

ERU	ERU Acres within Designated Areas	Total ERU Acres on Gila NF	% ERU within Designated Areas on Gila NF
Little Walnut - Ponderosa Pine	0	330	0%
Madrean Pinyon-Oak Woodland	12,662	17,361	73%
Mixed Conifer - Frequent Fire	251,508	367,209	68%
Mixed Conifer w/ Aspen	40,631	51,908	78%
Montane / Subalpine Grassland	15,994	113,806	14%
Mountain Mahogany Mixed Shrubland	118,887	166,488	71%
Narrowleaf Cottonwood / Shrub	11,292	22,681	50%
PJ Evergreen Shrub	3,697	10,679	35%
PJ Grass	123,062	291,647	42%
PJ Woodland	429,487	848,447	51%
Ponderosa Pine - Evergreen Oak	189,691	378,157	50%
Ponderosa Pine / Willow	63	862	7%
Ponderosa Pine Forest	198,533	630,294	31%
Semi-Desert Grassland	6,924	55,993	12%
Sparsely Vegetated	5,011	10,869	46%
Spruce-Fir Forest	20,926	23,779	88%
Sycamore - Fremont Cottonwood	2,574	6,427	40%
Upper Montane Conifer / Willow	478	670	71%
Willow - Thinleaf Alder	721	1,054	68%

In addition, should existing mining claims located near the Gila River RNA be determined as invalid, the establishment report recommended that it should be extended up the Gila River approximately ½ mile (USDA FS Gila NF 1969)

Contribution to Social, Economic, and Ecological sustainability

Designated special areas contribute to social sustainability by connecting people to their natural and cultural heritage, and providing economic benefits to surrounding communities. They promote the preservation of cultural traditions including historical features that contribute to social wellbeing through education, and provide recreational opportunities. Contributions to economic sustainability may occur by increased visitation to designated areas, which may increase employment opportunities, support to small businesses, and sharing Federal receipts with county and state governments. In addition, designated areas often contain particularly unique/valued resources of one kind or another that may result in specific public interest/value.

Designated areas contribute to ecological sustainability as well, by preserving intact natural systems and their individual components for future generations. Designated areas provide clean drinking water and function as biological strongholds for populations of threatened and endangered species. They provide large, relatively undisturbed landscapes that are important to biological diversity and the long-term persistence of at-risk species. Designated areas provide forest visitors with opportunities for dispersed outdoor recreation, opportunities that diminish as open space and natural settings are developed elsewhere. They also serve as bulwarks against the spread of non-native invasive plant species, and provide reference areas for study and research (USDA FS Gila NF 2013d).

There has been an economic transition from using the Forest as a commodity for the economy to also developing the Forest for economic benefits from recreation use (USDA FS 2006). There are many local businesses in the Gila NF surrounding area that receive a majority of their yearly business during hunting season, when some areas of the Forest are experiencing the highest volume of visitation. Many of the local businesses benefit economically due to the Forest visitors recreating in these designated areas when they are travelling through the local communities to their destinations. However, designated areas can also impose opportunity costs on local economies due to land use restrictions and foregone commodities (Steed et al. 2011; Ashcroft et al. 2012) and may increase permit compliance obligations and raise maintenance costs due to more restricted access methods.

National Scenic and Recreation Trails draw a variety of trail users to the area. The label of “gateway community” for towns such as Silver City, which was the first to be designated a Continental Divide Trail gateway community, creates opportunities for attracting visitors who want to access the trail for day trips or short treks or, in the case of thru hikers and riders, stop for resupply and rest before continuing on their journey. This benefits the economy of the town, and may even encourage people to relocate to the area. The communities then become stewards of the trail and partner with the Forest Service to maintain the sustainability of the recreation resource.

Stakeholder Input

From the input received from stakeholders, it is clear that designated areas is a polarized issue, especially concerning wilderness. Some comments praised the Gila National Forest’s unique wilderness heritage of being the first formal wilderness area in the nation. With increasing urbanization and development in the region, some stakeholders call for more designations to preserve important qualities of the Forest, such as watershed function, unfragmented wildlife habitat, clean air, hunting opportunities, scenery, recreation, and future scientific research. Some commenters noted that they perceived improvements to ecosystems, soils, and water conditions in the wilderness areas, and also connected the wilderness area designation to enabling the restoration of the natural role of fire to ecosystems on a landscape scale. One stakeholder suggested developing “quiet areas” in addition to wilderness.

Other stakeholders feel that designated areas, with their higher levels of management restrictions, have led to a narrowing of uses, access, and benefits, resulting in negative economic impacts. The restrictions within wilderness are viewed by some as restricting active management of resources and reducing public access to a limited few with the skills and resources for using horses, or the physical ability to travel by foot within the wilderness.

There are beliefs expressed by some that the Forest currently has sufficient (or too much) wilderness area, and does not require more. There is also perception by some commenters that the wilderness areas on the Forest have poor watershed quality, and poor forest health, resulting in larger fires. There is nearly universal agreement however, that trail conditions in the wilderness areas are poor and require increased maintenance, that signage needs to be improved, and wilderness maps require updating.

Wild and scenic rivers face a similar polarization. Some stakeholders believe that earlier Forest Service decisions not to recommend the Gila and San Francisco Rivers as eligible wild and scenic rivers were missed opportunities. They feel that climate change and current water development planning under the Arizona Water Settlement Act represents changed circumstances, warranting reevaluation of these waterways' Wild and Scenic designation eligibility. Others point to the historic and current water diversions for irrigation along the rivers and feel the Gila River can remain free flowing in designated wilderness, but that downstream water users should continue to have authority to manage water resources outside of these areas. The concerns expressed by these stakeholders is that changes in the Forest Plan, including additional designated area recommendations, could negatively affect downstream water rights holders or impinge on the State's ability to exercise its legal rights to administer water use.

There were suggestions that along with the status afforded the CDNST that similar motorized and mountain bike routes, including the Great Continental Divide Adventure Route, and the New Mexico Backcountry Discovery Route, should be given the same consideration within the forest plan. These trails and not formally designated or officially recognized for purposes of the assessment, however there may be excellent opportunities for partnering with groups advocating these trails for providing future recreation opportunities as individual projects during the implementation phase of the revised plan.

Other suggestions from the public for special designation consideration included a population of Chihuahuan pine near Bear Mountain; the Gila Middle Box; the Mogollon Box or Upper Gila Box; and Mineral Creek.

Summary

Designated areas on the Gila NF represent identified exceptional areas that have distinct or unique characteristics warranting special designation, either administratively by the Forest, region, or agency, or statutorily through legislation passed by Congress. Designated areas have specific management objectives to maintain their unique characteristics and are important ecologically and socially for the exceptional values they offer and protect.

The three congressionally designated wilderness areas of the Gila National Forest (Gila, Aldo Leopold, and Blue Range) are managed to protect their wilderness character. Because wilderness character measures are applied to a wilderness as a whole, localized threats to wilderness character affect the entire areas. Threats to wilderness character include potential impacts to air quality and associated loss of visibility, military aircraft overflights, excessive and concentrated amateur rock hounding activity, utility development near the wilderness boundary, the ecological effects of climate change, invasive, non-native species, poor trail conditions (that may directly and indirectly cause resource damage), impacts associated with inadequate oversight of the outfitter/guide program within wilderness (as discussed in Chapter 12: Recreation), and the encroachment of user-created motorized routes and accompanying motorized incursions. The implementation of the Travel Management decision on the Forest is expected to address many concerns with illegal motorized use and route development. With the New Mexico Wilderness Act of 1980, Congress previously designated two wilderness study areas on the Forest, Hell Hole and Lower San Francisco River WSAs. These were analyzed and recommended for removal of consideration as Wilderness under the 1986 Gila Forest Plan. However, because Congress has taken no further action, the Forest has the existing mandate to manage the WSAs to protect their wilderness characteristics. Threats to WSAs are similar to designated Wilderness, but also include localized issues such as illegal firewood gathering in the Hell Hole WSA, and salt cedar infestations potentially causing ecological impacts within the Lower San Francisco River WSA.

There are 29 Inventoried Roadless Areas (IRAs) within the Forest, designated under the 2001 Roadless Area Conservation Rule. IRAs are managed to protect their Roadless characteristics, with road construction, reconstruction, and timber harvest prohibited, although travel is allowed to continue on existing roads or motorized trails. These areas are managed by the Gila NF to provide for primitive and semi-primitive non-motorized recreation experiences. Threats to the IRA characteristics include unauthorized motorized use and the presence of illegal user-developed motorized routes. Current trend is increased management actions from implementation of the Travel Management decision, reducing existing unauthorized routes, and preventing new ones.

Currently there are eight Eligible Wild and Scenic Rivers (WSRs) within the Gila National Forest. Eligible WSR is an administrative designation, which carries a mandate to manage these rivers and their associated corridors for preservation of their Outstandingly Remarkable Values (ORVs). Threats to ORVs on the Gila NF include unauthorized, user-developed motorized routes within the river corridor, non-native invasive species, drought, wildfires that burn outside of the range of historic variability, and post-fire flooding and erosion damage.

During the plan revision process, the Forest is required to conduct an inventory and evaluation for lands that may be suitable for inclusion in the National Wilderness Preservation system, and inventory of eligibility of rivers for potential inclusion in the Wild and Scenic Rivers System. Both of these designations may only be made statutorily, through legislation passed by Congress. Other potential special designations (e.g. botanical, geological areas) and RNAs will also be further considered and evaluated in the Forest plan revision process.

The 1986 Gila Forest Plan established the Gila River Research Natural Area (RNA) for purposes of permanently protecting and maintaining natural conditions for the conservation of biological diversity, conducting non-manipulative research and monitoring, fostering education, maintaining the natural features for which they were established and maintaining natural processes. Potential threats to the RNA include possible future water diversion developments and the existence of the trail associated with the adjacent Gila River Bird Area passing through part of it that may provide a vector to introduce nonnative species and other human disturbances into the area. Because there is a lack of recent survey data, the presence of invasive species are unknown, but may be an additional threat to the area.

Two National Scenic Byways, the Trail of the Mountain Spirits and the Geronimo Trail, are located partly within the Gila NF boundary. The National Scenic Byways Program was established to help recognize, preserve, and enhance selected roads throughout the nation. Both Scenic Byways are managed in cooperation with partners and have corridor management plans in place to provide management guidance and direction for implementing changes and improvements. Potential threats to Byways include incompatible development outside the Forest but within the byway corridors, and any threats to scenic values of the corridor within the Forest.

The congressionally designated Continental Divide National Scenic Trail (CDNST) traverses the Rocky Mountains for approximately 3,100 miles, with 254 miles of the CDNST travelling through the Gila NF. Management direction for the Trail is provided by a Comprehensive Plan. All National Scenic and Historic Trails are managed as “extended trails so located as to provide for maximum outdoor recreation potential and for the conservation and enjoyment of nationally significant scenic, historic, natural, and cultural qualities of the area through which such trails may pass”. Threats to the CDNST are in common with other non-motorized trails on the Forest, detailed within Chapter 14: Infrastructure and Chapter 12: Recreation.

National Recreation Trails are administratively designated by the agency to recognize exemplary trails of local and regional significance and as part of America's national system of trails, provide for trail-based recreation activities in a variety of urban, rural, and remote areas. The Gila NF manages the Catwalk National Recreation Trail, the Sawmill Wagon Road National Recreation Trail and Woodhaul Wagon Road National Recreation Trail. Threats to these trails are concurrent with those of all trails on the Gila National Forest, see Chapter 14: Infrastructure and Chapter 12: Recreation for more detail.

The US Fish and Wildlife Service has analyzed species needs and designated critical habitat within the Gila NF boundary for six species of wildlife. See Chapter 8: At-Risk Species for more details.

In addition to the specially designated areas found within the Gila NF, there are areas specially designated by other agencies that surround the Forest. These areas add recreation values, scenic values, wildlife habitat, and other resources values complementing those of the Forest. The Gila NF works closely with all of these state and federal agencies to maintain communication and seek shared management objectives.

Forest Service designated special areas may contribute to social, economic, and ecological sustainability by connecting people to their natural and cultural heritage, preserving intact natural systems and their individual components, and potentially providing economic benefits to surrounding communities. It is possible that designated areas may also impose some opportunity costs on local economies by restricting certain uses or extraction of forest products, increase permit compliance obligations, and raise maintenance costs due to more restricted access methods.

Input received to the Forest Plan revision process so far has shown that Designated Areas, and in particular congressionally designated Wilderness, is a polarizing issue for Gila National Forest stakeholders. Some commenters feel that current conditions, both locally and globally (i.e. climate change) warrant the preservation of additional designated areas, including Wilderness and Wild and Scenic Rivers, while others feel that such designations hinder the management of these areas to prevent large scale wildfires and may negatively affect water rights holders.

Chapter 14. Infrastructure

Introduction

Infrastructure is considered the human built property created to support the use of NFS lands. It includes roads, trails, dams, bridges, and administrative and recreation facilities owned and managed by the Forest Service; and it includes roads and utility infrastructure owned and managed by other governments and private entities. The infrastructure influences the Forest's ability to contribute to the social, cultural, and economic conditions within the plan area and the broader landscape. Infrastructure allows for sufficient access and use of the Forest, through a variety of multiple uses and ecosystem services. It should be integrated within the landscape, to preserve its scenic beauty and character and enhance the experience of Forest users. Forest infrastructure should be well planned, managed, and maintained, so as not to harm the ecological integrity of the Forest and allow for continued enjoyment and use of the Forest by many user groups. This section identifies and evaluates:

- The current condition and maintenance level of the Forest's infrastructure – roads, bridges, administrative and recreation facilities, dams, utility systems, trails and other infrastructure.
- How funding and maintenance trends may affect infrastructure in the future.
- And the contribution infrastructure makes to the public's ability to use and benefit from Forest resources.

Ecosystem Services of Infrastructure

Forest transportation infrastructure supports the ability of the Forest to provide ecosystem services by allowing access for Forest Service employees to implement project work, which contributes to the health of Forest ecosystems. Healthy Forest terrestrial, riparian, and aquatic ecosystems increase the ability of the Forest to provide supporting and regulating ecosystem services. Transportation infrastructure allows visitors and permit holders to gain access to the many provisioning ecosystems services important to them. The trail system, campgrounds, and other recreation infrastructure provide cultural ecosystem services through recreation opportunities, scenic vistas, and enjoyment with nature.

Transportation Infrastructure

Visitors from all over travel to and through the relatively remote Gila National Forest. Most start off on federal, state and/or county roads and eventually make their way onto connecting Forest roads. Once on the Forest, users may choose to continue their journey on higher standard roads or transition to lower standard roads where high clearance and/or four wheel drive vehicles are recommended. Whether the road is a four lane highway or a primitive road, this multi-agency, multi-standard network of roads is maintained to provide reliable access by the motorized public.

Primary Access Routes Servicing the Forest

Access to the Gila National Forest, and many of the more popular destinations, is accomplished through a network of federal, state, and county routes (Figure 191). The portion of this network found in the higher elevations is subject to periodic closure during heavy winter snows. Motorists may also encounter delays associated with rock or debris flows from storm runoff especially in areas of recent fire activity. Several different agencies are responsible for keeping these roads open and safe for all users year-round. Many of these roads serve as primary access for communities in and around the planning area.

National Forest System Road (NFSR) 150, also known as the North Star Mesa Road, is the only National Forest System Road motorists can use to travel from the southern boundary of the Forest to the northern boundary. NFSR 150 falls within the corridor that separates the Gila Wilderness from the Aldo Leopold

Wilderness. In 2011, the Forest has made significant investments in NFSR 150. Even with those improvements, there are times when NFSR 150 may become impassable by low clearance vehicles. During those times, low clearance motorists traveling from north to south or vice versa will have to rely upon U.S. Highway (US) 180 on the west side of the Forest or Interstate (I) 25 and N.M. Highway (NM) 52 to the east.

The Gila National Forest's 3.3 million acres is separated into six ranger districts. The northern portion is primarily comprised of the Quemado and Reserve Ranger Districts (RD). These two districts are accessible from Quemado to the north via NM-32, or Socorro to the northeast via NM-12, and from Springerville, AZ via US60 or US-180. Motorists coming in from the south will typically use US-180 from Silver City, NM

The Glenwood Ranger District is located on the west central portion of the Gila National Forest and can be accessed from the north (Luna and Reserve) and south (Silver City) via US-180. Travelers coming from Arizona can access the Glenwood RD via NM-78 from the southwestern portion of the district.

The eastern portion of the Forest is occupied by the Black Range RD. It can be accessed from the north (Datil and Socorro) and east (Truth or Consequences) via NM-52 and NM-59. The southern end of the District can be accessed via NM-152 and NM-27.

The Wilderness District is primarily comprised of wilderness and thus motorized access is limited. NFSR 150 is the primary access from the north. The only other access is through Silver City or Mimbres via NM-15 or NM-35 from the south and southeast respectively.

The Silver City Ranger District is located on the southern end of the Forest. This district is the home of the Supervisor's Office, located in the town of Silver City. This is the only district on the Forest that is discontiguous. The Silver City RD is comprised of three separate areas; the area immediately surrounding Silver City, the portion in the southern Black Range Mountains, and the Burro Mountains area. Motorists can find their way to this district by way of US-180 when coming from the north and west (Glenwood) or south and east (Deming), via NM-90 from the south and west (Lordsburg) or from the east by way of NM-152 (Truth or Consequences and Hillsboro).

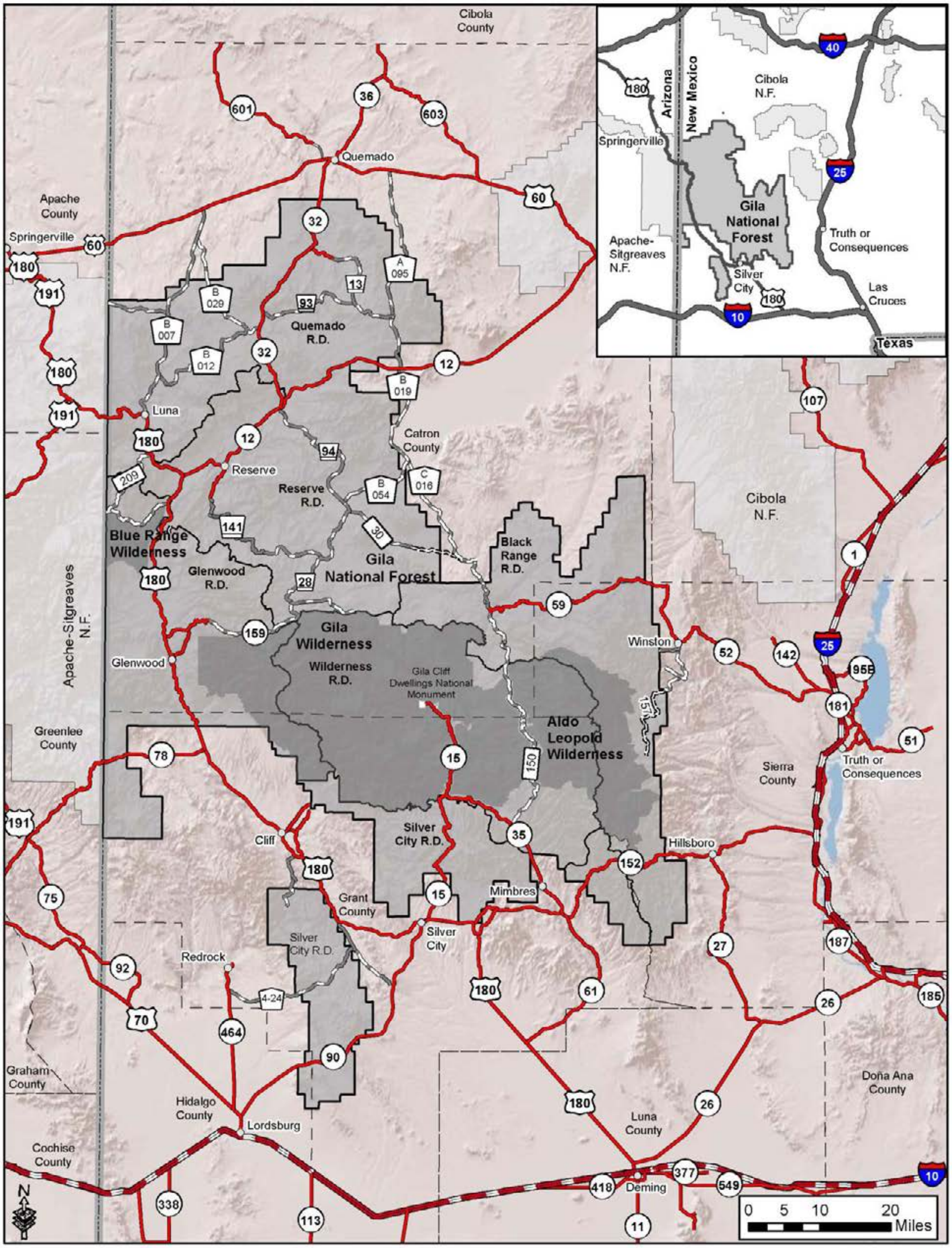

Figure 191. Major access routes in and around the Gila National Forest

Forest Transportation System

The Forest Service uses a Road Maintenance Management System to provide a systematic process for Forests to set priorities, plan, budget, schedule, perform, monitor, and evaluate maintenance of Forest roads. Every NFS road is assigned Road Management Objectives which then help determine its Maintenance Level (ML). The Forest Service uses the Road Management Objectives to describe the level of service provided by a specific NFS road. Several factors are considered when assigning maintenance levels; user safety, traffic volume, traffic speeds, road investment, user comfort and convenience, funding levels etc. When roads are scheduled for maintenance, the maintenance performed should meet the maintenance criteria for the road's assigned ML. Maintenance Levels range from 1 to 5. A ML 1 road provides the lowest level of service and a ML 5 is associated with roads providing the highest level of service. A road intended to move more traffic at a higher rate of speed would be assigned a higher maintenance level than a road maintained for high-clearance vehicles at much lower speeds.

ML 1 roads are closed to all vehicular traffic, but may require basic custodial maintenance to prevent damage to adjacent resources or to preserve the road for future resource management needs. Roads assigned to ML 2 through 5 may provide year-round or intermittent access. ML 2 roads, which are managed for high-clearance vehicles, account for the majority of the open NFS road miles. These roads typically don't receive a lot of traffic but they provide motorized access to more acres of Forest for various purposes (e.g., hunting, camping, access to trailheads, firewood gathering, recreational driving) than all of the ML 3 through ML 5 roads combined. No provision is made for user comfort, user convenience, and speed of travel. Neither is any provision made to warn users about changing conditions and safety concerns on the road ahead. On the other hand, level 3 roads are passable to prudent drivers in passenger cars. Users can reasonably drive with expectations of predictable road conditions and can expect warning signs and traffic control devices meeting standards from the Manual on Uniform Traffic Control Devices when hazards are present. The distinctions between maintenance levels 3, 4, and 5, which are roads managed as public roads, are not sharply defined. Some parameters overlap. Maintenance levels are selected based on the best overall fit of the parameters for the road in question. In those situations where the parameters do not indicate a definite selection, the assignment of ML should be based on the desired level of user comfort and convenience as the overriding criteria.

Maintenance of NFS roads on the Gila NF occurs year-round. NFS roads on the north end of the Forest (Quemado and Reserve RDs) are typically scheduled for maintenance during the warmer months to avoid the adverse conditions (frozen roadbeds, snow and other inclement winter weather, etc.) of the winter months. During the winter months, maintenance is performed on NFS roads on the southern end of the Forest where temperatures are typically milder and conditions are more conducive. Flash floods from isolated thunderstorms, persistent monsoon rains, downed trees from the past winter or spring winds, and potholed pavements from freeze-thaw cycles comprise the maintenance challenges through the year. Emerging trends are the impacts of larger and more severe fires, and the subsequent monsoon rains that follow, leading to increased flooding and roadway washouts.

Forest Service Handbook (FSH) 7709.59-40 requires roads "open to public travel", i.e., passable by four-wheel standard passenger cars and open to the general public, meet certain standards of the Highway Safety Act of 1966 associated with design, construction, maintenance, signing and traffic accident surveillance. NFS roads managed as ML 3, 4 or 5 are subject to the Highway Safety Act. These roads see more traffic traveling at higher speeds than ML2 roads and thus, more time and money are directed to the maintenance of these facilities.

Funding levels for road maintenance have significantly declined over the years. Since 2011, funding levels for road maintenance on the Gila National Forest have seen an average reduction of 11% per year. In 2015, the Gila NF road maintenance budget was $738,400. The Forest is completing basic custodial maintenance (grading the road surface, maintaining ditch lines, select sign replacement, minor brushing of roadside vegetation, etc.) on approximately 300 miles (out of the 3,334 total miles) of the existing roads on an annual basis; approximately 75% of those miles are ML 3, 4 and 5 roads and the remaining 25% are ML 2 roads. Approximately 80% of the 300 miles of maintained roads are the same and appear on the maintenance schedule every year. The Forest has worked with local county agencies to clarify jurisdictional issues associated with roads passing through the Gila NF. The end result is a transfer of nearly 400 miles of National Forest System roads to Catron and Grant counties.

The majority of these miles are not maintained fully, i.e., correcting all deficiencies to ensure the road and all its features are functioning properly. The annual maintenance needs displayed in Table 220 and the available maintenance budget shows a large discrepancy and presents the Forest having a road system that cannot be fully maintained. Further, road maintenance budgets are forecasted to decline in the foreseeable future, therefore continuing to make it difficult to provide basic custodial maintenance to entire road system.

Table 220. Annual road maintenance needs by maintenance level

Maintenance Level	Miles	Annual Estimated Maintenance Needs $/mile[a]	Total
2	2,932	$350	**$1,026,200**
3	251	$8,282	**$2,078,782**
4	129	$10,294	**$1,327,926**
5	22	$6,597	**$145,134**
Total	**3,334**		**$4,578,042**

[a] Annual Costs per Mile from “Identifying a Financially Sustainable Road System Spreadsheet Tool” (USDA FS 2006c)

The result of the Forest’s inability to perform full maintenance is a maintenance backlog known as deferred maintenance. Examples of deferred maintenance include replacing culverts, cattle guards, surfacing and signs based on their life cycle or only when needed, and removing all roadside vegetation encroaching into the roadway or only that which is limiting site distances. An estimate of the current deferred maintenance for NFS roads on the Gila National Forest is $272,265,429. This number is subject to grow as funding levels continue to decline.

Bridges

The Gila NF has 12 road bridges as part of its transportation system. All but one of the Forest’s bridges have been in service for 50 years or more. The Forest does plan to replace or rehabilitate eight bridges on NFSR 150 once funding becomes available. Two of the bridges are scheduled for replacement and another for rehabilitation in 2016. The Forest has designs in place to replace another five structures once funding becomes available. Of the remaining four bridges, two are rated in “good” condition or better and the other two are rated to be in “fair” condition. None of the remaining four bridges are subject to load restrictions at this time. All twelve bridges are inspected every two years. Inspectors document all observed deficiencies and create a list of work items that are prioritized and corrected as funding permits. The funding source for minor bridge repair and maintenance is the same as funds available for road maintenance. Funds for major work items, rehabilitation and bridge replacements are typically competed for at a regional level.

Travel Management

To address the concern about unmanaged off-highway vehicle (OHV) use, the Forest Service published final travel management regulations for use of motor vehicles on National Forest System lands on November 9, 2005. The Travel Management Rule (USDA FS 2005) requires that each national forest and grassland "provides for a system of National Forest System (NFS) roads, NFS trails, and areas on NFS lands that are designated for motor vehicle use...including the class of vehicle and time of year..." The Gila National Forest's Travel Management decision was released in June 2014, and the decision was implemented upon publication of the motor vehicle use maps (MVUMs) for the Quemado, Reserve, Wilderness and Black Range districts in July 2017, and the Silver City and Glenwood Ranger Districts in January 2017. Designated roads, trails, and areas open for motor vehicle use are identified on the Gila NF MVUMs. Consistent with the rule, motor vehicle use off designated roads, trails, and areas identified on an MVUM is prohibited on the Gila NF. The Gila NF MVUMs currently identify 3,334 miles of NFS roads designated for public motorized use (Table 221). Approximately 2,932 miles (88%) are ML 2. The remaining designated NFS roads (402 miles or 12%) are ML 3 to ML 5 and are managed for passenger car use.

Roads not selected as part of the designated public system can be used administratively or by written authorization (329 miles), or will be stored (908 miles) for future use or decommissioned. The status of these stored roads will be evaluated during future project planning. More information on travel management decision and implementation can be found at:
www.fs.usda.gov/detail/gila/home/?cid=STELPRDB5035773.

Table 221. Miles of Gila National Forest roads by maintenance level

Maintenance Level	ML2	ML3	ML4	ML5	Total
Miles	2,932 (88%)	251 (8%)	129 (4%)	22 (<1%)	3,334 (100%)

Aviation

There are 4 airstrips located on the Forest that receive semi-regular maintenance (Beaverhead, Negrito, MeOwn, and Jewett Mesa) by the Forest. These airstrips provide access for emergency services, fire management operations, burned area emergency response actions, and other administrative activities of the Forest Service. These airstrips are also considered open for general public use and receive occasional recreational use. Two other airstrips are located on the Gila National Forest, but are under special use permit to Catron County (Reserve and Glenwood). All the airstrips located on the Gila National Forest are considered "primitive" according to the Airstrip Classification matrix (USDA FS 2012e), with the exception of Reserve which is developed. The New Mexico Department of Transportation is actively working with the recreation aviation community and other stakeholders to promote the use of airstrips around the State and to help the Forest Service maintain recreational opportunities associated with existing airstrips. Pilots are reminded that it is their responsibility to check Federal Aviation Administration (FAA) Notices to Airmen (NOTAMS), the Aeronautical Information Manual, FAA flight service stations, and current airstrip conditions from the airstrip manager before conducting any flight operations.

Facilities

Administrative Facilities

Much of the planning for facilities for the Forest is guided by Facilities Master Plan which is scheduled to be updated and revised regularly. Currently, the Facilities Master Plan is overdue for update, however it will be updated by an independent group in fiscal year 2016, and this will reflect current vision and direction for facilities on the Forest. The Gila NF has six ranger districts of which one is a combination

Supervisor's Office / District Office. Of the six ranger district offices, four are owned by the USFS. Of the other two districts, the Black Range District Office in Truth or Consequences, NM is leased and the Silver City District office, which is shared with the Supervisor's Office, is also a leased facility. The Supervisor's Office also leases land from the Grant County Airport for facilities at the Aerial Firebase / Cache. With the exception of the Black Range Ranger Station, the ranger stations are self-contained compounds, typically including an office, warehouse/shop, residences/crew quarters, materials storage sheds, horse facilities, and water/wastewater systems. Several of the districts also have remote work centers due to long distances between district areas, which include living quarters as well.

The Wilderness Ranger District also has facilities and land owned by the USFS, but are used and managed by the National Park Service at the Gila Visitor's Center near the Gila Cliff Dwellings National Monument. These facilities are shared by both agencies in many cases, and costs are spilt for maintenance and upkeep on an informal basis. Currently, the USFS and the National Park Service are in the process of instituting a formal agreement between the two to determine responsibilities of these lands and structures going forward. While details aren't currently available, this should formalize who is both physically and fiscally responsible for the well-being of this infrastructure.

The Gila NF maintains a total of 264 non-recreation administrative buildings including all range facilities which include range cabins and barns and are maintained by the permittee. Each structure receives a facility condition assessment by qualified personnel every five years. The inspections result in the documentation of all required maintenance needs. The result of comparing the required maintenance to the generated replacement value for each asset is a facility condition index (FCI). The FCI correlates to a facility condition rating of good, fair, or poor (Table 222). A good condition rating is considered a site that is fully functional and pose little to no safety concerns to the public and agency personnel. With a good condition rating, there is room for improvements to the sites, but overall function of the site is acceptable. A rating of poor typically indicates the need for major repairs, replacement or decommissioning of the facility.

Table 222. Administrative buildings on the Gila National Forest, with their facility condition ratings

Ranger District	Number of Structures	Good	Fair	Poor
Supervisor's Office	50	24	7	19
Black Range	43	15	3	25
Quemado	43	22	5	16
Glenwood	35	14	3	18
Wilderness	35	16	2	17
Reserve	43	19	6	18
Silver City	15	8	1	6
TOTAL	264	118	27	119

The deferred maintenance of administrative facilities on the Gila NF, excluding the leased property, is valued at over $7.3 million dollars. With a limited budget to address all facility needs, prioritization of investment in maintenance occurs according to the following sustainability goals: (1) address existing or potential health and safety hazards; (2) emergency repairs to restore serviceability of building; (3) repair to existing building and utility system to prevent further damage and deterioration; (4) maintenance of facilities to the objective service level; and (5) improvements to reduce maintenance and operation costs.

Many of the facilities identified as being in poor condition are older buildings and many of those are range buildings (such as range cabins and barns) which are to be maintained by the permittee. These buildings are currently being maintained to address only required health and safety issues. Priority for maintenance is given to office, residential, and warehouse buildings. The facilities budget for maintenance of these buildings has not increased in recent years, leading to the significant deferred maintenance backlog. The expectation is that future funding will not increase, resulting in a decline in the condition of other administration facility structures. Current plans are to reduce overall footprint of facilities and consolidate resources in order to reduce facility maintenance costs.

Recreation Facilities

The Gila NF has a total of 33 developed campgrounds which include two group campgrounds. All of these campgrounds have vault toilets (see Wastewater Systems) and seven provide drinking water (see Drinking Water Systems). The Forest also manages a horse camp with water for stock and corrals. There are also a total of nine interpretive sites, five observation / vista areas, six picnic sites, five boating facilities, and 98 developed trailheads all with some type of development. Eleven sites have horse corrals (2 campgrounds, 7 trailheads, 1 interpretive site, 1 horse camp), while five different sites have a total of 10 pavilions.

The majority of recreation facilities are currently considered to be in good condition (Table 223). There are a couple of sites that are currently closed due to damages from wildland fires and/or flooding. There are other sites that currently have some sort of seasonal closure or restrictions due to time of year and threat of flooding (e.g. monsoon season). There has been a significant amount of rehabilitation work at several recreation facilities that have been affected by large wildland fires. Rehabilitation efforts have resulted in improved conditions compared to the previous ratings prior to the fire impacts. For more detailed information on conditions, risks, and trends related to recreation facilities see Chapter 12: Recreation.

Table 223. Recreation buildings on the Gila National Forest, with their facility condition ratings

Ranger District	Number of Structures	Good	Fair	Poor
Supervisor's Office	0	0	0	0
Black Range	7	6	1	0
Quemado	26	16	6	4
Glenwood	16	14	0	2
Wilderness	54	28	5	21
Reserve	16	12	2	2
Silver City	25	20	5	0
TOTAL	144	96	19	29

Drinking Water Systems

The Gila NF has 15 drinking water systems - 7 systems serve recreational facilities and 8 serve administrative sites. Many of the drinking water systems were developed or improved during the 1990s and early 2000s and currently range from good to poor in condition. However, each drinking water system still must meet water quality and system operation standards according to its classification type. The administrative sites include the Grant County Airport, Kingston Administrative area, Beaverhead Administrative area, Luna Administrative area, Glenwood Administrative area, Wilderness Administrative area, Negrito Administrative area and Fort Bayard Administrative area. The remaining administrative sites (Quemado, Reserve and Silver City Administrative sites) are served by municipal water systems. Recreation sites include Quemado Lake, Catwalk, Lake Roberts, Gila Visitor's Center, Willow Creek, Snow Lake and Little Walnut.

Due to shrinking budgets, current plans for the water systems are to correct and maintain these systems to a good condition rating and discourage installation of any new water systems. Testing and sampling of water systems are up to date and in compliance and will continue to do so until systems are properly decommissioned.

Wastewater Systems

The Gila NF manages 1 lagoon wastewater system near the Gila Cliff Dwellings National Monument which receives all sewage pumped from the nearby area (vault toilets, RV dumps, etc.), and multiple leach field / septic type wastewater systems. The Gila NF also ties into 4 municipal septic systems. There are 104 vault toilets on the Gila NF as well as 18 pit toilets.

The majority of the vault toilets on the Forest were installed in the 1970s and 80s, but have been replaced in the last 20 years as part of campground reconstruction projects by CXT model toilets. Vault toilets are an all-inclusive system which contains both the building and the below-ground vault for wastewater. Currently 73 vault toilets are in good condition, 14 are fair, and 17 are in poor condition. The approximate replacement value for one vault toilet is $40,000. Replacement of the 17 poor condition units would be a cost of around $680,000. Over time, we will seek to replace the 17 poor rated (older) vault toilets with new CXT vault toilets or equivalent.

The deferred maintenance of septic/wastewater systems on the Gila NF currently is estimated at $300,000. Once a septic tank/leach field system fails, it must be replaced in its entirety. Since wastewater is an important health and safety issue, funding for future administrative wastewater projects would be a priority.

Trail Systems

The Gila NF manages a total of 1,927 miles of trails. There is a total of 179 miles of motorized trails, 861 miles of trails within wilderness areas, and 891 miles of non-wilderness / non-motorized trails. Trails on the Gila NF are a vital contribution to Forest infrastructure since they provide access to the wilderness areas and are a key component to the recreation program. For information on condition, risks, and trends related to the trail system see Chapter 12: Recreation.

Communication Sites

The Gila NF has 6 control / base radios located throughout the Gila NF. In addition to this, there are 11 repeaters throughout the Forest that have communication equipment utilized by the Gila NF. The majority of the communication equipment and sites are all in good condition. However, some of the buildings are beginning to show some wear due to deferred maintenance.

To date, the Gila NF is currently in process of upgrading the current radio system via radio replacement. In that, there are plans to all existing base stations to control base repeaters in order to improve coverage and aide users in hearing and sending messages better throughout the Forest. A current issue the Forest is having is that the base stations receive traffic and send it to the Forest Dispatch Center via hard line and then are transmitted back via hard line to the base station and out to the users. In doing this, other users only hear the transmission sent by dispatch and not the initial traffic by other users. In only hearing one side of the communication, many users face confusion on messages, and other messages, which may be pertinent, are completely missed by listeners. Modifications to these base stations will now allow users to hear both transmissions from the other users as well as dispatch. This should improve communications at Glenwood, San Francisco Divide, Mangas Mountain, Signal Peak and Copperas Peak areas.

The continued maintenance and service of the communication sites and equipment is critical for Forest Service personnel and public safety. Most of the Forest is not accessible to mobile phone service. The current trend is for funding to be available when needed to perform maintenance. All funding for communication is borne by the Forest Service Communication Information Office.

Dams

The Gila NF has 3 large earthen dams forming lakes located within the Plan area. The Snow Lake Reservoir and Quemado Lake Reservoir are located entirely on National Forest land and the Lake Roberts Reservoir has some of the backwaters located on National Forest land. While all three of these lakes are located on National Forest Land, none of the dams are owned or maintained by the Gila National Forest. All three dams mentioned are maintained by the New Mexico Game and Fish Department, and current inspection reports show that while there are some operation and maintenance issues, the dams are in “satisfactory” condition. All three of these lakes have been separately permitted for use by “special use permit.”

Other Infrastructure

Several electrical, telephone, and oil and gas distribution systems cross the Gila NF, but are owned, operated, and maintained by public utilities or private companies. These systems and other infrastructure require a special use permit and / or easement from the Forest Service (see Lands). The infrastructure is significant because poor design and/or management can impact Forest resources.

In addition, the Gila National Forest has various range infrastructure including fences, corrals, cattle guards, and assorted types of water developments including; springs, wells, windmills, solar pumps, pipelines, water storage tanks, and water troughs. Range infrastructure such as water developments also benefit different species of wildlife. Many of these improvements related to livestock management were constructed years ago and are in states of disrepair or now obsolete. Many times new permittees inherit these through the waiver of permits and are faced with heavy and costly workload to repair or possibly remove improvements. Through the process of range analysis, improvements are inventoried to assess condition and efficacy. Improvements no longer needed are then scheduled for removal as time and funding will allow. New improvements or those that are still necessary for livestock management are constructed or maintained through a cost share partnership between the Forest Service and the livestock grazing permittees as part of their grazing permit. Vacant allotments on the forest pose a challenge to maintenance of infrastructure as many improvements such as fences, corrals or water developments have been abandoned since removal of the livestock. Those improvements such as water developments that continue to benefit wildlife are prioritized and maintained as funding allows. Any new range infrastructure proposed for livestock and/or wildlife is coordinated through the District Range Staff, permittees and Line Officers on the Gila National Forest, then taken through the proper NEPA analysis for implementation.

Implementation of the Travel Management Rule on the Forest will not affect the access or maintenance of range improvements for range and livestock management purposes. These uses are exempt from some of the restrictions and included as part of the term grazing permits.

Other wildlife infrastructure includes trick tanks and drinkers for wildlife, fish barriers, fishing piers, floating docks, boat ramps, fish habitat enhancement structures, and fish cleaning stations which are maintained by the US Forest Service. The fish barriers are located throughout the Forest and require little to no maintenance. Additional fish barriers may be considered pending recommendations and consultation between the U.S. Forest Service and the New Mexico Department of Game and Fish. All other fishing type infrastructure is also typically a joint effort as coordinated between the USFS and the New Mexico Department of Game and Fish.

Sustainability of the Forest Infrastructure

Over the last 20-years, the Gila NF has invested millions in mission critical and non-critical facilities. Money has been spent to upgrade facilities to be more energy efficient, abate hazardous materials and other health hazards as well as decommission and demolish facilities no longer needed for service. The Forest's trail system is in fair to poor condition, and its roads and bridges are currently safe for visitor travel. However, recent budgets are far less than what was distributed to the Forest in past years. If this trend continues, it is likely that some of the infrastructure will deteriorate beyond repair, which will force decisions on consolidation and possibly relocation.

Contributions of Infrastructure to Social, Economic, and Ecological Sustainability

The Gila NF's transportation system is integral to supporting the many uses and opportunities enjoyed by the public. Roads allow access to gather firewood, hunt, fish, hike, and recreate. Local businesses and communities benefit from visitors who want to use the Forest because they can safely access and experience the Forest on NFS roads and trails. Gaining access to the Forest through roads and trails are important for local residents to continue their traditional uses, which are integral in maintaining the social and cultural fabric of many Forest communities. The trail system allows Forest users to hike for exercise or simply to experience the beauty of the Forest. Recreation infrastructure (i.e., trails, roads, campgrounds, and toilet facilities) allow for recreation opportunities, which support communities directly (e.g., outfitter guide jobs) and indirectly (e.g., increased tourism in community lodges, shops, and restaurants). A well planned, managed, and maintained Forest infrastructure allows for these opportunities.

Infrastructure contributes to ecological sustainability when it is properly designed, integrated within the landscape, and well maintained. Transportation infrastructure allows Forest Service personnel to access the Forest to perform valuable monitoring and implement land and water restoration projects. The wildlife guzzlers provide fresh drinking water in times of low rainfall and when natural water sources are scarce.

Negative economic and social contributions would include having to close sites, because funds are inadequate to provide appropriate maintenance to keep sites safe for human use. Closures would reduce or limit opportunities to access and gain enjoyment of recreational resources and experiences. Negative ecological sustainability would result from a key dam failure, major road or trail erosion, or issues with septic systems. Roads and trails can have negative ecological impacts, which are described in more detail in Chapter 9: System Drivers and Stressors.

Stakeholder Input

Many stakeholders commented on the state of the infrastructure on the Forest. Some participants expressed concern about the lack of road maintenance and how that relates to resource damage or a loss to the local economies that rely on visitors who like recreational driving. Some people thought the Forest

Service should allow them to perform road maintenance. Others stated they felt there are too many roads while others thought more roads should remain open for fire management access, firewood gathering, general recreation, game retrieval, private land access, etc. A few participants indicated public road maps for the Gila National Forest are not accurate.

In regards to the travel management rule, which was a seperate planning effort, some expressed concern about losing access to parts of the Forest due to road closures, especially those who are elderly or mobility impaired. There were also those who felt the Forest was receiving resource damage from off road traffic and use of off road vehicles while others felt there was no damage associated with off road vehicle use. Some also commented that enforcement of the travel management rule will be difficult with reduced budgets and that road signage and additional public information will be important.

Public comments regarding trails and recreational facilities have several commonalities. As for the conditions of trails across the Forest, the vast majority of comments mention that current trail conditions are in poor shape. Many comments mention the need for additional emphasis on trail maintenance to keep the existing trails open and easy to navigate. There are a number of different suggestions on how to improve the condition of trails. Some comments include the need for addition funding, additional trail crews, improved signage, increase the use of different volunteer groups, utilize different partnerships (school groups, hiking and equestrian clubs, conservation groups), and create more loop trails. Another common theme presented by the public is the need for more information about the current condition of the trails on the Forest. Some of the different approaches include improved maps, updated information on the Forest website, and providing an avenue for the public to comment about trail conditions that they encounter. Other similar comments made by the public include the need to keep as many trails open as possible, not limiting trail access, and the use of outfitter / guides to do trail maintenance in exchange for waiving their fees for special use permits. Naming of trails was an issue, where the majority commenters would like to see geographic type names for trails instead of the standard of utilizing a numbered trail naming system.

An issue that has multiple different opinions is the motorized use of trails. One segment of the public would like to limit motorized use on trails and is distracted by the noise and damages caused by off road vehicle use on existing trails and roads. Another group of the public would like to see an increase of trails and roads that are made available for motorized use including an increase in the allowed width of motorized equipment on trails from 50” to 60” to accommodate side by side Utility Task Vehicles (UTVs).

Comments regarding recreation facilities were similar to those about trails. A common comment was how many of campgrounds and trailheads were in need of additional maintenance and repairs. A shared recommendation was to increase the number of campgrounds that have campground hosts to help with monitoring and maintaining campgrounds. Another mutual comment was to keep campgrounds open and available for motorized type camping, while the comments vary as to what kind of motorized type camping is requested. The range is from sites for car camping up to sites being able to park a 35’ recreational vehicle (RV).

Many people expressed how important recreational opportunities on the Gila NF are to the local economy. More services being offered on the Forest along with continued improvements to existing infrastructure will continue to draw more visitors to the Forest and surrounding communities. Having more visitors will increase the economic contribution to the local communities near the Forest and local economies will benefit. Therefore the local citizens have a strong interest in management activities that occur on the Gila NF.

After the release of the draft assessment report, stakeholders provided additional input, feedback and comments regarding this chapter of the assessment. Commenters suggested that partnerships with OHV clubs and other stakeholders could help maintain roads and trails given budget constraints. Another comment emphasized the need to be creative with potential infrastructure funding sources (such as the Resource Advisory Committee funding process) as these entities provide funding but they can also lead to strong community wide partnerships. A further suggestion was that roads determined to be “unneeded” should be considered and analyzed for repurposing as trails. There was also a request to provide more details on the Travel Management Plan decision and implementation. Another commenter requested that the information in Chapter 9: System Drivers and Stressors on potential negative ecological impacts from road and trail systems be cross referenced in this chapter, and the assessment report include that climate change is projected to increase the need for maintenance and exacerbate the deterioration of infrastructure. There were additional calls for reasonable access and that existing infrastructure be maintained and new infrastructure developed that supports the development of small business and local economies.

Summary

Infrastructure in the plan area is currently serviceable. Funding is the biggest risk to maintaining infrastructure into the future. Funding levels have decreased in recent years, while the costs to perform maintenance have increased. Closure of infrastructure (i.e., motorized roads, administrative facilities, and campgrounds) could result in reduced access, recreation services, and enjoyment by the public. Deterioration of infrastructure (i.e., roads, dams, range improvements, and utilities) could result in ecological damage to the Forest.

Chapter 15. Land Status and Ownership, Use and Access Patterns

Introduction

This chapter discusses existing patterns and trends of land ownership, status, and use both within, and near, the Gila National Forest (Forest). It also explains how land status, ownership, use, and access patterns influence management of the Forest and vice versa.

Land Ownership

Land ownership is the basic pattern of public and private ownership of both surface and subsurface estates and legal restrictions and permissions on the use of the land. It refers to the ownership of land and interests in land.

The Gila National Forest is composed of land proclaimed as Forest Reserve land by numerous Presidential proclamations, executive orders and laws through the years, along with lands which have been acquired from private or other governmental owners. The Gila National Forest is one of the largest National Forests in the nation, occupying approximately 3.3 million acres. Federal ownership within the Forest is mainly consolidated as a large whole unit with the exceptions of some communities and other large and small tracts of private land located within the Forest.

Private land inholdings within the three designated wilderness areas in the Gila National Forest are almost non-existent. The Aldo Leopold Wilderness has two five-acre private land parcels within its boundaries; the Blue Range Wilderness contains no private land parcels; and the Gila Wilderness has six parcels of private land within its boundaries. There are no private land parcels within the boundaries of the two wilderness study areas (Hells Hole and Lower San Francisco River).

The Gila NF is located in the southwest corner of New Mexico within the counties of Catron, Grant, Hidalgo, and Sierra. Table 224 displays land ownership within these counties (Headwaters Economics 2015a). The majority of the Gila NF land area resides in Catron and Grant counties. The Forest comprises approximately 46 percent of Catron County and 34 percent of Grant County. With the combination of other federal, state, and tribal lands, only 26 percent of Catron and 39 percent of Grant County is privately owned. The amount of the Gila NF within Sierra County (13%) and Hidalgo County (0.4%) is less significant although only 25 percent and 42 percent is privately owned in these counties, respectively, due to significant holdings by other federal and state agencies.

Table 224. Land ownership (percent) in the counties that include the Gila NF

	Catron County	Grant County	Hidalgo County	Sierra County	County Region	U.S.
Private Lands	25.5	38.6	42.1	25.3	31.3	58.7
Conservation Easement	0.1	0.0	0.8	0.0	0.2	0.6
Federal Lands	62.7	47.4	41.6	63.2	55.6	28.8
Forest Service	49.5	33.9	3.5	13.9	29.5	8.4
Gila NF	45.9	33.9	0.4	13.2	27.4	<0.01
Cibola NF	3.6	0.0	0.0	0.7	1.5	<0.01
Coronado NF	0.0	0.0	3.1	0.0	0.6	<0.01
BLM	13.2	13.4	38.1	28.8	21.4	11.1
National Park Service	0.0	0.0	0.0	0.0	0.0	3.4
Military	0.0	0.1	0.0	19.3	4.4	1.1
Other Federal	0.0	0.0	0.0	1.3	0.3	4.7
State Lands	11.5	14.0	16.3	11.4	12.9	8.4
State Trust Lands	11.5	14.0	16.3	10.5	12.7	1.9
Other State	0.0	0.1	0.0	0.9	0.2	6.6
Tribal Lands	0.3	0.0	0.0	0.0	0.1	4.0
City, County, Other	0.0	0.0	0.0	0.0	0.0	0.2

Land Ownership Adjustment

The current 1986 Forest Plan allows for the adjustment of landownership for resource management goals. Management of the enormous land base of the Gila National Forest can be extremely complex. This task is magnified by patterns of ownership that are not contiguous in particular locations. Parcels of private land have been acquired by the Forest in the past via donation, purchase and exchange (trade), and these opportunities still occur. Acquisition of some of these private parcels can be helpful in achieving a desired Forest landownership pattern that supports resource management goals, addresses fragmentation, and reduces future management costs. For example, acquisitions of specific properties may expand access opportunities for the general public in areas of the National Forest which may have been extremely difficult to reach in the past. Acquisition of particular private inholdings may assist in recovery efforts of threatened and endangered species. Conversely, the sale or disposal of Forest land can assist communities in moving toward community objectives such as area for expansion or other municipal purposes.

Trends Affecting Land Ownership

The land area of the Forest has also been adjusted by numerous acquisitions, sales and exchanges. It is unclear what the future holds as funding for land acquisition is extremely limited and this scarce funding is shared and competed for throughout the nation. Land exchanges are becoming more infrequent as the transaction costs continue to rise and the time for the completion of a transaction to occur can be many years.

There is a trend of private ranches being subdivided, and portions being converted to other uses including residential development. This residential development can often occur near the Forest boundary it is a desirable amenity (often reflected in the real estate listing and sale price) for a piece of private property to be near or adjacent to the National Forest. This conversion to residential development can also have implications for the Gila NF including growth of the wildland-urban interface (and the cost of protecting homes from wildfires), the spread of invasive plants onto the Gila NF, the loss of access to public lands for recreation, the loss of wildlife habitat and wildlife movement corridors that cross private-public land boundaries, and the potential for conflict among user groups (Headwaters Economics 2015b).

It is now common to have a large number of homes, second homes, and vacation homes bordering public lands in the western United States. Since wildfire is a natural disturbance on western public forests, these homes are especially vulnerable to the risk of wildfire, and are considered within the wildland urban interface (WUI). Prolonged drought over the past 15 years (see Chapter 6: Water for more details) has increased the risk of more severe and intense wildfire. Catron, Grant, Hidalgo, and Sierra counties each have County Wildfire Protection Plans (CWPP), which seek to manage residential growth in WUI areas, promote partnership and collaboration, and identify and prioritize hazardous fuels reduction areas. Six percent (1,726) of the homes found within the four-county area are located in WUI areas. In recent years, the Gila NF has planned and implemented many projects that specifically decrease the risk of wildfires within these areas (e.g., prescribed burning and mechanical treatments to reduce fuels). See the discussion on WUI in the Chapter 10: Social, Cultural, and Economic Conditions.

Influences of Land Ownership on Social and Economic Conditions

With approximately 69% of the area owned by Federal and State governments, the multi-county area of Catron, Grant, Hidalgo, and Sierra counties often lacks private land within and adjacent to existing communities for expansion and sustainability. Because so little of the multi-county area is in private ownership, land ownership has a strong influence on social, economic, and ecological conditions. The tax base in these counties is very limited, due to the lack of land that is able to be developed.

This area's unique land ownership pattern also acts as a draw for hundreds of thousands of visitors to the Gila NF each year. Visitors to the Forest and counties generate tourism, recreation-related jobs, and provide tax revenue for local governments. Expanding recreational uses both on and off the Forest has the potential of impacting adjacent private lands via trespass or resource damage. Payments are made by the federal government to state and local governments to compensate for non-taxable federal land within their borders (e.g. Payment in Lieu of Taxes-PILT). See Chapter 10: Social, Cultural, and Economic Conditions for more details on these programs as well as the economic contributions of public lands to local economies.

Land Status

Land status is defined as the ownership record of title to lands, including withdrawals, rights, and privileges affecting or influencing the use and management of National Forest System (NFS) lands. For NFS lands, land status refers to the use or specific designations of a geographic area that provide general guidance and policy for the management of a defined geographic area. This guidance can take the form of use restrictions (e.g., withdrawals or dedication) and encumbrances (e.g., rights-of-way acquired or granted, reservations, outstanding rights, partial interests, or easements). Land status differs from land ownership. Land ownership refers to the ownership of land and interests in land; whereas, land status refers to the legal character or condition of the land.

Certain portions of National Forest System lands on the Gila NF and Apache-Sitgreaves NFs along the New Mexico/Arizona state boundary are administered by the adjacent National Forest due to being a part of a grazing allotment overlapping both states and the difficulty of accessing these lands from the parent National Forest (Figure 192). This administration is authorized by a "State Line Agreement," which was originally instituted in 1979 and later amended by the respective Forest Supervisors.

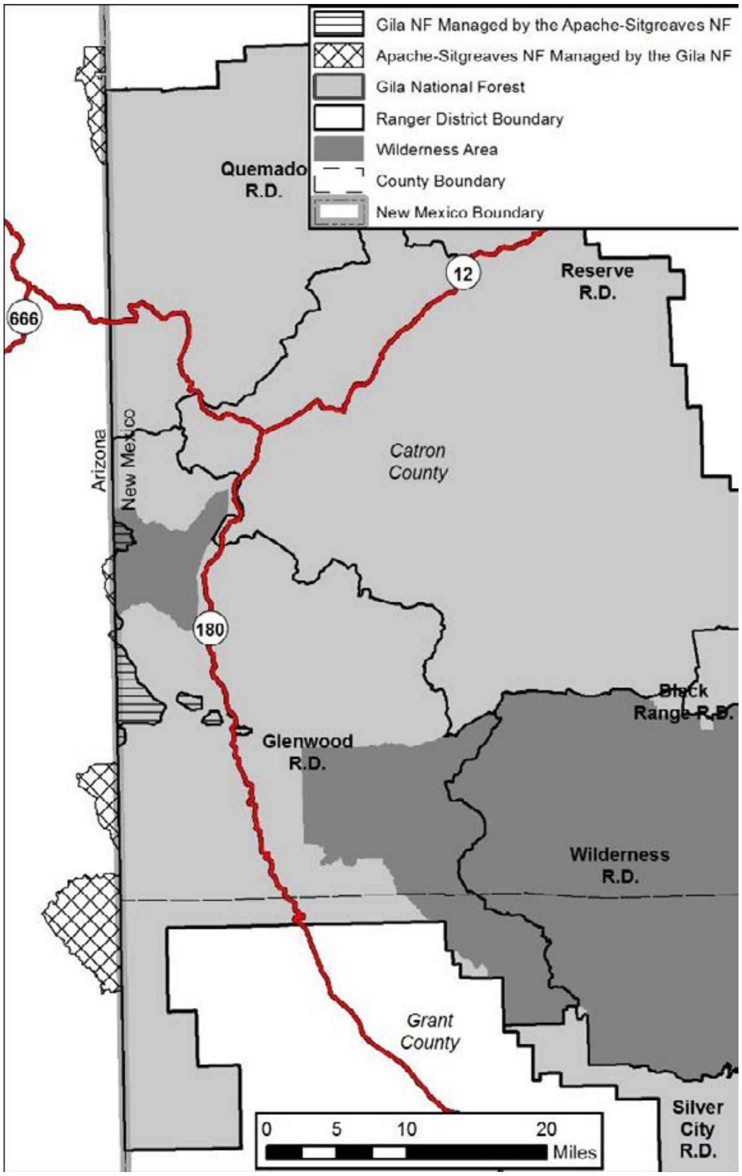

Figure 192. "State Line Agreement" areas administered by the adjacent National Forest along the NM/AZ boundary

The Gila National Forest also administers the portion of the Apache National Forest that is located in New Mexico (Figure 193), as well as designated Federal lands owned by the Veteran's Administration that are part of Fort Bayard (Figure 194). For purposes of clarification, "Forest" or "Gila National Forest" used throughout this report consists of all lands designated as the Gila NF and those lands it administers. "Administration" means that the portions of the Apache National Forest and Fort Bayard fall under the management direction outlined in the Gila Forest Plan.

The Apache National Forest split its administration up in 1971, where the New Mexico portion went to the Gila National Forest for administration, and the Arizona portion was combined with the Sitgreaves National Forest to form the Apache-Sitgreaves National Forests. The Gila National Forest combined with the New Mexico portion of the Apache National Forest and are managed as one National Forest. The use of "Apache National Forest" is only referred to when it is necessary to describe its location within a legal manner. In the National Forest System, the size of the supervisory administrative units has often been adjusted for efficiency and effectiveness. In many cases, two or more Forests are administratively combined and assigned to one supervisor's office. Since these combinations do not change the formal individual names of the Forests, or their boundaries, or the goods and services produced, there has been no need for congressional action regarding them (Davis 1983).

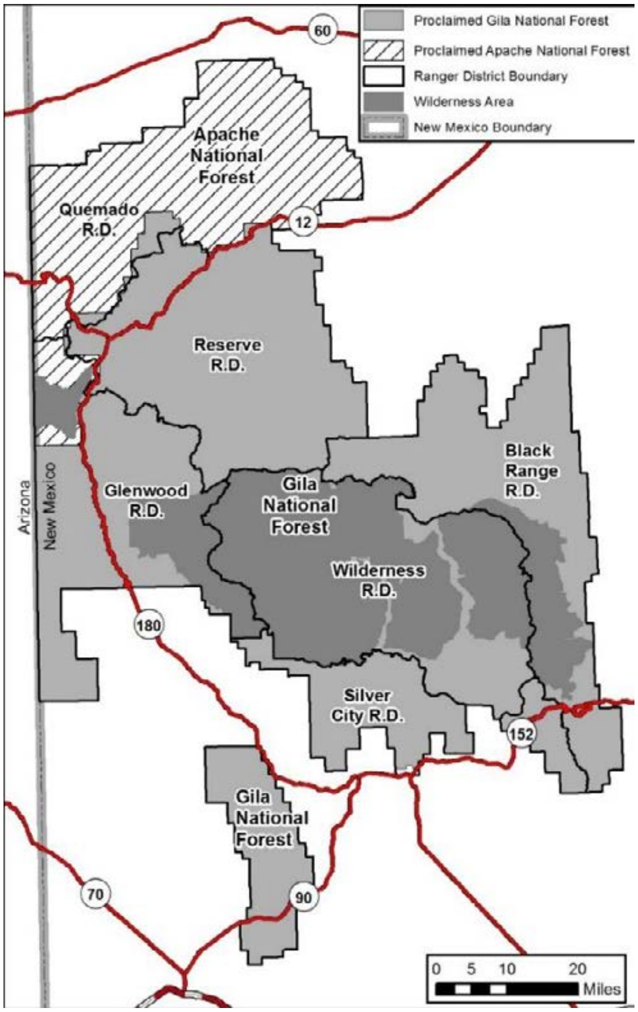

Figure 193. Proclaimed Gila and Apache National Forests that are administered by the Gila National Forest along with the current District Boundaries

Fort Bayard area started as a military reservation in 1869 consisting of approximately 8,200 acres and then in the early 1900s, the War Department added more acreage to the area. In 1941, the Fort Bayard area, excluding 640 acres which consisted of the hospital and associated facilities, was entrusted to the custody of the Department of Agriculture, through the Forest Service. Also there is an area composed of approximately three sections of land at Fort Bayard that is designated as Federal land that is classified as Veteran's Administration property, which was transferred by this government agency to the administration of the Gila NF in 1954 (Figure 194). The land has remained in the control of the Department of Agriculture with the exception of some sales to the State of New Mexico and adjacent community of Santa Clara.

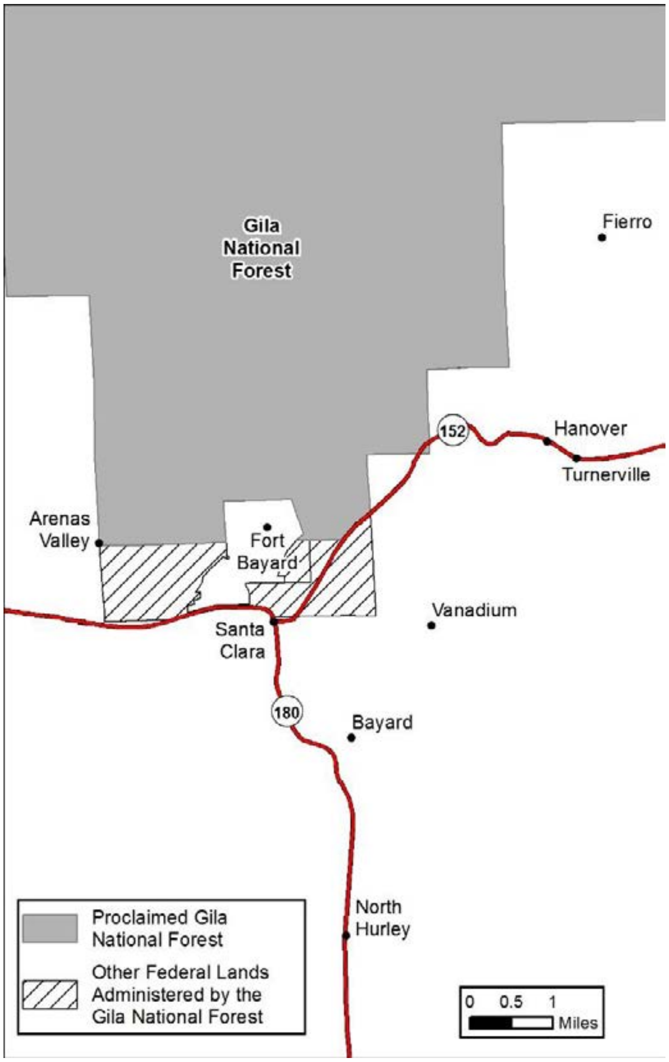

Figure 194. Other Federal lands administered by the Gila National Forest near part of the former Fort Bayard

Land Status and Boundary Management

Boundary Issues

Boundary problems on the Gila National Forest have generally resulted from the remoteness, terrain, and associated accessibility of the Forest area. All original survey work for township and range lines ceased in the early 1900s. Very few of the corners from the original surveys were able to be located. Lack of well-established boundary corners and markers adjacent to and within the Forest during the homestead period has resulted in boundary line disputes as new surveys with better technology are completed.

In the past, property disputes between land owners generated numerous complaints to the General Land Office. These complaints by land owners have resulted in independent resurveys by the BLM and General Land Office over the years to fix the boundary lines. This independent resurvey authority is still used today by the BLM and by Forest Service surveyors to fix problem areas.

Many of the corners that define the Gila National Forest boundaries need to be established or re-established. Some of these corners are missing due to substandard original surveys that have yet to be addressed by the Forest, while others are missing due to natural and human forces. In addition to the backlog of land boundaries to be defined, none of the administrative boundaries such as wilderness area boundaries have been surveyed and posted by a licensed Forest Service surveyor on the ground. Most of these administrative boundaries have been signed and posted by USFS employees that are not surveyors or under the direction of a surveyor, therefore these posted lines should be considered unofficial and for maintenance purposes only. These boundary issues have resulted in title claims and encroachments.

Title Claims

A title claim is a dispute over who owns the title to a parcel of land, i.e., two or more parties are claiming title to the same parcel of land, or interests in land. The nature of the private land ownership in and around the Gila National Forest has predominantly been composed of large ranching and mining interests. The mining interests have for the most part surveyed and maintained their boundary lines to protect the valuable minerals that they wish to extract below the ground. The large ranches that surround the Forest are comprised of multiple parcels of land that are generally separated by either BLM or Forest Service administered lands. These parcels are associated with grazing leases on the federal lands that surround them. Since the ranchers run their cattle on both the federal and private lands, fences are located and maintained based on the locations of water and forage more than they are on the location of federal and private lands. In some areas in and around the Forest, the nature of the ownership has changed from large ranches to smaller ranches and single family ownerships. As the nature of the ownership has changed, the attitude towards the land and the desire to define the boundaries has changed as well. This change in ownerships and attitudes has resulted in many ownership or title claims throughout the Forest.

Encroachments

An encroachment is the act of trespassing upon the domain of another. It is the partial or gradual displacement of an existing use by another use. There are numerous cases of encroachments throughout the Forest such as a portion of a building thought to be completely located on private property, but actually found by a survey to be partially located on the National Forest. Many of these property trespasses are innocent, due to the lack of known landlines on the ground or mistaken assumptions that a particular area was owned by another party. Encroachment issues are typically identified when a property adjacent to the Forest is sold and a survey is completed. Rectifying these mistakes can be expensive and time consuming. The responsible individual(s) creating the encroachment may have to pay to remove the property from the National Forest, as well as clean up the site of the infraction.

Mineral Entry

The Forest is open for mineral entry, unless a parcel is specifically designated as withdrawn. A withdrawal is: (1) A management tool for setting aside an area of NFS land from entry, or for limiting activities. (2) Withholding an area of Federal land from settlement, sale, location, or entry, under some or all of the general land laws, for the purpose of limiting activities under those laws in order to maintain other public values in the area, or reserving the area for a particular public purpose or program. Lands that have been designated as wilderness areas are withdrawn from mineral entry, under the mining laws and from disposition under all laws pertaining to mineral leasing (Wilderness Act of 1964). Mineral resource surveys were conducted to evaluate the mineral potential of areas prior to wilderness designations for the Gila Wilderness, Aldo Leopold Wilderness, and the Blue Range Wilderness (Figure 195). The Forest has also withdrawn mineral entry in other specifically designated areas to avoid interference with the main use or objective of the specific designation. This includes administrative sites and developed recreation sites. Some large waterpower withdrawals exist that would allow for future dams and adjacent water storage, however, these hydropower proposals are not currently being evaluated or planned. Appendix F contains all the areas withdrawn from mineral entry. A review and evaluation of all of the existing Gila NF mineral withdrawals is currently necessary.

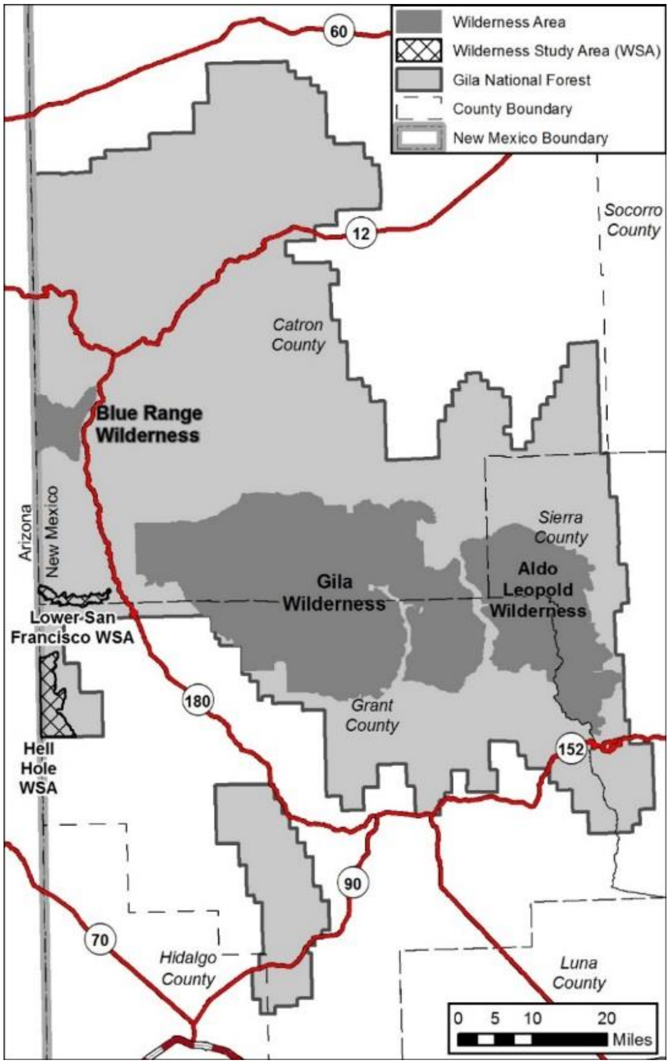

Figure 195. Wilderness Areas and Wilderness Study Areas on the Gila National Forest

Trends Affecting Land Status

Forest lands near or adjacent to communities or inholdings may receive concentrated uses due to proximity and ease of accessibility to participate in such things as recreating, hunting, or collecting fuelwood. Associated with some of the larger communities or inholdings are access roads, communication and power lines, and water conveyance structures for irrigation or domestic water uses. As larger inholdings have subdivided, there has been additional requests for access and sometimes expansion of utility corridors on Forest lands. The Forest will authorize these type of uses under a special use permits (see later section on Special Uses).

Due to its immense size, the Gila National Forest has a huge task of identifying all of its property lines, boundaries, and locations of its designated areas. Available funding to accomplish this work is not adequate to maintain what boundary posting needs currently exist. This contributes to the current situation of numerous occupancy and trespass issues scattered throughout the Forest.

Influence of Land Ownership Status on Social, Economic, and Ecological Conditions

Land status can restrict certain activities on Gila NF lands. Most notable of these are areas that are withdrawn from mineral entry, which eliminates commercial mining activity in those areas. Conversely, these same designations can provide additional opportunities for the public (see Chapter 13: Designated Areas and Chapter 12: Recreation).

Land Use

Land use describes the activities to which the land is devoted, such as residential, commercial, industrial or agricultural uses usually described for private lands, and current land allocations and the uses permitted for NFS lands, such as grazing, mining, recreation, administration, etc. There are often several land uses occurring simultaneously on many areas of the Gila NF Forest. The land base of the Gila NF is comprised of a vast multi-dimensional terrain having a wide variety of resources. Within this land base there is a multitude of ownerships, as well as many resources to be shared, used, and enjoyed by the mix of private land residents and Forest visitors. The goals and objectives of the Forest are to continue to provide its resources for public use and enjoyment without harming the integrity of the area or its resources.

Currently 2.6 million acres of the 3.3 million acres of the Gila National Forest are managed for livestock grazing. Other uses such as mining and timber harvesting occur on smaller scales while hunting and recreation uses are widespread, but can have localized impacts. Resources are protected from land uses via evaluation through NEPA or special use permit processes to ensure the continued integrity of the affected Forest resources. Many times potential impacts can be mitigated through Forest Plan components, best management practices and other permit/project conditions.

Land Use Policies

A recent review was conducted of the plans of counties and other governmental entities adjacent to the Gila NF. The following section examines the context of the regional entities from a land use perspective.

Gila National Forest Plan

The 1986 Gila Forest Plan (USDA FS Gila NF 1986) is the principal document that guides Forest managers' decisions about management of the land and resources. The 1986 Forest Plan identifies how resources will be managed Forest-wide, through a set of management prescriptions for each resource. The Plan currently subdivides the forest into geographic management areas. These areas specify management prescriptions for the more focused management of resources in a given area. Forest-wide prescriptions supplement and support the prescriptions for management areas. The Gila National Forest is currently in the process of revising the 1986 Forest Plan.

Other Neighboring Federal Land Management Agencies

The Apache-Sitgreaves National Forests revised Forest Plan was published in 2015 (USDA FS A-S NFs 2015). Key provisions in the 2015 Plan provide guidance to restore and/or maintain 14 vegetation types occurring on the Forests, resulting in a return to natural fire regimes, a reduction of excess tree densities, and a sustainable supply of wood products. Also addressed are the restoration of key watersheds and riparian areas to proper functioning condition, and the maintenance/restoration of key habitats for fish and wildlife.

The Bureau of Land Management has lands adjacent to the Gila National Forest. The Las Cruces District Office is located in Las Cruces, NM. The Las Cruces District released a draft Tri-County Resource Management Plan (RMP) in 2013 encompassing Sierra, Otero, and Doña Ana Counties. The Mimbres RMP (1993; currently under revision) encompasses Doña Ana, Grant, Hidalgo, and Luna Counties. The Socorro Field Office RMP (2010) encompasses Catron and Socorro Counties. These RMPs provide broad-scale direction for the management of public lands and resources using principles of multiple use and sustained yield.

Counties

There is a wide range of different planning and land use strategies in the adjacent counties. The impact of the Gila NF varies throughout the region, with the variation related to the proportion of the county that is NFS land, as well as the different relationships of county economies to areas in Federal ownership.

Catron County adopted its Catron County Capital Improvement/Comprehensive Plan in 2007. Planning areas include land use (including interface with public lands), water, infrastructure and transportation, housing, public safety (including the CWPP), and economic development. Catron County is predominantly rural in character, and its comprehensive plan reflects the County's commitment to maintaining traditional economic structures of mining, timber, ranching, and recreation. A key issue is ensuring that land is available to support future development given the limited amount of private land available. Other implementation measures include outdoor recreation/tourism promotion, revival of the timber industry with a focus on smaller diameter trees and wood products, localized CWPPs by community, WUI area fuel treatments, and forest health community outreach.

Grant County adopted its Grant County Comprehensive Plan in 2004. This Plan emphasizes preserving the county's unique natural and cultural elements, while meeting current and future needs, to maintain and improve the quality of life for long-term established residents and newcomers. The Plan includes policies to partner with the Gila National Forest in watershed management, tourism promotion, fire prevention, and WUI fuel load reduction.

Hidalgo County adopted its Hidalgo County Comprehensive Plan update in 2011. There are seven elements including land and water, economic development, housing, transportation, infrastructure/community facilities, hazard mitigation, and implementation. Hidalgo County has a tradition of ranching, farming, and mining uses. The Plan mentions the risk of large-scale flooding in the Virden Valley due to post-fire effects in the upper Gila watershed on the Gila National Forest.

Sierra County has a Sierra Country Comprehensive Plan dated 2006. The Plan suggests several ways to foster more communication and collaboration between local government and federal land management agencies including regular meetings around areas of mutual interest, cooperating agency status, data sharing agreements, and collaborative partnerships. Other Plan issues related to the Gila National Forest include WUI area fuel treatments, watershed restoration, small diameter wood utilization, forest products infrastructure, Sierra CWPP implementation, obtaining access easements, working with permittees during droughts, and "initial screening process for new subdivisions/development within inholdings on the Gila National Forest." There is also an Interim Land Use Policy of Sierra County (No. 91-00) that calls for closer coordination between federal, state, and local governments concerning land use planning, land acquisition/disposal/exchanges, and land adjustments.

Soil and Water Conservation Districts

The State of New Mexico has encouraged Soil and Water Conservation Districts (SWCD) to write land use plans (LUPs) to promote responsible and effective use and management of the soil and water resources in the SWCDs. Sierra SWCD has drafted a LUP which was adopted in 2014 (Sierra SWCD 2014). The San Francisco SWCD adopted their LUP in 2013 (San Francisco SWCD 2013). The Grant SWCD provided a 5-year Plan of Action that includes many land use concerns and proposed actions (Grant SWCD 2014). Other SWCDs containing portions of the Gila National Forest in their boundaries include Caballo, Hidalgo, Quemado, and Salado SWCDs. The Forest will continue to engage and work with SWCDs to mutually benefit the conservation and land use efforts of these entities.

State of New Mexico

The New Mexico Statewide Natural Resources Assessment and Strategy and Response Plan was issued in 2010 (NM EMNRD 2010). The Plan guides the planning and implementation of natural resource management and restoration activities for the state. The Plan also provides strategies of working with and integrating resources across boundaries with federal, tribal, and private landowners. Watershed health and restoration, healthy urban and community forests, and enhanced public benefit from the states natural resources are the primary components of the Plan.

Influence of Land Use Planning on Social, Economic, and Ecological Conditions

Due to the large amount of non-private land in Catron, Grant, Hidalgo, and Sierra counties, changes to zoning by the public land management agencies could have a significant influence on both the social and economic conditions in these counties. The amount of private land is such a low percentage of the counties that their tax base is very limited. Any changes, particularly acquisition of private land by public land management agencies, could appear to influence the counties’ revenue. However, Payments in Lieu of Taxes (PILT) could offset some of these losses (see Chapter 10: Social, Cultural, and Economic Conditions). The counties’ relatively large physical size can strain their ability to provide services.

Public lands that have been or could be withdrawn from mineral development may impact the economic well-being of the counties, as these withdrawals have the potential of reducing or eliminating commercial mining or leasing activities and the income associated with them. Any changes to zoning across the area of influence in regards to commodity resources could result in negative impacts to the surrounding counties’ economic and social conditions. In addition, any changes that cause a reduction in commercial enterprise on public land could have negative impacts on the economy of the counties.

Special Uses

Special uses are those primarily conducted by a single individual, a small group of people, a corporation, a university or another government agency which has a particular need to use a portion of the Forest without harming the integrity of the land base. These uses are authorized on a temporary or term basis. Some authorizations may be issued to a corporation for a use which may directly benefit the public (e.g. powerline). The issued authorization has limits and restrictions to help ensure that the use stays within the guidelines of laws and regulations governing management of National Forest lands.

In order for a special use permit to be issued, a review process is conducted including an environmental review to ensure that the proposed special use meets laws and rules, and protects resource integrity. Providing adequate biological assessments & evaluations, cultural resource clearances and engineering assessments and designs for permits involving ground disturbing activities are the responsibility of the special use applicant.

Cost recovery fees are required[60] for work conducted by the Forest Service for review and analysis of a special use application and resource reports. These fees are for the cost of Forest workers and specialists who are needed to study and evaluate the special use proposals. An assessment of the amount of time to accomplish the task is determined and assessed to the proponent of the project.

Special Use Authorizations are written permits, term permits, leases, or easements that authorizes use or occupancy of NFS lands, and specifies the terms and conditions under which the use or occupancy may occur. The Forest Service divides the management of special uses into two categories: recreation special uses (see Chapter 12: Recreation) and non-recreation (i.e. lands) special uses. The Gila National Forest has issued hundreds of special use permits related to lands. These authorizations include irrigation ditches, weather instrument locations, communication sites, access roads, electric transmission and distribution utilities, and scientific research among many others.

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[60] Some special uses are exempt from cost recovery.

The direct and indirect value and influence of NFS lands for delivering goods and services is critically important to the public at local, regional, national, and even international levels. Utility corridors accommodate high pressure natural gas pipelines for industrial, commercial, and domestic purposes; high-powered transmission lines provide for interstate transfer of electricity; as well as distribution lines for power delivery to local homes and businesses. Communication sites accommodate rapidly evolving wireless technology, while at the same time providing critical radio communication for safety and security needs.

The Forest has no designated utility or transportation corridors across the Forest other than the individual alignments of any one particular use. The reasoning for this is that the existing utility companies are not coming and going in similar directions to help encourage a consolidated route or corridor. Power and energy corridors and large utility sites need to be well-planned and coordinated. The following linear utilities cross portions of the Forest to transmit and/or distribute their current, signal or resource to areas off and/or within the Forest boundary.

Electric Transmission
El Paso Electric (EPE) (Arizona Interconnection Project – AIP)
Tucson Electric Power (TEP)
Public Service Company of New Mexico (PNM)

Electric Distribution
Navopache Electric Cooperative (NEC)
Public Service Company of New Mexico (PNM)
Sierra Electric Cooperative
Socorro Electric Cooperative

Natural Gas
Gas Company of New Mexico

Telephone Lines
Century Link
Western New Mexico Telephone Company (WNMTC)
Windstream Communications

Communication Sites
There are currently 18 designated communication sites located on the Forest which are compatible for low power administrative, government and/or commercial electronic communication use (Table 225). There are no sites currently identified on the Forest as suitable for high power commercial communication installations, which are typically high power radio and television broadcasters.

Since 1990, radio and wireless technology has evolved at an extraordinary rate. However, no new studies by the Forest Service have been conducted to determine if new communication sites should be added to the Forest. There have been individual studies by local entities to propose additional single client uses for areas outside of the delineated area for existing communication sites. Further, the Gila NF has low power sites which are limited to a maximum radio power output of 500 watts of effective radiated power that have been identified for commercial use. These sites may only be suitable for administrative use. Other low power sites have senior users (like the Federal Aviation Administration) which have very little room for additional uses due to potential interference, thereby limiting otherwise compatible uses.

Lack of cell phone service in certain areas is an issue affecting safety, visitor perceptions, and economic development. Because of the rapid pace of technological advancement, the high economic value that communication sites represent, the finite number of both low and high power sites and the significant gap in time since any analysis was conducted, a thorough analysis is necessary to determine how to best serve administrative and commercial needs, while also protecting natural resource objectives. Industry should be included in this analysis, and it is likely that the expertise necessary to perform the analysis is not available on the Forest and may need to be outsourced or contracted. Some topics like Homeland Security requirements and the inherently high risk nature of tower management have never been considered in a thorough analysis. In other instances, the Forest Service encourages shared facilities to be used in common wherever possible. This co-location would help accommodate more uses within the finite space available at communication sites.

Communication Site Plans are being developed by the Gila NF at sites with the most users. These Plans facilitate the administration of the area, and once an analysis of the type of use within the area has been conducted, updates and new uses are easier to get approved. The priority of developing a Communication Site Plan is based on the number of users on a particular site. Those sites with only one or a couple of users may not necessitate the creation of a Communication Site Plan.

Table 225. Designated Communication/Electronic Sites on the Gila National Forest

Name	Ranger District	Communication Site Plan in place?*
Apache Mountain	Quemado	No
Black Peak	Silver City	No
Boundary	Silver City	No
Copperas Hill (Peak)	Wilderness	Yes
Divide	Silver City	No
Emory Pass	Black Range	No
Forks	Wilderness	No
Fox Mountain	Quemado	Yes
Glenwood Brushy	Glenwood	Yes
Jack's Peak	Silver City	Yes
Luna C.O.	Quemado	No
Luna Passive	Quemado	No
Mangus Mountain	Quemado	No
Mimbres Passive	Wilderness	No
Radar Brushy	Glenwood	No
Signal Peak	Silver City	No
St. Cloud	Black Range	No
San Francisco Divide Mountain	Quemado	Yes

* Most of the communication sites without Communication Site Plans consist of one or two users, which may not necessitate a plan.

Access

Visitor accessibility to the Gila NF by way of federal, state, and county roads from outside the National Forest is good (see Chapter 14: Infrastructure). Within the Gila NF, motorized access on the 3,334 miles of NFS roads is available as designated on the Forest Motor Vehicle Use Map (MVUM).

While there are thousands of miles of NFS and other roads (county, state, other federal) on the Gila NF, there are some access issues primarily associated with private inholdings on the Forest. The sprinkling of parcels of private land along major travelways and water corridors can make access to desirable areas of the Gila NF sometimes difficult to obtain. The Gila NF lacks rights-of-way across some private lands and may not have a feasible alternative to accommodate a new route around the private land due to topography and/or funding. The Gila is looking to acquire easement/permits across private land for public access where possible.

Rights-of-Way

For most of the history of the Forest Service, access methods to areas of the Forest were mainly a product of the need, desirability, terrain, and cost of construction. Access routes are normally broken up into two categories: roads and trails. The trails are used for pedestrian and equestrian/horseback use, while roads are used for vehicles (originally constructed for the use of wagons and later motorized vehicles). Most of the access routes on the Forest were a product of the type of use. Road construction was often initiated by the need to access private property and/or remove a forest product from the Forest. This later resulted in engineered constructed roads to meet the needs of motorized vehicles for increasing speeds, as well as supporting large heavy transports loaded with commodities, and making the route smoother to travel on. Many roads also resulted from travel to and from tracts of private land within the boundaries of the National Forest. Access to private property was and remains an important purpose for roads within the Forest. Roads were initiated by use across the land, usually in a route which was the closest distance from point to point in good terrain. Sometimes these routes crossed over other parcels of private land to get to the final destination. At the time, there usually wasn't a problem with a particular road crossing other parcels of private land without a document of authorization, easement or right-of-way. This is no longer the case. It is now commonplace for owners of private property to restrict public travel across their parcel of ownership. Because of this change, the Forest Service is behind in acquiring legal easements for many of the Forest roads and trails which are currently routed across parcels of private land. This issue is especially prevalent on the Black Range District.

The backlog of easement needs is quite extensive for the limited budget the Forest Service is allocated for right-of-way (easement) acquisitions. Prioritization of these needs is continually being made. These priorities are fluid, as needs continue to arise or change for various reasons. Donations of easements are a way the agency can acquire a right-of-way. However, donations of rights-of-way and property to the Forest Service are not common.

At this time, right-of-way acquisitions are unpredictable due to the dependency on willing sellers or donors. It is useful to determine the highest of priority right-of-way acquisitions that are needed, as well as which landowners may be agreeable to negotiate an agreement. Sometimes, priorities are weighted in the favor of agreeable landowners since these cases are more likely to be processed and completed if there is a willing seller.

Public access is not solely dependent on the Forest Service acquiring easements. By law, county roads are open to the public. As subdivisions are created, some of the subdivision roads are dedicated to public use though dedication of the roads to the county. The local counties have also desired to take over the operation and maintenance of many Forest roads. This allows the county to receive funding from the State to be used for road maintenance.

Private Land Access

Reasonable access to private land is a right granted by the Alaska National Interest Lands Conservation Act (ANILCA 1980), which applies to other states besides Alaska. However, this right only applies to a private inholding (i.e. a parcel of private land completely surrounded by NFS land). It is incumbent upon the owner of the original patented tract of land (prior to its subdivision or parceling off) to provide access to the pieces of property which is or was originally broken off from it.

In essence, while the Forest Service may be required to allow access, this requirement is not unqualified. Within NFS boundaries, the Gila NF is legally obligated to allow physical access to private property that is identified as an inholding. The Forest Service is not required to physically construct an identified access route or to absorb the construction cost. The manner in which access is provided to a private inholding is a discretionary management decision, and is based upon the individual case circumstances. The Gila NF is not required to 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 is causing resource damage, an alternative means of access and location may be substituted and allowed instead. The Gila NF can also dictate the location of a new access route across its land. If a tract of land is already accessed, substituting the existing route for another route across NFS land is subjective and the decision to permit the new route is entirely up to the Forest Officers.

It is the responsibility of the owner of a particular property to obtain access from adjacent private lands. Once a private patented inholding property is accessed by a road, the entity subdividing a parent parcel is obligated to provide access to the new parcel, which is broken off from the original patent. It is not incumbent on the Forest Service to provide access to every ownership parcel because of convenience, or because an owner of a parcel does not desire to share his property for access to another adjacent parcel, or to avoid an environmentally difficult access route within the property. The Gila NF will work with owners of inholdings desiring access across NFS land where no access exists. Construction and maintenance of this access will be the responsibility of the owner. The route used and mode of travel will be determined by the Gila NF and will be in compliance with the laws of the designated land. This means that a constructed road may not be permitted where motor vehicle use is prohibited, but only trail access may be considered reasonable access.

While the Gila NF is required to authorize access to inholdings, a similar requirement does not exist for authorizing power to private lands. The ever-expanding spread of power distribution lines is closely aligned with the similarly expanding WUI areas. In addition to providing service to existing primary home sites and recreational properties, the Gila NF receives requests for extensions into new areas which have the potential to dramatically alter the landscape with a proliferation of WUI areas.

Developers of recreational and rural home sites typically request that power be extended to their properties. However, the proliferation of above-ground distribution lines, which may be maintained by small rural electric cooperatives, has left a landscape compromised by significant wildfire threats from possible downed powerlines. These rural co-ops are suffering maintenance challenges with aging infrastructure, increasing right-of-way costs, and rate structures driven by local economic conditions. The result has been several significant wildland fires within the Region (although not on the Gila NF) caused by downed trees hitting powerlines, resulting in extensive damage, controversy and legal/financial challenges.

Although regulation of private lands is not the responsibility of the Forest Service, it is responsible for managing NFS lands as they are used to develop private lands. There are reasonable and justifiable natural resource-related motivations for making improvements, such as reducing visual impacts and minimizing forest fires (e.g. by burying powerlines), and more stringent requirements associated with roads used for subdivision purposes. Subdivisions created under the family subdivision exemption often create difficult or unmanageable demands on local governments. If local governments are unable to support unregulated growth by maintaining these road systems, then access across NFS lands could be delayed until the local governments are prepared to handle the growth. The Forest Service needs to meet its ANILCA-based requirements for authorizing access, but it also must manage the rate of WUI expansion in coordination with county governments. Failure to recognize and act on these trends has the potential to seriously affect management of natural resources on the Forest.

Trends Affecting Access in the Broader Landscape

Access controlled by the State and counties is not expected to change dramatically in the near future. For access controlled by the Forest Service, the Gila NF will implement the travel management decision that was released in June 2014, which involves signage, Motor Vehicle Use Map (MVUM) distribution, education, and enforcement. Designated roads, trails, and areas open for motor vehicle use are identified on the Gila NF MVUMs. The Gila NF MVUMs currently identify 3,334 miles of NFS roads open for motorized use. Roads not selected as part of the designated system will be used administratively or by written authorization, or will be stored for future use or decommissioned. The status of these stored roads will be evaluated during future project planning, as needed.

Historically, many landowners have been willing to provide access to public hunters and recreationists across their private lands. Personal relationships were established, and respect for private property was demonstrated. Unfortunately, this traditional access has diminished as changing patterns of landownership have eroded the personal relationships between landowners, hunters, and recreationists. Landowners now often perceive recreationists as trespassers who are disrespectful of their private property rights, or sometimes lack an understanding of simple courtesies like closing gates and not scaring livestock. Many access opportunities have been lost across private lands due to historic landownership patterns, changing private ownership conditions, and a lack of established, legally defensible access across private lands. Inadequate access to public lands impacts a wide range of outdoor recreation activities, including hunting, hiking, camping, viewing scenery and wildlife, horseback riding, fishing, wilderness area use, and mountain biking. People want to use their public lands and are becoming sensitive to restrictions on that ability.

Influence of Access on Social, Economic, and Ecological Conditions

The Gila NF occupies much of the land that provides for the traditional and cultural uses of local communities and families. Generations of users have relied upon the Forest for firewood gathering, grazing lands, and hunting. These traditional and cultural uses contribute to the social fabric and support the economies of the families and communities who live near the Forest. As land ownership changes around the Forest, there is a potential threat that access to tribal, cultural, and sacred sites on the Forest may be impacted. Access to both recreational and commercial facilities has a great influence on social and economic conditions.

Opportunities to Provide Open Space Connections

The Forest shares boundaries with other federal, state, and private lands. The Gila Cliff Dwellings National Monument, administered by the National Park Service, is surrounded by the Gila NF. The Bureau of Land Management has a significant amount of land surrounding the Gila National Forest boundary. The Gila NF manages about 254 miles of the Continental Divide National Scenic Trail. The trail traverses the length of the country from Mexico to Canada and provides an open space connection for the public. The majority of the trail is complete and provides a unique opportunity to hike and experience vistas in five states. There have been discussions on how to create a connector trail from Western New Mexico University in Silver City to the Continental Divide National Scenic Trail nearby on the Gila National Forest. The Town of Silver City Trails and Open Spaces Plan (2002) includes a goal and action items to develop an area-wide trail system providing connectivity between neighborhoods, commute destinations, and open spaces including the Gila National Forest.

Stakeholder Input

People feel strongly about ensuring access to public and private property. There is especially a concern over increased instances of locked gates blocking access over traditionally used roads. This typically demonstrates a lack of easements for roads that have been traditionally used by the public. Others have noted a decline in private property in the counties, but when talking to people they still want additional access to public lands. When learning that certain properties are acquired to increase access, most people are content.

Many people noted conversion of ranch properties to subdivisions. There is strong interest in planning treatments in the WUI to reduce risk to private property from wildfire. In addition, many people and emergency service providers desire cell phone and internet access for safety and communication purposes across more areas of the Forest even in remote and wilderness areas. The airspace over the Gila NF is used by the military for training and overflight purposes, which can create conflicts with the wilderness experience as well as wildlife and livestock.

People suggested that trail and road closures due to access issues be posted regularly on the Gila Forest website. People also suggested that federal government agencies need to increase coordination with all stakeholders with respect to local landowners/leaseholders and their individual uses.

After the release of the draft assessment report, some organizations expressed opposition to Gila NF purchasing private lands and suggested other mechanisms such as negotiated land exchanges or purchased easements to acquire public access while not reducing private land ownership and the tax base used to provide services. Commenters also emphasized the importance of maintaining access to private inholdings and range improvements and other allotment activities.

Summary

Land ownership patterns are important because decisions made by public land managers may influence the local economy, particularly if public lands represent a large portion of the land base. Communities in the four-county assessment area, Catron, Grant, Hidalgo, and Sierra Counties, are limited in their ability to grow and expand. Communities and local governments rely upon the Gila NF and other federal and state lands for support of their economies, available clean water, and the products integral to supporting traditional and cultural uses. The federal land agencies also make payment in lieu of taxes to the counties, which is a vital source of county revenue.

Federal and state land managers, private landowners, and others are constrained in different ways by laws and regulations that dictate how different lands can be managed. This can lead to adjacency challenges and opportunities. Residential development has increased adjacent to many Forest boundaries, and adjacent at-risk communities in the wildland-urban interface have responded to the threat of uncharacteristic wildfire by developing community wildfire protection plans.

A trending loss of access to Gila NFS lands has developed as a result of unwillingness of many private landowners to allow public access across their property to NFS lands. The Gila NF desires to acquire road rights-of-way where possible to provide adequate access for public and administrative use.

Chapter 16. Energy and Mineral Resources

Introduction

This chapter identifies and discusses available information relevant to the assessment area for mineral and renewable and non-renewable energy resources.

Energy and mineral resources provide ecosystem services that are important to people at a local and, in some cases, regional and even global scales. They are an important contribution to social, cultural, and economic conditions of the assessment area. This section identifies and evaluates:

- The potential for renewable and nonrenewable energy sources on the Gila NF, such as wind, solar, coal, oil, or natural gas. Existing energy transmission corridors are also described.
- Existing and potential nonrenewable mineral resources, such as locatable mineral deposits, leasable minerals, and mineral materials on the Gila NF and their production trends.
- The presence and condition of known abandoned mines and existing geologic hazards in the Plan area.
- Impacts of these resources on ecological integrity and species diversity.
- The contribution of these resources to social and economic sustainability.

Ecosystem Services of Renewable and Nonrenewable Energy and Mineral Resources

Within the region, a variety of resources have provided energy or mineral materials to meet the needs of the country and the world. Energy and mineral production provide the raw materials necessary to sustain the quality of life we all enjoy. Along with the direct benefit of usable minerals or energy resources for homes, businesses and transportation, these resources provide economic benefits through jobs and taxes, and the cultural service of educational and research experience.

Management of Renewable and Nonrenewable Energy and Mineral Resources

The U.S. Mining and Mineral Laws authorize the appropriation of mineral resources on federal lands, including minerals located by mining claims, those obtained by mineral leases/contracts, and those disposed of by free-use or mineral sale. Forest Service regulations designated by 36 CFR 228, Minerals, sets forth rules and procedures for use of the surface of the National Forest in connection with operations conducted under the U.S. Mining and Mineral Laws. These regulations cover the use of the land surface for mineral prospecting, exploration, extraction and reclamation.

The Southwestern Region of the Forest Service is party to a New Mexico state-wide Memorandum of Understanding (MOU), along with the New Mexico State Office of the Bureau of Land Management (BLM) and the New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division regarding the coordination of federal, locatable minerals administration in concert with the State Mining Act administrative regulations. Under this MOU, most operations are jointly bonded to avoid duplication for operators and, when possible, joint operations visits are made. Bonding is conducted to assure completion of reclamation of a site following an operation. The participating agencies share information regarding significant administrative actions and coordinate those actions where appropriate.

For the assessment area, minerals and energy are very different types of resources.

- **Minerals** information can best be addressed specific to each commodity and geographic area where key minerals occur. This is because for each mineral occurrence, the relevant information consists of an integrated mix of information about mineral type, extent, current activity, potential activity, trends and social economic and ecological sustainability information that is specific to that particular mineral resource occurrence and geographic area.
- **Energy** resource information will be addressed for the assessment area as a whole, and will be organized by the relevant topics of information listed above.

The likelihood for energy and mineral activities to be conducted within the assessment area is based upon the geologic presence of a particular mineral, as well as the type of mineral and the specific laws regulating legal access to the mineral. Chapter 17: Land of this assessment report discusses land status classifications and how they affect mining and mineral administration activity.

Access for locatable minerals is granted under the 1872 Mining Law, whereas for leasable minerals, access is only granted following an analysis through an area-specific NEPA process. The interplay of several factors determines whether the minerals activity is discretionary (leasable) or non-discretionary (locatable) on the part of the Forest Service. It is essential to know the class of mineral resource and the land status of the area in order to identify whether a legal right to the mineral resource may already exist.

Before beginning the assessment, it is important to detail how all federal minerals (which include energy resources) are administrated as falling into one of three categories: locatable minerals, leasable minerals, or mineral materials. Each of these categories of minerals is administrated under separate laws and regulations, and each requires a different means for the public to obtain these resources.

Three Classifications of Minerals

- **Locatable minerals** are, in general, the hardrock minerals mined and processed for metals (for example: gold, silver, copper, zinc, tin, and some types of non-metallic minerals), and rare earth elements, plus some “uncommon variety minerals”. These minerals are called “locatable” because they are subject to mining claim location under the United States mining laws. All public domain lands are available for locatable mineral entry under the 1872 Mining Law (as amended), unless the lands are withdrawn from mineral entry (and in such case they are not available for mineral activities). Withdrawn lands include congressionally withdrawn areas, such as Wilderness, designated National Recreation Areas, Wild and Scenic Rivers, Resource Natural Areas and administrative withdrawals, such as campgrounds or administrative sites. Areas also restricted for entry include “acquired” lands, which were once out of federal ownership and then acquired back, including the mineral estate. Other than the above exceptions, the public may obtain locatable minerals by a mining claim through the BLM by staking a mining claim according to federal rules and regulations. Access to these minerals will necessitate an approved Plan of Operation through the Forest Service.

  The discretion of the Forest Service to allow mining operations is governed by the United States Mining Laws, including the 1872 Mining Law. The Forest Service has limited discretion regarding the development of locatable minerals on National Forest System (NFS) lands. Specifically, the Forest Service cannot categorically deny an otherwise reasonable plan of operation for locatable minerals. United States v. Weiss, 642 F.2d 296 (9th Cir. 1981). The Forest Service does have the authority to deny an unreasonable plan of operations or a plan otherwise prohibited by law. The Forest Service would return an illegal or unreasonable plan to the claimant with the reasons for disapproval and request submission of a new plan that addresses the issue(s) of concern. The Mining Law, as amended, does not “trump” or preclude the application of any other environmental laws, such as the Clean Water Act, the National Environmental Policy Act (NEPA), the Endangered Species Act, or the National Historic Preservation Act. Though a proposal to mine may be allowed under the law, it is incumbent upon the Operator or proponent to provide a detailed Plan of Operation to layout the mitigation measures which will be incorporated with the action, so that the surface resources are minimally affected by the proposed operation.

The 1872 Mining law has been amended multiple times by law (most notably to remove leasable minerals and saleable minerals as not subject to location on a mining claim). The U.S. Mining Laws have been defined through court cases and rulings such that the laws now provide considerable authority to land management agencies, including the Forest Service, to regulate all aspects of locatable mining operations by imposing conditions as part of any operating plan approval. These conditions are developed and specified for each operation and are intended to reduce the impact of the operation to the resources of the National Forest. An approved plan for reclamation of the area during and/or following the specific operation or portion of it will be required, as well. Bonding for this work is usually required in advance to insure the reclamation will be completed.

- **Leasable minerals** are, generally nonrenewable energy resources including fossil fuels, such as oil, gas and geothermal energy sources. These are important national energy resources. Leasable minerals are defined by the Mineral Leasing Act of 1920, and include: coal, oil, natural gas, oil shale, sodium, phosphate, potassium, geothermal and (in New Mexico) sulfur. Leases to extract these minerals from NFS lands are obtained through the BLM, with the consent or concurrence of the Forest Service to offer these mineral resources. Once a BLM lease is issued, the Forest Service must allow resource extraction subject to the stipulations and conditions in the lease. Discretion by the Forest Service of whether to allow use is exercised at the time of offering lands for lease. For coal, oil, natural gas, and geothermal leasing, the regulations require that decisions regarding the availability (and therefore suitability) of National Forest System (NFS) lands for leasing require a leasing analysis as set forth in 36 CFR 228.102. Court decisions have affirmed that leasing availability decisions must be made with full NEPA disclosure.

- **Mineral Materials/Salable/Common Variety Minerals**. Mineral materials are also known as salable or common variety minerals. These are synonymous terms for the class of minerals that can be sold under a mineral material contract. These mineral resources are found “commonly” unlike precious metals, for example. These minerals are relatively low value per volume, such as sand, gravel, cinders, common building stone, and decorative rock. Many of the materials are used for road surfacing, landscape boulders and engineering construction or may be specialty resources such as soil amendments or decorative rock.

  These minerals are typically sold unless used internally by the Forest Service, by another government agency, or needed for ceremonial uses. In these cases, they may be provided free of charge. Non-commercial permits are sold to individuals for a small amount for personal use. Commercial use may require a public bid sale. Issuing a permit for all types of salable minerals whether for commercial or personal use is discretionary on the part of the Forest Service.

Locatable Minerals

The Gila National Forest contains mineral resources, with metallic ores concentrated in the mountainous portions of the region often as a result of interactions between hydrothermal (hot water) solutions with host rock during volcanic activity (North and McLemore 2005). Past mining for metallic minerals has primarily produced gold, silver, copper, lead, manganese, zinc, iron, and tin. Historically, the concentrations of metallic ores found throughout in the area helped lead to populating the region as a whole. Over a hundred years ago, the mountain regions of the Forest were the focus of intense prospecting and mining. The existing communities and former communities of Mogollon, Kingston, Grafton and Cooney are examples of communities which had large populations in their mining peaks and were located within the current National Forest boundary, but these lands didn't have National Forest status at the time they were heavily populated. These communities presently have very low to non-existent populations. The communities of Chloride, Pinos Altos, and Silver City, which are adjacent to the National Forest, also boomed as a result of mining. They all experienced a major population growth and then a rapid decline, once the ore prices dropped and the mining boom ended. Only Silver City has held out from the mining downturn to remain a robust, full-service community.

Mining of metallic minerals is a supply and demand type of market prone to significant commodity price fluctuations. The Forest to this day experiences cycles of mineral interest when prices of metals increase nationally. The deposits of minerals within the context area of the Forest are distributed in a number of known mining districts (Figure 196). Future demand for locatable minerals will likely occur in and around these mining districts. Table 226 lists the mining districts in the context area with past production and future potential. As shown on the table, most of the districts are not presently active. Any one particular mineral may or may not have high enough concentrations to facilitate an active mining operation. Economic feasibility is dependent upon many different situations, including concentration of the ore body, form of the chemical nature of the ore, value of the ore, access availability, location of a smelter or processing plant capable of processing the type of ore available, etc.

Figure 196. Mining districts in southwestern New Mexico with significant metal deposits.

Table 226. Significant metal deposits in the context area, by mining district, based on past production and known resources.

Mining District	Mine or Deposit	Year of Initial Production	Year of Last Production	Estimated Cumulative Production	Is There Future Potential	Significant Commodities
Bayard		1902	1969	>$60,000,000	no	gold, silver, copper, lead, zinc
Burro Mountains	Tyrone, Little Rock, Niagra	1879	present	>$2,000,000,000	yes	gold, silver, copper, lead, fluorite
Chloride	St. Cloud	1879	1988	$20,000,000	possible	silver
Chloride Flat	Boston Hill, Chloride Flat	1871	1946	$13,000,000	no	gold, manganese, iron

Mining District	Mine or Deposit	Year of Initial Production	Year of Last Production	Estimated Cumulative Production	Is There Future Potential	Significant Commodities
Fierro-Hanover	Cobre, Hanover Mountain, Continental	1889	1980	>$2,000,000,000	yes	gold, zinc, copper, iron
Georgetown		1866	1985	$3,500,000	no	silver
Hillsboro	Copper Flat, Mesa del Oro	1877	1982	$8,500,000	yes	copper, molybdenum, gold, silver
Kingston		1880	1957	$6,600,000	no	silver
Lordsburg		1870	1999	>$60,000,000	yes	gold, silver, copper, lead
Mogollon		1875	1969	>$25,000,000	possible	gold, silver
Pinos Altos	Pinos Altos	1860	1997	>$11,000,000	yes	gold, silver, copper, lead, zinc
Santa Rita	Chino	1801	present	>$2,000,000,000	yes	copper, gold, silver
Steeple Rock	Carlisle, Center, Jim Crow, Summit	1880	1993	$10,000,000	yes	gold, silver
Taylor Creek		1919	1969	$7,500	no	tin

Economic and other factors must be considered before mining of most of these deposits can occur. From McLemore (2005).

Gold and Silver

Gold and silver were mined heavily on the Gila NF and the context area in the late 1800s and 1900s. There are still individuals classed as “recreational miners”, who pan for gold on the Forest (see the Noncommercial Mineral Collecting Activities section). Recently, a mill operated on the Forest adjacent to Mogollon, NM in the 1980s. The mill operated for a 10 year period extracting both gold and silver from numerous mines and waste locations on both the Forest and private land. There are no production quantities available to report on what was milled and processed.

Copper

The area of Silver City and the Mining District (comprised of Bayard, Santa Clara, and Hurley) south of the assessment area is rich in copper from porphyry-copper and associated contact metamorphic (or skarn deposits). There are three large open-pit copper mines operated by Freeport-McMoRan Inc. with parts of two of them (Tyrone and Cobre) directly adjacent to the Forest boundary. Freeport-McMoRan Inc. is the largest employer in Grant County, NM. However, when production is cut back due to the prices of the metal on the world market, employment suffers due to resulting layoffs. Currently, the copper extracted from the ore bodies is being shipped all over the world with China currently being one of the main purchasers of the metal.

Tin

In the early 1990s an approved Plan of Operation for tin production was initiated for the Taylor Creek mining district. The development of this resource stopped as the closest smelter for the ore was located in St. Louis, Missouri. Other smelters would not accept the material because the ore was too pure.

Uranium

Current Condition

There are no active uranium mines or exploration projects on the Gila National Forest. Uranium occurrences are primarily found in the White Signal, Black Hawk, Tyrone, and Telegraph mining districts in the Burro Mountains (McLemore 1983). A few mines from these mining districts produced some limited uranium ore in the 1950s (McLemore 1983).

Future Potential

Most of New Mexico's uranium reserves, and virtually all past production, are in northwestern New Mexico (Bland and Scholle 2007). As global demand and prices have increased, there has been renewed interest from the private sector in uranium mining in New Mexico using conventional and in-situ leaching methodologies although this interest is predominantly focused in northwestern New Mexico (McLemore et al. 2013).

Rare Earth Elements

Current Condition

Rare earth minerals, which contain rare earth elements (REE), are needed for cell phones, televisions, computers, iPods, video games, wind turbines, hybrid/electric cars, and solar panels. The Burro Mountains in the Silver City District encompass a number of mining districts (Black Hawk, Gold Hill, Telegraph, and White Signal) with rare earth elements consisting of Proterozoic alkaline rocks and pegmatites (McLemore 2015). Currently, no proposed plan of operations to mine for rare earth minerals has been received by the Forest.

Future Potential

According to McLemore (2015), pegmatites in New Mexico are usually too small to be currently mined for rare earth elements, but residual placers from the pegmatites could have future potential.

Kaolin

An open pit mine for kaolin clay (Sierra Kaolin Project) on the Black Range District was approved in 2009 in an area previously mined. There has been no recent activity at this site.

Silica (Quartzite)

A mine currently exists on the Forest which supplies high quality silica rock, used principally as packing and rip-rap for drainage, transportation, and other infrastructure features vulnerable to degradation in acidic environments since acids do not react to silica (quartzite). Silica content in excess of 90 percent SiO_2 in surface mine-able quantities is rare, particularly near populated areas that are close to markets. Production figures have varied over the years but it is around 1500-2000 short tons per year. Most of the material is used locally at the copper mines.

Mineral Materials

Current Condition

Deposits of common variety minerals, including sand, gravel and rock are found throughout the assessment area and are concentrated in the drainages. According to data collected by the Forest Service, the only mineral materials currently removed directly from the Forest are crushed stone and construction sand and gravel. Between 2011 and 2013, an average of 16,305 short tons of crushed rock and 370 short tons of construction sand and gravel were removed from the Forest.

Future Potential

The demand for the materials, the relative remoteness of the area where they exist, and the local economy dictate whether there may have value and demand for any particular rock commodity as a mineral material. Generally, demand for mineral materials is related to population growth as construction occurs to accommodate growth. The trend for salable minerals is expected to remain level. Efforts are underway to foster partnerships with local county governments through the use of gravel and aggregate sources on the Forest to be used for road construction purposes in the Forest.

Noncommercial Mineral Collecting Activities

The Gila National Forest allows non-commercial rock and mineral collecting. This falls into the category of "casual use". The Forest allows members of the public to go onto NFS lands and use non-mechanized tools to search and collect minerals for personal use. Caution should be used under these categories, as no authorization is given if the lands are claimed under the mining law. Parcels of private land are scattered throughout the Forest. Most of these parcels are not fenced nor their boundaries marked. Also, all mining activity is banned from designated wilderness areas.

Recreational gold panning is permitted on the Forest. It is policy to allow this activity if the member of the public reports beforehand in writing the proposed activity with the location, duration of time and the individual's name and contact information requesting the activity.

Abandoned Mine Lands

Abandoned mine lands include known abandoned mines and/or mining-related hazards in need of reclamation or restoration. An abandoned and inactive mine land inventory was conducted on the Gila National Forest in December 1998. This inventory identified 353 mine sites, of which, some were inaccessible and some were located on private land. It is the desire of the National Forest to eliminate known and potential hazards relating to abandoned mine lands. Many abandoned mine lands contain minerals like arsenic, cadmium, copper, lead, mercury and zinc which can cause human health and environmental hazards as well as other physical safety hazards (USDA FS MGM 2012). Work to reclaim these mine problem areas is conducted as time and money permits. However, the number of problems within the assessment area is vast and it will take many years and a lot of money to complete all of the work which is needed to accomplish.

To avoid the future occurrence of abandoned mine lands, all Plan of Operation now incorporate a Reclamation Plan. This Reclamation Plan is developed by the operator and approved by the agency. Usually a bond is required to accompany this Reclamation Plan to ensure that the proposed reclamation work will be accomplished following the proposed mining work. This bond is held until the reclamation is conducted and approved. If the operator fails to comply with the terms of the approved Reclamation Plan, then the bond is forfeited, so the agency can use it to complete the work.

Energy Resources

Renewable Energy Resources.

These resources include solar, wind, hydropower, biomass, and geothermal. However, constructing the infrastructure to utilize these resources may be a limiting factor for development. Renewable portfolio standards, which require utilities to produce or procure a minimum amount or percentage of their electricity from renewable energy sources, exist in New Mexico and other western states, and may contribute to increased renewable energy development statewide.

Geothermal Resources

Current Condition

Several hot springs are directly used for recreational purposes on the Forest, although there are no developed geothermal resources in the assessment area. The Gila National Forest has two identified Known Geothermal Resource Areas (KGRA) and a couple of areas identified for noncompetitive lease applications. Under the Final Environmental Statement Geothermal Leasing completed in 1978 (USDA FS Gila NF 1978), these areas were identified as the Gila Hot Springs KGRA and the Lower Frisco KGRA. The final decision restricted areas available for leasing to a small area of the San Francisco Hot Springs Known Geothermal Resource Area and lands west of the community of Glenwood. New Mexico. There has not been any proposed action taken on this potential resource in this area.

Future Potential

Areas on the Gila National Forest have been classified as low to moderately favorable for geothermal energy (Figure 197) (DeAngelo and Williams 2010). Issues limiting large scale use of geothermal energy are water rights, limited power transmission capability, markets, federal regulatory requirements, and a lack of government incentives (Fleischmann 2006). In 2013, New Mexico's first utility-scale geothermal power plant came online in the Animas Valley in Hidalgo County south of the Forest.

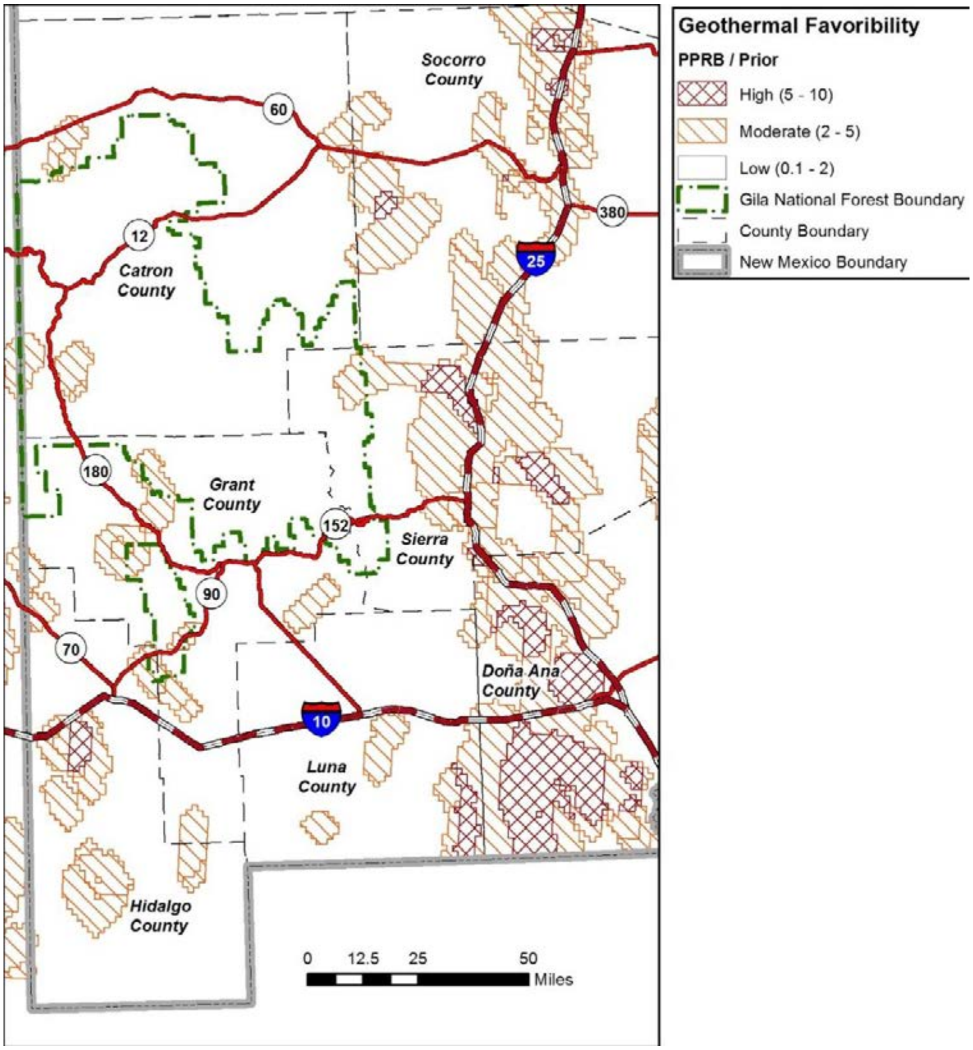

**Figure 197. Geothermal favorability in southwestern New Mexico.
Data from DeAngelo and Williams 2010.**

Wind Energy

Current Condition

There are no active or pending proposals for wind energy on the Forest. However, the Forest has had an application for wind power development in the past. The location of the proposal was in an inventoried roadless area, and located in steep terrain without reasonable access routes to the sites for development.

Future Potential

Due to low average wind speeds, the Forest does not likely have the conditions necessary for economical wind energy production (Karsteadt et al. 2005; NM EMNRD 2007a).

Solar Energy

Current Condition

The Forest has not received any proposals for solar power facilities.

Future Potential

The Forest has a high potential for solar development (Karsteadt et al. 2005) with a significant acreage of land with modelled solar resources of 7 kWh/m2 or more conducive for concentrating solar power or photovoltaics. Development of these resources may be limited due to the lack of infrastructure to any current potential site locations. Electric transmission lines would have to be built to connect the sources to a power grid. The potential areas would probably need to be located along existing power transmission line alignments. At present, it appears that other available areas off the Forest would be less costly and more efficient. These resources can be found around major population areas, without the need for major electric transmission lines to be constructed for many miles to move the energy to the locations desiring to use the electricity.

Hydropower

Current Condition

There is no Federal Energy Regulatory Commission licensed hydroelectric power generation on the Forest.

Future Potential

The Forest does not have any water sources that would likely support a large commercial hydropower facility.

Biomass

Current Condition

There is one biomass plant adjacent to the Forest at the old Fort Bayard Medical Center consisting of a commercial scale wood-chip boiler system to produce steam and heat. This 150-horsepower steam boiler was designed to annually consume 1,000 tons of wood thinned from the Gila National Forest (NM EMNRD 2007b). However, this system has been idle since the new Fort Bayard Medical Center replacement facility was constructed, since it was unable to cost effectively heat the new facility compared to conventional gas systems (Ecosphere 2013).

Future Potential

The future of biomass energy in the Forest faces limitations. The current market demand for biomass heat is diminished due to the relatively low price of natural gas. If market conditions change, the biomass systems may become economical to operate (Ecosphere 2013). Another limitation to biomass cost effectiveness is hauling costs. Wood is expensive to transport, so it needs to be used near wood source areas. Material handling in the supply chain also needs to be minimized for cost effectiveness.

Energy Transmission Corridors

Currently, there are two large high voltage electric transmission lines that cross the Gila National Forest (Figure 198). The existing energy transmission corridors were currently designated by the individual permitted area of each of the power companies requiring access through the Forest namely, Tucson Electric Power and El Paso Electric. There are no defined corridors for several companies to use in tandem to transport energy resources or to collocate transportation facilities (e.g. highways and railroads). The reason for this is that the electric transmission lines and transportation routes are coming and going from different places and there were not any opportunities to share the same routes at the time of construction. The Forest is not positioned in the direct path of transcontinental or multi-state connection routes for energy and transportation. Some of this is due in part to the topography or mountain ranges which exist on the Forest. Recently proposed regional transmission corridors (SunZia and Southline) designed to transport electricity to western power markets have been located off the Forest. There is a small distribution natural gas line which crosses part of the Forest to reach the Fort Bayard Medical Center. However, there are no large interstate natural gas transmission lines crossing the Forest.

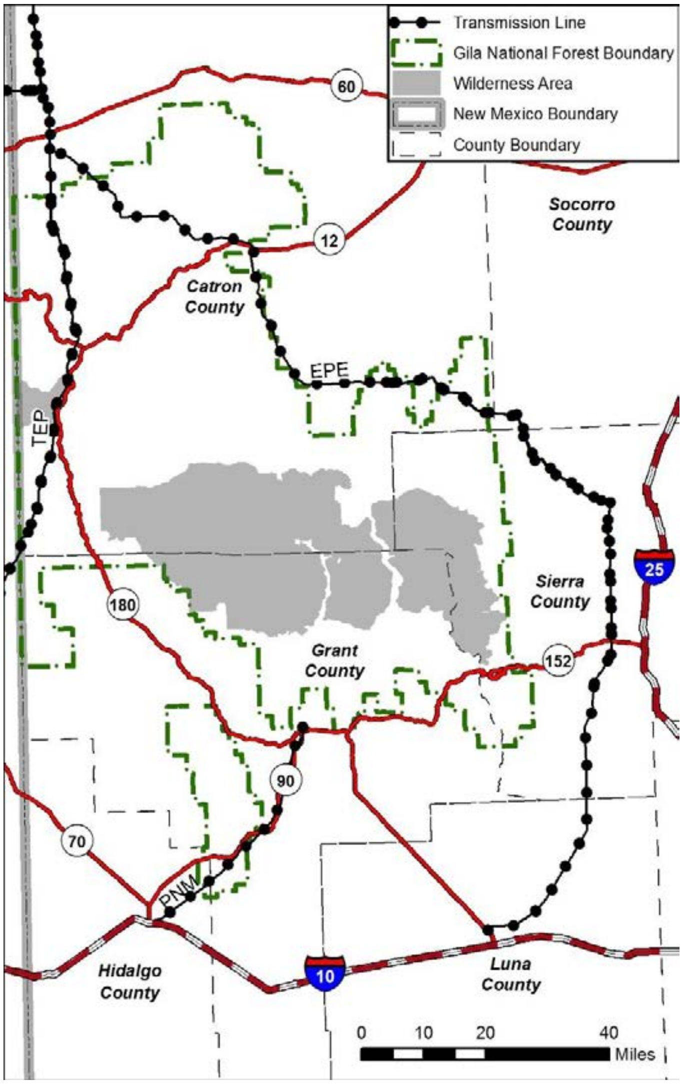

Figure 198. Major energy transmission lines intersecting the Gila National Forest.

Non-Renewable Energy Resources.

Leasable minerals (i.e. coal, oil, natural gas) within the assessment area have historically been minimal to no development. There is no current development, extraction or use of this form of mineral material from the assessment area. Companies have conducted test drilling and seismic analysis of the subsurface for non-renewable energy resources in various locations of the Forest throughout the years.

Oil and Gas

Current Condition

The Analysis of the Management Situation for the 1986 Gila Forest Plan identified interest in the Quemado Lake and Beaverhead areas for potential oil and gas development. To date, only limited geophysical prospecting work has been conducted. There is currently no oil and gas exploration surveys or production or leases (active or pending) on the Forest.

Future Potential

The Zuni Uplift and San Agustin Basin plays (or prospects) in Catron County have low and moderate potential, respectively, for oil and gas (URS 2003). The currently producing oil and gas basins in New Mexico are located outside of the context area primarily in the San Juan and Permian Basins (Figure 199). Limited understanding of the oil dynamics of the Zuni Uplift and San Agustin Basin plays represent a high level of risk to private companies under current market conditions (URS 2003). If market demands for oil and/or gas change substantially, more exploratory activity might occur in these areas in the future.

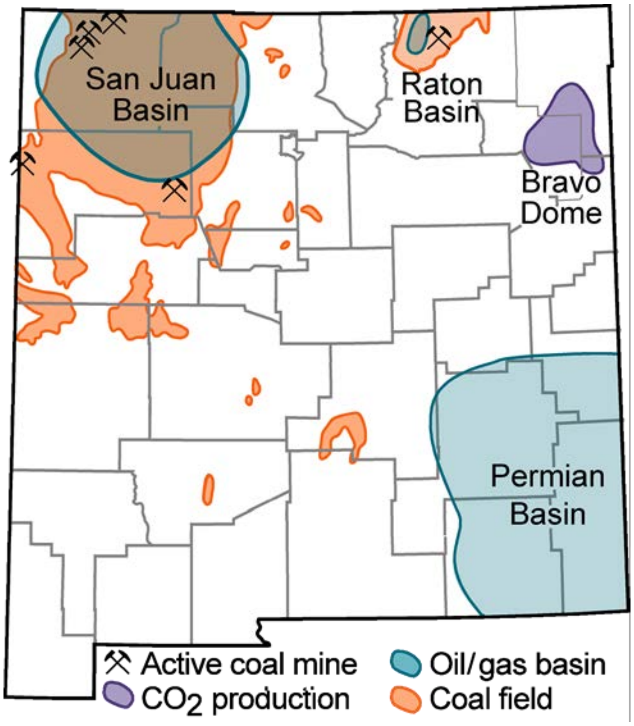

Figure 199. Currently producing oil and gas basins in New Mexico. From New Mexico Bureau of Geology and Mineral Resources (2016).

Coal

Current Condition

There is currently no coal production or leases (active or pending) on the Forest.

Future Potential

The U.S. Geological Survey identified no coal areas on the Forest (East 2013), so the future potential of coal is low for the assessment area. The nearest coal fields to the assessment area are the Salt Lake and Datil Mountain Coal Fields located north of US Highway 60 in Catron County and the Engle coal field east of Interstate 25 in Sierra County (Figure 200). Most of the active coal mines found in New Mexico are in the northern half of the state, primarily in the San Juan and Raton basins.

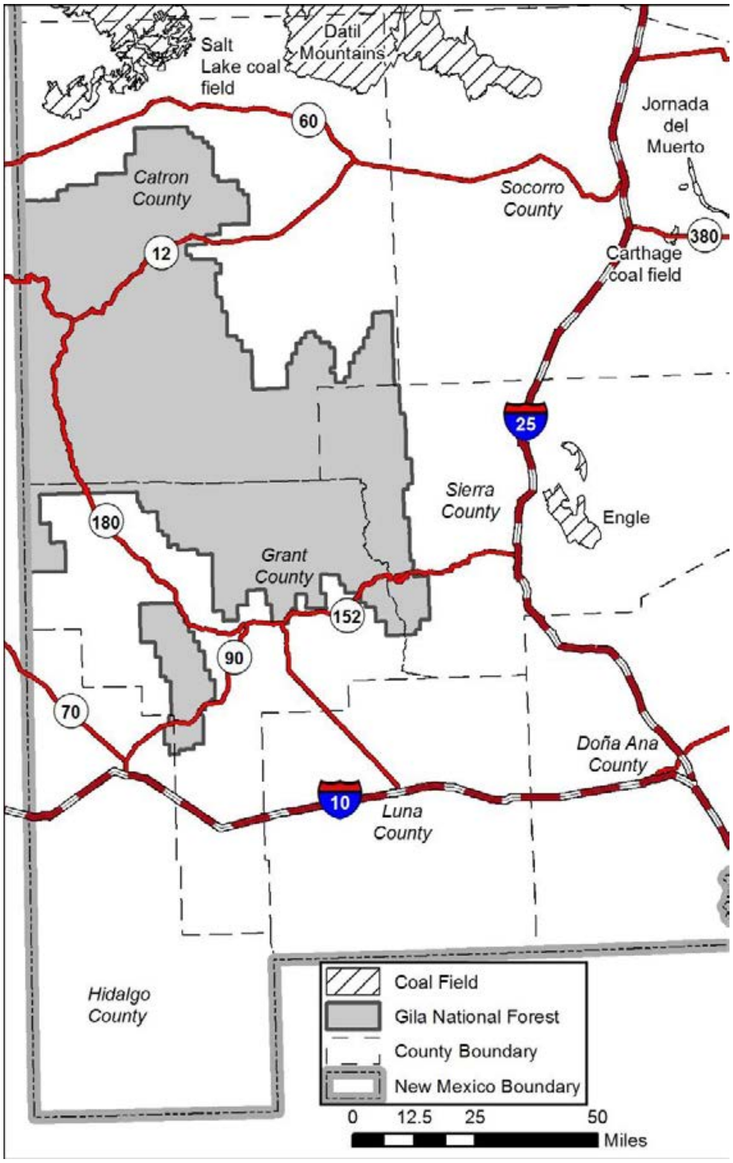

Figure 200. Coal fields in southwestern New Mexico. Data from McLemore et al. 2005.

Geologic Hazards

Geologic hazards are defined as those hazards that are geological in nature that pose a risk to human health and safety. They include risks such as earthquakes, floods, avalanches, mud slides, and volcanic activities. Geologic hazards are important in the social context, because they have the potential to affect human safety or the landscape humans use for various needs. On the Gila NF, the specific geological hazards that are relevant to the Forest include seismic hazards, flooding, landslides, and rockfalls.

Seismic hazards

Historically, the majority of earthquake activity in New Mexico has occurred along the Rio Grande Rift, and has been concentrated in the Rio Grande Valley between Socorro and Albuquerque (USGS 2015a). Figure 201 shows the probability of an earthquake measuring over 5.0 magnitude in southwest New Mexico within the next 20 years (USGS 2015b). The probability of an earthquake strong enough to do significant damage within the assessment area is low.

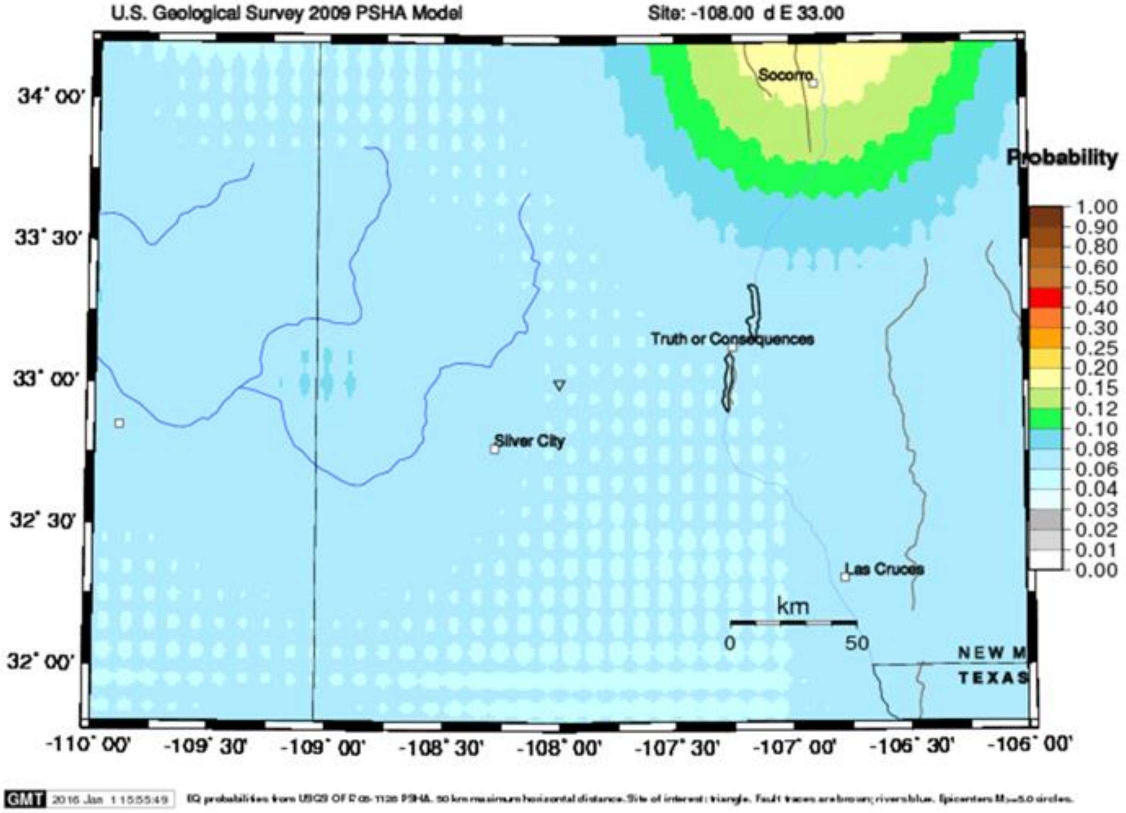

Figure 201. Probability of an earthquake measured over 5.0 magnitude in southwest New Mexico over the next 20 years
From USGS 2015b.

Landslides and Rockfalls

Many of the soil units on the Forest are conducive to landslides and rockfalls. Rockfalls are a continual hazard on the Gila NF and frequently occur during the summer monsoon season. Rockfalls are of the greatest concern when they occur along Forest and state or county roads with high vehicle traffic.

Impacts of Renewable and Nonrenewable Energy and Minerals Development on Ecological Integrity and Species Diversity

The former release of contaminates into the environment from historical mining activities predating environmental regulations is known as a “legacy” issue that can have effects on ecological integrity and species diversity. For example, Cold Springs Creek is listed as impaired for water quality for cold water aquatic life due to elevated concentrations of cadmium and lead (NMED 2014b). Historic mines in the upper watershed are the proximal source of the metal contamination. The Forest Service in cooperation with the New Mexico Environment Department is working to prepare, fund, and implement a comprehensive remediation effort.

Renewable energies in the form of geothermal or solar energy developed on a large scale disturb soils and potentially displace vegetation. Disturbances occur in the localized area of development, from motorized vehicle access, and the need for transmission lines. These disturbances can impact vegetation, wildlife habitat, and water resources. No renewable energy sources have been developed on the Gila NF and it is unlikely there will be in the near future.

Stakeholder Input

There is interest in additional mining and energy development on the Forest although people felt this should be well-regulated with consideration given to water supplies. There is a perception that the Forest has not done enough to promote mineral and energy development although many times commodity prices, other market or regulatory forces, and deposit characteristics play larger roles than Forest Service management.

Individuals also desired to know the policies and regulations concerning personal collecting of rocks, minerals and gold ore from the Forest as this information has been disseminated in an ambiguous or uneven way in the past. More internal Forest Service training and communication on this subject was requested to improve the accuracy and consistency of responses to public inquiries. Questions also came up concerning personal use collecting of rocks and minerals within areas designated as withdrawn from mineral entry (specifically areas with wilderness designation).

Summary

The Gila National Forest and surrounding areas contain mineral resources, with past mining for metallic minerals primarily producing gold, silver, copper, lead, manganese, zinc, iron, and tin. Future demand for locatable minerals (primarily copper) will likely occur in and around known mining districts. Mining is an especially important industry in southwestern New Mexico. Recreational gold panning is permitted on the Forest. Uranium and rare earth elements occur in the Burro Mountains, but the future potential is low at least in the near term. The Plan area contains many salable/mineral materials/ common variety minerals such as sand, gravel, and rock. There are abandoned mine lands from historical mining operations in the Plan area, some of which could pose physical and environmental hazards.

Leasable minerals (i.e. coal, oil, natural gas) within the Plan area have historically been minimal to no development of non-renewable energy resources. There is currently little to no renewable energy production on the Forest; although, the potential for solar and geothermal energy sources does exist. Currently, there are two large high voltage transmission lines that cross the Gila National Forest, but the Forest is not positioned in the direct path of transcontinental or multi-state connection routes for energy and transportation.

Chapter 17. Cultural and Historic Resources

Introduction

The Gila National Forest (the Plan Area) contains archaeological resources that demonstrate human occupation and use for approximately the past 12,000 years. The occupation and use of the Forest by Native Americans (American Indians) with Pueblo and Athabaskan ethnic affiliation and groups ancestral to these ethnic affiliations has occurred over this entire time span. Occupation and use of the Forest by Euro-Americans and other peoples from the Old World occurred over the past 400 years. The Plan Area has been under the management of the United States Department of Agriculture, Forest Service beginning in A.D. 1907, or for a little more than 100 years. Native American, Hispanic, and Anglo-American traditional communities continue to use the Gila National Forest for economic, social, and religious purposes.

This chapter presents an assessment of the current known cultural and historic resources and uses on the six ranger districts of the Gila National Forest. This chapter will discuss:

- Ecosystem services of cultural and historic resources
- Cultural and historical context of the Plan Area
- Description of cultural and historic properties
- National Register sites, National Register eligible sites, and priority heritage assets on the Gila NF
- Current conditions and trends of known cultural and historic resources on the Forest
- Contributions of cultural and historic resources to social, economic, and ecological sustainability
- Summary of cultural and historic resources on the Gila NF

Ecosystem Services of Cultural and Historic Resources

Cultural and historic resources and uses in the Plan Area are critical to the social, economic, and ecological sustainability of the Forest, the Southwestern Region, and the Nation. Archaeological sites within the Gila National Forest are a record of historic process and events important in the identity of local communities, the state of New Mexico, the region, and the Nation. Contemporary uses of resources and characteristics of the Plan Area by Native American, Hispanic, and Anglo-American traditional communities are critical to maintaining the identity of these communities. Cultural tourism is a significant component of the regional economy. Tourists are attracted by the nature and significance of archaeological resources and by the character of surrounding traditional communities. Archaeological sites contain a wealth of information for scientific researchers regarding ecological conditions and changes over the past twelve millennia, and human successes and failures in coping with these changes. This information is of value to managers making decisions regarding the contemporary ecological management of the Forest. This information is also of value for educating the public about ecological sustainability.

Cultural History of the Assessment Area

This section summarizes the history of the occupation and use of the Plan Area over the past approximately 12,000 years. Contemporary uses of the Forest by traditional communities that are considered important to the cultural identity of those communities are discussed in the Description of Cultural and Historic Resources section. The Gila National Forest encompasses what archaeologists describe as the Mogollon Culture area. The larger Mogollon area represents a rather large portion of the southern southwest and extends from the northern portions of Chihuahua, Mexico north to the modern town of Quemado, New Mexico. The eastern and western boundaries of the Mogollon Culture area are located in the Trans-Pecos area of Texas and along the San Simon River drainage in eastern Arizona.

Relevant to the Plan Area, two subdivisions of the larger Mogollon Culture area are present. These subdivisions include the Highland/Mountain Mogollon located in areas north of the Gila River, and the Mimbres Mogollon located in the areas south of the Gila River. In general, these two Mogollon groups exhibit similar characteristics throughout much of the area's occupation (around 6,000 through 1,000 years ago). However, differences emerge that warrant this geographical division particularly during the Pueblo period (ca. A.D. 1000-1400).

Occupational History

This sub-section is divided into three parts:

- Native American views of their historic origins.
- Native American history prior to A.D. 1600. This section addresses the span of time when Native Americans were the only groups to use the Plan Area.
- The span of time after A.D. 1600, when both Native American and Euro-Americans (and others of Old World descent) used and occupied the Plan Area.

This history of occupation and use has been prepared from archaeological studies, which employ historical documents and records, and from oral histories that transmit the traditions of Native American groups and others. While this history incorporates information from Native American oral history, it is written from a Western archaeological and historical perspective. Traditional Native American oral history differs from Western history in its measurement of the passage of time and in the causality identified for the course of human events and historic process. Despite these distinctions, scholars have found broad concordances in information regarding Native American history in the American Southwest between archaeology, historic records, and Native American oral history for at least the past millennium.

Native American oral tradition and Western scholarship differ regarding the ultimate origins of Native Americans in the region and in the Western Hemisphere. Western scholarship, using evidence from archaeology, genetics, and linguistics, places the ultimate origins of Native Americans in northwestern Asia, with a migration to the Western Hemisphere sometime prior to 12,000 years ago and movement into the American Southwest soon afterwards.

Archaeological, genetic, and linguistic evidence indicates that Pueblo people are the descendants of these earliest migrants, while Athabaskan people are in part descendent from peoples that migrated from Asia more recently, and entered the American Southwest as recently as 500 to 600 years ago. The oral traditions of both Puebloans and Athabaskans, however, place their ultimate and organic origin within the region itself. As such, Native Americans' views of their own origins are considered in a separate section.

Relative to the Plan Area, there are 10 federally recognized American Indian tribes with which the Gila National Forest routinely consults. Five of these tribes are of Pueblo ethnic affiliation: Acoma Pueblo, Laguna Pueblo, the Hopi tribe, Ysleta Del Sur Pueblo, and the pueblo of Zuni. Five of the tribes are of Athapaskan affiliation: the San Carlos Apache Tribe, the Mescalero Apache Tribe, the Fort Sill Apache Tribe, the White Mountain Apache Tribe, and the Navajo Nation (additionally contacting the Alamo and Ramah Chapters of the Navajo Nation).

While united by common origins, within each ethnic group, there is tremendous cultural diversity. This diversity manifests itself in the variety of languages spoken between groups and the various methods of organizing the social and cultural practices performed by different groups.

Native American Perspectives on their Origins

Native Americans, who have occupied and used the Plan Area both currently and historically, understand their own history in ways that are distinct and sometimes differ from the version of history that is derived from Western scholarly traditions. The historical traditions of Native Americans with ties to the Plan Area are oral in nature. This is to say, that historical knowledge is maintained by passing it from one generation to the next through verbal communication, rather than having historical knowledge transmitted through written documents.

Until recently, Native American groups connected to the Gila National Forest did not have what Western society considers 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 groups affiliated with the Forest, however, do not have a written form of their language, though other iconographic displays (e.g. rock art, pottery designs, etc.) likely were imbued with symbolic content that conveyed messages. In some cases, the lack of written language is an intentional act, reflecting traditional beliefs that historical knowledge, along with other types of esoteric 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. Native groups describe their 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 (Deloria, Jr. 1994; Ferguson and Hart 1985; Van Dyke 2008). 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 past to the present and vise-versa (Ball, M.W. 2000). Although the Native American groups affiliated with the Plan Area all trace their historical roots to the American Southwest, origin histories are diverse among the various groups.

In discussing Native American origin stories in the Plan Area, it is important to note that even within a particular tribe, there is no unified account of a group's emergence and/or entrance into the Southwest. Oral traditions tend to place more emphasis on understanding and internalizing the message of the story rather than recounting an absolute truth. As a result, the details of any one story may vary from one individual to the next.

Three types of Native American origin stories are discussed in this section:

1. Pueblo origin stories (with emphasis on the Acoma, Hopi, and Zuni, which have had more ethnographic documentation),
2. Apache stories from the Chiricahua and the Mescalero tribes, and
3. Navajo/Diné origin stories.

Many of the Pueblo groups share a particular origin myth that involves a gradual assent through three different worlds before emerging into the present (fourth) world. The details and characters involved in the account vary from group to group. For instance, in the Hopi origin story, the people are led through the worlds by a series of animals. In the Zuni accounts, it was the twin boys of Earth Mother and Sun Father that led all beings into the final world (Griffin-Pierce 2000; Sando 1992; Sheridan and Parezo 1996). The point of emergence is usually described as being somewhere in the Southwest, but the exact location varies from tribe to tribe. Once inside the fourth world, many of the pueblos describe a time of migration where the group searched for the place that was granted to them as their ultimate homeland. This period of migration is believed to have occurred over many years and across much of the Southwest (Anscheutz 2012; Colwell-Chanthaphonh and Ferguson 2012a; Colwell-Chanthaphonh and Ferguson 2012b).

Although stories that recount the creation of human beings and the world are common among Athapaskan groups (and even other Apache groups), neither the Chiricahua nor the Mescalero Apache have a true creation story (Opler 1983, 1994). However, there are several stories that discuss the early history of the world and the Apache's place within that history. According to contemporary Mescalero Apache oral history, people were once ethnically and linguistically homogeneous, with no cultural differentiation. At some point, the first Big Tipi was created and as people stood around it, they were given different beliefs and cultural practices. References indicate that the first "Big Tipi" was revealed to the Mescalero Apache "at the top of the world" (presumably some place north of the Southwest) and the group subsequently migrated to the Southwest (Ball, M.W. 2000). Once settled in this new territory, the landscape gradually became an embodiment of Apache identity and relationship to place.

The way relationship to place is connected with identity is particularly evident in the Apache's adoption of the Mountain Spirit tradition. The Mountain Spirit tradition has no definitive date of origin, but is seen by both Apache people and anthropologists as relatively recent, probably originating sometime in the past few hundred years. The mountain spirits are healing spirits that help the Apache during times of need. They reside within the mountains of the Southwest. Apache groups will most commonly cite four mountains as being sacred mountains that represent the four directions. However, there are many mountains that have been listed as being important to Apache tribes. Even within a single Apache tribe, there is often no consensus on which mountains the four sacred mountains are and which of the four directions they represent (Ball, M.W. 2000).

Navajo/Diné creation stories describe a journey through a series of worlds (three or four depending on the account) before arriving in the present world. The earlier worlds are chaotic, each a different color and filled with its own primordial beings. As they traveled through the different worlds, the Diné were in search of a place where there would be order and harmony. In the third (or fourth) world, a water monster created a flood to take revenge on Coyote for kidnapping her baby. As the flood waters rose, the people and animals gathered onto a hollow reed and climbed towards the final world. Once in the present world, the first man and the first woman formed the four sacred mountains: Blanca Peak in the east, Mount Taylor in the south, the San Francisco Peaks in the west, and Hesperus Peak in the north. They adorned the world with natural beauty and created the night and day (Griffin-Pierce 2000; Parezo 1996).

Brugge (2005) contends that some Navajo oral tradition reflects a division between two types of Navajo clans, each claiming a separate point of origin. According to Brugge, the first group of Navajo clans claims a local place of origin in the Southwest. These clans claim to have either descended from the people who survived the age of the monsters or that a supernatural event resulted in their creation. The second group of clans (the Western Water Clans) claim to have been created by the Navajo deity, Changing Woman, at her home in the ocean. Some accounts indicate that the two groups merged some place along the San Juan River.

Native American Occupation and Use to A.D. 1600

For virtually the entire span of human history in the Plan Area, Native Americans were the only people to occupy and use the land. Their use of the Plan Area is concurrent with the earliest human occupation of the Western Hemisphere, and persists to the present day. In the American Southwest, prior to A.D. 1600, Native American history is divided into five broad time frames:

1. *The Paleoindian period* is associated with the initial colonization of the region during the end of the Pleistocene, when dramatic environmental changes took place within the region. The first Paleoindian occupants were nomadic hunter and gatherers.
2. *The Archaic period* is a long span of time in the early and middle Holocene when environmental conditions stabilized and became approximately the same as those in the present day. The Archaic era saw an increase in population, social and technological changes, along with the initial introduction of maize (corn) and other domesticated plants from Mesoamerica, but with continued focus on wild resources.

3. *The Pithouse period* corresponds to the period of time when Native American groups inhabiting the Plan Area manufactured ceramic wares and lived in semi-subterranean dwellings. This time period generally dates from roughly 1,800 to 1,000 years ago (ca. A.D. 200-1000) and is divided into the Early Pithouse period (ca. A.D. 200-550) and Late Pithouse period (ca. A.D. 550-1000). It is during this time period that maize agriculture takes hold across the Plan Area, groups become increasingly sedentary, and populations grow in size.
4. *The Pueblo period* corresponds to the last millennium of Native American occupation prior to A.D. 1400. It is characterized by the advent of a more sedentary life way, increased population, and an increased reliance on cultigens. The origins of the modern ethnic identities of contemporary Pueblo peoples also lie within this era. Athabaskan peoples colonize portions of the American Southwest during the end of the Pueblo era, although initially as small bands of hunters and gatherers.
5. *The Protohistoric period* represents the time period from the pan-regional abandonment of once densely populated areas around A.D. 1450 through when permanent settlement of the area was undertaken by groups with written historical records (ca. A.D. 1600). It is during this time period that Native Puebloan groups aggregate into extant pueblo settlements (e.g. Hopi, Zuni, etc.) and the first Spanish explorations enter the area. Athabaskan groups continue their southward migration and enter the Plan Area during this time period.

The human occupation of the Western Hemisphere, and the American Southwest, began around 12,000 years ago, as nomadic hunters and gatherers who entered the hemisphere from northern Asia via Alaska. These earliest Native Americans are known as Paleoindians. Their arrival in the hemisphere coincided with the end of the Pleistocene (last ice age), and rapidly changing climatic and ecological conditions.

The Paleoindian period

The Paleoindian period (ca. 11000 B.C. – 6000 B.C.) within the Mogollon culture area is probably the most poorly understood in the cultural sequence. This is due both to the lack of investigation of sites dating to this time period and to preservation issues associated with the great time depth of this time period. Most of what is known of this period comes from cross dating projectile point styles found in the Plan Area to dated specimens found elsewhere in the Southwest (Lekson 1992, 2006).

While there has been considerable debate regarding the existence of groups inhabiting the Americas prior to 12,000 years ago, there is little controversy surrounding the fact that humans were within the present-day Southwest by around 12,000 years ago (Fiedel 2002; Waters and Stafford 2007). The sites of Folsom and Blackwater Draw in eastern New Mexico provided evidence of early man in association with extinct mega-fauna that attested to the presence of people in the area during Paleoindian times (Bousman et al. 2004; Collins 2002; Cotter 1938; Figgins 1927; Howard 1935; Meltzer 2004; Nemecek 2000). The presence of Paleoindian peoples within the area is based upon the fact that distinctive projectile points, for example Clovis, Folsom, Sandia, and Plainview have been found at sites throughout the United States and many are associated with extinct mega-fauna (Collins 2002; Hofman and Graham 1998; Meltzer 2004; Wyckoff 1999). The life-ways of groups inhabiting the continent during this time are thought to be based on highly residentially mobile groups following a wandering subsistence base, megafauna. While this view of Clovis peoples as big-game hunters has been within the theoretical lexicon of archaeology since the excavations at Blackwater Draw were undertaken in the 1930s, new research is showing that these groups developed a knowledge of local flora and faunal regimes and might have been broad spectrum foragers as opposed to specialized hunters reliant on large megafauna (Collins 2002; Meltzer 2004; Nemecek 2000; Stanford 1991).

After Clovis, a number of other occupations/adaptations to life in the southwest emerged and evolved. Currently, the chronology for these occupations/adaptations (Holliday 2000; Justice 2002) are based on radiocarbon dates obtained from materials associated with distinctive projectile points as follows: Folsom and Midland (9000-8000 B.C.); Plainview, Milnesand, and Agate Basin (8200-7200 B.C.); Lake Mojave and Silver Lake (9000-6000 B.C.); and Scott's Bluff, Eden, and Cody (7500-6500 B.C.). The sites dating to these different time periods have been interpreted differently, either as groups consisting of broad spectrum foragers, or as specialized hunter groups traversing the landscape in their subsistence quest.

Paleoindian groups undoubtedly used the Plan Area as a place to hunt and gather resources; and there is evidence that tools were manufactured from stone collected from nearby areas (Banks 1990; Hamilton et al. 2013; Haynes and Huckell 2007; LeTourneau 2000). While there are some isolated artifacts, there are few archaeological sites from the Paleoindian era known on the Forest. Only a handful of archaeological resources in the Plan Area have Paleoindian components (No. < 5). Most of these are present in the more mountainous areas surrounding the modern day Reserve and Quemado Ranger Districts.

The Archaic period

The Archaic period (ca. 6000 B.C. – A.D. 200) represents a time of substantial change amongst prehistoric peoples. The transition between the Paleoindian and Archaic eras took place around 8,500 to 8,000 years ago. The era is marked by the onset of the Holocene epoch, and with it the arrival of climatic and ecological conditions similar to the present day. During the Archaic period, Native Americans continued the hunting and gathering lifestyle seen during the Paleoindian period. It is distinguished from the preceding Paleoindian period by the appearance of part-time cultivation of domestic plants and associated plant processing tools (i.e. groundstone tools). Many of the defining characteristics of the following Pithouse and Pueblo periods, such as the cultivation of domestic plants and the construction of permanent dwellings, make their first appearance in the later years of the Archaic period. The adoption of pottery containers is often used as a marker for the end of the Archaic period (Huckell 1996).

The Archaic period is poorly understood in most portions of the U.S. What is known about Archaic period peoples is that they pursued a hunter-gatherer life-way similar to that of the preceding Paleoindian period peoples, although the mobility of the latter groups is believed to have decreased. In the Southwestern U.S. this is evident by the emergence of variation within projectile point assemblages recovered from different portions of the region (Huckell 1996). Here, between 9,000 and 7,500 years ago, Archaic populations replaced earlier Paleoindian populations. Based on the evidence at hand, regional variation is thought to represent decreasing ranges traversed by groups who possess a greater knowledge of the exploitable resources within their local landscape. It is during this period that the seeds of the vicious feedback loop involving increased sedentism, increased reliance on cultigens, and population growth are planted.

The criteria used to differentiate the Archaic period from the Paleoindian period are somewhat varied. Most archaeologists place the emergence and proliferation of groundstone technology as the key hallmark that separates the two periods. This coupled with the use of thermal features (i.e. burned rock middens) for food processing points to another key aspect that differentiates the Archaic from the Paleoindian period: the increased use of locally available resource and the incorporation of more of these resources into group subsistence regimes. Finally, it is during the Archaic period that side-notched projectile points appear and begin to replace the lanceolate and stemmed projectile points of the preceding period (Huckell 1996; Justice 2002; McBrinn 2010; Sayles and Antevs 1941).

As stated above, the Archaic Period in the American Southwest traditionally dates from around 8,000 to 1,800 years ago (ca. 6000 B.C. – A.D. 200). This long time span is divided into the Early Archaic period (6000-3500 B.C.), the Middle Archaic period (3500-1500 B.C.) and the Late Archaic/Early Agricultural period (1500 B.C.-A.D. 200) (Huckell 1996). As can be imagined, considerable variability exists among the groups inhabiting the vast area of the Southwest during these time periods. Despite this problem, researchers have postulated that some groups exhibit enough similarities in material culture to be classified as distinct traditions/cultures. One of these distinct traditions, the Cochise Culture, inhabited what is today southeastern Arizona and southwestern New Mexico (Sayles and Antevs 1941).

The Archaic is either not well reported or well represented in the Mimbres Valley but it is documented from work in the nearby Gila Hot Springs area, the upper reaches of the Gila River near Cliff and Gila, New Mexico and in the Middle San Francisco River Valley near Glenwood. Surveys near Gila Hot Springs by Honea (1963) resulted in the documentation of a probable Cochise site. West, in the Upper Gila area, small villages of shallow pithouses occupied toward the latter part of the Archaic have been documented (Hemphill 1983; Hammack et al. 1966; Chapman et al. 1985). The presence of pithouses and corn at the Eaton Site (Fitting et al. 1982) and at LA 29397 (Laumbach 1980) from the same area suggest that between 200 B.C. and 350 B.C. Archaic populations at these sites may have led a relatively sedentary lifestyle even before the introduction of pottery.

While Archaic period sites are limited in areas south of the Gila River, a few sites around Reserve have demonstrable Archaic period occupations (e.g. Bat Cave, Cordova Cave, Tularosa Cave, and O-Block Cave, LA 37917, LA 43766, LA 45508, LA 70188, LA 78439, and LA 89846) (Dick 1965; Martin et al. 1949, 1954; Oakes and Zamora 1999; Waters 1998; Wills 1988, 1996). Early in the history of the region's research solid carbon radio-carbon assays associated with these sites often gave false dates in excess of 4,000 years before present, reanalysis of some of these samples as well as samples collected from more recent research endeavors show that populations were firmly established in the area by the Late Archaic/Early Agricultural period (ca. 1500 B.C. – A.D. 200) (Huckell 1996; Oakes and Zamora 1999; Waters 1998; Wills 1988, 1996).

The Pithouse periods

The Pithouse periods (ca. A.D. 200-1000) in the Plan Area represent a time of substantial change. Archaeologists traditionally divide this time span into the Early Pithouse period (ca. A.D. 200-550) and the Late Pithouse period (ca. A.D. 550-1000). It is during this time that Mogollon brownware ceramics begin being produced in the area. Initially, ceramics of this tradition consisted of non-decorated wares and decorated varieties with fairly simple exterior surface treatments (e.g. neck banding/corrugations, scoring, incising, etc.). As time progresses through the Pithouse and Pueblo periods, surface treatment on Mogollon Brownware ceramics become more elaborate (e.g. Mimbres Classic Corrugated, Reserve Indented Corrugated, Tularosa Patterned Corrugated, etc.). Similarly, ceramics with painted designs make their appearance during the Pithouse periods. Red slipped ceramics first appear during the Early Pithouse period and Black-on-white ceramics first appear during the Late Pithouse period. As was the case for textured wares, Black-on-white ceramics become more elaborate through time, culminating with Mimbres Black-on-white Style III and Mimbres Polychrome ceramics during the Pueblo period (discussed below).

It is also during this time that extra-regional exchange relations become more prevalent. Specifically, during the Late Pithouse period, interaction with Hohokam groups intensifies. This is evident through the increasing presence of shell items procured from the Gulf of California as well as the presence of stone palettes and stone censors at Late Pithouse period sites throughout the Mogollon area. Similarly, interaction with northern and southern groups appears to have intensified through time. This is evidenced by the increasing presence of Cibolan Whiteware ceramics in the Plan Area as well as the increasing presence of copper and turquoise materials in areas to the north and south that likely originated from source groups in close proximity to the Gila National Forest. It is also during this time period that macaws enter the archaeological record. Macaws were likely obtained either through exchange with groups occupying portions of southern Mexico or were directly procured by Mogollon peoples. Finally, during the Late Pithouse period, Mogollon groups likely began trading Mule Creek obsidian throughout the Plan Area and with other nearby cultural groups (Taliaferro et al. 2010).

The Early Pithouse period (ca. A.D. 200 – A.D. 550), like other earlier occupations of the Forest is relatively poorly understood. This is primarily due to the lack of investigation of sites dating to this period. The dates associated with this period are based solely on a few radiocarbon assays which range from A.D. 130 to A.D. 645 (Lekson 1992: 66-74). The Early Pithouse period is distinguished from earlier occupations by the introduction of ceramic technology, a notable shift in subsistence strategies, a unique settlement pattern, and the appearance of new architectural characteristics.

The Early Pithouse period is marked by the introduction of Alma Plain brownware pottery and thinly slipped redwares. Like ceramics common to later occupations in the area, Early Pithouse period brownwares are formed using the coil and scrape method and exhibit a variety of surface finishing techniques (e.g. incising, scoring, etc.). These plainware and textured-ware varieties are the first that appear in the sequence and are followed by thinly slipped redware vessels that have come to be called Mogollon Early Red ceramics (Diehl and LeBlanc 2001). Mogollon Early Red wares are differentiated from their later San Francisco Red counterparts due to their thinner slip and the absence of other surface treatments (e.g. polished surfaces, dimpled exteriors, and scored interiors) (Diehl and LeBlanc 2001: 109).

Finally, the Early Pithouse period was initially interpreted as marking the transition from a hunting and gathering life-way to one with a greater dependence on agriculture. However, new evidence from the Tucson Basin demonstrates that Late Archaic people were fairly reliant on cultigens, at least for some portions of the year, and took great strides to improve agricultural productivity of lands surrounding their settlements. It should be noted that the Late Archaic period is poorly documented for the Plan Area when compared to surrounding areas to the north and west. Be this as it may, research in these areas demonstrates that people were experimenting with horticulture well before the advent of the Early Pithouse period. Research in these areas suggest that Early Pithouse period subsistence economies represent an intensification of those present in preceding periods (Wills 1988, 1996).

To date, roughly nine Early Pithouse period sites have been partially excavated in the Mogollon area (Diehl and LeBlanc 2001; Fitting 1973a; Haury and Sayles 1947; Martin 1943; Martin and Rinaldo 1947; Martin et al. 1940, 1949; Oakes et al. 1999; Wallace 1998). In the Highland/Mountain Mogollon area this time period is sometimes referred to as the Pine Lawn phase (Martin and Rinaldo 1950a; Oakes and Russell 1999). The results of these investigations demonstrated that house floor plans of this period vary from circular, to “Bean” shaped, to amorphous in shape, though most have lateral entryways (Diehl and LeBlanc 2001). These structures cover roughly 26 square meters on average and are relatively large when compared to domestic structures of the Late Archaic and Late Pithouse periods (Diehl and Leblanc 2001; Martin 1943; Martin and Rinaldo 1947; Martin et al. 1940, 1949). The exact reason for this size difference is unknown but could be related to social organization, in that larger social groups may have been needed to perform household practices. These larger social groupings may have carried over or been replaced by the courtyard groupings of the Late Pithouse period (see below). While villages range in size, all appear to have at least one larger structure that is believed to have served communal/ceremonial purposes. Early Pithouse period communal structures were generally larger in floor area and possessed lobes on either side of their entryway. Other than their size and their lobed protrusions around the entryway, no other features distinguish communal/ceremonial structures from their domestic counterparts during the Early Pithouse period (Anyon and LeBlanc 1980).

The Late Pithouse period (ca. A.D. 550- A.D. 1000) is subdivided into the Georgetown phase (ca. A.D. 550-700), the San Francisco phase (ca. A.D. 700-850), and the Three Circle phase (ca. A.D. 850-1000). While the sample of excavated Early Pithouse period sites is small for the Mimbres and Highland Mogollon areas, numerous Late Pithouse period components have been excavated. The vast majority of these have been the result of work undertaken at later occupations where surface architecture is present and few isolated Late Pithouse period sites have been excavated (see Haury 1936; Martin and Rinaldo 1950a; and Roth

2010, 2015 for examples of isolated Late Pithouse period sites). Because the Late Pithouse period has been so intensively investigated in the areas surrounding the Gila National Forest, only a cursory overview is presented highlighting the key traits of the period (see Anyon 1980; Anyon and LeBlanc 1984; Bradfield 1929; Cosgrove and Cosgrove 1932; Creel 2006a; Haury 1936; Lekson 2006; Martin 1943; Martin and Rinaldo 1947, 1950a; Nesbit 1931, 1938; and Shafer 2003 for detailed discussion of Late Pithouse period remains within the Mogollon area).

The traditional phase designation used for the Late Pithouse period was first established by Haury (1936) based on his work at Mogollon Village along the San Francisco River near Alma, New Mexico and Harris Village along the Mimbres River near Mimbres, New Mexico. Based on his work at Mogollon and Harris Villages, Haury (1936) differentiated the Georgetown, San Francisco, and Three Circle phases primarily due to changes in architecture and ceramic assemblages.

Aside from these changes in architecture and ceramic assemblages, the other main characteristic of the Late Pithouse period is a shift in settlement patterns. While Early Pithouse period sites tend to be located on higher elevation landforms, Late Pithouse period sites are usually located along the first bench overlooking drainages. If LeBlanc’s rationale for the positioning of Early Pithouse villages were correct, then this would indicate that the threat of violence decreased during the Late Pithouse period (Diehl and LeBlanc 2001; LeBlanc and Whalen 1980). However, if Diehl’s model is correct, then this would suggest that population densities reached a certain threshold whereby the visibility of a community was no longer deemed necessary to facilitate social interaction (Diehl and LeBlanc 2001).

Regardless of the scenario responsible for the changes in settlement location, other patterns present in preceding periods intensify during the Late Pithouse period. It is during this time period that feedback mechanisms involving population increase, increased sedentism, and increased reliance on cultigens become firmly entrenched. As populations grow, so too does the need to feed them. Cultigens provide a predictable source of nourishment and can be relatively easily manipulated to produce greater yields and thrive in different environments. Conversely, having a predictable subsistence base also allows for population growth. Because cultigens are modified by human agency, they often require this intervention to survive. Thus, once groups begin to invest in agricultural production to meet the food demands of the burgeoning population, they will probably need to remain present throughout some portion of the year to ensure that this subsistence base produces. This causes groups to become more sedentary for at least some part of the year. Similarly, as populations grow, it becomes increasing more difficult to remain highly mobile. Throughout the Late Pithouse period agricultural production intensifies.

Throughout the Georgetown, San Francisco, and Three Circle phases, domestic structures change in morphology from circular in shape to square in shape with lateral entryways. Communal structure morphology changes from circular structures with lobed entryways to square structures that are nearly quadruple the size of their domestic counterparts. Decorated ceramic production changes from simple red-slipped vessels, to brownwares with red designs (Mogollon Red-on-brown), to black-on-white designs executed on brownware vessels with increasing complex designs (Mimbres Black-on-white Style I, Mimbres Black-on-white Style II). Plain and textured varieties of brownwares are produced throughout the Late Pithouse period. Subsistence practices seem to follow earlier occupations and generally consisted of increasing reliance on cultigens as a result of increasing population that was partially offset by hunting and gathering of wild resources. Sometime during the San Francisco phase, a more productive variety of Maiz de ocho was introduced and grew in prominence (Diehl 1996, 2012; Gruber 2007). Finally, it is during this period that the inhabitants of the Forest and surrounding areas begin intensively targeting the Mule Creek obsidian sources for lithic tool stone raw material.

At some point in time, probably during the late Three Circle phase, a new form of social organization likely emerged. Researchers have noted that certain structures during the Three Circle phase were organized as what some call courtyard groups or clusters (Creel 2006a; Lucas 1996; Roth 2015). These courtyard groupings consist of multiple contemporaneous pithouse structures arranged so that their entryways open onto a common area/courtyard and most groupings tend to have a non-domestic pitstructure incorporated amongst their ranks. These groupings have come to be interpreted as corporate groups that are thought to have consisted of a multifamily kin-group (Creel 2006b). The emergence of these corporate groups represents another level of social organization that had not existed during preceding periods. Prior to their emergence, village organization consisted of a low level of organization, the individual pithouse social unit, and a higher level of organization, the community as a whole integrated through the large communal facilities (great kivas) present at most pithouse villages. Corporate groups are believed to represent co-residential units that shared domestic and economic practices and could thus be interpreted as households (Shafer 2006; Wilshusen 1989). Shafer (2006) argues that these corporate groups emerged as a response to the need to share commonly controlled resources, namely the irrigation system that is hypothesized to have existed in Mimbres valley during the Late Pithouse and Classic periods (Creel and Adams 1986; Herrington 1979; Shafer 2003). The emergence of this irrigation system and the ensuing emergence of corporate groups are believed to have had drastic ramifications for socio-political organization in the region (Shafer 2006).

The Pueblo period

The Pueblo period (ca. A.D. 1000-1400) refers to the time span when groups began to construct above ground architecture. The time period traditionally dates from around 1,000 years ago to roughly 600 years ago and is separated into early and late components. The Early Pueblo period traditionally dates from around 1,000 to 800 years ago (ca. A.D. 1000-A.D. 1200) and the Late Pueblo period traditionally dates from around 800 to 600 years ago (ca. A.D. 1200-A.D. 1400). Perhaps the greatest divergence of distinct traditions in the Mogollon culture area takes place during these time spans. For areas south of the Gila River, the Early Pueblo period is referred to as the Classic period (ca. A.D. 1000-1150). For areas north of the Gila River in the Highland/Mountain Mogollon area, this time period is referred to as the Reserve phase (ca. A.D. 1000-1200). For areas south of the Gila River, the Late Pueblo period is divided into the Black Mountain phase (ca. A.D. 1150-1300) and the Cliff/Salado phase (ca. A.D. 1300-1450). For areas north of the Gila River in the Highland/Mountain Mogollon area, the Late Pueblo period is referred to as the Tularosa Phase (ca. A.D. 1200-1400). In both areas these time periods are marked by the transition to above ground architecture, the continued growth of populations in the area, an increased reliance on cultigens, and an increase in regional interaction.

During the Early Pueblo period, the extra-regional exchange relations with Hohokam groups to the west appears to decrease in intensity. This is based on the decreasing quantities of stone palettes and stone censors at Mogollon sites. However, shell ornaments obtained from the Gulf of California are encountered at Classic period sites (Gilman 2006). Interaction with northern Ancestral Pueblo groups potentially intensifies during the Pueblo periods. It is during this period that Mimbres Black-on-white ceramics wane in popularity in the Highland Mogollon area and Cibolan ceramics become more prevalent at Reserve and Tularosa phase sites. Some researchers speculate that the southern extent of the Chaco regional system extends into the Quemado and Reserve Ranger Districts. Indeed, there are certain sites in the northern portions of the Forest that exhibit Chaco style architecture with faced masonry construction and high proportions of Cibolan Whiteware ceramics. During the Late Pueblo period in the Mimbres area, production of Mimbres Black-on-white ceramics ceases and groups begin obtaining decorated ceramics from areas to the north, south, east, and west. Obsidian data demonstrates that patterns present in the Late Pithouse period continue into the Pueblo periods. Specifically, Mule Creek obsidian continues to be the most utilized source throughout much of the Mogollon culture area and continues to be traded with groups to the north, south, east, and west (Taliaferro et al. 2010). Some researchers speculate that Salado groups originally from the Kayenta area in present day northeastern Arizona migrated into the Mule Creek area during the 13th or 14th centuries to lay claim to this important source group (see Huntley 2010, 2012 and papers therein).

The Classic period and Reserve phase date from around 1,000 years ago to around 850-800 years ago (ca. A.D. 1000-A.D. 1150/1200) and is marked by the transition from pithouse architecture to above ground cobble-walled roomblocks that, in some cases, incorporate kivas. Pueblos of this time period range in size from one to 200 rooms arranged as multiple roomblocks. Most, however, contain between one to 12 rooms (Bluhm 1960). Large communal structures (great kivas) cease being constructed in the Mimbres area during this time period. However, based on limited data, large communal structures appear to continue to be constructed in the Highland/Mountain Mogollon area.

The presence of Mimbres Black-on-white Style III pottery also marks the beginning of this period in the southern portions of the Forest. The exchange of this commodity, as well as the exchange of exotic materials, is characteristic of the increased socio-political interactions taking place during this time period. Near the end of the Classic period, production of Mimbres Black-on-white Style III ceramics declines and ceramics produced in areas to the north, south, east, and west begin to appear in the southern portions of the Forest. While Mimbres Black-on-white Style III pottery is common in the Mimbres area, the prevalence of Mimbres Black-on-white pottery decreases in the Highland/Mountain Mogollon area as Reserve Black-on-white and other Cibolan ceramics increase in popularity (Bluhm 1957, 1960; Martin and Rinaldo 1950b; Martin et al. 1949; Oakes and Zamora 1999). Based on the relative abundance of sites believed to date to this time period, researchers believe that populations reached their peaks during the Classic period and Reserve phase (Blake et al. 1986; Bluhm 1960).

The Black Mountain phase dates from around 850 to 700 years ago (ca. A.D. 1150-A.D. 1300) and exhibits distinct differences from the preceding Classic period. These differences included the apparent cessation of Mimbres Black-on-white pottery production and use, the emergence of new ceramic traditions in the area, the increasing use of cremation as a means of disposing of the dead, and the emergence of new architectural styles and features within the Mimbres area near the end of the Classic period (Creel 1999; LeBlanc 1977, 1980a; Shafer 1999). The new ceramic traditions that entered the area include the apparently immediate appearance of Playas Redware, El Paso Polychrome, St. Johns Polychrome, Chupadero Black-on-white, and Three Rivers Red-on-terracotta vessels at the time that Mimbres Black-on-white ceramics cease to be present in the archaeological record. The main differences in architecture and settlement patterns during the Black Mountain phase include the apparent abandonment of large Classic period villages during the Black Mountain phase and the emergence of new villages in the lower portions of the Mimbres Valley which were constructed of coursed adobe. These coursed adobe structures are perceived as generally containing rooms which are larger than their Classic period counterparts. They incorporate small clay lined circular adobe hearths, raised box-hearths, and a two-post roof support system which differ from the square slab-lined hearths, three post roof support pattern, and cobble masonry rooms of the Classic period (LeBlanc 1977, 1980a).

To date, only five Black Mountain phase sites have been moderately tested in the Mimbres area: Black Mountain, Galaz, Montoya, Old Town, and Walsh (Anyon and LeBlanc 1984; Creel 2006a; LeBlanc 1976, 1977; Putsavage 2015; Ravesloot 1979; Taliaferro 2014). All of these sites are located outside of the Plan Area. However, there are a few sites where Black Mountain phase ceramics have been encountered on the Gila National Forest. Usually these Black Mountain phase ceramics are present in small numbers and could represent the occupation of a Classic period site into the Terminal Classic period (ca. A.D. 1130-1180) or a limited occupation of a Classic period site by Black Mountain phase peoples.

The Tularosa phase dates from around 800 to 600 years ago (ca. A.D. 1200-A.D. 1400). In contrast to the Black Mountain phase, Tularosa phase sites do not appear to represent a distinct break in cultural traditions when compared to earlier manifestations in the Highland/Mountain Mogollon area. In these areas the Tularosa phase appears to represent a direct trajectory of the preceding Reserve phase. Tularosa phase sites mirror their Reserve phase counterparts in all respects except for size. Tularosa phase sites grow larger in comparison than those present during the Reserve phase with some containing upwards of 60 rooms. While larger, Tularosa phase sites are less numerous when compared to the settlement pattern present in the Reserve phase. The combination of larger pueblos and less numerous small structures during this time period could represent the consolidation of populations into fewer settlements. Ceramic assemblages present at Tularosa phase sites mirror those of the preceding Reserve phase though new ceramic types are introduced (e.g. Tularosa Black-on-white, Tularosa White-on-red, and St. John's Polychrome) and gain in popularity (Oakes 1993; Oakes and Zamora 1999). Tested Tularosa phase sites in the area include the East Ridge Ruin (Oakes 1993), Higgins Flat Pueblo (Martin et al. 1957), the Hough Site (Oakes and Zamora 1999), Starkweather Ruin (Nesbitt 1938), Fornholt (Dungan 2012; Dungan et al. 2012), and 3-Up (Dungan et al. 2012).

In stark contrast to areas to the south around the Mimbres River, inhabitants of the Highland/Mountain Mogollon area continue to construct and use large communal pitstructures throughout the Pithouse periods and into the Pueblo Periods. A few Reserve phase great kivas have been excavated in the Pine Lawn valley (e.g. Sawmill site) though the vast majority of tested great kivas in the northern Mogollon area date to the Tularosa phase (e.g. Fornholt, Higgins Flat, Hough Pueblo, East Ridge, and WS Ranch). These generally tend to be similar to Three Circle phase great kivas in their overall shape as well as the features present within their confines though some are either attached to room blocks or are surrounded by ancillary rooms.

The Cliff/Salado phase dates from around 700 to 550 years ago (ca. A.D. 1300-A.D. 1450) and was originally formulated by the Mimbres Foundation to describe sites occupied during the time span during which Salado Polychrome ceramics were manufactured. Sites dating to this time period represent the late occupation of portions of the Plan Area by groups who share a similar material culture with groups occupying the Hohokam heartland of the Tonto Basin, the lower Salt River Valley, and the Middle Gila River Valley (LeBlanc and Nelson 1976; LeBlanc and Whalen 1980; Lekson 2002, 2006; Lyons 2004; Lyons and Lindsay 2006). Based on the presence of Gila and Tonto polychrome ceramics, as well as similarities in architectural construction techniques, Mimbres Foundation archaeologists stipulated that "Cliff phase populations entered the Mimbres River bearing a fully developed Salado pattern rather than having evolved" in situ from resident populations (LeBlanc and Nelson 1976: 77). Thus, the Cliff phase is seen as a distinct break in the area's occupation where migrating groups reoccupied an essentially abandoned landscape.

While Cliff phase remains are found as far east as the Mimbres Valley, the phase gets its name from the dense occupation of Salado-like sites around the modern town of Cliff, New Mexico. In this area the presence of Tucson and Maverick Mountain Polychrome ceramics show connections with groups in east-central and southeastern Arizona though the architectural patterns at these sites shows more similarities to "puebloan patterns" than to the "compound architecture" of the Hohokam area (Wallace 1998:6). Despite the fact that there appears to have been a substantial Cliff/Salado period occupation in southwestern New Mexico, few sites relating to this occupation of the area are found north of the Gila River in New Mexico (Hegmon et al. 1999).

The Protohistoric period

The Protohistoric period in the American Southwest covers a relatively short time period and refers to the time span after the pan-regional large scale abandonments that took place around 550 years ago (ca. A.D. 1450) up to the time when permanent settlements occupied by groups producing historic written records were present in the area (around 400 years ago). Sometime around 550 years ago the native puebloan groups occupying the Plan Area are believed to have abandoned the Mimbres area and the

Mountain/Highland Mogollon area. There are two possible scenarios as to where these Mogollon groups went. In one scenario, these groups likely dispersed to neighboring settlements to the north, east, and south. In another scenario, these groups were possibly assimilated into Athabaskan groups migrating south from the Great Plains.

After A.D. 1450, and well into the historic era, Athabaskan groups occupied the Plan Area. The exact timing of the introduction of Athabaskan groups into the Plan Area, as well as their route into the Southwest, is debated. Most early dates associated with Athabaskan components tend to cluster around 550 to 450 years ago (ca. A.D. 1450-A.D. 1550). However, these dates range up to 1,100 years ago to as late as 300 years ago (ca. A.D. 900 to A.D. 1700) (Brown 1996; Hogan 1989; Oakes and Russell 1999; Schaafsma 1981; Wiley 1966). The migration route for the different Athabaskan groups entering the area was likely along the flanks of the Rocky Mountains and/or through the Great Plains into the San Juan Basin (Perry 1991; Schaafsma 1981; Seymour 2012; Towner and Dean 1996). Radio carbon assays, Native American oral histories, and Spanish accounts demonstrate that Apaches were present in the Forest possibly as early as 550 years ago with a definite presence by 480 years ago (Oakes and Russell 1999; Seymour 2008a).

The Spanish presence within the southwest likely began shortly after Athabaskan groups entered the area. Expeditions into the northern frontier of New Spain in what is now New Mexico and Arizona began after Cabeza de Vaca's return from his years of wandering in the wilderness after being shipwrecked off the Florida/Alabama coast in 1528 (Bandelier 1981). Upon his return to Mexico, Cabeza de Vaca and those within his party (Alonzo Maldonado, Andres Dorantes, and Estevanico) told their accounts and of what they had been told about the natives to the north. Even though their accounts made little mention of vast riches within these lands, they spurred Spanish interest within the northern frontier (Bandelier 1981; Burke 1973).

Numerous Spanish entradas would enter the Northern Territory after Cabeza de Vaca. However, only the initial entradas led by Fray Marcos and Coronado likely entered the Plan Area (Figure 202). The early expeditions followed a different route into the northern frontier which traversed from Compestela in the modern Mexican state of Nayarit; up to Vacapa in the modern Mexican state of Sonora; before crossing the present day international boundary by traveling up the Rio de Sonora, San Pedro River, and Gila River. After the Coronado expedition of 1540-1542, expeditions followed a different route, called the Camino Real which led from Mexico City up to present day El Paso, Texas, before traversing north along the Rio Grande.

After Coronado, It would be roughly forty years before another expedition into the northern frontier would be undertaken. Spanish settlement within the Northern Frontier of the present day Mexican states of Sonora and Chihuahua in the forty years since Coronado's expedition had allowed entradas to follow a new route: the Camino Real de Tierra Adentro (Figure 202). From 1581 until a permanent Spanish settlement was established at Santa Fe in 1598, five major expeditions traversed the Camino Real on their way to pueblos in the Northern Territory (Table 227). In most instances, the interaction that took place between the Spanish and Native American Puebloan groups ended in violence and the removal of Spaniards in the area. It would take the establishment of Santa Fe and a permanent presence with military personnel in the region to stabilize relations.

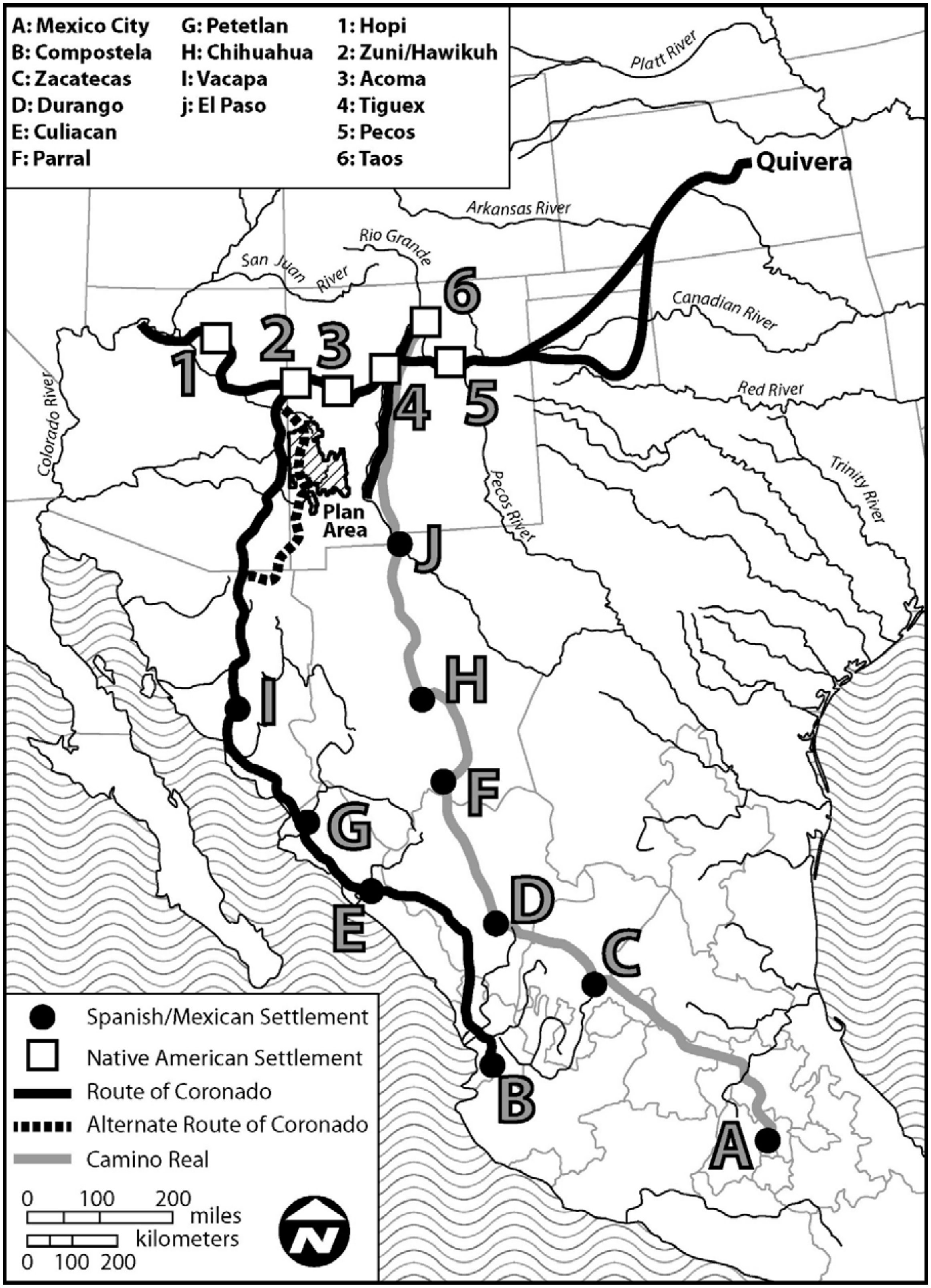

Figure 202. Depiction of routes followed by Fray Marcos and Coronado and later entradas along the Camino Real.

Table 227. Early Spanish entradas entering New Spain along the Camino Real.

Year	Expedition	References
1581	Fray Augustin Rodriguez	Barrado 1967a, 1967b; Bolton 1967; Burke 1973; Bustamente 1967; Kessell 2002; Villamanrique 1967
1582	Antonio de Espejo	Barrado 1967a, 1967b; Burke 1973; Espejo 1967a; Kessell 2002
1590	Gaspan Castano de Sosa	Burke 1973; Hackett 1923; Kessell 2002
1590	Francisco Leyva de Bonilla and Antionio Gutierrez de Humana	Burke 1973; Hackett 1923; Kessell 2002
1596	Don Juan de Onate	Bolton 1967; Burke 1973; Hackett 1923; Kessell 2002; Onate 1923a, 1923b, 1967a, 1967b, 1967c, 1967d, 1967e; Riley 1999

Native American Occupation and Use after A.D. 1600

After the establishment of Santa Fe in 1598, the Spanish Government began producing copious records of its activities associated with their attempts to colonize the northern frontier. As time progressed, and colonial administrations entered into previously unoccupied areas, the number of such records increased. These records allow for a more thorough study of activities taking place from A.D. 1600 through to the present. For the intents of the following discussion, Native American and Anglo-American history can be divided into three broad time frames:

1. *The Early Historic period* corresponds to the time period from 1600 to 1680. During this time span numerous Spanish settlements are established along the Camino Real and missions are established at Native American pueblo settlements. The Early Historic period ends with the expulsion of European settlers from the region as a result of the Pueblo Revolt of 1680.
2. *The Middle Historic period* corresponds to the time period from 1680 to 1890. It is during this time period that European settlement is reestablished in New Spain's northern frontier. It is during this time span that administration of present day New Mexico shifts as different nation states gain control of the area through armed conflict (i.e. Spain, Mexico, and the United States).
3. *The Late Historic period corresponds to the time period from 1890 through to the recent past (ca. A.D. 1950). It is during* this period that Apache groups residing in the Plan Area are forcibly removed and Anglo-American settlement within the region expands, the Plan Area is established as a Forest Reserve, and New Mexico gains statehood. Cattle ranching, logging, and mining activities increase in the region as America enacts its Manifest Destiny.

The Early Historic period

The Early Historic period (ca. A.D. 1600-1680) was a time of substantial change for both the colonial and native populations. During this period, many missions were established. In relation to the Gila National Forest, the closest missions were those present in the Salinas Basin, roughly 75 miles to the northeast. From 1625 through 1629, a series of missions were established in this area by Fray Francisco Acevedo (Prince 1915). Father Acevedo was responsible for the construction of missions at the pueblos of Abo, Tabira, and Tenabo. By 1630 missions had also been established at nearby Quarai and Gran Quivera. Between 1675 and 1680, the missions present in the Salinas Basin were destroyed (Prince 1915). Some attribute the demise of these institutions to Apache raids while others attribute their destruction to intracommunity conflict that emerged from economic stress brought about by drought, the introduction of pathogens into Native American communities, the desecration of traditional ceremonial structures, and the increasingly authoritative hand of Spanish settlers at nearby communities (Prince 1915).

A combination of socio-economic factors led to the Pueblo Revolt of 1680, where, under the guidance of Pope, an Indian from San Juan Pueblo (today known as Ohkay Owingeh), the puebloan populations rose in unison and attacked Spanish settlements and missions, causing those who did not perish, to flee from the area and resettle in areas surrounding El Paso, Texas. On August 10, 1680, pueblo Indians throughout the province of New Mexico rose up and slaughtered the Spanish within their communities and razed evidence of their presence to the ground. The final battle of the revolt took place at Santa Fe on the 16th of August; Pope accompanied by Indians from the Tewa pueblos, Taos, Picuris, Tiwa groups and others, numbering around 2,500 natives in all, attacked the town of Santa Fe, pushing the Spanish soldiers in the town to fortify the Governors Palace. Pope laid siege to the Palace and managed to set part of the structure on fire; on the 18th, Otermin, governor of New Mexico, took two hundred of his toughest soldiers and fought through the Indian forces. On the 19th, the governor led his population to Isleta Pueblo to search for survivors; there they caught news of a plotted attack, picked up and moved south, taking a group of Isleta natives with them to El Paso.

The Middle Historic period

The Middle Historic period (ca. A.D. 1680-1890) represents the time span after the Pueblo Revolt to when Apache groups occupying the Plan Area were forcibly removed from their native homelands. This time period is further subdivided based on the nation state administration responsible for the Plan Area. From 1600 through 1821, present day New Mexico was administered by the Spanish Government. In 1821, Mexico gained its independence from Spain and as a result gained control of the Plan Area. In 1848, with the signing of the Treaty of Guadalupe Hidalgo, the United States acquired the Western Territory, an area encompassing lands west of the Rio Grande to present day California. The southern portions of present day New Mexico and Arizona were acquired through the Gadsden Purchase of 1854.

The Spanish Administration of its northern frontier was partially interrupted by the Pueblo Revolt. However, settlement into present day Sonora and Chihuahua, Mexico continued during this time frame. While the Pueblo Revolt represents one of the only attempts by Native Americans to expel the European colonists invading the New World, it was a short-lived revolution. By 1690 the northern frontier was again part of New Spain. While the Spanish had made some strides in reestablishing relations with Pueblo groups along the Rio Grande, their relations with other Native American groups waned. This was in part due to the fact that Spanish settlements near areas occupied by non-Puebloan groups prior to the Pueblo Revolt were depopulated and/or abandoned (e.g. the Salinas Basin pueblos). It would be roughly 100 years before Spanish explorations entered the Plan Area again.

Despite sporadic conflict with Navajos, Apaches, and other tribes, Spanish settlement expanded from the northern and central Rio Grande Valley following the Pueblo Revolt. The Spanish crown (followed by the Mexican government after 1821) issued grants of land to individuals and communities to settle and use lands along the margins of the Spanish colony. Fifteen grants were issued for settlements adjacent to the Plan Area between 1718 and 1844 (Figure 203, Table 228).

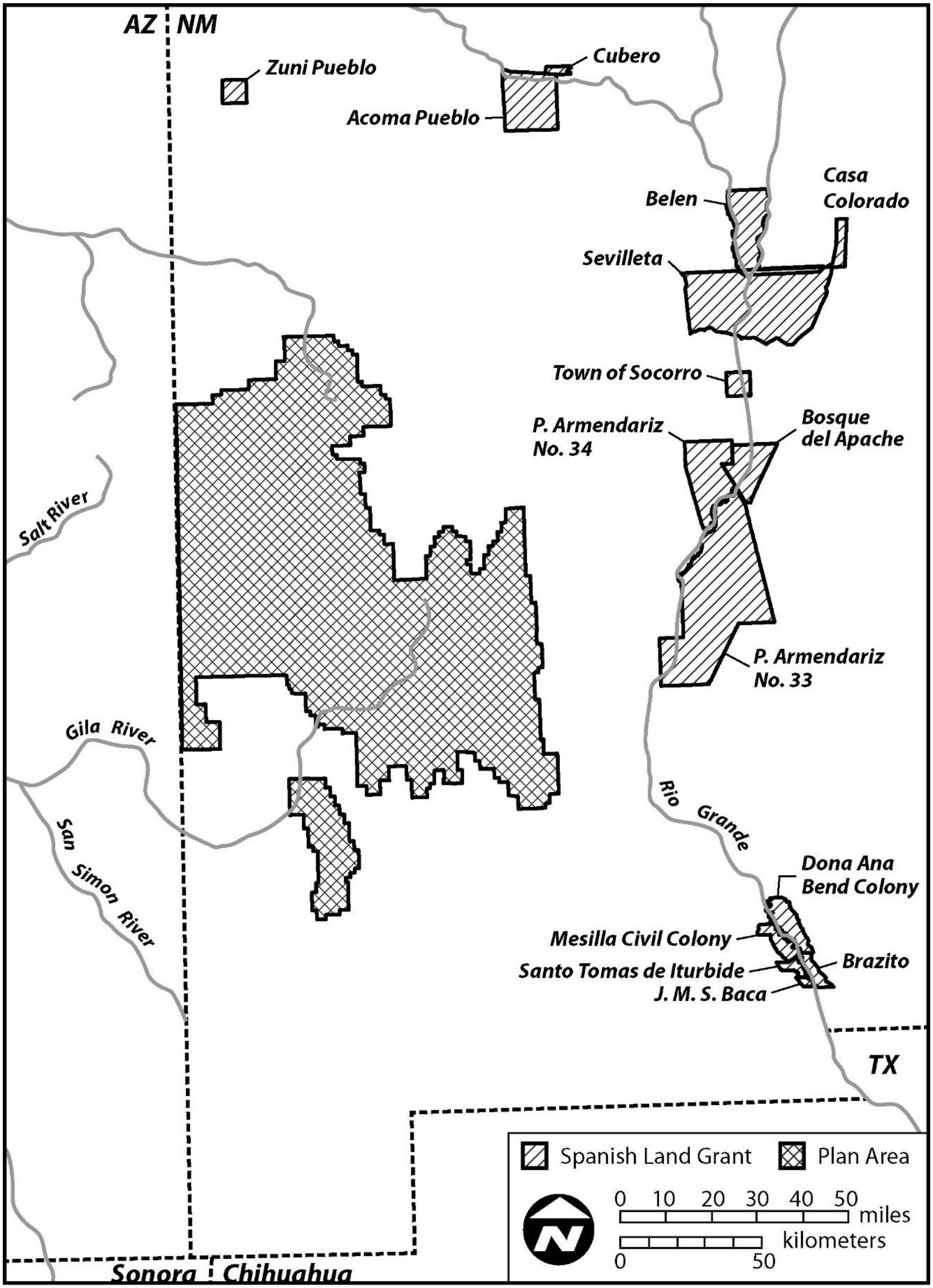

Figure 203. Location of Spanish and Mexican land grants adjacent to the Plan Area

Table 228. Spanish and Mexican land grants established within 50 miles of the Plan Area.

Grant Name	Date Issued (Spain/Mex.)	Type	Date Confirmed (U.S.)	Adjacent/Nearest Ranger District
Acoma Pueblo	1689	Community	1877	Quemado
Armendaris No. 33, Pedro	1819	Private	1860	Black Range
Armendaris No. 34, Pedro	1820	Private	1860	Black Range
Belen	1740	Community	1858	Quemado
Bosque del Apache	1845	Private	1860	Black Range
Brazito	1823	Private	1879	Black Range/ Silver City
Casa Colorado	1823	Community	1858	Quemado
Cubero	1833	Community	1897	Quemado
Dona Ana Bend Colony	1840	Community	1902	Black Range/ Silver City
J.M.S. Baca	1853	Private	1902	Black Range/ Silver City
Mesilla Civil Colony	1853	Community	1902	Black Range/ Silver City
Santo Tomas de Iturbide	1853	Community	1903	Black Range/ Silver City
Sevilleta Grant	1819	Community	1901	Quemado
Town of Socorro Grant	1815	Community	1895	Quemado/Black Range
Zuni Pueblo	1689	Community	1877	Quemado

After attempts to use missions to convert Native groups had failed, Spain began implementing a system whereby the military was used to secure amicable relations between Euro American and Native American groups who occupied the Plan Area. After 1786 the Spanish government offered Apaches goods in exchange for residing near presidios, termed “establieimientos de paz” (peace establishments), these administrative units would influence future relations between Apache groups and the shifting Nation-State administrations of the area (Griffen 1989:9). From 1786 through 1793, the Spanish government issued rations to peaceful Apache groups living within 10 miles of presidios. While none of these “peace establishments” existed in New Mexico, those present in the modern Mexican states of Sonora and Chihuahua serviced Apache groups who sometimes resided in the Plan Area. In 1794, the Spanish government began steadily decreasing funding for these rations. Despite the lessening rations, there was a period of relative stability and peace between the Spanish and Apache groups in the Northern Frontier until Mexican independence in 1821 (Griffen 1989).

Between ca. A.D. 1770-1790, the Chiricahua Apache occupied the Plan Area. This group belonged to the southern division of the Athabaskan linguistic stock and was divided into four bands: a southern group referred to as the Nednhis band, the Central Chiricahua band, a northern group known as the Bedonkohes band, and an eastern group referred to as the Chihenne band (Sweeney 1998). Each of these groups had a fairly well defined territory. The Nednhis band is sometimes referred to as the Janeros, Carrizalenos and/or the Pinery Apaches. These distinctions refer to geographic locations where these groups were known to frequent. The Janeros were frequently encountered around the presidio of Janos while the Carrizalenos were commonly encountered near the presidio of Carrizal, both in the modern Mexican state of Chihuahua (Sweeney 1998). However, the range of these groups extended north past the present-day international four-corners area (Arizona, New Mexico, Sonora, Chihuahua). The Central Chiricahua band was commonly encountered in southeastern Arizona, north to the Gila River, south to the northern portions of the modern Mexican states of Sonora and Chihuahua, and east into southwestern New Mexico (Sweeney 1998). The Bedonkohes inhabited areas around the Gila River north into the Mogollon Highlands. To the east, the Chihenne band inhabited the region encompassed by much of the Plan Area (Sweeney 1998). Like the Janero/Carrizaleno local group distinction for the Janero band, the Chihenne are sometimes referred to variously as the Mimbres, Copper Mines, Warm Springs, or Gila Apaches based on areas frequently inhabited by different local groups.

The leaders of the Janero band from roughly 1820 through 1860 were Juan Diego Compá, Juan José Compá, Coleto Amarillo, Láceres, Galindo, and Juh. During this same time period, the Carrizalenos were led by Jasquedegá, Cristóbal, Francisquillo, Cigaretto, Cojinillin, and Felipe. From 1800 through 1860 the leaders of the Central Chiricahua band were Pisago Cabezón, Matias, Tapilá, Yrigóllon, Esquinaline, Miguel Narbona, and Cochise. During this same time period, the Bedonkohes were led by Mahko, Mano Mocha, Teboca, and Phalios Palacio. Finally, the Chihenne band was led by Ojos Coloradas, Mangas Coloradas, Pluma, Cuchillo Negro, Itán, Ponce, Delgadito, and Victorio.

Many of these early band leaders inherited a general time of peace. From roughly 1780 through 1810, hostilities between the Spanish and the Apaches were minimal, though small raiding parties did attack Spanish settlements on occasion. Many of these conflicts erupted over the establishment of a mining settlement at Santa Rita del Cobre in 1803 (directly south of the Plan Area). By 1807, members of the Chihennes and Bedonkohes Apache began systematically attacking this settlement. The frequency of attacks on Santa Rita del Cobre and other Spanish settlements increased throughout the following years.

The Mexican Administration of the region began in 1821 when Mexico won its independence from Spain and assumed control over the colony of New Mexico. Located at the fringe of the newly organized nation, New Mexico was relegated a minor role in national politics. The change of government resulted in less official oversight of local politics and permitted a greater degree of religious and secular autonomy for Native American groups in New Mexico. The lack of oversight, however, also resulted in additional losses of Pueblo lands that were once protected by the Spanish Crown (Hudson 2011; Weber 1982).

Unlike their Spanish predecessors, the Mexican government did not initially provide rations to Apache groups living in the territory of New Mexico (Griffen 1989). From 1821 through 1830, the Mexican government sent little to the frontier. Busy dealing with expended treasuries and reorganizing a central government, the frontier settlements were essentially left to whither. With what little assistance came, some rations were able to trickle into Apache Rancherias near presidios. By 1830, rationing ceased, and by 1831 nearly “every Apache band formerly under Mexican influence had gone to war” (Sweeney 1998: 43). With no reason to remain settled around the Spanish presidios, Apache groups began dispersing into the surrounding mountain ranges. With the dissolution of amicable relations, Apache groups resumed their raiding of the invading European and Mexican settlers.

Throughout the early part of the nineteenth century, western expansion of the United States increased the level of American influence over the Southwestern region. Following disputes over the Unites States’ annexation of Texas, and the subsequent attack of Mexico on Texas settlements in disputed territory, the

United State declared war on Mexico on May 13, 1846. General Zachary Taylor was ordered to attack Mexico from Texas and Colonel Stephen Watts Kearny was charged with organizing an invasion force from Fort Leavenworth, Kansas. Kearny was ordered to occupy New Mexico, and then head west towards California. Kearny left Kansas with roughly 3,200 men spread out in three companies led by himself and Colonel Sterling Price.

On August 18, 1846, Kearny entered Santa Fe and garrisoned his troops; on September 25, 1846 he headed to California with 300 of his men. On April 6, 1846, Kearny's contingent crossed paths with Kit Carson near Socorro. Apparently Carson had encountered a group of Apache outside of Santa Rita del Cobre who were waiting for the American General who controlled the territory. Carson had conducted peaceful exchanges with this Chihenne group. Upon hearing this, Kearny enlisted Carson as a guide for his route to California and sent 200 of his men back to Santa Fe. On October 10, 1846, Kearny, Carson, and 100 soldiers made camp near Santa Rita del Cobre. Later that evening, Mangas Coloradas entered camp where he "pledged good faith and friendship to all Americans" (Sweeney 1998:143). Due to the years of nearly constant war between the Chiricahua Apache and the Mexican Government various Apache groups were willing to enter peaceful relations with the American Government if this meant aid against Mexico.

The American Administration of the region began in 1848 as a result of the United States' victory over Mexico during the Mexican-American War. As a result, the United States found itself with a new frontier in need of exploration to determine the nature and extent of the newly acquired resources. In efforts to inventory these resources, it quickly became apparent the area was inhabited by both Native American groups with a long history of occupation as well as more recent Spanish/Mexican groups. While some of these groups acclimated to the change in government, other groups made attempts to preserve their life-ways in the face of an "unknown and alien power" (Stewart 1993: 4).

As stipulated in the Treaty of Guadalupe Hidalgo, the "savage tribes" occupying the newly acquired territory were to become the responsibility of the United States Government. The treaty also stipulates that incursions of these savage tribes into Mexico "would be prejudicial in the extreme…and that such incursions shall be forcibly restrained by the Government of the United States…and that when they cannot be prevented, they shall be punished by said government…with equal diligence and energy, as if the same incursions were mediated or committed within its own territory, against its own citizens" (Thrapp 1967:7). While these demands were later rescinded in the Gadsden Treaty of 1854, the United States Government was still expected to keep Apache groups inhabiting the new territory from raiding Mexican settlements across the newly established international boundary.

It was from a series of ever expanding military posts that many campaigns were mounted against the Apache groups inhabiting the Plan Area. The time period come to be known as the Apache Wars (ca. A.D. 1849-1886) had its roots as the entrance of Spanish into the southwest and the increasingly urgent desire to protect native homelands from the invading onslaught of Euro-American settlers.

Military fortifications in New Mexico began with the construction of Fort Marcy near Santa Fe in 1846. This and other forts constructed in the area in the intervening years were used to hold and protect population centers, protect travel routes, and mount campaigns against hostile Native American groups. The first military presence near the Plan Area began shortly after the construction of Fort Marcy. In 1851 Fort Fillmore was constructed to protect the inhabitants of Mesilla (present day Las Cruces) and traders traveling to California. In the same year, the first Fort Webster was established in Santa Rita to protect the workers of the emerging mining town. In 1853, the garrison stationed at Fort Webster moved to the newly constructed Fort Thorn, located just north of Santa Barbara (modern day Hatch, New Mexico). By the 1860s, multiple forts had been established in southwestern New Mexico. In 1866, Fort Bayard was constructed to protect the mining operations and resident populations around Silver City and Pinos Altos.

In the same year, Fort Webster was reoccupied to protect the Santa Rita mines. Finally, Fort Tularosa was constructed in 1872 to administer an Apache reservation intended to house Warm Springs Apache groups.

In July of 1852, Mangas Coloradas met with Colonel Edwin Vose Sumner, the military commander of New Mexico, and John Greiner, the acting Superintendent of Indian Affairs in New Mexico, at Acoma Pueblo to go over the terms of a peace treaty. The treaty contained eleven articles which called for the Chihennes and Bedonkohes to recognize the United States and establish friendly relations between the two races, and to allow the United States to establish military and administrative units in their territory. Mangas Coloradas was the only Chiricahua Apache leader to sign the treaty, though the names of Ponce, Itán, Sergento, Dosientos, and José Nuevo were included on the treaty. In the following months many important Chiricahua Apache leaders inhabiting the Plan Area came into Fort Webster to formally express their interest in having peaceful relations with the American military. These compacts obligated the United States government to issue rations to peaceful Apache groups living in proximity to Fort Webster. In exchange, Apache groups were to begin practicing agriculture along the Mimbres River and were to be given a breeding stock to become pastoralists. These stipulations were never fully carried out by the Americans stationed in New Mexico despite the peaceful relations between the Apaches and Americans.

Because of the inability of the U.S. Government to follow through on its treaty obligations, tensions between American settlers and Apache groups inhabiting the Plan Area grew and culminated in various armed confrontations. On December 4th, 1860, a number of miners and settlers from Texas attacked an Apache Rancheria in the Mimbres Valley. The Battle of the Mimbres River, and the ensuing Bascom Affair, which led to the capture of members of Cochise's immediate family, led to multiple retaliations including battles at Cookes Canyon in August of 1861, in the Florida Mountains in August of 1861, in Pinos Altos in September of 1861, and at Apache Pass in July of 1862 (Sweeney 1998: 412-440). These and other armed confrontations established a precedent that would guide relations between Americans and Chiricahua Apaches until the latter were forcibly removed from the area.

In retaliation to these skirmishes, the United States Government established Fort West near Santa Lucia to more easily agitate the group of Gila Apache under the guidance of Mangas Coloradas. On January 17, 1863, Mangas Coloradas was lured into Pinos Altos where he was captured by the town militia. The Apache leader was later handed over to General Joseph Rodman West at Fort McLane which had been abandoned in 1861 and later burned to the ground by Apache raiders. Mangas Coloradas was murdered the following night by a group of soldiers ordered to guard the prisoner.

Upon the death of Mangas Coloradas, Delgadito assumed leadership responsibility for the Bedonkohe and Chihenne Apaches at Santa Lucia. His tenure as tribal leader was short lived and upon his death in 1864, Victorio became one of the most prominent leaders of the Santa Lucia local group of Apache.

By 1866, most Chiricahua Apache groups inhabiting the Plan Area had actively expressed interest in establishing peace with the United States though only if they were able to settle their native lands at Ojo Caliente/ Cañada Alamosa. Finally, in 1870, the U.S. Government began establishing a reservation for the Warm Springs Apache at Ojo Caliente and by the end of the year nearly 1,000 Apaches were present in the area (Thrapp 1974). However, as the Apache presence in the area increased, surrounding Anglo-American inhabitants became increasingly weary of having such a concentration of "hostile" Apaches nearby. Because of growing tensions, Chiricahua Apache groups began to abandon the informal Ojo Caliente reservation and retired to the safety of the surrounding mountains.

Another reservation was hastily established at Tularosa and Apache groups began the forced relocation in May of 1872. By June of 1872, roughly 400 Apaches were residing within the confines of the reservation (Thrapp 1974). However, by October of 1872, Apaches had begun filtering out of the reservation due to "sickness and death amongst children; the impurity of the water; coldness of the climate; (and) the crops failing from early frost" (Thrapp 1974: 148). By this time, the Chiricahua Apaches residing at Tularosa were growing weary. They had been promised that they would be allowed to return to Cañada Alamosa within a year. However, unbeknownst to the Apaches, plans had already been made to resettle Apaches further east.

By May of 1877, many of the Warm Springs Apache were forced to resettle at the San Carlos Reservation (Thrapp 1974) and by July of 1879 were again forced to the Mescalero Apache reservation at Fort Stanton. On April 21st, 1879, shortly after hearing he was wanted for theft and murder charges in Grant County, Victorio and the majority of the Warm Springs Apache groups at Fort Stanton fled the Mescalero Reservation (Thrapp 1974:218).

Victorio and his forces entered their first in a series of armed skirmishes with the U. S. Military on September 14th, 1879. Victorio led his group of Chiricahua Apache in a number of armed confrontations throughout the following year (Table 229). These culminated on October 15, 1880 with the battle at Tres Castillos, where Mexican forces led by Juaquine Terrazas ambushed Victorio's Apaches. When the conflict ended the following morning, 78 apaches had been killed, among them Victorio, and 68 Apaches had been taken prisoner (Thrapp 1974:303).

Table 229. Armed confrontations led by Victorio from September, 1879 through October, 1880.

Battle Name/Location	Military	Date
Massacre Canyon/New Mexico	United States	September 14, 1879
Cuchillo Negro Creek/New Mexico	United States	September 29, 1879
Guzman Mountain/Mexico	United States	October-November, 1879
Candelaria Mountain/Mexico	Mexico	November-December, 1879
Hembrillo Canyon/New Mexico	United States	April, 1880
Cooney's Mining Camp/New Mexico	United States	April 29, 1880
Palomas River/New Mexico	United States	May 23, 1880
Cookes Peak/New Mexico	United States	June 5, 1880
Tres Castillos/Mexico	Mexico	October 15, 1880

As Thrapp notes, the death of Victorio marked the last time Apaches were able to roam in such numbers as to "ravage" the country (Thrapp 1974:312). While opposition to the reservation system being implemented was always present, more Chiricahua Apaches began to accept the system. Future forays from notable Apache leaders such as Nana, Loco, Juh, and Geronimo were brief and generally entailed less than 30 warriors (Thrapp 1967). The last major armed confrontation between Chiricahua Apaches and the U.S. military took place in the spring of 1886. After the resulting surrender of Geronimo, many of the Chiricahua Apaches residing on reservations were gathered as prisoners of war and transported to military establishments in Florida. In 1914, the remaining Prisoners of War received allotments in Oklahoma (the Fort Sill Apache Tribe). To date, the Warm Springs Chiricahua Apache are one of the only Native American groups to never have a formal reservation established in the ancestral homeland (Thrapp 1967).

The Late Historic period

The Forest Service administration of the area began with the establishment of seven forest reserves and national forests between 1899 and 1909. The Big Burro National Forest was added to the Gila in 1908. Portions of the Datil National Forest were transferred to the Gila in 1931 and portions of the Crook National Forest were transferred to the Gila in 1953. The Gila National Forest also administers portions of the

Apache National Forest in New Mexico. Portions of the Apache National Forest in Arizona were combined administratively with the Sitgreaves National Forest in 1974 (see Chapter 17: Land for more details).

The initial establishment of Forest Service jurisdiction over the Plan Area likely had an impact on its use by traditional Spanish and Native American communities, with the greatest effect being the regulation of grazing. Many small operations were granted free use permits by the agency, but this practice was phased out after World War II with a strong negative impact on small operators (deBuys 1985; Raish and McSweeney 2008). The advent of industrial logging and mining in the Forest arguably had a greater impact on the Native American, Hispanic, and Anglo peoples who lived in the vicinity of the Plan Area.

The development of the logging and mining industries on the Gila National Forest were driven by the development of the transcontinental railroad system in the United States. The railroad reached Albuquerque in 1880, and the Santa Fe Railroad connected with the Southern Pacific Railroad at Needles in 1883, cutting the travel time to New Mexico from Chicago from three months to five days. Along the spine of this railroad connection was built a network of railroad lines throughout Arizona and New Mexico, and the commercial logging industry in New Mexico boomed (Baker et al. 1988).

In nearly every ranger district on the Forest, commercial logging endeavors took place. In certain instances, like logging activities near Pinos Altos, these endeavors were facilitated by the establishment of railroad spurs that transported harvested timber to mills located outside the Gila National Forest. In other instances, mule teams transported timber to mills constructed within the Forest. Milled lumber was then distributed via the emerging rail lines. Logging activities on the Wilderness Ranger District were severely hampered by the administrative establishment of the Gila Wilderness area in 1924. Similar acts of Congress (i.e. the Endangered Species Act of 1973), the removal of railroad spurs adjacent to the Plan Area, and the subsequent relocation of timber mills away from the Forest likewise dealt substantial blows to the logging industry in the Plan Area over the coming years.

As with the logging industry, the railroad facilitated mining in the vicinity of the Plan Area. The early part of the twentieth century saw copper, gold and silver mines in the mountains on the Black Range, Silver City, and Glenwood Ranger Districts. Many of these mining districts, particularly those surrounding the Silver City Ranger District, first began being exploited by Spanish miners and continue to produce substantial quantities of ore today.

The Great Depression was the worst economic disaster the United States has ever experienced and marked a turning point in American history. Young people entering the work force were most affected by the economic crisis. Jobs were not available for unskilled laborers and there were limited opportunities for people entering the job market to gain experience.

In 1933, President Roosevelt introduced the New Deal program to the American people. The New Deal was a combination of short-term strategies designed for immediate relief, and longer-term strategies designed to promote the economic recovery. It included banking practice reforms like the Federal Deposit Insurance Corporation (FDIC), the Farm Security Administration, and the Civilian Conservation Corps (CCC). Men in the New Deal programs operated under several Federal agencies, including the Soil Conservation Service and the National Park Service, but more than 50 percent of all the public works projects administered by the New Deal were undertaken by the Forest Service (Otis et al. 1986).

From 1933 through 1939 approximately 13 CCC camps and spike-camps were established within or near Plan Area (Table 230). Work conducted by enrollees at these camps included extensive watershed rehabilitation projects, construction of campgrounds, construction of telephone lines, construction of range improvements (e.g. cattle tanks, fences, etc.), and construction of roads.

Table 230. Civilian Conservation Corps camps established in the Plan Area.

Camp No.	Camp	Company No.	Date	Railroad	Post Office
DF-2-N	Tularosa	1849	7/12/1934	Silver City	Reserve
DPG-1-N	Silver City	1861	6/9/1934	Silver City	Silver City
F-11-N	Mimbres/Camp Sully	2841	4/29/1936	Silver City	Silver City
F-11-N	Mimbres/Camp Sully	3343	10/14/1939	Silver City	Mimbres
F-12-N	Redstone/Jack Fleming Camp	813	5/10/1933	Silver City	Pinos Altos
F-15-N	Little Walnut/Whitehill Camp	846	5/25/1933	Silver City	Silver City
F-1-N	Pueblo Park/Camp Beale	841	6/4/1933	Silver City	Reserve
F-24-N	Glenwood	3835	10/11/1939	Silver City	Glenwood
F-25-N	Glenwood	813	10/15/1934	Silver City	Glenwood
F-25-N	Glenwood	3836	10/11/1941	Silver City	Glenwood
F-25-N	Glenwood	3836	5/4/1936	Silver City	Glenwood
F-2-N	Apache Creek/Camp Chaffee/Tularosa	1818	6/30/1933	Silver City	Apache Creek
F-2-N	Apache Creek/Camp Chaffee/Tularosa	2358	11/1/1939	Socorro	Apache Creek
F-34-N	Beaverhead	835	5/1/1934	Silver City	Silver City
F-34-N	Beaverhead	886	5/18/1935	Silver City	Silver City
F-34-N	Beaverhead	3343	6/28/1940	Silver City	Mimbres
F-52-N	Willow Creek/Mogollon	3836	6/1/1938	Silver City	Glenwood
SCS-14-N	Little Walnut	2844	7/26/1935	Silver City	Silver City
SCS-15-N	Whitewater	2846	10/22/1936	Whitewater	Whitewater
SCS-18-N	Buckhorn	1851	8/9/1934	Silver City	Gila
SCS-18-N	Buckhorn	2845	7/22/1935	Silver City	buckhorn
SCS-20-N	Mangas	843	10/7/1934	Lordsburg	Red Rock
SCS-26-N	Silver City	2839	12/31/1939	Silver City	Silver City

Description of Cultural and Historic Resources including Heritage Assets Present in the Assessment Area

Cultural and historic resources can be divided into two, overlapping categories: archaeological resources; and characteristics of historic and cultural importance to traditional communities. Historic properties are defined under Section 110 of the National Historic Preservation Act (NHPA) [16 U.S.C. 470(a)(1)(A) and (B)] and NPS Bulletin 15 (National Register of Historic Places Staff 2002) as objects, structures, buildings, and sites, and districts of the four aforementioned property types, that are listed or eligible for listing to the National Register of Historic Places (NRHP), based on their importance to local, regional, or national history. Thus, the term "historic properties" represents a specific designation for archaeological resources that are eligible for listing in the NRHP. In accordance with the Region 3 Programmatic Agreement (USDA 2010), archaeological resources for which eligibility cannot be established ("undetermined" resources) are treated as if eligible to the NRHP. The treatment of "undetermined' resources as if they are eligible for inclusion in the NRHP is a general practice for all projects in the Plan Area. Also included in this discussion are resources that have been evaluated and found to be not eligible to the NRHP. Although not considered historic properties under U.S.C. 470(a)(1)(A) and NPS Bulletin 15, because of the information gathered as part of their NRHP evaluation can be valuable for the interpretation of historic occupation and use of Gila National Forest, resources determined to be not eligible for inclusion in the NRHP are also considered here. Traditional cultural properties (TCPs) are a subset of historic properties, and are discussed more in Chapter 18: Areas of Tribal Importance. Traditional cultural properties are historic properties that are in the main or in part eligible to the NRHP because of their "association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1998). The sources and descriptions of the data used to describe historic properties in this and the remaining sections of this assessment are found in the Planning Record.

The places and characteristics of the Plan Area that are of cultural and historic significance to the traditional communities in the vicinity of the Gila National Forest can include TCPs and other historic properties, but are not limited to them. More broadly, characteristics of cultural and historic importance are places within or qualities of the Plan Area that are important to maintaining the cultural and historic identity of traditional communities. These characteristics can be defined as historic properties, general areas corresponding to the distribution of physical attributes such as types of plants or geographic features, or non-place based characteristics such as solitude.

Information used to compile this assessment consisted of published sources, site and report records for the Gila National Forest, corporate geographic information system (GIS) and INFRA databases for the Gila National Forest, State of New Mexico GIS clearinghouse, and New Mexico Cultural Resources Information System (NMCRIS) database information relevant to the Gila National Forest. As directed by 36CFR 296(a)(2), interested parties who are knowledgeable about the cultural and historic resources and uses of the Forest, including American Indian tribes, traditional communities, scientific researchers, and professional and avocational organizations, were contacted to request information regarding the Plan Area. Letters were sent to interested parties in the winter and fall of 2015 and other activities (e.g. email correspondence and phone calls) were conducted to contact interested parties.

In the following discussions, the terms cultural resources and archaeological sites are somewhat used interchangeably. For the Gila National Forest, a cultural resource site is defined as "a locus of purposeful human activity which has resulted in a deposit of cultural material beyond one or a few accidentally lost artifacts." Cultural resources that qualify as sites should exhibit at least one of the following:

1) One or more features

2) One formal tool if associated with other cultural material, or more than one formal tool

OR

3) An occurrence of cultural material that contains one of the following:
   a. Three or more types of artifacts
   b. Two types of artifacts or materials in a density of at least 10 items per 100 square meters
   c. A single type of artifact or material in a density of at least 25 items per 100 square meters.

Likewise, usage of the term "historic property" is reserved for those heritage/cultural resources that have been determined to be eligible for inclusion, or those that are listed in the National Register of Historic Places (NRHP). Thus, historic properties represent a specific type of archaeological site with a specific determination of eligibility in relation to national guidelines.

Description of Archaeological Resources

On the Gila National Forest, the parameters for the description of archaeological resources are set by the extent of inventories conducted for the identification of those resources, which are typically termed cultural resources inventories or surveys. Such inventories have been conducted systematically since the early 1970s as part of the Section 106 (NHPA) process. Additional surveys have been conducted under Section 110 (NHPA), and by other entities for research purposes unrelated to forest management.

As of September of 2015, approximately 580,092 acres within the Plan Area or approximately 17.1 percent of its total area have been inventoried. Of this, approximately 399,421 acres or 11.8 percent of the total Forest are considered to have been inventoried to current standards. The term "current standards" reflects inventory endeavors what have been conducted by systematically walking a survey block with transect spacing no greater than 15 meters apart. As one can imagine, survey standards have changed through time. In most instances, those surveys not conducted to current standards implemented either a sampling strategy whereby the entire project area was not systematically inventoried or the transect interval implemented in the survey exceeded the 15 meter spacing required by the State of New Mexico for current inventories. Inventory has not been conducted evenly across the six districts, or within each district. Acres inventoried by district are listed in Table 231 and shown in Figure 204.

Because the vast majority of inventory conducted within the Plan Area has been conducted for Section 106 (NHPA) purposes, the amount of inventory reflected in Table 231 for each district is a consequence of the extent of land management activities conducted on each over the past four decades. An emphasis on timber harvesting and fire-adapted ecosystem restoration has meant that inventory has been concentrated in the ponderosa pine and mixed conifer vegetation zones on the Reserve and Quemado Ranger Districts. On the Wilderness Ranger District, a major portion of these forest types are in designated wilderness areas where timber harvesting and most ecosystem restoration activities are prohibited or limited in scope.

Table 231. Archaeological survey acres for each Ranger District.

District and Inventory Characteristic	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
District Size (Ac.)	557,572	603,382	525,448	686,171	613,118	406,766
Survey to Standard (Ac.)	27,256	136,435	56,423	18,839	108,222	52,243
Survey not to Standard (Ac.)	23,629	72,758	4,699	3,863	70,600	5,118
Total Survey (Ac.)	50,886	209,194	61,123	22,702	178,823	57,361
Percent Inventoried	9.13	34.67	11.63	3.31	29.17	14.10

While the spatial distribution of inventories has biased our understanding of the location of archaeological sites within the Plan Area, there is enough information to describe the nature, cultural affiliation, and distribution of archaeological resources in its holdings. As of September of 2015, a total of 6,168 archaeological sites have been recorded on the Gila National Forest. As most of the inventories conducted have been carried out for management purposes, almost all of the archaeological sites recorded were located by these inventories. The distribution of archaeological sites and their densities are listed in Table 232 and their locations are displayed in Figure 205.

Table 232. Number of archaeological sites and their density on each Ranger District

Ranger District	Number	Density/100 Acres Surveyed	Density/Mile^2 Surveyed
Black Range	338	0.66	4.25
Quemado	1,685	0.81	5.16
Glenwood	811	1.33	8.49
Wilderness	922	4.06	25.99
Reserve	1,344	0.75	4.81
Silver City	1,068	1.86	11.92

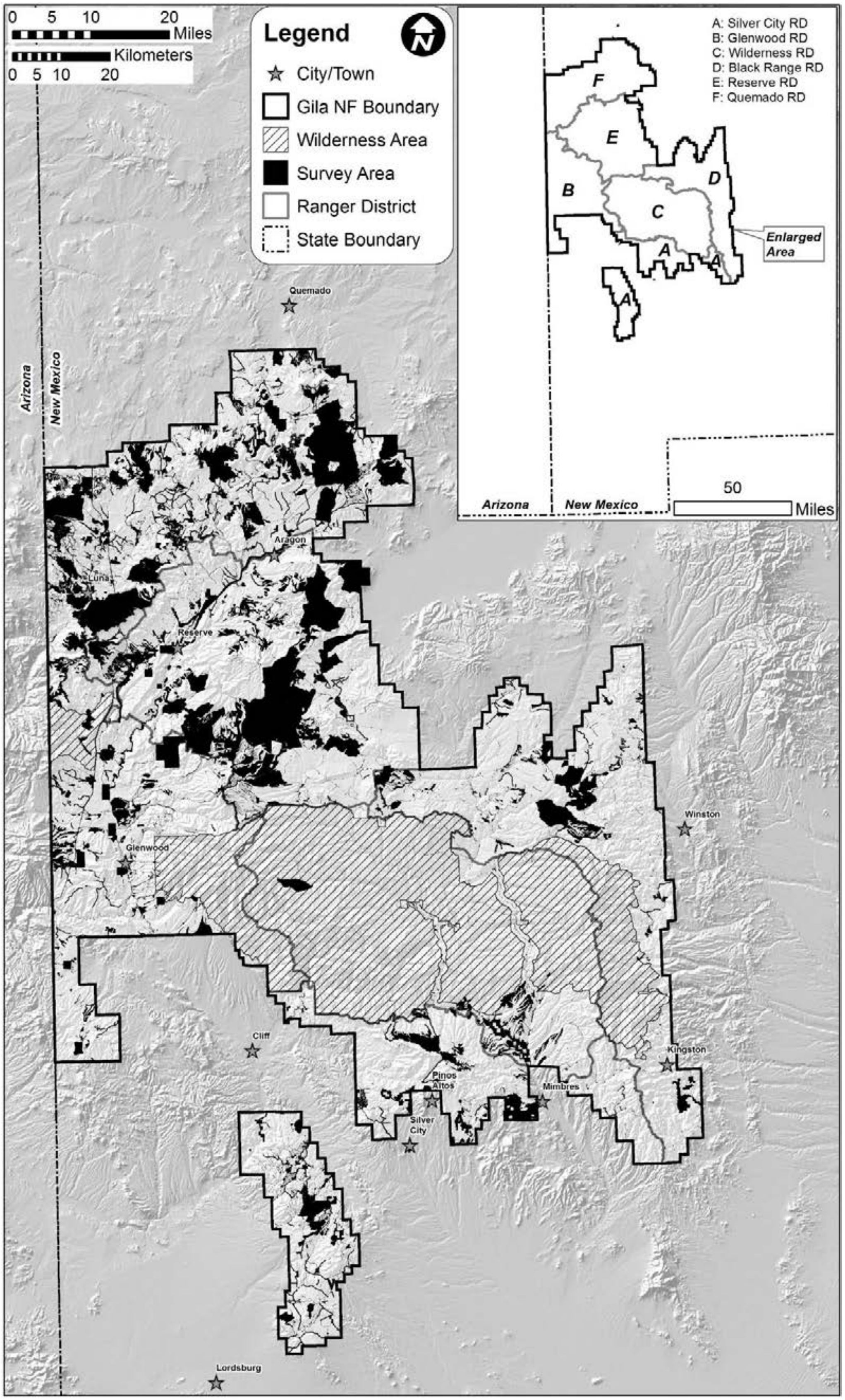

Figure 204. Depiction of areas where archaeological survey has been conducted in the Plan Area

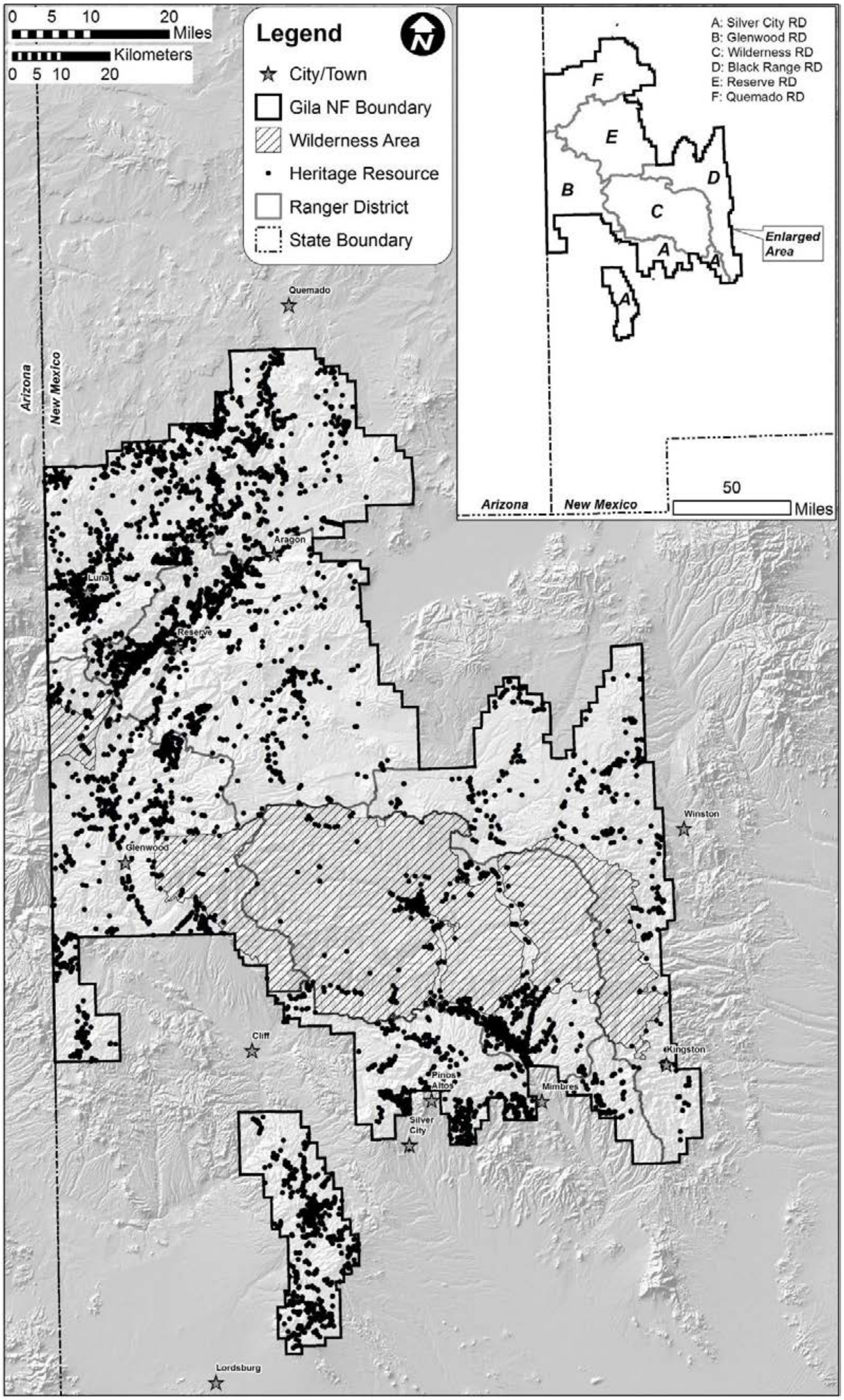

Figure 205. Location of known archaeological sites present within the Gila National Forest.

In the following sections attempts are made to describe the distribution of archaeological sites in relation to characteristics of the natural landscape. The characteristics chosen for analysis include the elevation of the landform upon which a site located, the major vegetation community surrounding a site, the gradient of the landform the site is located on, the distance to the nearest water source from a site, the agricultural potential of the landform upon which the site is situated, and the physical description of the landmass the site is located on. These variables were chosen for analysis because they influence the types of activities possible by site inhabitants. For instance, elevation affects what types of natural resources are available in an area (e.g. elk, deer, piñon nuts, etc.) and also affects agricultural pursuits as the length of the frost-free-period decreases as elevation increases. The variables used in this analysis were likely similarly considered when prehistoric and historic peoples undertook activities responsible for the site formation process.

Roughly 95 percent of the archaeological resources on the Forest are found at elevations below 8,000 feet above mean sea level (Table 233). Some of this pattern can be explained by the fact that approximately 80 percent of the terrain in the Plan Area falls at or below 8,000 feet in elevation and that statistically less high elevation territory has been inventoried. However, sampling doesn't fully account for the lower site count at higher elevations; this is particularly evident on the Glenwood, Wilderness, and Silver City Ranger Districts, where site densities drop sharply even in areas where inventory has been conducted at high elevations (>8,000 ft). The Reserve and Quemado Ranger Districts are an exception to this pattern. Roughly 10 percent of the sites on the Quemado District are located in areas above 8,000 feet, and nearly five percent of sites on the Reserve District are located in higher elevations (>8,000 feet). This is in part because these districts have a considerable portion of their holdings in these high elevation areas (Reserve ca. 28% and Quemado ca. 36%). However, this is also a reflection of past land use strategies. Many of the high elevation sites on these districts are a result of logging activities in the area as well as high elevation hunting areas of unknown socio-temporal affiliation. From an archaeological standpoint, it appears that prehistoric use was focused on lower elevation areas. This is potentially a result of subsistence practices associated with the prehistoric occupation of the Plan Area. For many of the prehistoric resources on the Forest, agricultural products are believed to have contributed to groups' subsistence economies. Inhabiting lower elevation areas increases the growing season for certain crops and allows for a greater number of frost-free days for plant growth.

Table 233. Number of archaeological sites located in specified elevation bands on each Ranger District.

Elevation	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
4,000 - 5,000			52	13		30
5,000 - 6,000	12	12	322	127	130	232
6,000 - 7,000	122	102	372	658	807	704
7,000 - 8,000	194	1402	52	121	349	100
8,000 - 9,000	8	162	7		56	1
9,000 - 10,000	1	7	5	1	2	1
>10,000	1		1	2		

The distribution of archaeological sites relative to the major vegetation and ecological communities aligns closely with their distribution across the Forest (Table 234). The three most common vegetation communities associated with archaeological sites are ponderosa pine woodland, juniper woodland, and piñon-juniper woodland in order of occurrence. These vegetation communities are also the most prevalent types of vegetation across the Forest. Most of the cultural resources in the Plan Area are found within the ponderosa pine woodland biotic province. The high proportion of archaeological sites in this vegetation community is in all likelihood the result of a sampling bias, in that the majority of projects within the Plan Area were conducted in ponderosa pine woodland areas for logging activities and fuels reduction projects.

Table 234. Number of archaeological sites located in specified vegetation zone on each Ranger District.

Vegetation Zone *	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
Madrean Encinal				4		126
Piñon-Juniper Woodland	30	29	335	190	313	200
Pine-Oak Forest and Woodland		1	58	4	7	62
Aspen Forest and Woodland	1	1	4	2	2	1
Spruce-Fir Forest and Woodland		2	1	4		
Mixed Conifer Forest and Woodland	3	6	7	1	3	2
Ponderosa Pine Woodland	145	1,169	197	408	522	446
Juniper Savanna		21			1	
Juniper Woodland	127	339	77	272	457	110
Riparian Woodland and Shrubland	1		2		3	2
Subalpine Grassland		4		1	1	
Mogollon Chaparral	3	2	23	16	1	40
Mesquite Upland Shrub			31			14
Grassland and Steppe	3		55	1	10	29
Juniper Savanna			1	2		2
Semi-Desert Grassland	14	30		11	13	5
Semi-Desert Shrub Steppe	5	56	1		7	
Cliff, Canyon, and Massive Bedrock	2	1	13	4	1	6
Other	4	24	6	2	3	23

In order to ascertain if other characteristics of the physical environment influenced the location of archaeological resources on the Gila National Forest, a number of additional analyses were conducted that measured the distribution of archaeological sites in relation to the slope of the landform upon which the resources reside, the distance to the nearest water source, the agricultural potential of the land upon which the resource is located, and the landform classification of the area where the archaeological resource is located.

With respect to the gradient of the land mass upon which the archaeological site is located, most resources are generally located on relatively gently sloping landforms (Table 235). Roughly two-thirds of all archaeological sites located in the Gila National Forest are on landforms with less than a ten degree gradient. From a cultural standpoint, the high frequency of sites on relatively level landforms is to be expected given that such conditions are conducive to human behavior (e.g. sleeping, cooking, processing resources, etc.). Be this as it may, landforms with a 0-10 degree gradient compose, on average, roughly 38 percent of each Ranger District's holdings (Table 236). Conversely, landforms with a 10-40 degree gradient compose approximately 60 percent of each Ranger District's holdings (Table 236). The proportion of archaeological resources located on landforms with steeper gradients decreases exponentially across the entire Plan Area.

Table 235. Number of known archaeological sites within each district that are located on landforms with the specified gradient.

Slope (degrees)	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
0 -5	115	823	344	310	628	473
5 -10	94	529	213	262	400	340
10 -20	79	266	137	238	201	200
20 -30	30	58	61	62	74	43
30 - 40	15	7	32	28	32	6
40 - 50	3	1	13	19	7	5
>50	2	1	11	3	2	1

Table 236. Proportion of each Ranger District's holdings with landforms of the specified gradient.

Slope Interval (Degrees)	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
0-5	18%	37%	14%	11%	25%	14%
5-10	18%	22%	15%	14%	21%	20%
10-20	28%	26%	28%	29%	32%	33%
20-30	23%	12%	25%	27%	17%	23%
30-40	11%	3%	15%	14%	4%	8%
40-50	2%	<1%	3%	4%	<1%	1%
>50	<1%	<1%	<1%	<1%	<1%	<1%

The distribution of archaeological sites in relation to their proximity to water is fairly predictable and is inversely correlated. Thus, more archaeological sites are located closer to water resources than further from these resources (Table 237). Nearly 43 percent of the archaeological sites on the Forest are located less than 100 meters from a stream channel. Nearly 92 percent of all archaeological resources are located less than 400 meters from a stream channel. While the data present in Table 237 depict some sites in excess of 600 meters from a stream, this is likely a result of the spatial data used in the analysis. High resolution stream data was pulled from the Gila National Forest's geospatial database. In some instances the streams extended beyond the jurisdictional boundary for the Forest. In other instances, streams present outside of the Gila National Forest were not included. Thus, there is a possibility that streams located outside of the Gila National Forest boundary were closer than the 600+ meter distance depicted in Table 237 but were not captured due to data limitations. The majority of archaeological sites in excess of 600 meters from a stream are generally located along the boundary of the Plan Area.

Table 237. Number of known archaeological sites on each Ranger District that are located within the specified distance to a stream.

Distance to Stream (Meters)	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
0 - 100	203	635	369	434	621	421
100 - 200	63	447	233	295	322	271
200 - 300	42	273	96	121	195	176
300 - 400	14	144	52	38	110	99
400 - 500	11	88	17	24	59	52
500 - 600	5	47	18	6	25	18
>600		51	26	4	12	31

As one can imagine, if agriculture was an important part of a group's subsistence base, then the availability of agricultural land would greatly affect the settlement pattern of that group. For much of the Plan Area's occupation, both in prehistoric and historic times, groups practiced agriculture. Numerous models have been developed to investigate the suitability of lands around the Gila National Forest for agricultural practices (Pool 2002; Pyne 2004; Schoolmeyer 2009; Toney 2012). These models have generally shown that much of the Plan Area was potentially arable despite modern and historic land use practices. Generally, the models demonstrate a strong correlation between those areas most suitable for agriculture and archaeological site location. A similar study was conducted for the Forest to investigate if historic property location had a similar pattern.

The agricultural potential of an area was investigated based primarily on soil characteristics, namely soil permeability, and a series of hydrological parameters (i.e. precipitation and runoff catchment areas)(see Schollmeyer 2009 and Toney 2012 for a discussion of methodology). These data were compiled from the State Survey Geographic databases available through the Natural Resource Conservation Service and Gila National Forest corporate data. The results of these analyses divided the Gila National Forest into three regions differentiated by their agricultural potential. The distribution of archaeological sites within the Plan Area in relation to the agricultural potential of the land upon which they reside is presented Table 238.

Table 238. Number of known archaeological sites within each Ranger District located on lands with different degrees of agricultural potential.

	AGRICULTURAL POTENTIAL		
Ranger District	Non-Productive	Marginal	Productive
BLACK RANGE	223	114	1
QUEMADO	1,115	510	60
GLENWOOD	526	285	
WILDERNESS	651	216	55
RESERVE	841	455	48
SILVER CITY	777	285	6

Generally, the majority of archaeological sites on the Forest are located in areas whose agricultural potential is severely limited. Approximately 67 percent of all known cultural resources are located on land which was determined to be non-productive agriculturally. This is to somewhat be expected given the fact that people practicing agriculture would likely build their habitation in areas adjacent to the most productive lands, but not on the lands themselves. This would maximize the amount of prime agricultural land that could be brought into production. This also explains the relative lack of archeological resources in areas that are agriculturally productive. It is of interest to note that few archaeological sites within the Plan Area have been interpreted as representing the remains of agricultural fields. This is likely due to multitude of reasons but historic and modern land use practices are likely responsible for their lack of recognition. In most cases, those areas most conducive to agriculture were occupied for long periods of time. Thus, modern land use practices in areas with relatively dense modern populations have potentially altered the prehistoric features once present in an area.

Only around three percent of the cultural resources in the Plan Area are located on agriculturally productive lands. It should be noted that the majority of resources located on agriculturally productive lands on the Quemado and Reserve Ranger Districts are rock art sites located along the bluffs overlooking drainages. The high proportion of archaeological sites on agriculturally productive land in the Wilderness District are located in an area that has a long history of dense occupation. The majority of these resources are located along the Mimbres River and Sapillo Creek drainages. While the model demonstrates that sites in these areas are shown to reside on agriculturally productive lands, this may not be the case. Sites in these areas area normally located on higher elevation landforms overlooking the agriculturally productive floodplains below. The resolution of the data used in the analysis (30 meter grids) may not have been sufficient to capture the subtle variations in topography located in these areas. Finally, one third of the known archaeological sites reside on lands which were determined to be marginally productive agriculturally. These sites likely represent attempts to bring marginal land into agricultural production or represent other resource procurement locales.

The last variable measured for the current analysis was a classification of the landform upon which a historic property was located. The historic property records for both the State and the Gila National Forest require that an assessment be made of the landform upon which a property is located. While these data were available for use, they are often inconsistent between individuals recording the information. To alleviate this ambiguity, landforms were classified using the methodology outlined by Weiss (2001). This landform classification model differentiates ten landform types based on their slope and topographic position.

The distribution of archaeological sites in relation to the landform upon which they reside is presented in Table 239. These data demonstrate that roughly 46 percent of the sites in the Plan Area are located on Mountain Tops/High Ridges and in Canyons/Deeply Incised Streams. These two landform classes also constitute a high proportion of the study area (15 and 13 percent respectively). Thus, the high proportion of archaeological sites in these landform areas is to be expected. Upland Drainages/Headwaters is the most prevalent landform class within the Plan Area (ca. 32 percent). However, only two percent of the archaeological resources on the Forest are located in these landforms. This is likely because these areas are generally located above 8,000 feet in elevation and on relatively steep terrain (>20 degree gradient).

Similarly, both U-Shaped Valleys and Local Ridges/Hills in Valleys were shown to contain a high proportion of sites (ca. 25 and 10 percent respectively). However, these two landform classes compose a small proportion of the overall Plan Area (ca. seven and five percent respectively). These results suggest that these two landform classes are good predictors of site location. These areas usually consist of the relatively gently sloping terrain (<10 degree gradient) and ridges surrounding broad drainage valleys and their associated flood plains. This observation would support the contention that sites were often located adjacent to the most agriculturally productive lands, rather than immediately on them, maximizing the amount of suitable land that could be brought into production.

Table 239. Number of known archaeological sites on each district located on specified landforms.

Landform Classification	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
Mountain Tops, High Ridges	57	337	155	254	233	263
Canyons, Deeply Incised Streams	130	392	223	239	326	246
Midslope Drainages, Shallow Valleys	1	17	2	2	4	2
Upland Drainages, Headwaters	7	43	15	20	30	18
U-Shaped Valleys	80	502	175	190	367	218
Plains	6	48	33	19	76	30
Open Slopes	1	15	6	4	18	9
Upper Slopes, Mesas	14	154	96	51	148	114
Local Ridges, Hills in Valleys	37	139	89	126	107	132
Midslope Ridges, Small Hills in Valleys	3	22	13	15	35	18
Unknown	2	16	4	2		18

Archaeological sites in the Plan Area are traditionally separated into those with a Native American affiliation that predates A.D. 1600 and those with an increasing diversity of cultural affiliation that date to after A.D. 1600 (Table 240). These data demonstrate that the majority of cultural resources on the Gila National Forest are of Native American affiliation that predate A.D. 1600. Roughly 80 percent of archaeological sites are of prehistoric Native American affiliation. Only 13 percent of sites on the Forest represent a post-A.D. 1600 occupation. Finally, roughly three percent of cultural resources represent a combination of these two broad occupational categories.

Table 240. Number of known archaeological sites within each district dating to the specified time period where features are either present or absent.

	HISTORIC		MULTIPLE		PREHISTORIC		UNKNOWN		
Ranger District	Feature Present	Feature Absent	Feature Present	Feature Absent	Feature Present	Feature Absent	Feature Present	Feature Absent	No Data
BLACK RANGE	13	94	3	22	141	52	3		10
QUEMADO	33	122	9	43	324	1109	8	16	21
GLENWOOD	24	114	6	10	237	372	9	4	35
WILDERNESS	14	46		4	215	592		2	49
RESERVE	42	108	3	20	252	894	1	1	23
SILVER CITY	22	187	8	44	224	548		4	31

While there are archaeological sites in the Plan Area that date to all periods of human occupation, there are portions of the Forest with clusters of resources that correspond to specific time periods and/or with specific ethnic affiliations [i.e. resources dating to the Pueblo Era (ca. 1,000 to 600 years ago)] (Table 241). In some cases, these clusters of sites are evenly distributed across the Forest, while others are concentrated on specific districts. Based on current data, roughly 84 percent of the archaeological sites within the Gila National Forest are associated with its prehistoric occupation. Archaeological resources associated with the historic occupation of the area (ca. 400 to 50 years ago) comprise roughly 16 percent of the known resources in the Plan Area. The vast majority of these prehistoric sites are classified as containing either an Archaic era occupation or a Pueblo era occupation. Archaic era sites constitute roughly 14 percent of all known prehistoric resources in the Plan Area and Pueblo Era sites constitute approximately 58 percent of all known prehistoric resources. For Historic era resources, those postdating A.D. 1912, or around the time of New Mexico’s statehood, are the most common on the Gila National Forest. Archaeological sites dating to this time period compose roughly 79 percent of known Historic era resources on the Gila National Forest.

Table 241. Number of archaeological site within each Ranger District that date to the specified time period.

Time Period	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
Recent	10	16	5	2	13	13
Statehood to WWII	17	70	21	6	24	41
Statehood to WWII – Recent	18	52	39	11	81	54
U.S. Territorial – Recent	39	16	36	9	6	18
U.S. Territorial – WWII	16	12	21	8	16	90
U.S. Territorial	12	18	18	14	12	25
Spanish/Mexican – WWII			1		1	1
Spanish/Mexican - U.S. Territorial						1
Historic Unspecified	20	23	13	14	20	18
Late Pueblo		96	2	1	41	5
Early Pueblo – Late Pueblo	7	352	60	86	246	37
Early Pueblo	8	497	206	255	317	350
Late Pithouse – Late Pueblo		46	3	29	25	12
Late Pithouse – Early Pueblo	2	39	19	41	29	65
Late Pithouse	14	53	12	36	55	36
Early Pithouse – Late Pueblo	1	23	4	2	9	5
Early Pithouse – Early Pueblo		7	6	7	10	13
Early Pithouse – Late Pithouse	4	25	8	16	27	18
Early Pithouse	3	3	9	27	22	15
Late Archaic – Early Pueblo		4	9		6	6
Late Archaic – Late Pithouse		2	5		6	12
Late Archaic – Early Pithouse	3	1		1	2	4
Late Archaic	70	112	89	61	108	116
Middle Archaic – Late Archaic	2	5	1	1	5	
Middle Archaic		3	3		3	
Early Archaic – Late Archaic	1	2	1		4	
Early Archaic – Middle Archaic	1					
Early Archaic		2			1	
Archaic Unspecified	13	16	15	1	11	3
Paleoindian			1		1	
Prehistoric Unspecified	33	197	172	247	238	127

There are few Native American resources on the Forest that date to after A.D. 1600. The exceptions to this are a number of known Apache battlefield locales on the Black Range and Wilderness districts that date to time of the Apache Wars (ca. A.D. 1849-1886). To date, investigations have been conducted along Las Animas Creek searching for the location of the Massacre Canyon battlefield that took place in September of 1879, along the Palomas River where Victorio's forces were ambushed in May of 1880, along Sapillo Creek where Apache forces under the leadership of Geronimo were attacked by Apache Scouts in May of 1885, and a 17th century Apache Rancheria along the East Fork of the Mimbres River.

Similarly, there are a few locales where culturally scarred trees are present. These resources are generally located in higher elevation areas and likely represent the collecting of inner cambium tissues by Native American populations during times of extreme socio-economic stress. Two known clusters of these peeled trees are known in the Plan Area. One is located in the Wilderness district and the other is located in the Reserve district. The scars on the peeled trees in the Wilderness Ranger District have been dated by dendrochronology to around A.D. 1865 (Swetnam 1984) and the peeled trees on the Reserve Ranger District were dated by similar means to around A.D. 1890. Both sets of peeled trees are believed to represent the utilization of this inner bark by Native groups as an emergency food source or for medicinal purposes.

There are a few locales that contain traditional historic Native American architecture. These resources generally consist of the remains of wikiups or sweat lodges. These remains are usually composed of a number of sticks/logs arranged as spokes radiating from a center point. The remains of these structures are conical in shape and enclose a circular space of roughly four square meters. Few artifacts are associated with these structures. Some Native American rock art has also been identified as probably dating to post A.D. 1600. Finally, there are a number of resources that are likely misclassified as other socio-cultural phenomena that could date to historic times. For instance, a number of resources that consist solely of lithic artifact scatters were classified as dating to the Late Archaic period. These sites could easily represent areas utilized by historic Native American inhabitants as opposed to the Late Archaic period inhabitants of the Plan Area. However, no further diagnostic artifacts were encountered at these sites.

Archaeological sites with a Euro-American affiliation account for roughly 16 percent of all known resources on the Forest. Sites dating to this period range from simple artifact scatters associated with a range of activities (e.g. logging camps, mining camps, etc.), to artifact scatters and associated simple features (e.g. sawmills, mines, camp sites, etc.), to single log cabins associated with homesteading, to large residential communities associated with mining. Roughly 18 percent of known Historic era sites in the Plan Area are composed simply of artifact scatters (often representing trash dumps). The remaining 82 percent of known Historic era sites contain features (e.g. habitation structures, mine adits, windmills, etc.). These resources are fairly evenly distributed across districts with each district containing, on average, roughly 17 percent of all known Historic era sites.

Resources associated with Governmental functions are located across the Gila National Forest. These usually are associated with either the C.C.C. or with Forest Service activities. Resources associated with the Civilian Conservation Corps range from the remnants of old camps, to simple erosion control features, to numerous features associated with roads constructed by the C.C.C. Archaeological resources associated with Forest Service activities range from the remnants of old Ranger stations to fire lookout towers still used to manage Forest Service holdings.

There remain significant data gaps concerning the nature and distribution of archaeological sites in the Plan Area. As mentioned previously, a fair number of lithic scatters were classified as Late Archaic period resources. It is likely that these and similar sites were occupied for a vast span of the prehistoric era but lack other attributes that are diagnostic. These coupled with the resources whose socio-temporal affiliation is unknown demonstrate that roughly 11 percent of the archaeological sites on the Forest have no known socio-temporal affiliation. Additional research at these sites, including archaeological excavations and radiometric dating of surface remains, could shed additional light on these site types.

There are many portions of the Gila National Forest that have seen little inventory for archaeological resources, but where the likelihood of there being numerous and important cultural resources is high. Based on the data presented earlier concerning the distribution of known archaeological sites in relation to different physical characteristics of the surrounding landscape (e.g. elevation, slope, distance from water, landform classification, land productivity, etc.), it is possible to determine the different arrangement of these natural phenomena where archaeological resources are known to be present. These data can then be used to determine where similar physical characteristics are present in the natural landscape. This provides a proxy measure for where sites have a high probability of being located. Based on analyses using this line of evidence, there are portions of the Plan Area that were deemed to be similar to where known archaeological sites are located which have not been adequately inventoried.

The initial analyses conducted at the Forest level discussed above were heavily biased towards the arrangement of physical characteristic present on the northern Ranger Districts (i.e. Reserve and Quemado). For instance, if the model were to be conducted at the Forest level, the analysis would be biased towards higher elevations (>6,000 ft amsl) based on the high proportion of sites located in these environs on the Reserve and Quemado Ranger Districts. If this model was extrapolated to each district, large portions of the Silver City and Glenwood Ranger Districts would be shown to have a low probability of containing archaeological sites because they are below the 6,000 foot threshold established by the Forest wide model. To alleviate the potential for sampling biases, each Ranger District was analyzed separately.

The results of these analyses demonstrated that certain environs were favored for archaeological site location within each Ranger District though some environs were common between districts (Table 242, Figure 206). For instance, roughly four percent of archaeological sites on the Quemado, Glenwood, Reserve, and Silver City Ranger Districts were located on marginally productive lands at 7,000 to 8,000 feet in elevation on mesas with a 0 to 5 degree slope that were 300 to 400 meters from a stream. Landforms with a similar combination of characteristics (and others) were chosen as high probability regions for these districts. While resources were found in similar areas on the Black Range and Wilderness Ranger Districts, the proportion of resources located in these areas differed from those present on the Quemado, Glenwood, Reserve, and Silver City Ranger Districts. Additional results and the methodology employed in these analyses are presented in a supporting document to the assessment report.

There are also several important types of resources that have been under-recorded across the Forest (e.g. historic artifact scatters post-dating 1945, high elevation shrine locations, logging roads, etc.) either due to a lack of inventory in the areas where they are likely to occur, or due to the past research biases of individuals conducting the inventory.

There has been no systematic attempt to inventory traditional cultural properties (TCPs) across the Gila National Forest. There are many previously recorded and unrecorded archaeological sites within the Plan Area that may be eligible to the National Register of Historic Places (NRHP) as TCPs. Property types that are potential TCPs may include, but are not limited to: village sites, shrines, rockshelters, caves, rock art sites, springs, mountains and mountain top localities, geological formations, quarries, plant collection areas, trails, and irrigation works (i.e. acequias).

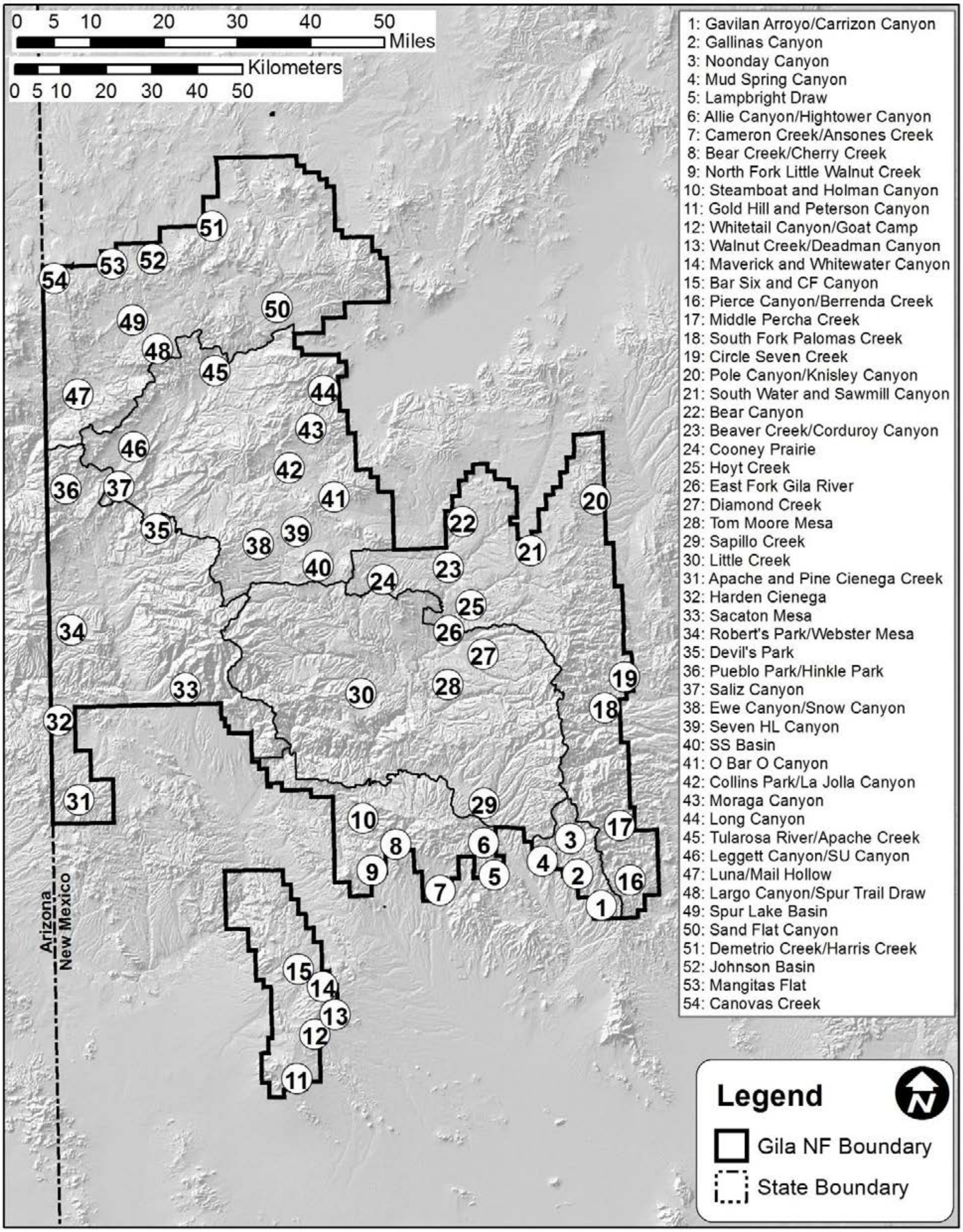

Figure 206. Location of some areas determined to have a high probability of site location.

Table 242. Distribution of areas deemed to contain a high probability of site location across Ranger Districts and the amount of these high probability areas covered by archaeological survey activities.

Ranger District	District Size (ac)	High Prob. Acreage	High Prob. Survey Acres
Black Range	557,572	125,807	8,904
Quemado	603,382	155,437	42,442
Glenwood	525,448	69,591	8,911
Wilderness	686,171	92,866	5,095
Reserve	613,118	104,427	28,398
Silver City	406,766	67,452	7,813

Characteristics of Cultural and Historic Resources

The Gila National Forest contains characteristics that are of cultural and historic importance to both Native American and Euro-American peoples. Those characteristics of the Forest that are of cultural and historic importance to Native Americans are described in the assessment for Areas of Tribal Importance.

Inventory for characteristics of importance to non-Native traditional communities has been limited within the Plan Area. This is in part due to the fact that use of the Forest by non-Native traditional communities was likely limited to sheep ranching activities associated with early Spanish/Mexican settlements to the north and east along the Rio Grande. A number of archaeological sites relating to use of the Forest by Spanish/Mexican sheep herders are present on the Quemado District and likely relate to sheep herders bringing their flocks into the Mogollon Highlands for seasonal forage. It is likely that members of these non-Native traditional communities valued, and were concerned for, many of the characteristics in the Plan Area which modern community members using the Forest value. The most common resources cited by community members were water and forage for wildlife and livestock, wild game for food, solitude, wilderness values, scenery, and visual and physical access to the Plan Area.

Current Conditions of Known Cultural and Historic Resources, and Trends Affecting their Condition and Use

The current condition of cultural and historic resources can be characterized by examining the numbers of archaeological sites that have been placed or have been determined eligible for inclusion in the NRHP and by examining data and other information on impacts to historic properties and other archaeological resources. If a historic property is listed or is eligible for inclusion in the NRHP, this reflects that it retains the integrity of the characteristics that make it significant to American history, and thus implies that the property has not been so severely impacted by disturbances to affect its ability to contribute to either the national patrimony or affect its value to researchers. Other archaeological resources may be found not to be eligible for inclusion in the NRHP because they area in poor condition, but such a determination may also be made because the property has no intrinsic significant historic value.

Eligibility of Archaeological Resources to the National Register of Historic Places

There are eight historic properties that are listed on the National Register of Historic Places (NRHP) in the Plan Area (Figure 207, Table 243). In order for a property to be listed on the NRHP, the resource must be formally nominated through completion of official nomination forms. The completed nomination forms are then reviewed by the State Historic Preservation Office, Federal Preservation Officer, and Keeper of the Register (NPS).

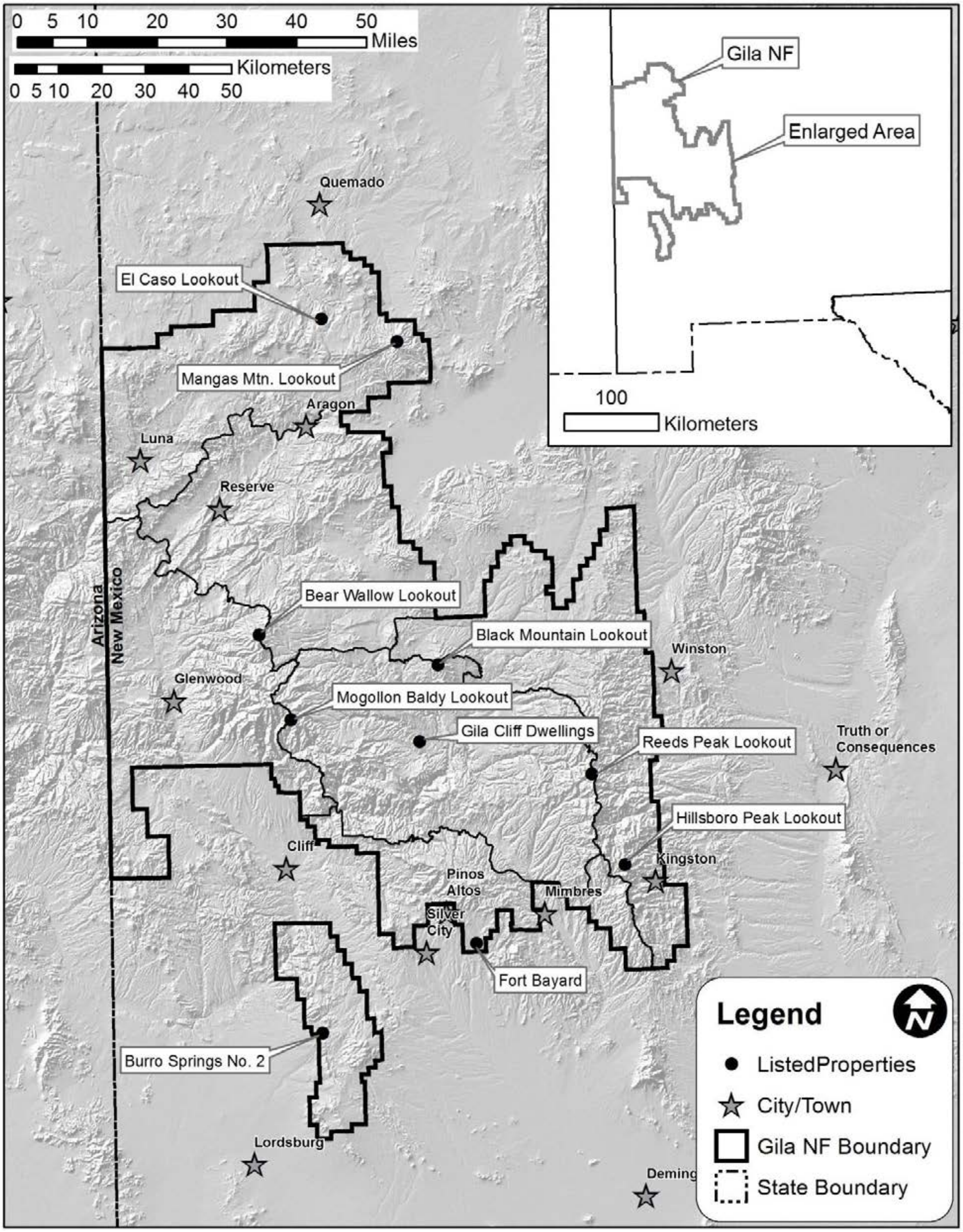

Figure 207. Location of archaeological sites within the Plan Area that are listed in the NRHP.

Table 243. Number of archaeological sites on each district with the specified determination of eligibility for inclusion in the National Register of Historic Places.

Determination of Eligibility	Black Range	Quemado	Glenwood	Wilderness	Reserve	Silver City
Designated/Listed	1	2	1	3		1
Eligible	79	454	232	320	425	506
Undetermined	222	1,103	471	569	855	439
Not Eligible	28	117	107	22	62	114
Total Evaluated	330	1,676	811	915	1,342	1,061
No Data	8	9		7	2	7
Total	338	1,685	811	922	1,344	1,068

For the Forest Service, formal listing in the NRHP does not affect how the property is managed and all archaeological sites determined to be eligible for inclusion in the NRHP and those resources whose eligibility for inclusion in the NRHP is undetermined are treated as if they are listed. The main difference is that the formal nomination and review process for these resources has not been conducted. Because formal listing does not affect how the Forest Service manages eligible and undetermined resources, many archaeologists simply do not have the time to complete the necessary nomination forms. Likewise, if projects are reliant on consultation before implementation, the additional time needed for completion of the nomination forms as well as the following review process would push implementation dates for projects back to upwards of three months (and often for over a year). For many Forest Service programs, this additional time needed for consultation prior to project implementation would be unacceptable, especially in emergency situations or when funding cycles necessitate quick turnaround times for consultation.

The vast majority of archaeological sites listed on the NRHP (n=7) represent the historic fire lookout complexes located throughout the Plan Area. There is a single prehistoric archaeological site, Burro Springs No. 2, listed on the NRHP. Burro Springs No. 2 represents the remains of a large Pithouse period site containing in excess of 200 pitstructures. The site covers a minimum of 15 acres and aside from numerous pithouse depressions, tens of thousands of artifacts are present on site. Based on the limited testing of the site, Fitting (1973b) postulated that the site likely dated to the San Francisco phase and/or the Three Circle phase of the Late Pithouse period.

Two historic properties listed in the NRHP (not reflected in the numbers above) are located adjacent to the Plan Area and are currently managed by different agencies. The Gila Cliff Dwellings National Monument is administered by the United States Department of Interior, National Park Service, and the Fort Bayard Historic District is currently administered by the State of New Mexico. Both of these cultural resources have been administered by the Gila National Forest in the past and the Forest Service maintains records on some resources associated with these listed properties. Similarly, there are three National Register Districts which are located on, or near, the Gila National Forest. These three districts (Pinos Altos Historic District, Mogollon Historic District, and the Socorro Mines Mining Corporation Mill) are either located on private inholdings within the Plan Area, or are located adjacent to the Plan Area. Archaeological resources associated with these historic districts are present within the Gila National Forest but have not been formally nominated as contributing elements.

Of the 6,168 archaeological sites recorded on the Forest, roughly 40 percent have had evaluations made on their eligibility (Table 243). The high number of resources that have been recorded but never evaluated is because prior to 1995 (“undetermined” and “no data” resources in Table 243), the Forest Service in the

Southwestern Region did not consistently make evaluations of eligibility for archaeological sites. In some instances an "undetermined" determination of eligibility (DOE) represents the DOE established by archaeologists conducting survey for various projects, in other instances this DOE actually represents a DOE generated by the State for those archaeological resources without formal determinations of eligibility which were migrated from the State database. For management purposes, the Forest Service treats undetermined and unevaluated resources as if they are eligible for inclusion in the NRHP. Of those archaeological sites that have been evaluated, the vast majority (ca. 82 percent) have been determined to be eligible for inclusion in the NRHP (or are listed or designated National Historic Landmarks). The remaining 18 percent of evaluated resources were determined to be not eligible for inclusion in the NRHP.

Condition of Cultural and Historic Resources and Trends Affecting their Use

The evaluation of the condition of cultural resources, including historic properties, is problematic. For archaeological resources, objective criteria such as the evaluation of impacts from natural and human forces can be used to generate statements regarding their condition. However, the nature, intensity, and quality of the evaluation of impacts to archaeological resources have changed over the past half-century. Until 1977, archaeological sites within the Plan Area were largely recorded on the State of New Mexico's Laboratory of Anthropology (LA) forms. From 1977 to 1990, the Forest's Cultural Resources Automated Information System (CRAIS) forms were used, after which recording was accomplished using a newer version of New Mexico's LA form. We anticipate being directed to use the "new" Forest Service form in the near future.

All of these forms used different methodologies for assessing site condition. The data from three forms has been normalized in the state of New Mexico's NMCRIS database and the Forest Service's INFRA database, despite categorical equivalence, differences in the level of detail and quality of the data persist. As such, any determination of the condition of archaeological sites will necessarily be qualitative and judgmental. For cultural resources and characteristics of importance to traditional communities, their condition is a reflection of the perceptions of those traditional communities of that condition, regardless of the objective condition of those resources and characteristics, assuming such objective conditions can be measured (for example, the availability of natural resources for collection, or the quality of noise- and viewsheds).

Data on current conditions and trends for archaeological resources can be examined from the recording and monitoring of cultural resources over the past 50 years (Table 244). Overall, water erosion (including sheetwash erosion, rill erosion, drainage formation, and arroyo down-cutting) is the most prevalent impact observed at archaeological sites. Water erosion has been noted as impacting deposits at nearly one-third of all resources visited.

Table 244. Number of sites on each Ranger District exhibiting the specified disturbances during distinct time spans

Ranger District	Time Span	No. of Visits	Bio.	Const./LD	Vand.	Water	Wind	Other
Black Range	2000-Present	122	38	38	18	69	12	32
	1990-1999	80	34	41	39	27	5	
	1980-1989	28	7	21	5	10	1	
	1960-1979	2		1	1			
	Total	232	79	101	63	106	18	32
Quemado	2000-Present	601	259	306	207	366	99	175
	1990-1999	271	158	150	78	215	89	45
	1980-1989	130	38	110	32	67	10	8
	1960-1979	91	18	57	48	55	3	6
	Total	1093	473	623	365	703	201	234
Glenwood	2000-Present	161	72	53	28	133	34	18
	1990-1999	139	50	67	36	121	35	1
	1980-1989	60	10	50	10	27	1	2
	1960-1979	4	1	2	1	1		
	Total	364	133	172	75	282	70	21
Wilderness	2000-Present	156	56	55	85	95	19	23
	1990-1999	125	60	42	66	66	17	5
	1980-1989	72	15	36	56	22	3	2
	1960-1979	74	9	6	63	18	1	3
	Total	427	140	139	270	201	40	33
Reserve	2000-Present	380	321	198	133	314	116	177
	1990-1999	152	53	140	66	106	17	22
	1980-1989	163	39	144	83	80	14	33
	1960-1979	82	27	50	43	58	6	23
	Total	777	440	532	325	558	153	255
Silver City	2000-Present	464	147	133	169	399	102	37
	1990-1999	138	42	86	56	212	20	4
	1980-1989	68	25	41	20	41	8	
	1960-1979	19	7	9	9	9	1	
	Total	689	221	269	254	661	131	41

Note: Disturbance sources are bioturbation (Bio.), construction/land development (Const./LD), vandalism (Vand.), water erosion (Water), wind erosion (Wind), and other disturbance sources (Other).

Construction, which also includes land development activities such as mining and logging in addition to road construction and other activities, has been noted during slightly more than one-fifth of all site visits. Land development impacts can be slight, but construction activities involving heavy equipment often results in severe impacts to sites. Bioturbation, which includes impacts from cattle grazing in addition to damage from rodents, insects, and other wildlife, was noted during roughly 17 percent of all visits. This seems to indicate that grazing, despite its prevalence on all of the districts, is not a major impact to archaeological resources. However, due to recording strategies this number is likely under-reported (as with other impact data). Intensive grazing in the past contributed to watershed degradation and soil deflation that would have affected sites but wouldn't be considered related to current grazing practices.

Vandalism, a category that includes looting, the defacement of standing structures and other features (i.e. rock art panels), arson, and the collection of surface remains such as pottery sherds, arrow and spear points, and bottles was noted during roughly 16 percent of site visits.

There are significant differences between Ranger Districts with regard to the prevalence of different categories of impacts to archaeological resources. Specifically, the Glenwood and Silver City Ranger Districts contain more than the expected proportion of resources affected by wind and water erosion when compared to other districts. Similarly, the Wilderness Ranger District contains more than the expected frequency of resources affected by vandalism when compared to other districts. Finally, the Reserve Ranger District contains a high proportion of resources affected by bioturbation when compared to other districts.

If we assume that different archaeologists were systematically recognizing all disturbances to cultural resources objectively across Ranger Districts, then there is a general trend towards increasing disturbance through time (which, may be more about recording trends than on-the-ground conditions). This is true for all districts in relation to all disturbance sources. Thus, disturbances brought about by bioturbation, construction/land development, vandalism, water erosion, and wind erosion increases through time on all districts. The exceptions to this are the decrease in vandalism disturbances on sites in the Black Range District from 2000 through the present when compared to earlier years; the decrease in disturbances associated construction/land development, vandalism, and wind erosion on the Glenwood District from 2000 through the present when compared to earlier years; the decrease in disturbances associated with bioturbation on the Wilderness Ranger District from 2000 through the present when compared to earlier years; and the decrease in disturbances associated with construction/land development on the Reserve Ranger District from 1990 through 1999 when compared to earlier years.

There have been no consistent efforts to record impacts to resources and characteristics important to traditional communities, other than those observed traditional cultural properties and/or sacred sites. For the general consideration of resources and characteristics important to Native Americans, please see Chapter 18: Areas of Tribal Importance. There has been no assessment of the condition of resources and characteristics important to traditional Hispanic and Anglo-American communities. However, the information collected by Raish and McSweeney (2008) has some bearing on current resource conditions and recent trends for traditional Hispanic communities. In particular, there is a perception that there have been declines in the condition of range land and timber resources. The perception is that these resources are currently insufficient to maintain community needs, and their availability has been declining over the past 50 years.

Contribution of Cultural and Historic Resources to Social, Economic, and Ecological Sustainability

Cultural and historic resources used in the Gila National Forest/Plan Area are critical to the social, economic, and ecological sustainability of the immediate area, the Southwestern Region, and the Nation. Archaeological sites within the Forest are a record of historic processes and events important to the identity of local communities, the State of New Mexico, the Region, and the Nation. Contemporary uses of resources in the Gila National Forest by Native American, Hispanic, and Anglo-American traditional communities are critical to maintaining the identity of these communities. Cultural tourism is a significant component of the surrounding regional economy. Tourists are attracted by the nature and significance of archaeological resources and by the character of traditional communities, a character maintained by resources and uses of the Gila National Forest. Archaeological resources contain a wealth of information for scientific researchers regarding ecological conditions and changes over the past twelve millennia, and human adaptations to these changing socio-cultural and environmental conditions. This information is of value to managers making decisions regarding the contemporary ecological management of the Forest. This information is also of value for educating the public about ecological sustainability.

Archaeological resources are a major source of information regarding the history of the human occupation and use of the Forest. For the first 12,000 years of human occupation, the remains found at archaeological sites are the only source of information pertaining to the socio-cultural adaptations of various social groups to changing environmental conditions in the Plan Area. Scientific researchers, professional organizations, and cooperating groups that have provided input for this assessment have emphasized the value of archaeological resources in the Gila National Forest for providing information about American history.

The Gila National Forest also contains individual resources that are important to the traditional history of Native Americans, to the military history of the Nation, and to the history of the Nation's westward expansion.

The use of archaeological resources to generate information about the history of the Plan Area, the Region, and of the Nation is vital to maintaining cultural identity at each of these levels. The importance of history to maintaining social sustainability has been cited by members of Hispanic traditional communities (Raish and McSweeney 2008) and scientific researchers and professional organizations cite strong interest among Native American communities in the historical information generated by researchers that study archaeological resources. Interpreted archaeological sites also afford an opportunity to educate children and the public at large about the history of the Forest, the Southwest Region, and the Nation.

The importance of historic and cultural places and characteristics of the Gila National Forest for maintaining the identity of traditional communities is well documented. For their importance to Native American traditional communities, please see the assessment for Areas of Tribal Importance. Hispanic traditional communities have identified the traditional use of the Plan Area for subsistence economic activities as central to their cultural identity. This includes access to land for grazing, wood for fuel and construction, water for the irrigation of crops, plants used in folk medicine, and areas of traditional religious significance (Raish and McSweeney 2008). While there has been little written research, district personnel report that access to resources and characteristics are also important to the maintenance of traditional Anglo-American communities, in particular access to land for grazing, hunting, and recreation. Community input during community meetings during this Forest Plan Assessment process has also identified these values as important.

Cultural and historic resources and uses serve as a driver of economic sustainability in the vicinity of the Gila National Forest by fueling cultural tourism. Archaeological sites are a major attraction for cultural tourism. Indeed, from 2008 through 2011, roughly 37,000 people on average visited the Gila Cliff Dwellings National Monument per year (Mitchell et al. 2014). Visitors to this and other interpreted cultural resources in New Mexico generated roughly 137 million dollars for State and local governments, with the Gila Cliff Dwellings generating roughly 17 million dollars alone (Thomas et al. 2015). In the Plan Area, there are a few cultural resources that are interpreted and readily available for visitation to the public. These include:

- The Trail to the Past on the Reserve Ranger District that includes a trail and interpretive placards at the remains of the Tularosa Ranger Station and a Reserve style petroglyph panel.
- The Apache Creek Rock Art trail on the Reserve Ranger District that includes a trail and interpretive placards at a small Reserve Phase pueblo and near a series of Reserve style petroglyph panels.
- The Trail to the Past in Pueblo Park on the Glenwood Ranger District includes an information kiosk where brochures are available that provide information concerning a series of Reserve and Tularosa phase pueblos located along the trail.

- The Lake Roberts Vista site on the Wilderness Ranger District includes a trail and interpretive placards at the remains of a small Classic period pueblo and Late Pithouse period structural remains.
- The Lower Scorpion campground trail on the Wilderness Ranger District includes a short trail and interpretive placards at a Mogollon Red pictograph panel.
- The Arrastra Site on the Silver City Ranger District includes a short trial leading to placards at a reconstructed arrastra used around the turn of the century.
- The Big Tree Trail on the Silver City Ranger District includes a brochure interpreting the history of the area.
- The Chloride Canyon trail on the Black Range Ranger District passes a number of Mogollon Red pictograph panels which are in the process of being formally interpreted for the public.
- The Dragonfly trail on the Silver City Ranger District passes a number of Jornada Style petroglyph panels that are in the process of being formally interpreted for the public.

Similarly, there are a number of interpreted resources adjacent to the Gila National Forest which provide information on the history of occupation of the area's inhabitants. These include the Fort Bayard National Historic Landmark, the Mogollon Mining district, the Gila Cliff Dwelling National Monument, the West Fork ruin near the Gila Cliff Dwellings, a number of sites along the Trail of the Mountain Spirits, the Santa Rita Mines, and the Geronimo Trail at Kingston.

Scientific information generated from the studies at archaeological sites has provided a wealth of information important to the ecological sustainability of the Forest. Places of past human settlements and use contain faunal remains, macrobotanical materials, microbotanical remains, soils, and other remains relevant to the reconstruction of ecological patterns over the past 12000 years, and have been vital for reconstructing patterns of environmental change within the region. Scientific investigation of archaeological resources can also provide an understanding of how humans have successfully adapted to a changing environment, or when they have failed to do so (Dean 2007; Gregory and Nials 2007; Minnis 1985; Wills 1988).

Climactic fluctuations tend to correspond to time periods when significant cultural transformations took place in prehistory. Usually, these time periods in the archaeological record are marked by substantial changes in mobility patterns, subsistence practices, and technological adaptations (e.g. the introduction of groundstone technology, the introduction of new projectile point types, the introduction of cultigens into the Southwest, the abandonment of the Four-Corners area, etc.) that likely emerged as groups responded to changing conditions.

Perhaps the most often cited process used in analyzing how prehistoric populations responded to changing environmental conditions is variability in precipitation. As anyone living in the southwestern United States today can testify, precipitation varies in the region both temporally and spatially. Thus, there are times when more precipitation is present when compared to earlier or later periods, and there are geographic areas which receive more precipitation than others during the same time period. Using tree-ring data in tandem with modern and historic records pertaining to rain fall totals, researchers have been able to reconstruct prehistoric precipitation values for different regions in the Southwest. The most commonly used annual precipitation reconstruction for the Plan Area was constructed by Grissino-Mayer and colleagues (1997) based on their analyses of the tree-ring sequence present in areas from the Magdalena Mountains near Socorro, New Mexico; south to the Organ Mountains near Las Cruces, New Mexico; east to the Sacramento Mountains near Tularosa, New Mexico; and west to the Mimbres River near Mimbres, New Mexico. This precipitation reconstruction spans from near modern times back to roughly 1,300 years ago and provides the most robust record of changing micro-scale environmental processes for the Plan Area.

Based on this precipitation reconstruction (Figure 208), one can deduce that some of the extreme variation from long term trends corresponds to rather significant changes in the archaeological record. For instance, many of the divisions associated the time-space systematics for the Mogollon area corresponds to rather long periods of less than average precipitation. The transition from the Georgetown phase to the San Francisco phase coincides with a rather lengthy drought that lasted from around A.D. 690 through A.D. 710. Similarly, the transition from the San Francisco phase to the Three Circle phase is marked by extreme variability in annual precipitation from around A.D. 790 through A.D. 820. This time span witnessed less than average precipitation from A.D. 790-800, greater than average precipitation from A.D. 800-808, and less than average precipitation from A.D. 809-819. The transition from the Three Circle to the Classic Period witnessed a series of less than average precipitation events from A.D. 978-985, A.D. 990-1014, and A.D. 1026-1042. The transition from the Classic period to the Black Mountain phase witnessed an initial increase in precipitation from roughly A.D. 1085-1124. This upward trend was followed by a significant decrease in precipitation from A.D. 1125-1150. The transition from the Black Mountain phase to the Cliff/Salado phase is characterized by a series of years that experienced less than normal precipitation from A.D. 1246-1260 and A.D. 1269-1297. The end of the Pueblo period in the Plan Area was characterized by extreme variability in precipitation beginning with more than average precipitation throughout A.D. 1370-1389. This was followed by less than average precipitation from A.D. 1407-1423, greater than average precipitation from A.D. 1426-1435, and less than average precipitation from A.D. 1445-1465. Finally, annual precipitation from roughly A.D. 1650 through to the present is characterized by increased variability. During this time span there are multiple instances where periods of less than average precipitation is followed by periods of greater than average precipitation. Less time elapses between these episodes of fluctuating precipitation values than in previous years suggesting that precipitation became less predictable for the inhabitants of the Plan Area.

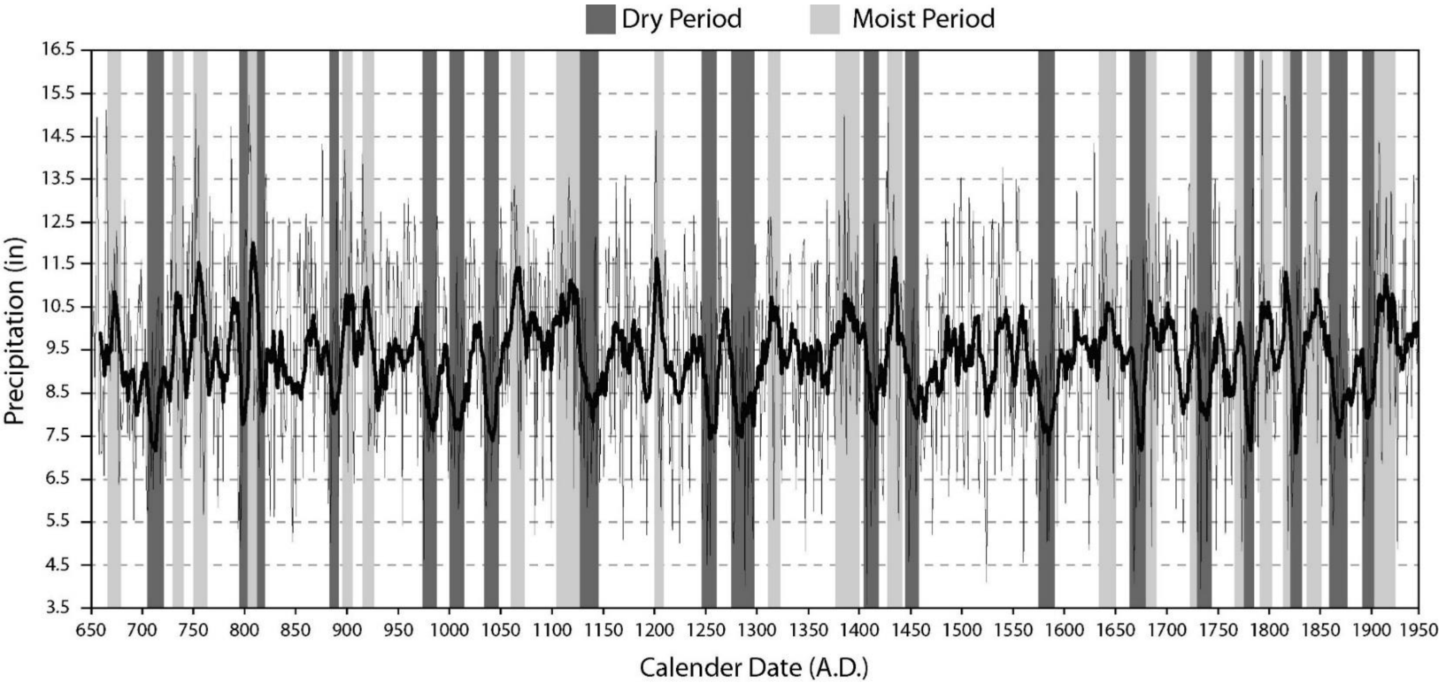

Figure 208. Precipitation reconstruction for A.D. 650-1950 depicting dry and moist periods.

Note: The bold line represents the 10 year moving average of reconstructed yearly precipitation values.

While certain aspects of changing environmental conditions are, to some extent, outside the control of prehistoric human populations, other aspects of environmental change responded directly to pressure exerted by prehistoric human populations. With respect to the Gila National Forest, researchers have demonstrated that the distribution of specific natural resources fluctuated as a result of population pressure. Specifically, researchers have demonstrated that, in some portions of the Plan Area, timber resources and wild game resources became increasing denuded as populations grew (Creel et al. 2010; Creel and Speakman 2012; Minnis 1985; Schoolmeyer 2009). These processes were likely exacerbated by the climactic fluctuations described above and increased, or created new, stressors on the overall social system.

As one can imagine, the combination of temperature fluctuations, precipitation fluctuations, and changes in the amount and type of vegetation present in areas along floodplains increased the potential for severe erosion. Such erosion in floodplains would have proven detrimental to prehistoric peoples especially if they were heavily invested in agriculture for their subsistence needs. As a result, archaeologists have long been interested in how cycles of erosion affected human populations. Perhaps the most in depth study of floodplain erosion processes was conducted for areas in northern New Mexico along the Colorado Plateau (Dean 1988, 1996; Dean and Funkhouser 1995; Gregory and Nials 2007). For areas along the Colorado Plateau, researchers have demonstrated that there are long term cycles of floodplain aggradation and degradation. Specifically, periods of aggradation, or those times of higher water tables and soil deposition in floodplains, were present from A.D. 350-750, A.D. 925-1250, and A.D. 1450-1880. Conversely, periods of floodplain degradation, or those times of lower water tables and soil erosion, were present from A.D. 750-925 and A.D. 1250-1450 (Dean 1988, 1996; Dean and Funkhouser 1995; Gregory and Nials 2007). As Gregory and Nials (2007) show, the aggradation/degradation episodes correspond to periods of variable El Nino frequencies. Similar studies conducted for areas along the Gila River in the Gila River Indian Reservation south of present day Phoenix, demonstrate that similar processes occurred (Waters and Ravesloot 2000).

The above examples show that there is substantial variability throughout the Southwest with respect to floodplain and stream channel dynamics. As of yet, no such studies of aggradation/degradation cycles has been conducted for stream channels and floodplains within the Gila National Forest. However, using the studies conducted by other researchers as proxy measures, it is possible to interpret the precipitation data presented above in a new manner. Briefly, the periods of stream channel and floodplain degradation/erosion episodes recognized in the Colorado Plateau and middle Gila River correspond to periods of precipitation that are preceded by periods of declining effective moisture. This is usually followed by shorter intervals of above average precipitation before returning to precipitation levels approximating long-term trends (Dean 1988, 1996; Grissino-Mayer et al. 1996; Waters and Ravesloot 2000) (Figure 209). In analyzing the precipitation data along these lines, it is possible that in certain areas surrounding the lower Rio Grande, including the Plan Area, that an additional period of floodplain instability is present in the area when compared to the Colorado Plateau and the middle Gila River. This additional period of floodplain degradation covers the time span form roughly A.D. 1600-1700. It should be noted that more nuanced temporal controls and sedimentological analyses were conducted in the Colorado Plateau and middle Gila River examples. Thus, this interpretation should be taken as anecdotal until similar analyses can be conducted in the Plan Area.

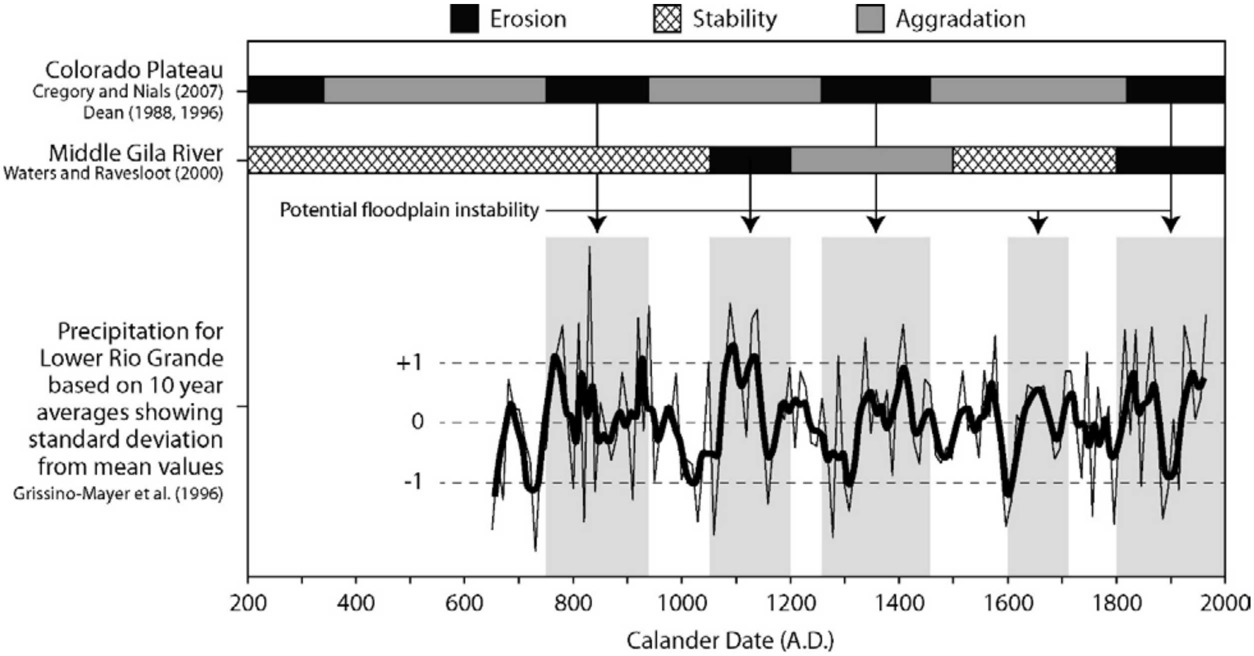

Figure 209. Stream channel dynamics for Colorado Plateau and Middle Gila River areas and possible stream channel dynamics for Plan Area based on yearly precipitation reconstruction.

Periods of floodplain degradation could have possibly been disastrous for groups practicing floodplain agriculture, especially if irrigation canals were used to transport water to irrigated fields. Such episodes could incise/down-cut channels and/or shift channel courses, both of which could render the irrigation canals practically useless if not destroy the canals and agricultural fields themselves.

For the Mimbres Mogollon, and likely other Mogollon groups inhabiting the Gila National Forest, the socio-ecological systems implemented by Mogollon groups were relatively resilient when compared to other contemporaneous groups inhabiting the Southwest (Hegmon et al. 2008; Nelson et al. 2012; Redman and Kinzig 2003). As the above data demonstrates, there were time periods when ecological stressors appear to correlate with periods of transformation/reorganization in the Mimbres/Mogollon cultural sequence. Whether these changing environmental conditions caused the potential reorganization events is unknown. However, the precipitation reconstruction demonstrates that nearly every transitional period associated with the Mimbres/Mogollon sequence is characterized by departures from long-term ecological trends.

The Intergovernmental Panel on Climate Change posits that the environmental changes presented above will likely continue to escalate over the coming years (IPCC 2014). Specifically, it is believed that if emission of greenhouse gasses (e.g. carbon dioxide, methane, nitrous oxide, etc.) continues along its current trajectory, that global temperatures will continue to rise (IPCC 2014). This will lead to a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels, and an increase in the number of heavy precipitation events in some regions of the world. In some portions of the world, heat waves are expected to increase in frequency and duration and precipitation events are expected to increase in intensity though will become sporadic in their frequency of occurrence (IPCC 2014). All of these general trends have the potential to adversely affect cultural resources in the Plan Area.

Perhaps the greatest threat that climate change poses to cultural resources is the increased threat of erosion. As temperatures rise, vegetation communities are likely to be affected. Elevational shifts in vegetation communities and/or "extreme" fire events could lead to reduced canopy cover available to intercept precipitation and reduce raindrop impact energies and loss of vegetative ground cover (basal area + litter). This loss of vegetative ground cover combined with more of the precipitation falling in higher intensity storms increases the risk of erosion (see Chapter 4: Soil and Chapter 6: Water for more details). This erosion risk can lead to increased sediment delivery to stream channels and potentially altered flow regimes and stream channel dynamics such as degradation (i.e. downcutting) or aggradation. Channel down cutting events, increased arroyo formation, and shifts in stream channel dimension or location have the potential to destroy or damage cultural resources located in the Plan Area.

As Nelson and colleagues espouse, while archaeological studies of past adaptations to changing climactic regimes "do not help us predict the future, they do provide natural experiments by which we can come to better understand the relationships between vulnerabilities and change and examine assumptions used to make contemporary decisions about managing for change versus managing for stability" (Nelson et al. 2012: 201). With respect to future management of actions for Forest sustainability, these studies demonstrate that change is the only constant, and that attempts must be made to incorporate this into management activities. The best strategy for managing for change is one that is flexible in design and where this flexibility includes feedback for monitoring system component vulnerability.

Input Received at Community Meetings

During 2015 the Gila National Forest held a series of public meetings, in communities where ranger districts are located, regarding Forest Plan Revision. Participants were asked what assessment topics were most important to them, about conditions and trends they had seen, and what opportunities they saw. One assessment topic was "cultural and historical resources." However, it should be noted that participants discussing other assessment topics also mentioned cultural resources. Overlapping responses were found in discussions of "areas of tribal importance, recreation, and multiple uses and the benefits people obtain from the Forest." Both positive and negative responses were collected.

Community input regarding cultural resources fell into four major categories (listed in order of frequency): concerns about looting and protection; interest in interpretation of cultural resources (often combined with an interest in recreation); negative feelings about the process of cultural resource management; distrust of management of cultural resources by the Forest Service.

Four comments expressed frustration with the process of cultural resource management, some referencing the amount of time and money that is spent protecting and/or identifying cultural resources. One read, "Maintain significant cultural and historic resources and let nature take care of the tens of thousands of inconsequential ones."

The vast majority of responses displayed a concern for cultural resources. Six responses focused on how to best protect sites. Five responses could be classified as interested in interpretation of cultural resources by the Forest Service and/or interest in accessing these sites for recreational purposes. These comments were generally positive about current management and wanted to make sure that cultural resources are preserved for future generations. Two responses indicated some distrust of Forest Service management. One of these read, "Cultural and historical resources need to be preserved and safeguarded from/for public and FS employees." The other also displayed a concern that the Forest not damage or destroy cultural resources. Overall, many participants recognized the national significance of the cultural resources found on the Gila National Forest.

After the release of the draft assessment report, commenters continued to express the importance of protecting cultural resources, and there was also interest in volunteer opportunities to assist these efforts.

Current Management and Regulation

The 1986 Gila National Forest Plan (USDA FS Gila NF 1986) established a series of management prescriptions for cultural resources and required that management of cultural resources follow State and Federal laws for cultural resource protection. Significant changes in how cultural resources are managed on the Forest since 1986 include the adoption and use of the Region 3 Programmatic Agreement and meeting new laws and directives that have been established. The Forest currently follows the *First Amended Programmatic Agreement Regarding Historic Property Protection and Responsibilities Among New Mexico State Historic Preservation Officer And Arizona State Historic Preservation Officer And Texas State Historic Preservation Officer And Oklahoma State Historic Preservation Officer And The Advisory Council on Historic Preservation And United States Department of Agriculture Forest Service Region 3* (USDA FS 2010i) in meeting NHPA Section 106 responsibilities. Programmatic agreements are well established ways to apply systematic approaches for implementing Section 106 of NHPA that take into account the effects of FS undertakings on historic properties, provide for appropriate tribal consultation and public participation, minimize redundant documentation, and reduce the need for case-by-case review of routine land management activities when historic properties will not be affected or when standard protocols and treatments can be applied.

Additionally, new Federal and State laws have come into existence that dictate how agencies manage cultural resources. 36 CFR 79 (1990) established regulations for how archaeological artifacts would be curated; these regulations formally established how to meet the requirements of NHPA. Curation on-Forest remains a challenge on the Gila, as within many Forest Service units; planning into the future needs to consider these requirements. The Native American Graves Protection and Repatriation Act (NAGPRA) was enacted on November 16, 1990, to address the rights of lineal descendants, Indian tribes, and Native Hawaiian organizations to Native American cultural items, including human remains, funerary objects, sacred objects, and objects of cultural patrimony. NAGPRA regulations affect both how collections are treated and how human remains are handled when they are discovered.

Additionally, two executive orders (EO), which have the force of laws, have been added that affect treatment of cultural resources (or resources that can be cultural resources). Executive Order 13006 (1996) encourages locating federal facilities on historic properties in our central cities; this has little direct application on the Gila National Forest and reiterates similar requirements laid out in NHPA. Executive Order 13007 Indian Sacred Sites (1996) is designed to protect and preserve Indian religious practices, this EO directs each federal agency that manages federal lands to “(1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and (2) avoid adversely affecting the physical integrity of such sacred sites.” This executive order can apply to many geographical areas and sites on forests, including but not limited to traditional cultural properties (TCPs under NHPA). Additionally, the Forest Service 2360 Manual has been modified and the 2309 Forest Service Handbook is new; standard measures of Heritage Program management (Heritage Program Managed to Standard) have changed. This shift in Heritage Program Managed to Standards (HPMtS) has established a different set of targets for Heritage Programs to meet than was present under the previous Forest Plan. Changed laws, direction, and standards need to be incorporated into new planning documents.

Consultation with Tribes is an ongoing process and enriches our understanding of resources we manage. Tribal consultation is also a requirement both of Manual and Handbook Direction and many laws. Within Cultural Resource Management, Tribal consultation is imperative not from only a legal perspective but also in order to better identify and address the concerns of communities who still are connected to sites. Native communities have a vested interest in many locations which may be seen as (still) inhabited by the ancestors, have value as sacred places, or be important for other reasons. Working with tribes as we manage these resources enriches our understanding, management, and interpretation of many sites.

Volunteers & Partnerships

The Forest regularly engages volunteers and partnerships to help address both research and management concerns. Research projects involving universities, museums, Passport in Time (PIT) volunteers, and other Forest Service volunteers occur on the Forest. Many of these projects address management concerns, such as erosion. A dedicated group of New Mexico SiteWatch volunteers serve as site stewards, monitoring changing site conditions and alerting the Forest to significant changes in condition. These volunteers and partnerships provide a valuable service to the Forest and represent a meaningful and lasting way for the public to contribute to and learn about our cultural resources.

Summary

Archaeological resources on the Gila National Forest (the Plan Area) reflect a 12,000 year occupation of the area. These resources remain important to descendant populations (Tribal and non-tribal), Forest visitors, and our National heritage. Tribal, local, and academic outreach during plan assessment attests to the importance of these resources as sacred places, important destinations for visitors, and as scientific resources.

Of the 3.4 million acres encompassed by the Gila National Forest, roughly 17 percent (ca. 580,000 acres) have been inventoried for cultural resources. However, only 12 percent (ca. 400,000 acres) have been inventoried to current standards. These inventory endeavors have recorded 6,168 archaeological sites across the six Ranger Districts comprising the Plan Area. Analyses demonstrate that the vast majority of these resources are located in areas below 8,000 feet in elevation; are located on gently sloping landforms with less than a ten degree gradient; are located in either piñon-juniper woodland or ponderosa pine woodland biotic provinces; are located within 200 meters of a stream; are located in areas modeled to be non-productive from a modern agricultural perspective; and are located on landforms classified as mountain tops/high ridges, canyon/deeply incised streams, U-shaped valleys, and/or local ridges/hills in valleys. Roughly 84 percent of all known cultural resources contain a prehistoric component. Of these, the vast majority date to the Early to Late Pueblo period or represent Late Archaic period occupations. The remaining 16 percent of all known cultural resources contain a historic component. Of these, the majority date from New Mexico Statehood to recent times.

Of the 6,168 archaeological sites on the Forest, only eight have been formally listed in the NRHP. Roughly 33 percent of all cultural resources in the Gila National Forest have been recommended as being eligible for inclusion in the NRHP, and only seven percent of all resources have been recommended as being not eligible for inclusion in the NRHP. The eligibility of the remaining 59 percent of known cultural resources for inclusion in the NRHP is currently undetermined. While the data should be treated as anecdotal, disturbances brought about by bioturbation, wind and water erosion, construction/land development, and vandalism increases through time on all districts comprising the Plan Area.

Data derived from studies conducted on archaeological sites in the Plan Area and in surrounding areas indicate that past environmental conditions fluctuated through time. There were time periods when ecological stressors, or deviations from long-term trends, appear to correlate with periods of transformation/reorganization in the Mogollon cultural sequence. However, many of these transitional periods are not associated with relatively extreme variability in the archaeological record. Using these and similar data, researchers have shown that the Mogollon socio-ecological system was fairly resilient and able to accommodate environmental change without substantially reorganizing the social system.

Current changes in climatic and environmental conditions, if left to continue along their current trajectories, pose substantial problems for cultural resources on the Forest. Threats include those posed by uncharacteristic fire events and the increased threat of erosion. Channel down cutting events, increased arroyo formation, and shifts in stream channel dimension or location have the potential to destroy or damage cultural resources located in the Plan Area. The best way of managing for these potential future conditions is to implement a strategy that is flexible in design and where this flexibility includes feedback for monitoring system component vulnerability.

The cultural resources present within the Plan Area have the potential to elucidate information on the varied lifeways of the region's inhabitants for the past 12,000 years. Such information could be used to address issues vital to the changing concerns of the Nation by providing examples of how historic and prehistoric social groups adapted to changing socio-ecological conditions (i.e. climate change, sustainability, pan-regional interaction, etc.). Similarly, cultural resources throughout the Forest are likely to increase in importance with respect to cultural tourism. These phenomena (increased research, increased tourism, and climate change) all have the potential to increase the risk of loss of archaeological resources. Through establishing new partnerships with interested stakeholders, and maintaining existing ones, the Gila National Forest will be better able to reduce existing risks to cultural resources and mitigate new risks as they arise.

Chapter 18. Areas of Tribal Importance

Introduction

This chapter identifies and evaluates available information on areas of tribal importance relevant to the plan area, including tribal rights, areas of known tribal importance within the plan area affected by management, and conditions and trends of resources that affect areas of tribal importance and tribal rights.

Ecosystem Services of Areas of Tribal Importance

The Forest provides many ecosystem services from its lands that are important to tribes. Among them are *cultural* ecosystem services in the form of opportunities for religious pilgrimages to place offerings at sacred sites and visits to shrines and springs. *Provisioning* services are also produced by Forest lands to tribes in the form of game and fish for sustenance, fresh water for drinking, and wood and fiber for heating, cooking and construction. *Supporting* services provided to tribes from Forest lands include plants for gathering for food and medicine, plant pigments, and stone and minerals for tools and agriculture. Tribes also benefit from *regulating* services produced by Forest lands, including climate regulation, water purification, and flood regulation.

Indian Tribes Associated with the Plan Area

The Gila National Forest routinely consults with 10 federally recognized tribes that are based in New Mexico, Arizona, Oklahoma, and Texas. These tribes include: the Pueblos of Acoma, Laguna, Zuni, Ysleta Del Sur Pueblo, the Navajo Nation, the Hopi Tribe, the San Carlos Apache Tribe, the Ft. Sill Apache Tribe, the Mescalero Apache Tribe, and the White Mountain Apache Tribe. These tribes have all expressed some level of interest in the resources and management of the Forest, and sometimes provide input to the Forest pursuant to Section 106 of the National Historic Preservation Act and the National Environmental Policy Act. These tribes recognize the lands managed by the Gila National Forest as part of their aboriginal or traditional use areas, and many acknowledge contemporary use of these lands for traditional cultural and religious activities.

No tribally held land abuts the Forest (Figure 210). All government centers for tribes and pueblos are located over an hour from the Forest by vehicle, with many over two hours from the Forest boundary. The physical distance between the Forest and tribal lands reduces the day-to-day use of the Forest by Native peoples and poses a logistical challenge. However, these factors do not reduce the Forest’s importance as a traditional homeland and a significant and sacred place to tribal people.

The Forest maintains a governmental relationship with 10 federally recognized tribes, and routinely consults with these tribes on policy development, and proposed plans, projects, programs, and Forest activities that have a potential to affect tribal interests or natural or cultural resources of importance to the tribes. The Forest strives to build and enhance its working relationship with these tribes.

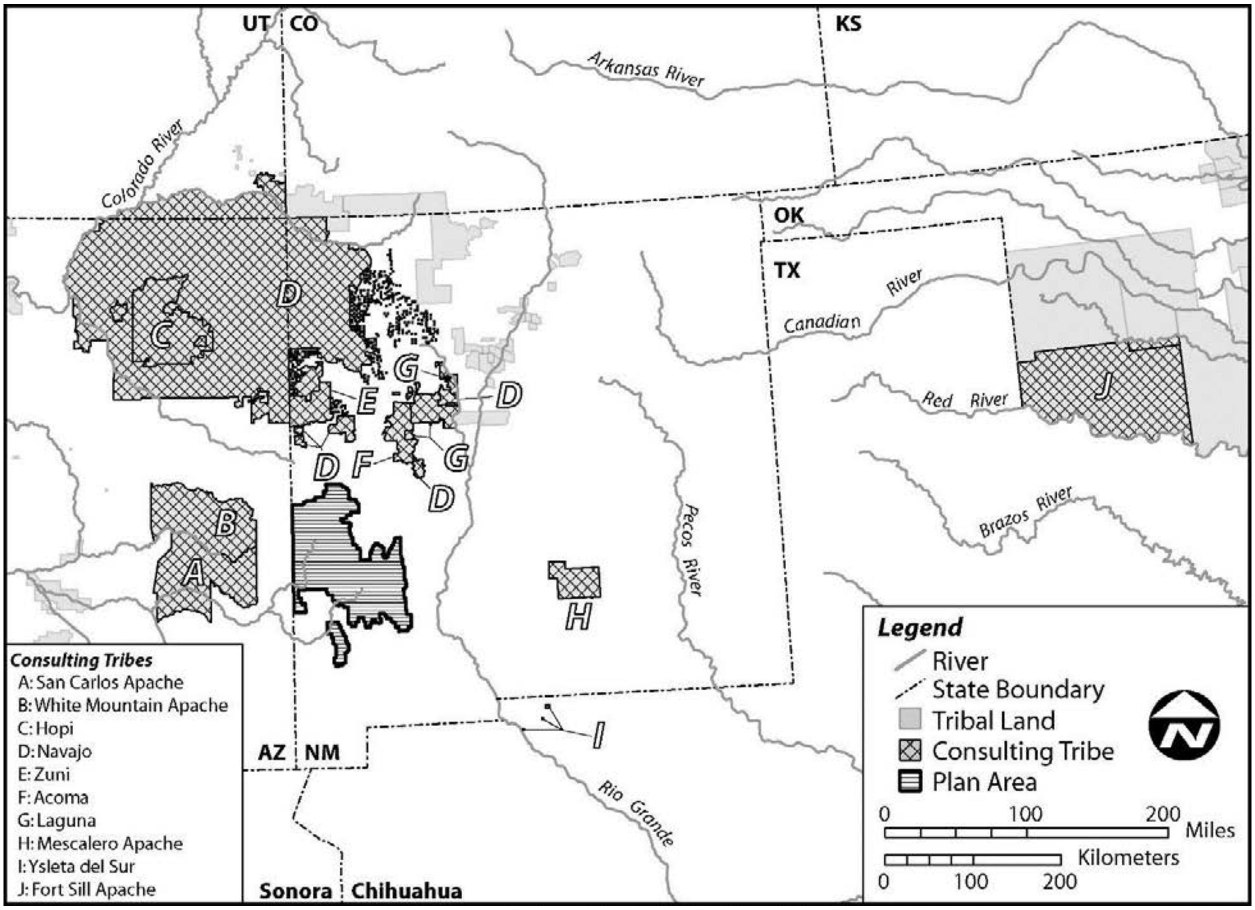

Figure 210. Location of the Gila National Forest (plan area) in relationship to consulting tribes.

Existing Tribal Rights

The federal government has certain trust responsibilities, and a unique legal relationship with federally recognized Indian tribes, defined by history, treaties, statutes, and court decisions. The span of responsibilities and nature of the relationships can vary between federal agencies.

The federal trust responsibility is summarized by Pevar (2004: 33) as “Broadly, the trust doctrine requires the federal government to support and encourage tribal self-government and economic prosperity, duties that stem from the government’s treaty guarantees to “protect” Indian tribes and respect their sovereignty. In 1977, a Senate report expressed this obligation as follows:

> The purpose behind the trust doctrine is and always has been to ensure the survival and welfare of Indian tribes and people. This includes an obligation to provide those services required to protect and enhance Indian lands, resources, and self-government, and also includes those economic and social programs which are necessary to raise the standard of living and social well-being of the Indian people to a level comparable to the non-Indian society.

Under this broad approach, the federal government’s trust duty “is owed to all Indian tribes”, including those that did not enter into treaties with the United States. The trust doctrine “transcends specific treaty promises and embodies a clear duty to protect the native land base and the ability of tribes to continue their ways of life.”

The Forest Service's policy regarding tribal relations is defined primarily by the authorities listed in Forest Service Manual part 1563.03-Policy (Effective Date 3/9/2016).

The agency's policy focuses on fourteen key points:

- Sovereignty. Respect and uphold the sovereignty of all federally-recognized Tribal governments.
- Government-to government relationship. Maintain government-to-government relationship with federally recognized Tribes.
- Consultation. Consult with Indian tribes and Alaska Native Corporations on matters that may affect their rights and interests.
- Accountability. Maintain an accountable process to ensure regular and meaningful consultation with Tribal officials in the development of policies or actions that may have Tribal implications.
- Tribal Summary Impact Statement. Prepare tribal summary impact statements in an identifiable portion of the preamble to each regulation that has tribal implications to be issued in the Federal Register.
- Certification. Provide certification of compliance with Executive Order 13175 to OMB when transmitting a draft final regulation that has tribal implications.
- Negotiated Rulemaking. On issues relating to tribal self-governance, tribal self-determination, tribal trust resources, or tribal treaty and other rights, the Forest Service should explore use of consensual mechanisms for developing regulations, including negotiated rulemaking.
- Tribal Relations Training. Forest Service employees shall complete tribal relations training.
- Confidentiality. Forest Service employees shall protect the confidentiality of culturally sensitive and proprietary information.
- Sharing Information. The Forest Service shall assist Indian Tribes and tribal organizations by providing technical, educational, financial, and other information, and establish information exchanges where mutually agreed to and authorized by law.
- Reducing Impediments. Wherever possible, the Forest Service should reduce or remove legal or administrative program impediments that inhibit the Agency's and Indian tribes' capacity to work directly and effectively with each other.
- Repatriation. Repatriation of Native American human remains and associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony is consistent with the requirements of the Native American Graves Protection and Repatriation Act (NAGPRA).
- Reburial. Support, where appropriate, shall be provided for request(s) for reburial of human remains and cultural items on Forest Service-administered lands.
- Education. The Forest Service shall help improve educational opportunities provided to all American Indian and Alaska Native students.

The Forest carries out its trust responsibilities under a variety of authorities. Some of the laws that address the agency's requirement for government to government consultation include: the American Indian Religious Freedom Act (AIRFA); the Archaeological Resources Protection Act (ARPA); the National Forest Management Act (NFMA); the Native American Graves Protection and Repatriation Act (NAGPRA); the National Environmental Policy Act (NEPA); the National Historic Preservation Act (NHPA) -Sections 106 and 110; 36 CFR Part 800 Protection of Historic Properties, and the Religious Freedom Restoration Act (RFRA). Executive Orders, such as EO 13175 Consultation and Coordination with Indian Tribal Governments and EO 13007 Indian Sacred Sites, also speak to the agency's responsibilities.

Other more recent authorities, directives and/or guidance relevant to Forest management, collaboration, and consultation include the Tribal Forest Protection Act (2004), the Food Conservation and Energy Act of 2008 (The Farm Bill), Report to the Secretary of Agriculture-USDA Policy and Procedures Review and Recommendations: Indian Sacred Sites (December 2012), Memorandum of Understanding Among the Department of Defense (DOD); Department of Interior (DOI); U.S. Department of Agriculture (USDA); Department of Energy (DOE), and ACHP Regarding Interagency Coordination and Collaboration for the Protection of Indian Sacred Sites (December 2012), and FSH 2409.18-Trees, Portions of Trees, or Forest Products Free of Charge for Indian Tribes for Non-Commercial Traditional and Cultural Purposes.

The U.S. Forest Service Tribal Relations Strategic Plan (2010) outlines three basic goals around Tribal Rights, Partnerships and Program Development:

- American Indian and Alaska Native Rights: Ensure the agency redeems its trust responsibility and protects American Indian and Alaska Native reserved rights as they pertain to Forest Service programs, projects, and policies.
- Partnerships: Leverage partnerships to maximize mutual success.
- Program Development: Promote integration and utility of the Tribal Relations Program throughout the agency.

The strategy targets specific outcomes, and delineates the Tribal Relations Program, mission, goals and objectives. The Region's First Amended Programmatic Agreement Regarding Historic Property Protection and Responsibilities (December 2003) addresses project-level consultation pursuant to the National Historic Preservation Act (as amended).

Under the current administration, there has been an increased emphasis on work with American Indian tribes within USDA and the agency. Both the revisions to Forest Service Manual Chapter 1560, part 1563, and Forest Service Handbook 1509.13 (Chapter 10, American Indian and Alaska Native Relations Handbook) became effective on March 9, 2016. Direction within this further clarifies who may conduct government-to-government consultation with Tribes. The Handbook now states "Government-to-government consultation may only occur between Forest Service Line Officers and tribal leaders who have authority to consult on behalf of their Tribe…Tribal consultation may not be delegated from line to staff in the field." The handbook also supports the development and use of memoranda of understandings (MOUs) between Forests and Tribes.

Areas of Known Tribal Importance Affected by Management of the Plan Area

Lands managed by the Gila National Forest have been used, and continue to be used, by many tribes for a variety of traditional cultural and religious activities. Over time, these activities have included, but are not limited to: collection of plants, stone, minerals, pigments, feathers, soil, catching eagles, hunting game, and conducting religious pilgrimages to place offerings and to visit shrines and springs.

Places and properties valued and used by the tribes for a variety of purposes have been identified on every District of the Gila National Forest. Properties can possess traditional cultural or religious significance for a number of reasons. Some of these reasons include locations with long-standing cultural use, locations of buried human remains repatriated under NAGPRA, locations where ceremonial objects have been retired, locations of contemporary ceremonies, and locations where specific forest products are gathered for ceremonial use. Some locations such as shrines, springs, caves, and resource collection areas have long-standing and ongoing historical, cultural, and religious significance.

In addition to specific noted locations, peaks and entire mountain ranges are frequently regarded as sacred, and viewed as an integral part of a tribe's cultural landscape. Multiple peaks on the Forest have been identified as sacred to one or more tribes. Many have place names tied to tribes' oral traditions. Cultural and traditional use of specific mountains is ongoing, dictated by the cycle of cultural activities.

Existing information regarding sacred sites is based on published sources as well as the results of project-level consultation conducted by the Forest. To date, approximately 30 locations of cultural and religious significance have been identified Forest-wide.

Certain locational types (e.g., caves & springs) tend to be considered sacred, once identified. The importance of natural water sources to Tribes is underscored by their interest in having the Forest Service do a better job of protecting and enhancing them.

Certain archaeological site types including battlefields, ceremonial sites, and rock art sites are frequently identified as sacred. For example, oral histories, which continue to be passed down about battlefields, convey the events and sacrifices that ensured community survival and cultural transmission. Rock art can be found across the Forest in the form of petroglyphs and pictographs. Recent consultation with multiple tribes indicates these resources played an important role in instruction and ritual. Some images depict the story of emergency and migration. Other images are associated with specific rites or activities. Areas where rock art is found are often considered sacred. There is ongoing tribal visitation to some rock art sites (Figure 211).

The locations and ongoing tribal uses of sacred locations generally remains confidential in order to best protect these resources and their ongoing use.

Under the National Historic Preservation Act (NHPA) some identified archaeological sites can be designated as TCPs. This designation has not been applied to all locations that tribes consider sacred. The Forest, together with tribes, has formally documented one location as a traditional cultural property (a petroglyph site); it has been determined eligible for the National Register of Historic Places, though not formally nominated to the National Register in order to protect its anonymity. Additional sites, landscape-level properties, and historic districts, containing a number of historically or functionally related properties, remain minimally documented but clearly meet the criteria of a TCP. As an example, several, if not all, historic Apache battlefields located on the Forest could qualify as TCPs.

It is important that traditional practitioners have access to TCPs and other sites of spiritual or traditional significance and that they are afforded privacy to conduct ceremonies as requested.

Cultural resources (e.g., archaeological sites) are often of importance to tribes and it is important that tribes are consulted regarding management of these resources, particularly when it comes to interpretation, excavation, and the treatment of human remains. The Forest uses a proactive approach in protecting cultural resources from adverse impacts and conducts outreach to educate the public on the history of the Gila NF and historic preservation issues. Working in partnership with federally recognized tribes helps us protect ancestral sites and manage cultural resources through meaningful collaboration. The Forest also recognizes that there are important tribal sacred sites, ethnographic resources, and traditional use areas that may not meet the definition of a historic property. The Forest works to protect these resources using existing authorities in collaboration with federally recognized tribes. For a discussion of Cultural Resources see Chapter 17.

Figure 211. The Zuni Cultural Resource Advisory Team visiting a rock art site on the Gila National Forest.

Forest Product Collection

Although gathering forest products for personal, commercial, and ceremonial uses is limited to some extent due to distance, there is tribal use of and interest in forest products. Distance does not reduce the significance of the area in tribal memory, although it can make daily use less common. Zuni sources have identified at least 15 areas of importance for gathering and hunting. Tribal members from multiple groups have hunted on the Forest. Firewood is a forest product that is of interest to tribal members for personal and ceremonial use. This includes juniper, piñon, oak, and ponderosa pine. However, due to travel distance, only a few groups have been known to collect these resources on the Gila National Forest. Collection of forest products for "special" uses seems more common than for heating. For example, there have been instances of tipi pole collection. There is use of the National Forest for collecting forest products for traditional and cultural purposes. Some examples include soils/minerals, yucca, willow, cactus, grasses, osha root, Douglas fir, ponderosa pine, and oneseed juniper. Due to distance, most tribal use of forest products on the Gila focuses on ceremonial, medicinal, or artistic products. The act of procuring certain products is a sacred activity, requiring preparation on the part of participants. Traveling to collect these materials can be a sacred activity with deeper meaning and importance to participants. The Forest recognizes that tribal forest product collection within our boundaries helps maintain and reinforce sacred connections to the land for tribal individuals.

Multiple authorities provide for tribal use of forest products. These include:

- FSM 1563.03 directs Forests to "assist Tribal members in securing ceremonial and medicinal plants.
- Food, Conservation, and Energy Act of 2008, Sec 8105 provides authority to provide, free of charge, to federally recognized Indian Tribes trees, portion of trees or forest products from National Forest System lands or noncommercial, traditional and cultural purposes.

- FSH 2409.18 Chapter 80 provides authority to grant trees, portion of trees, or forest products to federally recognized Indian Tribes for a wide variety of noncommercial uses that serve to promote traditional native culture, activities and practices, and may be used where treaty reserve rights may be absent or ambiguous.

Conditions and Trends of Resources that Affect Areas of Tribal Importance and Rights

Conditions and trends that are social and/or economic based are influencing tribal use of the Forest and affecting areas of tribal importance. Some of these include: changes in land ownership, degradation of forest health and watershed conditions, changing technologies and energy development, population growth, expanding recreation use, and the development of private lands.

Change in Land Ownership and Access to Land and Resources

Tribal access and use of the lands and resources now managed by the Gila National Forest, as well as the general landscape, have been altered over time due to a number of factors. The primary factor is the change in land ownership and jurisdiction. Historically, resources on the land were more widely available to tribes, and they had nearly unfettered access to these lands for hunting, acquiring construction material, gathering firewood, and collecting resources for food, medicine, and ceremony. There were often well-established travel routes between communities, and prescribed routes to specific locations of tribal importance. As the Spanish, Mexicans, and later the Americans moved into the area, recognition of land ownership became increasingly important. Access to and use of resources continued to change with the establishment of the National Forest in the early 20th century, and the gradual progression of environmental policy, resulting in the passage of federal laws and regulations, and greater federal oversight.

In some cases, access to culturally significant locations has been severely restricted or eliminated altogether in places where land has gone into private ownership. Although the Forest Service has the ability, under a variety of authorities, to assure tribes access to sacred sites and privacy to conduct cultural activities, few tribes have exercised these rights on the Gila National Forest. There have been few requests for temporary closure, through authorities such as the 2008 Farm Bill, for these purposes. There seems to be a pervasive lack of awareness about the options and the process for securing these types of closures. There is also some confusion about the process of obtaining free use permits for the collection of forest products, and under what situations a permit is needed. Nevertheless, the Forest is very responsive to tribal requests, although the Forest lacks a consistent procedure to authorize for the collection of forest products for ceremonial use.

The process of preparing for and travelling to an area to conduct traditional and cultural activities is often as significant as the activity itself. The construction of fences, installation of gates, and checkerboard land ownership patterns, has contributed to complicating the tribes' ability to do resource collection and to visit areas of traditional cultural and religious significance. Land ownership can affect how tribes approach areas of tribal importance, and conflicts have been known to arise with landowners or with Forest Service personnel who are unfamiliar with tribal rights on National Forest land. Ownership and development of private land has led to a greater reliance on National Forests. Still, there is only limited use of the Gila National Forest by tribes for traditional, cultural and religious activities. Instead, they will opt, where they can, to obtain these resources on their own lands, or will travel to National Forest lands that are closer to their reservations.

When tribes do go to important places on National Forests, their methods of travel and their activities often have to be adjusted for factors such as road development, fences, gates, mixed land ownership, and other permitted or recreational uses of Forests.

Degradation of Forest Health and Watershed Conditions & Restoration

There are a number of factors that have led to compromised watersheds and forest ecosystems. Broadly speaking, historic agency fire suppression policies, timber harvesting, logging practices, livestock grazing and localized mining practices have all contributed to the compromised watersheds and forest ecosystems that the Forest is managing today (see Chapter 6: Water). Much of this occurred during a period in the agency's history when output was a top priority, in response to the social demands of the time. Ground-disturbing permitted activities and dispersed recreation have also contributed to the disturbance and degradation of some resources (see Chapter 12: Recreation).

For example, the Navajo believe that if plants are misused, they will move away. Drilling or digging into the earth is an example that the Navajo use to describe misuse. The effect that drilling and digging have upon plants is one reason these activities are viewed as negative. Digging into the earth is also believed to alter the otherwise beneficial effect of activities such as prescribed burning. Generally burning is considered positive, because it tends to bring about a re-growth of plants.

Many Tribes view large landscape scale restoration as a way to restore and enhance the resources. There is an understanding from Tribes that a healthy functioning resilient ecosystem is a healthy sacred place.

The Tribal Forest Protection Act of 2004 (Public Law 108-278) allows tribes to propose projects on National Forest System lands to protect their own trust resources. The Tribal Forest Protection Act (TFPA) basically authorizes the Secretaries of Agriculture and Interior to give special consideration to tribally proposed Stewardship Contracting or other projects on Forest Service or Bureau of Land Management (BLM) land bordering or adjacent to Indian trust land to protect the Indian trust resources from fire, disease, or other threats originating from Forest Service or BLM land. Given the proximity of the Gila National Forest to tribal lands; these types of projects have not been proposed. However, in 2012, the Gila NF entered into a three year Collaborative Forest Restoration Project (CFRP) grant with the New Mexico Forest Industry Association. This grant provided job training and work (some on-Forest) marking timber to the local Alamo Navajo.

Additional discussion on vegetation management can be found in Chapter 2: Upland Vegetation where ecosystem characteristics are analyzed: vegetative structure, fire regime, patch size, invasive species, coarse woody material, climate, snags, insects and disease.

Climate Change

Climate change, discussed in Chapter 9: System Drivers and Stressors, is affecting the environment in multiple ways. Catastrophic floods, increased fire activity, species becoming less viable in their native ranges, and the expansion of invasive plants and animals have all been associated with climate change. Environmental degradation that occurs has the potential to change the character of sacred places and the availability of traditionally used resources. Traditionally used plants may shift range or become unavailable in some areas due to climate change; these changes can affect the availability of products desired by tribes. Forests, with large land bases, may prove somewhat more resilient due to less environmental fragmentation and other factors, rendering Forests increasingly important sources of forest products for tribes.   Impacts to specific sites will also have the potential to cause tribal concern as resources such as shrines, rock art, and sites where the ancestors still reside could be disturbed by fire or flood (see discussion of impacts of climate change to archaeological resources in Chapter 17: Cultural and Historic Resources).

Changing Technology and Energy Development

As a multiple use agency, the Forest Service permits a wide variety of activities on National Forest System lands. Activities such as the development of communication sites, mineral exploration and extraction, and construction and maintenance of transmission or utility corridors have affected, and continue to affect, areas of tribal importance.

In recent years, there has been a greater emphasis on alternative forms of energy development such as wind, solar, and nuclear power. While many tribes support the development and use of wind and solar power, there is also recognition that these types of energy development result in a large footprint on the landscape, and often impact the viewshed. Evidence of past mineral exploration is still evident today on Districts of the Forest, and the agency has only recently begun to address the remediation of older mines on the Forest. In the aftermath of the 2015 Gold King Mine waste water spill originating in Colorado, and subsequent response of the Navajo Nation and other tribes in the region, we can anticipate heightened tribal interest in the successful remediation of mines on the Forest.

Changes in telecommunication technology over the past century resulted in a proliferation of communication sites developed on the Forest, most located on high points such as mountain tops. These constructed features are a mixed blessing for tribal communities. While communication sites make certain technologies readily available to all, they are perceived to cause impacts to the landscape, wildlife, and traditional tribal use of the land. For example, radio communication sites contain towers that can be seen for great distances, and if greater than 200 feet in height, will be lit at night per Federal Aviation Administration (FAA) requirements. Those tribes that have expressed opposition to the development of new communication sites have encouraged co-location of communication infrastructure to the maximum extent feasible.

Impacts created by the presence of towers or any other highly visible anthropogenic objects, obstruct the “line of sight” from the physical location of the ceremony to a given location (e.g., a peak). This can interfere with the practitioner’s accuracy of diagnosis and proper treatment of patients. These visible impacts represent an intrusion to the traditional experience and the ability to properly conduct prescribed cultural practices.

The continued permitting and development of electronic facilities and mines on the Forest, particularly on or near the higher mountains, disallows the meditative atmosphere, quietness, and privacy necessary for traditional cultural activities. The additional vehicular traffic associated with the use, maintenance, and/or expansion of these types of facilities is also a concern from the standpoint of intrusion and interference with traditional and religious practices.

Places of tribal importance have an integral relationship with a tribe’s beliefs and traditional cultural practices, and are viewed as critical to the maintenance of a tribe’s cultural identity and transmittal of their beliefs and practices. Practitioners sometimes engage in certain traditional activities that can only be conducted in a specific place. Tribes have expressed concern that as development continues in areas of tribal importance, it forces these individuals to alter their cultural activities, and in time, is seen as a cumulative impact to their cultural activities. Development does not always stop the cultural activities and practices, but is perceived to degrade the traditional practices and diminish their value.

Large and intrusive development has the potential to affect a tribe’s relationship with an area of traditional and cultural significance, and risks the disruption and/or alteration of traditional cultural activities that are critical to the continuity of cultural beliefs and practices. In the view of the tribes, impacts to a traditional practitioner’s ability to conduct traditional cultural activities in the area will render the overall effectiveness of medicine and healing ceremonies less effective.

Title V, Section 503 of the Energy Policy Act of 2005 (Public Law 109-58) and Indian Mineral Development Act of 1982 (Public Law 97-382) provide increased flexibility for tribes to develop energy resources. A number of tribes in the region are currently developing energy under the provisions of the Energy Act of 2005. According to the Department of Energy, Tribal Energy Program website (http://apps1.eere.energy.gov/tribalenergy/projects_state.cfm/state=NM), there are 18 energy related projects in New Mexico, virtually all of which focus on renewable energy. Renewable energy can be developed to meet a tribe's needs for sovereignty, energy independence and diversification, environmental sustainability, and to strengthen the tribal economy.

The Forest does not share a common boundary with any tribe. Despite this, it is possible that the Forest could receive requests for special use permits to cross National Forest land. This would include requests to transmit electricity or natural gas across National Forest land by the Department of Energy and the Department of Interior, working on behalf of tribes to develop their resources. Additional discussion on energy and mineral development can be found in Chapter 16: Energy and Mineral Resources.

Population Growth, Development, and Expanding Recreation Use

Recreational use of the Forest is on the rise. Some popular activities involve day use (such as picnicking, hiking, mountain biking, and horseback riding), driving for pleasure and scenic beauty, and wildlife viewing. Located away from urban areas, hunting, backpacking, and camping represent important activities that are enjoyed by locals and bring visitors and resources into the area. As a Forest with three Wilderness Areas, including the Gila Wilderness, the first designated Wilderness in the Nation, longer trekking (including backpacking and packing with horses) is also popular and draws visitors from around the world to the Forest. See Chapter 12: Recreation and Chapter 13: Designated Areas for more details.

The Pueblo of Acoma has expressed concern regarding dispersed motorized use of the Forest and the proliferation of motorized trails and roads. They are concerned that too much motorized use degrades watersheds, displaces plants, disturbs animals, and reduces the sense of solitude. They, and other tribes, have been supportive of the Forest's efforts to regulate motorized travel via the Travel Management Plan. As recreation increases on the Forest, conflicts between traditional practitioners and other Forest visitors can be expected to increase.

Development of Private Land

There are inholdings of private land within every District of the Forest. In some cases, these properties contain strategic and culturally significant features such as springs. Most of these lands have not been subdivided. However, development of subdivisions within or adjacent to the Forest can create concerns for a variety of reasons including: changes to the visual characteristics of the landscape, construction of new transmission lines and other utilities on Forest, concerns for wildlife, introduction of new species, degradation of watershed condition, increased fire risk, and when residents who live immediately adjacent to the National Forest and/or wilderness areas establish informal trail systems for their personal use (see Chapter 17: Land).

Input Received at Community Meetings

Community meetings were held across the Forest in 2015; over 200 individuals participated in these meetings. One assessment topic posed to participants was "Areas of Tribal Importance." Given the location of these meetings in communities with District Offices, responses do not represent input from tribal communities. Only 5 responses directly discussed the importance of the Forest to Tribes and these reflected different levels of understanding. Responses to the assessment prompt ranged from "none" to "everywhere." The "none," which presumably indicates the respondent doesn't recognize there are any areas of tribal importance, is concerning. One response stated that "cultural and historic resources are [should be] protected and tribal areas respected." This response and another on the desirability of signing archaeological sites reflect the general community understanding that archaeological sites can be important to tribal communities. Another participant responded: “manage for the recreational purposes while being aware of local customs and cultures (fuelwood collection, cultural herb use, etc.).” This response reflects and understanding that a broad range of values can be important to tribes. Ongoing interpretation has been designed to help inform the public on the ongoing significance of the Forest to tribal communities. Efforts by Tribes and the Forest can help enhance community understanding of the Forest as a traditional tribal area.

Tribal Consultation During Plan Revision Assessment Phase

The Gila National Forest maintains a governmental relationship with ten federally recognized Indian tribes, also directly contacting specific bands within those tribes that live nearby. All of these groups have been contacted by mail and by phone in regards to Forest Plan Revision. Face-to-face consultation has occurred with four tribes so far during the assessment phase. We hope that as the Forest Plan Revision process progesses that we will have substantive conversations with all ten tribes, developing a growing understanding of their vision of how we can best partner with them and how this landscape should best be managed into the future.

Topics of conversation with tribes during this phase covered a range of topics. Tribes discussed concerns about climate change, the importance of forest restoration, and an appreciation of recent travel management efforts, which hopefully reduce resource degradation and habitat fragmentation. There was some discussion of hunting and gathering on-Forest. Cultural resource management issues discussed included: research interests and concerns, and opportunities for tribal involvement in interpretation of cultural sites for Forest visitors. Another major topic was opportunities for tribal youth to be exposed to the traditional lands that are now part of the Gila National Forest, either through educational activities (on the ground or virtual), through working with other researchers, or as employees. Other Forests have solicited the tribes regarding their concerns and interests in forest management; comments they have received have reflected similar concerns and interests. Specific comments have been received by other Forests about concerns over increased development, impacts to resources from off-road travel, the environmental and cultural impacts of mining, chemical treatments of native plants, and protection of agave. We anticipate continued tribal involvement throughout the plan revision process and anticipate that the revised plan will emphasize mutually beneficial relationships between the Forest and Tribes.

Summary of Conditions, Trends, and Risks

The Gila National Forest maintains a governmental relationship with ten federally recognized Indian tribes, and routinely consults with these tribes on policy development, plans, and projects, programs, or activities proposed on the Forest that have a potential to affect tribal interests or natural or cultural resources of importance to the tribes. Lands managed by the Gila National Forest have been used, and continue to be used by many tribes, for a variety of traditional cultural and religious activities. Places and properties valued and used by the tribes for a variety of purposes have been identified on every District of the Gila National Forest. To date, approximately 30 locations of cultural and religious significance have been identified Forest-wide.

It is hard to characterize the trends associated with tribal use of the Gila National Forest. Some changes tend to reduce access and use: (1) changes in adjacent land ownership and development of private lands affecting access, (2) degradation of forest health and watershed conditions affecting plant collections, (3) changing technologies and development interfering with traditional ceremonies, and (4) recreation use contributing to conflicts with traditional practitioners. However, within these challenges there is also room for optimism. Despite being located a distance from tribal populations, programs are being established (by tribes with Forest participation) which bring youth onto the forest to reconnect with traditional lands. Landscape restoration provides an opportunity for tribes and the Forest Service to work together towards common goals. The Forest strives to build and strengthen relationships with tribes and hear and incorporate tribal input into a broad range of activities.

Tribal uses occur on every District of the Gila National Forest and are at risk from change in land ownership, access to land and resources, degradation of forest health and watershed conditions, changing technology, energy development, population growth, expanding recreation use, development of private land, and management activities on sacred places. Maintaining and developing a strong government to government relationships with Tribes is important to the Gila National Forest; these relationships inform management of the Forest. Facilitating meaningful access to the Forest for tribal members enhances connections.

Chapter 19. Social, Economic and Cultural Sustainability Risk

The Gila NF has identified several risks to ecological integrity and sustainability for terrestrial, riparian and aquatic ecosystems (see Section I: Ecological Integrity and Sustainability). These risks may impact the Forest's ability to contribute to some of the social, cultural and economic benefits desired and enjoyed by people in local communities, surrounding areas and visitors to the area. These risks are a direct result of ecological condition and impact available water, forage for livestock grazing, timber, and hunting and wildlife viewing. Addressing these risks will require balancing ecological sustainability and the management of ecosystems for public benefit. Additional areas at risk for non-ecological reasons are: recreation programs and use, infrastructure, and economic and social conditions. These risks and their causes are discussed below, followed by a discussion of how future management approaches and plan direction could make use of opportunities that might mitigate risk.

Water

The ability of the Gila NF to continue to supply the quantity of surface and groundwater to meet existing needs of local counties and communities is at high risk of being unsustainable. Although drought is a common occurrence, climate change is expected to increase the frequency and severity of drought and alter the timing, duration and magnitude of streamflow. Many areas at high elevation that are important to streamflow and groundwater recharge have experienced large extents of high and moderate severity fire resulting in loss of forest cover, vegetative groundcover and soil. In these areas, the ability of the watershed to capture, store and release water is reduced. Water quality has also been negatively impacted.

The Gila NF contributes the majority of water to the Upper Gila, Upper Gila-Mangas, and Mimbres subbasins and is a significant contributor to the San Francisco subbasin. The Forest contributes a smaller portion to seven other subbasins, including Elephant Butte Reservoir and Caballo. A large proportion of the population in the assessment area resides within the Mimbres, San Francisco, Elephant Butte and Caballo subbasins. To reduce this risk to water availability and quality, the Forest can improve watershed health and function to maintain or recover water retention and infiltration. Vegetation and soil management that focuses on the restoration and maintenance of terrestrial and riparian ecological integrity is required to reduce this risk.

Forage for Livestock Grazing

The ability for the Gila NF to provide adequate forage to contribute to opportunities for livestock grazing in southwestern New Mexico is at risk of being unsustainable. The encroachment of conifer tree species has reduced the size of grassland openings and the quantity of available grasses that are necessary to provide sustainable forage on the Forest. Recent drought has contributed to the decrease in quality and quantity of available forage in some areas on the Forest. Climate change in general creates risk of invasive species establishment.

Recent drought and voluntary livestock reductions due to market conditions have resulted in the fluctuation of authorized (actual) livestock numbers in the last several years, while permitted numbers have remained constant. The Forest has utilized adaptive management to work with permittees to adjust authorized livestock numbers to maintain and protect forage, which has been stressed from recent drought conditions. Vegetation management that focuses on the restoration and maintenance of ecological integrity is required to address this risk.

Hunting and Wildlife Viewing

The ability for the Gila NF to sustain habitat for many terrestrial and aquatic species are at risk of being unsustainable. Wildlife and fish habitat faces threats from uncharacteristic wildfire, woody species encroachment, drought, climate change, and invasive species. Habitats may become fragmented causing terrestrial and aquatic populations to become isolated which may result in increasing competition and decreasing population numbers. Aquatic species may be impacted by decreasing stream flows and associated increase temperatures. Habitat and population changes may decrease hunting and wildlife viewing opportunities for certain species, while possibly increasing opportunities for other species. Management that focuses on the restoration and maintenance of ecological integrity of terrestrial, aquatic and riparian ecosystems is required to address this risk.

Timber

Current stands contain more small trees, and fewer large trees than existed in the past, increasing the amount of ladder fuels. Relatively drier climatic conditions and slow decomposition rates, combined with the interruption of historical fire return intervals, have resulted in large accumulations of burnable materials. Current tree growth rates are commonly slow, and stand vigor is declining as competition for water, nutrients, and growing space has increased as a result of higher tree density. The low level of tree and stand vigor makes trees more susceptible to insect attack and disease mortality, combined with increased density of vegetation and continuity of fuels coalesces in an increased risk of severe effects from wildfire. Timber management activities on the Gila National Forest are trending toward targeting improvements to forest structure and function. Addressing mid- and overstory conditions is critical to these restorative efforts, as this affects overstory species composition, stand structure, potential crown fire starts and spread, stand density, and influences on understory conditions.

This approach includes selective cutting methods paired with prescribed burning, intended to develop and maintain uneven-aged forest conditions that are considered more resilient to natural disturbance, and thus more sustainable long-term. However, their extent covers only a small fraction of the landscape. Treatments are limited in part by workforce capacity and current forest plan standards that are very prescriptive, restraining management options across broad extents. The magnitude of prescribed burning accomplishments is affected by weather and other environmental factors that can be highly variable year to year, and is limited by air quality regulations, and to a lesser degree, workforce capacity and concerns over public safety and values at risk (i.e. water quality, wildlife habitat, soil productivity). Long-term benefits to ecosystem resilience, disturbance regime, nutrient cycling, biodiversity and food webs, old-growth condition, overall hydrologic function, wood products, and aesthetics and recreation can outweigh short-term negative impacts. Across the nation and in the Southwest, there is broad public support for actively managing forests to be more resilient to threats. In response, the Gila National Forest is generally shifting planning and implementation efforts to encompass larger landscapes. This work will be completed within the agency as well as with the assistance of partners that would include Federal, State, and local government agencies, conservation groups, businesses, and any other interested stakeholders. The Gila NF's primary contribution of timber and forest products is to local communities around the Forest for logs, firewood, and other forest products. An increased emphasis on land restoration projects should allow for the continued ability to contribute to this demand.

Recreation Programs and Use

The ability for the Gila NF to remain relevant and responsive to changing recreation user trends, adapting to fluctuations in budget, and ability to adequately maintain existing recreation infrastructure are at risk of being unsustainable. Many of the Forest recreation programs and opportunities are not aligned with current visitation trends and demands. The Forest has many developed recreation facilities that have been heavily impacted by fires and floods; are in declining condition due to an increased backlog of deferred maintenance; and/or not properly designed to provide the desired services. The Forest cannot adequately maintain all of its facilities to standard. Many of developed recreation sites are currently being managed to accommodate many different uses within the same site, which can result in a site not properly functioning to meet the need of any of the desired uses. In addition, many developed sites are located within floodplains which poses safety hazards and limits the opportunity to redesign the site to better meet the needs of the public

The Gila NF has a total of 1,927 miles of system trails. The perception of trails across the Forest is that there are more miles of trail than can be maintained by the Forest. This combined with the Forest trail system being heavily impacted by many recent large, high severity fires has resulted in the decline of trail conditions. Several popular trails receive regular maintenance which provides users a quality trail experience, but the majority of system trails are less traveled and tend to be in need of significant maintenance. The large percentage of trails needing significant maintenance combined with having more miles of trails than that can be maintained is causing a trend of losing many miles of trail over time. Another trend is increased conflicts on trails occurring between hikers, equestrian users, and mountain bikers near urban trail systems in certain parts of the Forest.

The ability of the Gila NF to provide meaningful recreation opportunities and experiences is an important social and economic contribution to local communities and businesses. The Gila NF has developed a Sustainable Recreation Strategy Action Plan to move towards a more flexible and efficient organization that can better align opportunities that meet the needs of current users, are economically feasible, and can be adapted to future changing recreation trends. A sustainable recreation program may require closing underutilized recreation sites, the planning and development of new sites, and/or upgrading existing sites to meet user needs and desires. The current trail system needs to be assessed to create a more manageable trail system that better meets the needs of trail users while reducing the potential for user conflicts.

Infrastructure

The ability of the Gila NF to maintain its current infrastructure is at risk of being unsustainable. Over the last 20 years, the Gila NF has invested millions in mission critical and non-critical facilities. Money has been spent to upgrade facilities to be more energy efficient, abate hazardous materials and other health hazards as well as decommission and demolish facilities no longer needed for service. The Forest's trail system is in fair to poor condition, and its roads and bridges are currently safe for visitor travel. Much of the infrastructure on the forest is old and in continual need of routine maintenance. The backlog of required large maintenance repairs has perpetually increased, and is currently valued at several million dollars. Funding levels have decreased in recent years, while the cost to perform maintenance has increased. The inability to adequately maintain existing infrastructure could result in negative impacts on the management of the Forest resources. The expectation is that future funding will not increase, resulting in a decline in the condition infrastructure across the Forest. This will force decisions on the possibility of consolidating, decommissioning, limiting future development, and / or relocating infrastructure to create a sustainable program.

The Gila NF's transportation system is integral to supporting the many uses and opportunities enjoyed by the public. Local businesses and communities benefit from visitors who want to use the Forest because they can safely access and experience the Forest on NFS roads and trails. Gaining access to the Forest through roads and trails are important for local residents to continue their traditional uses, which are integral in maintaining the social and cultural fabric of many Forest communities. Recreation infrastructure (i.e., trails, roads, campgrounds, and toilet facilities) allow for recreation opportunities, which support communities directly (e.g., outfitter guide jobs) and indirectly (e.g., increased tourism in community lodges, shops, and restaurants). Infrastructure contributes to ecological sustainability when it is properly designed, integrated within the landscape, and well maintained. The wildlife guzzlers provide fresh drinking water in times of low rainfall and when natural water sources are scarce.

Negative economic and social contributions could include having to close sites, because funds are inadequate to provide appropriate maintenance to keep sites safe for human use. Closures would reduce or limit opportunities to access and gain enjoyment of recreational resources and experiences. Negative ecological sustainability would result from a key dam failure, major road or trail erosion, or issues with septic systems. Furthermore, climate change is projected to increase the need for maintenance and exacerbate the deterioration of infrastructure not designed to withstand new weather patterns and flood regimes.

Economic and Social Conditions

The ability of the Gila NF to continue contributing the social and economic benefits (e.g., recreation programs and use, infrastructure, ranching and grazing, and recreational hunting) desired by local communities, families, and the visiting public is at risk. These Forest uses contribute to the many benefits for communities and families (i.e., local traditional uses, social and family traditional values) and the economic opportunity within the assessment area. The ability to recreate on the Forest provides intrinsic values, such as a connection to nature, family togetherness, and improved physical and mental health. Infrastructure provides the ability to access and use the Forest. Without safe, available infrastructure Forest users would be limited in their ability to maximize the many benefits the Forest contributes. For some forest users grazing and ranching are their primary source of income, or an important supplement to their income. Grazing and ranching provide strong cultural and family connections for many communities and families around the Forest. Hunting contributes to the economic opportunity for local sportsman, businesses, and outfitters. The State of New Mexico and local communities receive important revenue from sales of licenses, taxes, and other economic activity resulting from wildlife associated recreation including hunting, fishing, and trapping. Hunting provides a strong social and cultural connection for families, to each other and to the land.

The Gila NF is a Forest surrounded by many small towns, communities, and people who rely upon the Forest to provide resources and uses important to their social and cultural traditions and way of life, and as a means of contributing economic opportunity. Forest management that focuses on contributing to these needs, while maintaining the ecological integrity of the Forest, is required to address this risk.

The Gila NF is an integral part of the local cultures and communities it serves. Relationships with local communities and groups are vital in Forest management and in providing services to local and visiting Forest users. Poor or ineffective communication with the public and the inability to establish partnerships for completing work on the Forest were two issues identified by the public, when the Forest Service held community meetings in 2015. Given the future potential for declining budgets and workforce, the Gila NF will need to engage other public and private entities to effectively manage the Forest resources to continue to provide for the needs and desires of the public. The Forest is engaging with private and public entities to acquire funding for watershed restoration work and working with partners on forest restoration projects through the Collaborative Forest Restoration Program. The Forest will need to be creative in accomplishing other work related to recreation, minor maintenance, and education programs. The challenge for the Forest will be in developing the capacity and expertise to identify, plan, and manage new partners and volunteers. For the new Gila forest plan to be successful, the public and the Forest Service will need to share ownership and implementation of the new forest plan.

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Appendix A. Local Unit Development Process

5th Codes clipped to Forest boundary

Rule set:

Three regional “rules of thumb”

- 4-8 local units
- At least 10x historical patch size
- Try to have representation of each ERUs in as many units as possible

1. Set min and max local unit size
    - Gila is roughly 3,300,000 acres
    - 3,300,000 acres/8=400,000 acres=minimum local unit
    - 3,300,000 acres/4=800,000 acres=maximum local unit

2. Start with smallest watershed

3. Set 400,000 acre threshold. Lump smallest polygon with adjacent polygon with fewest acres. Continue lumping until all polygons cross the 400,000 acre threshold.

    - Results of this process create 6 local units.
    - Any additional lumping would cross the 800,000 maximum acre threshold.
    - Smallest unit is well above the 10x historical patch size.

Table A1 compares representativeness of this proposal with using administrative boundaries (Districts) as an alternative approach. Note: this is based on the draft ERUv5 with grassland corrections and excludes riparian/wetland and Madrean ERUs.

Table A1. Representation of Ecological Response Units

ERU	# of Proposed Local Units ERU Occurs In	# of Local Units ERU Occurs in if Ranger Districts are used
SFF	4 of 6 (very few acres in “Apache” unit)	3 of 6
MCW	6 of 6	6 of 6
MCD	6 of 6	6 of 6
CP/GBG	5 of 6	4 of 6
MSG	6 of 6	4 of 6
SDG	3 of 6	3 of 6

ERU	# of Proposed Local Units ERU Occurs In	# of Local Units ERU Occurs in if Ranger Districts are used
PPF	6 of 6	6 of 6
PPE	6 of 6	6 of 6
PJG	6 of 6	6 of 6
PJE	6 of 6	6 of 6
PJW	6 of 6	6 of 6
JGW	5 of 6	2 of 6
GOS	5of 6	4 of 6
MMS	6 of 6	6 of 6

Wilderness representation in 5 out of 6 units.

Appendix B. Carbon Assessment Methods

Assignment of Biomass Carbon Values by Seral State – Forests and Woodlands

The Southwestern Region incorporated a process of using the Forest Vegetation Simulator (FVS) in conjunction with the Vegetation Dynamic Development Tool (VDDT) to help inform State and Transition Models (STM) that were developed in support of forest planning. One objective of this dual modeling system was to test the assumptions made by the STM developer—in some cases, this process lead to modification of some STM model parameters. Another objective of this process was to use existing forest inventory data as input into the FVS model to provide an empirical basis to more fully understand important vegetation pathways that may not have been adequately represented through expert opinion or pertinent research literature—and perhaps, therein expand the STM framework. Conversely, a development pathway conceived to be important in the STM may be shown through the FVS process to be not as prevalent as originally thought—and therefore, lead to eliminating a particular pathway in a revised STM. Finally, we know of no better way than an FVS analysis to estimate outputs for the many complex transitions that are likely to be modeled in an STM—FVS, especially when used with the Event Monitor, can be used to develop outputs such as standing and harvest volumes, fuel conditions, stand structural attributes, and biomass and carbon stocks that can be linked to vegetation states in VDDT models.

Inventory Data

The modeling process began by dividing the southwestern United States into terrestrial ecosystems that range from dry grasslands-shrublands, to semi-arid woodlands, to moist forestlands. Each ecosystem is representative of an Ecological Response Units (ERU) (aka Potential Natural Vegetation Type (PNVT)) (Schussman and Smith, E. 2006). Each ERU, which is depicted within separate VDDT models, was then further broken into vegetation states. A vegetation state is a composite of cover type (prevailing species composition) and stand structure (dominant tree size, canopy cover density, and vertical canopy layering).

During this initial phase, Forest Inventory and Analysis (FIA) plots were filtered by habitat type (USDA Forest Service 1997) to represent each ERU[61]. Table B1 provides a listing of the habitat types associated with the ponderosa pine/bunchgrass (PPG) ERU. Table B2 shows FIA plot distribution by ERU and representation by National Forest. For reference, the PPG ERU is highlighted. Table B3 lists the criteria used to develop the vegetation states for the PPG ecosystem and its associated VDDT model. Table B4 displays the FIA plot samples that were tallied for each vegetation state within the PPG ERU.

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[61] The terms "habitat type" and "plant association" are synonymous in the southwestern region. An ERU is comprised of several habitat types.

Table B1. Habitat type codes associated to the ponderosa pine/bunchgrass ERU.

Habitat Type Code	Common Name
011092	ponderosa pine/Arizona fescue/blue gramma
011093	ponderosa pine/Arizona fescue/Gambel oak
011330	ponderosa pine/mountain muhly
011340	ponderosa pine/screwleaf muhly
011341	ponderosa pine/screwleaf muhly/Gambel oak
011350	ponderosa pine/Indian ricegrass
011380	ponderosa pine/black sagebrush
011390	ponderosa pine/screwleaf muhly-Arizona fescue
011391	ponderosa pine/screwleaf muhly-Arizona fescue/blue gramma
011392	ponderosa pine/screwleaf muhly-Arizona fescue/Gambel Oak
011400	ponderosa pine/kinnikinnik
011470	ponderosa pine/Arizona walnut

Table B2. Forest Inventory and Analysis (FIA) Plot Distribution by ERU.

Forest Type	ERU - VDDT Model	FIA Plots	Σ FIA Plots
Spruce-Fir_pure	Spruce-Fir Forest	21	93
Spruce-Fir_mix		72	
Mixed_Conifer-Wet	Mixed Conifer Wet (infrequent fire)	123	123
Mixed_Conifer-Dry	Mixed Conifer Dry (frequent fire)	372	372
Ponderosa-Grass	Ponderosa Pine Forest	482	788
Ponderosa-gmbOak		306	
Ponderosa-evgOak	Ponderosa Pine-Mild/Evergreen Oak	137	137
Wdlnd_PJGrass	PJ Woodland	713	1803
Wdlnd_PJOak		163	
Wdlnd_PJChap	PJ Evergreen Shrubland	303	
Wdlnd_PJSage	PJ Sagebrush	48	
Wdlnd_JUGrass	JU Grassland	268	
Wdlnd_Oak	WDL Evergreen Oak	308	
Wdlnd_None		53	970
Riparian		5	
Non-Forest		912	
Total:		4286	4286

			Plot Count			Dates	
Forest: Code	State	Name	Periodic	Annual	Total	Periodic	Annual
01	AZ	Apache-Sitgreaves	326	172	498	1996-1997	2001-2005
02	NM	Carson	235	0	235	1998-1999	
03	NM	Cibola	268	0	268	1997	
04	AZ	Coconino	301	167	468	1995-1996	2001-2005
05	AZ & NM	Coronado	282	157	439	1996-1998	2001-2005
06	NM	Gila	526	0	526	1993-1996	
07	AZ	Kaibab	247	146	393	1995-1997	2001-2005
08	NM	Lincoln	187	0	187	1997	
09	AZ	Prescott	193	107	300	1995-1996	2001-2005
10	NM	Santa Fe	255	0	255	1998-1999	
12	AZ	Tonto	464	253	717	1996-1998	2001-2005
Total:			3284	1002	4286		

Table B3. Stratification of ponderosa pine/bunchgrass ERU vegetation states A through N, according to key attributes of dominant tree size, canopy cover, and canopy layering.

	Tree Diameter					
GFB	0-5"	5-10"	10-20"	20"+	Canopy Cover[1]	Canopy Layering
A or N[2]	B	C	D	E	Open	Single
	F	G	H	I	Closed	Single
			J[3]	K[3]	Open	Multi
			L	M	Closed	Multi

[1] – Except for States A and N, "Open" states have 10 to 30% canopy cover and "Closed" states have greater than 30% canopy cover. States A and N have less than 10% canopy cover.

[2] – States A and N are grass, forbs, brush, and shrub states (GFB). State A is the characteristic state which existed in reference conditions. State N is the uncharacteristic state resulting when stand-replacing fires occur in closed canopy states. (Smith 2006)

[3] – The *desired condition* is an open multi-layered (≥ 5 age classes) state with average diameter varying by site productivity with State J occurring on low productive sites and State K occurring on high productivity sites. (Triepke et al. 2011)

Table B4. FIA sample plot counts and percentages for the PPG ecosystem.

Model	PPG	
State Class	n	%
A	32	6.6%
B	7	1.5%
C	24	5.0%
D	61	12.7%
E	18	3.7%
F	23	4.8%
G	84	17.4%
H	52	10.8%
I	6	1.2%
J	44	9.1%
K	21	4.4%
L	92	19.1%
M	18	3.7%
Total	482	100.0%

FVS Adjustments

Before projecting the FIA inventory plots with FVS, it was important to adjust default parameters for growth, mortality, and regeneration for each ERU. The purpose of performing these adjustment steps is so that the projections more closely mimic the empirical (i.e. endemic) conditions determined from the actual field measurements. One example of a situation where calibration is essential is for projecting old-forest stands. The sample base upon which the empirical growth and mortality equations in FVS are built are intrinsically not well suited to modeling old-growth forests over long time horizons, and yet typically VDDT simulations are performed for 200 to 300-year intervals. Thus, thoughtful calibration can greatly improve the realism of simulations when projecting stands over long time periods by attenuating height and diameter growth and mortality during stand senescence.

Adjustment procedures include using the FVS self-calibrating feature (for example, altering the baseline estimate of the large-tree diameter growth models), accounting for tree defect for volume estimates (adjusting net merchantable volume from gross tree dimensions), determining tree species size attainment, limiting stand maximum density, and estimating and inputting natural regeneration response (querying existing stands to tabulate their seedling component). Vandendriesche 2009a addresses this topic in more detail.

Natural Growth Projections

In VDDT, the successional classes, pathways, and transition probabilities are defined for each Ecological Restoration Unit. A single ERU may have more than one set of probabilities defined to represent different management regimes or ecological conditions. In general, two types of transitions can occur. One type is movement between states due to natural succession. This process integrates background disturbances that affect regeneration, growth, and self-thinning, but not extrinsic disturbances such as insect or disease outbreaks, wildfire, or silvicultural treatment. Transitions representing natural successional dynamics (or ‘natural growth’) are modeled deterministically in VDDT. What this means is that transitions from one class to the next class occur when the residence time (a surrogate for successional ‘age’) has exceeded the value set for the state. For transitions in VDDT related to disturbances, movement between states is determined stochastically according to probabilities conveyed by modeling or set by the user.

Once the FVS adjustment procedure has been completed, FVS commands (keywords) were used to adjust growth, mortality, and regeneration responses as outlined in the above section. To model natural succession in FVS, residence time in a state was tracked —the average length of time that vegetation typically remains in that state before transitioning to the next state along the successional pathway. This was accomplished by projecting all the plots in the specific ERU without invoking any disturbances such as pest effects or catastrophic wildfires in FVS. Then 250-year projections are performed for every plot, outputting tree lists and stand summaries each cycle for completing the next two steps in the process.

Classify the Tree Lists, Calculate Residence Times

In order to accomplish the integration of FVS within the VDDT-STM approach, a computer program was developed to classify inventory data into vegetation states (i.e. cover type, size class, canopy cover, canopy layers) for initial conditions and for subsequent projection cycles. The Preside program (Vandendriesche 2009b) summarizes various vegetation classes into classes and provides average time in a particular vegetation state and the probability of movement to associated states.

Preside classifies the current tree list for each plot at each projection cycle boundary. Estimates of the residence times and resultant pathways are summarized by use of an array of all possible transitions from one state to another, and indexed by vegetation state to which a plot belongs. For each plot at each cycle, its source (that is what state it began the cycle in) and destination (that is what state it ended the cycle in) are recorded. The length of time each plot remains within a state class between cycles is accumulated and the mean and variance of residence times is summarized over all the cycles and transitions in the projection. The pathways (direction of movement between source and destination) between vegetation states are also summarized using the array.

Accumulate and Summarize Outputs

At the end of an FVS projection, a set of FVS post-processing steps have been bundled together that produce aggregate summaries for each of the vegetation classes, using the sample of plots populating each vegetation state during the projection. It is then relatively easy to display graphics for communicating the STM results. For example, images from the Stand Visualization System (SVS) can be displayed for each vegetation state that is an aggregate of the plots in that state (Figure B1). The post-processing programs also index the aggregate state classes to summary values derived from the tree lists, attributes from standard FVS output reports, and variables computed from the Event Monitor. This feature is useful for tracking important values such as stand volume and biomass across states (example, Figure B2).

Figure B1. Aggregate Stand Visualization System (SVS) Graphic Depictions of Vegetation States within the PPG ecosystem.

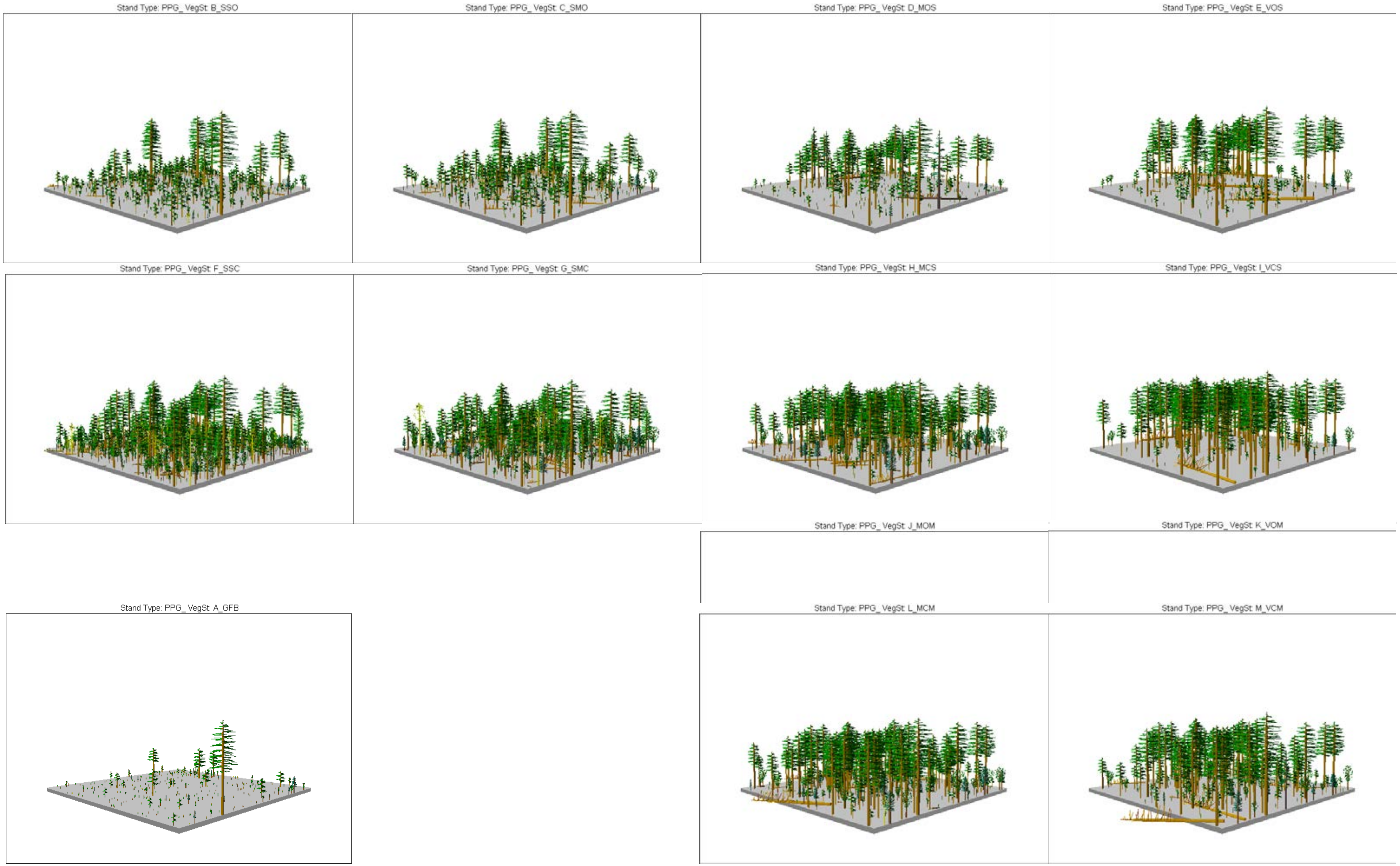
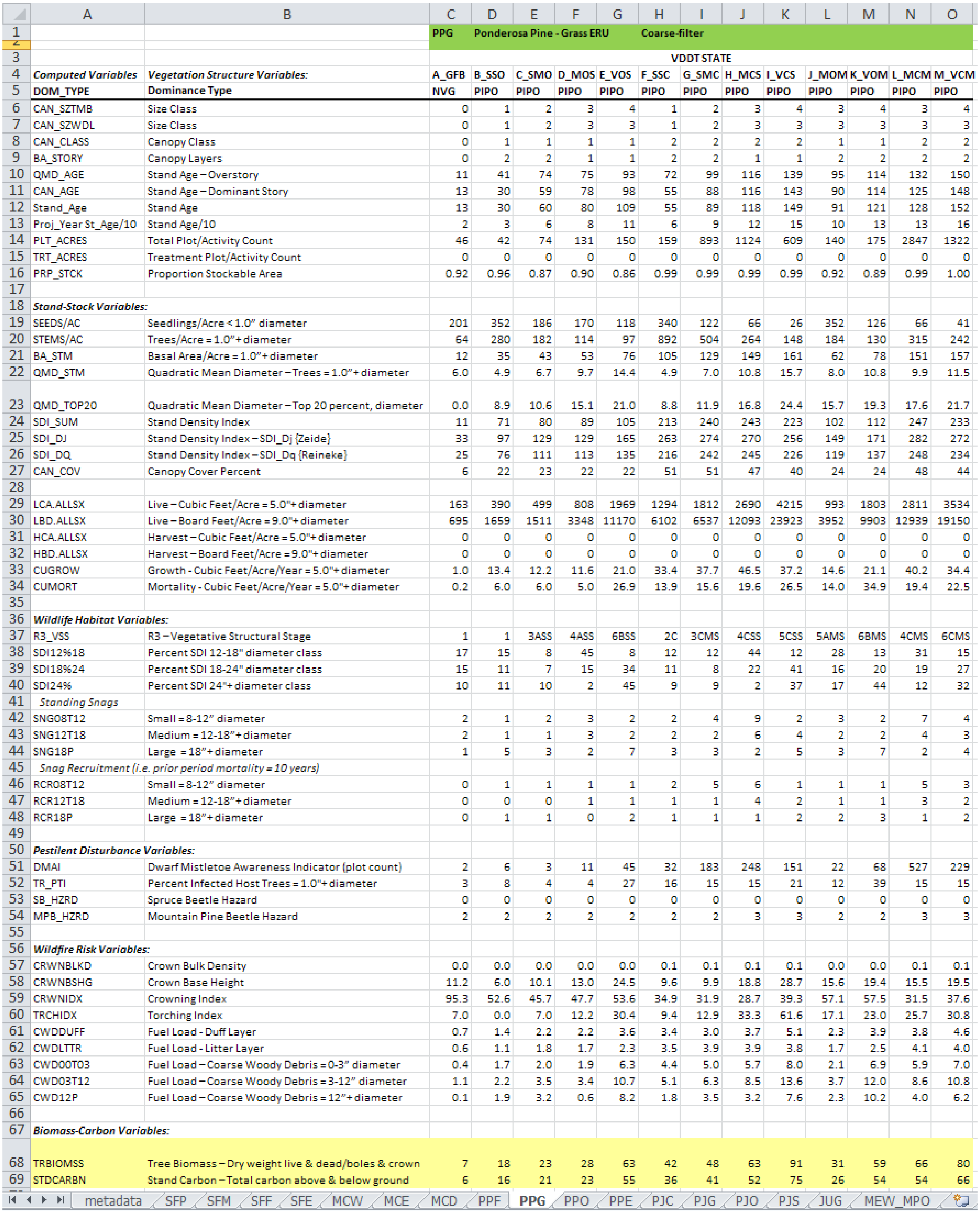


Figure B2. Aggregate Summarizes of FVS Event Monitor Computed Variables for PPG ERU



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1			PPG	Ponderosa Pine - Grass ERU				Coarse-filter							
2															
3									VDDT STATE						
4	***Computed Variables***	***Vegetation Structure Variables:***	A_GFB	B_SSO	C_SMO	D_MOS	E_VOS	F_SSC	G_SMC	H_MCS	I_VCS	J_MOM	K_VOM	L_MCM	M_VCM
5	DOM_TYPE	Dominance Type	NVG	PIPO	PIPO	PIPO	PIPO	PIPO	PIPO	PIPO	PIPO	PIPO	PIPO	PIPO	PIPO
6	CAN_SZTMB	Size Class	0	1	2	3	4	1	2	3	4	3	4	3	4
7	CAN_SZWDL	Size Class	0	1	2	3	3	1	2	3	3	3	3	3	3
8	CAN_CLASS	Canopy Class	0	1	1	1	1	2	2	2	2	1	1	2	2
9	BA_STORY	Canopy Layers	0	2	2	1	1	2	2	1	1	2	2	2	2
10	QMD_AGE	Stand Age – Overstory	11	41	74	75	93	72	99	116	139	95	114	132	150
11	CAN_AGE	Stand Age – Dominant Story	13	30	59	78	98	55	88	116	143	90	114	125	148
12	Stand_Age	Stand Age	13	30	60	80	109	55	89	118	149	91	121	128	152
13	Proj_Year St_Age/10	Stand Age/10	2	3	6	8	11	6	9	12	15	10	13	13	16
14	PLT_ACRES	Total Plot/Activity Count	46	42	74	131	150	159	893	1124	609	140	175	2847	1322
15	TRT_ACRES	Treatment Plot/Activity Count	0	0	0	0	0	0	0	0	0	0	0	0	0
16	PRP_STCK	Proportion Stockable Area	0.92	0.96	0.87	0.90	0.86	0.99	0.99	0.99	0.99	0.92	0.89	0.99	1.00
17															
18	***Stand-Stock Variables:***														
19	SEEDS/AC	Seedlings/Acre < 1.0” diameter	201	352	186	170	118	340	122	66	26	352	126	66	41
20	STEMS/AC	Trees/Acre = 1.0”+ diameter	64	280	182	114	97	892	504	264	148	184	130	315	242
21	BA_STM	Basal Area/Acre = 1.0”+ diameter	12	35	43	53	76	105	129	149	161	62	78	151	157
22	QMD_STM	Quadratic Mean Diameter – Trees = 1.0”+ diameter	6.0	4.9	6.7	9.7	14.4	4.9	7.0	10.8	15.7	8.0	10.8	9.9	11.5
23	QMD_TOP20	Quadratic Mean Diameter – Top 20 percent, diameter	0.0	8.9	10.6	15.1	21.0	8.8	11.9	16.8	24.4	15.7	19.3	17.6	21.7
24	SDI_SUM	Stand Density Index	11	71	80	89	105	213	240	243	223	102	112	247	233
25	SDI_DJ	Stand Density Index – SDI_Dj {Zeide}	33	97	129	129	165	263	274	270	256	149	171	282	272
26	SDI_DQ	Stand Density Index – SDI_Dq {Reineke}	25	76	111	113	135	216	242	245	226	119	137	248	234
27	CAN_COV	Canopy Cover Percent	6	22	23	22	22	51	51	47	40	24	24	48	44
28															
29	LCA.ALLSX	Live – Cubic Feet/Acre = 5.0"+ diameter	163	390	499	808	1969	1294	1812	2690	4215	993	1803	2811	3534
30	LBD.ALLSX	Live – Board Feet/Acre = 9.0"+ diameter	695	1659	1511	3348	11170	6102	6537	12093	23923	3952	9903	12939	19150
31	HCA.ALLSX	Harvest – Cubic Feet/Acre = 5.0"+ diameter	0	0	0	0	0	0	0	0	0	0	0	0	0
32	HBD.ALLSX	Harvest – Board Feet/Acre = 9.0"+ diameter	0	0	0	0	0	0	0	0	0	0	0	0	0
33	CUGROW	Growth - Cubic Feet/Acre/Year = 5.0"+ diameter	1.0	13.4	12.2	11.6	21.0	33.4	37.7	46.5	37.2	14.6	21.1	40.2	34.4
34	CUMORT	Mortality - Cubic Feet/Acre/Year = 5.0"+ diameter	0.2	6.0	6.0	5.0	26.9	13.9	15.6	19.6	26.5	14.0	34.9	19.4	22.5
35															
36	***Wildlife Habitat Variables:***														
37	R3_VSS	R3 – Vegetative Structural Stage	1	1	3ASS	4ASS	6BSS	2C	3CMS	4CSS	5CSS	5AMS	6BMS	4CMS	6CMS
38	SDI12%18	Percent SDI 12-18" diameter class	17	15	8	45	8	12	12	44	12	28	13	31	15
39	SDI18%24	Percent SDI 18-24" diameter class	15	11	7	15	34	11	8	22	41	16	20	19	27
40	SDI24%	Percent SDI 24"+ diameter class	10	11	10	2	45	9	9	2	37	17	44	12	32
41	*Standing Snags*														
42	SNG08T12	Small = 8-12” diameter	2	1	2	3	2	2	4	9	2	3	2	7	4
43	SNG12T18	Medium = 12-18”+ diameter	2	1	1	3	2	2	2	6	4	2	2	4	3
44	SNG18P	Large = 18”+ diameter	1	5	3	2	7	3	3	2	5	3	7	2	4
45	*Snag Recruitment (i.e. prior period mortality = 10 years)*														
46	RCR08T12	Small = 8-12” diameter	0	1	1	1	1	2	5	6	1	1	1	5	3
47	RCR12T18	Medium = 12-18”+ diameter	0	0	0	1	1	1	1	4	2	1	1	3	2
48	RCR18P	Large = 18”+ diameter	0	1	1	0	2	1	1	1	2	2	3	1	2
49															
50	***Pestilent Disturbance Variables:***														
51	DMAI	Dwarf Mistletoe Awareness Indicator (plot count)	2	6	3	11	45	32	183	248	151	22	68	527	229
52	TR_PTI	Percent Infected Host Trees = 1.0"+ diameter	3	8	4	4	27	16	15	15	21	12	39	15	15
53	SB_HZRD	Spruce Beetle Hazard	0	0	0	0	0	0	0	0	0	0	0	0	0
54	MPB_HZRD	Mountain Pine Beetle Hazard	2	2	2	2	2	2	2	3	3	2	2	3	3
55															
56	***Wildfire Risk Variables:***														
57	CRWNBLKD	Crown Bulk Density	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1
58	CRWNBSHG	Crown Base Height	11.2	6.0	10.1	13.0	24.5	9.6	9.9	18.8	28.7	15.6	19.4	15.5	19.5
59	CRWNIDX	Crowning Index	95.3	52.6	45.7	47.7	53.6	34.9	31.9	28.7	39.3	57.1	57.5	31.5	37.6
60	TRCHIDX	Torching Index	7.0	0.0	7.0	12.2	30.4	9.4	12.9	33.3	61.6	17.1	23.0	25.7	30.8
61	CWDDUFF	Fuel Load - Duff Layer	0.7	1.4	2.2	2.2	3.6	3.4	3.0	3.7	5.1	2.3	3.9	3.8	4.6
62	CWDLTTR	Fuel Load - Litter Layer	0.6	1.1	1.8	1.7	2.3	3.5	3.9	3.9	3.8	1.7	2.5	4.1	4.0
63	CWD00T03	Fuel Load – Coarse Woody Debris = 0-3” diameter	0.4	1.7	2.0	1.9	6.3	4.4	5.0	5.7	8.0	2.1	6.9	5.9	7.0
64	CWD03T12	Fuel Load – Coarse Woody Debris = 3-12” diameter	1.1	2.2	3.5	3.4	10.7	5.1	6.3	8.5	13.6	3.7	12.0	8.6	10.8
65	CWD12P	Fuel Load – Coarse Woody Debris = 12”+ diameter	0.1	1.9	3.2	0.6	8.2	1.8	3.5	3.2	7.6	2.3	10.2	4.0	6.2
66															
67	***Biomass-Carbon Variables:***														
68	TRBIOMSS	Tree Biomass – Dry weight live & dead/boles & crown	7	18	23	28	63	42	48	63	91	31	59	66	80
69	STDCARBN	Stand Carbon – Total carbon above & below ground	6	16	21	23	55	36	41	52	75	26	54	54	66

Appendix C. Air NAAQS NMAAQs

Table C1. National and New Mexico ambient air quality standards

Pollutant	Averaging Time	New Mexico Standards	National Standards[a] Primary[b,c]	National Standards[a] Secondary[b,d]
Ozone	8-hour	—	0.070 ppm	Same as primary
Carbon monoxide	8-hour	8.7 ppm	9 ppm	—
	1-hour	13.1 ppm	35 ppm	—
Nitrogen dioxide	Annual	0.05 ppm	53 ppb	Same as primary
	24-hour	0.10 ppm	—	—
	1-hour		100 ppb	—
Sulfur dioxide	Annual	0.02 ppm	—	—
	24-hour	0.10 ppm	—	—
	3-hour	—	—	0.5 ppm
	1-hour		75 ppb	—
Hydrogen sulfide	1-hour	0.010 ppm	—	—
Total Reduced Sulfur	½-hour	0.003 ppm	—	—
PM_{10}	24-hour	Same as Federal	150 µg/m^3	Same as primary
$PM_{2.5}$	Annual (arithmetic mean)	Same as Federal	12 µg/m^3	15 µg/m^3
	24-hour	Same as Federal	35 µg/m^3	Same as primary
Total Suspended Particulates (TSP)	Annual (geometric mean)	60 µg/m^3	—	—
	30-day Average	90 µg/m^3	—	—
	7-day	110 µg/m^3	—	—
	24-hour	150 µg/m^3	—	—
Lead	Rolling 3 month average	—	0.15 µg/m^3	Same as primary

Notes:

(a) Standards other than the 1-hour ozone, 24-hour PM10, and those based on annual averages are not to be exceeded more than once a year.

(b) To attain the 8 hour ozone standard the 3 year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.070 ppm.

(c) Concentrations are expressed in units in which they were promulgated. µg/m3 = micrograms per cubic meter and ppm = parts per million. Units shown as µg/m3 are based upon a reference temperature of 25oC and a reference pressure of 760 mm of mercury.

(d) Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.

(e) Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Averaging Time: the amount of time that the associated data is averaged to assess compliance with the standard.

µg/m3 = micrograms per cubic meter; ppm = parts per million; ppb = parts per billion

Appendix D. Water

Table D1. Plan area subbasin, watershed and subwatershed extent and Gila NF percent

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
13020208	***Plains of San Agustin***	***1,275,453***	***135,981***	***11***
1302020804	*Nester Draw*	*169,190*	*5,328*	*3*
130202080401	Bear Canyon	11,723	4,485	38
130202080404	Headwaters Nester Draw	28,451	843	3
1302020806	*Y Canyon*	*97,476*	*52,140*	*53*
130202080601	La Jolla Canyon	36,942	36,581	99
130202080603	Y Canyon	37,145	15,558	42
1302020807	*Patterson Lake*	*207,398*	*78,514*	*38*
130202080701	Alamocito Creek	23,076	8,590	37
130202080703	West Pasture Springs	24,184	340	1
130202080704	Patterson Canyon	28,535	18,842	66
130202080705	Dark Canyon	15,833	6,701	42
130202080706	Patterson Lake	27,991	11,194	40
130202080707	Long Canyon	22,698	21,762	96
130202080708	T H Canyon	36,866	11,085	30
13020211	***Elephant Butte Reservoir***	***1,403,516***	***40,451***	***3***
1302021106	*Headwaters Alamosa Creek*	*257,399*	*40,451*	*16*
130202110603	Little Pigeon Canyon-Alamosa Creek	22,562	4,846	21
130202110606	Wahoo Canyon-Alamosa Creek	32,951	17,010	52
130202110607	Sim Yaten Canyon-Alamosa Creek	24,360	3,800	16
130202110608	Wildhorse Canyon	39,987	14,795	37

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
13030101	***Caballo***	***795,153***	***211,635***	***27***
1303010101	*Cuchillo Negro Creek*	*236,142*	*76,046*	*32*
130301010101	Turkey Creek	21,754	18,396	85
130301010102	Poverty Creek	35,362	16,904	48
130301010103	Chloride Creek	24,175	18,462	76
130301010104	South Fork Cuchillo Negro Creek	20,241	14,426	71
130301010105	Monument Creek	12,175	3,662	30
130301010106	Monument Creek-Cuchillo Negro Creek	20,852	4,196	20
1303010102	*Palomas Creek-Rio Grande*	*234,606*	*57,833*	*25*
130301010204	Mud Spring Canyon	11,488	11,483	100
130301010205	Circle Seven Creek	11,783	11,362	96
130301010206	North Fork Palomas Creek	27,832	15,537	56
130301010207	South Fork Palomas Creek	34,090	19,451	57
1303010103	*Percha Creek*	*77,379*	*24,763*	*32*
130301010301	South Percha Creek	24,291	12,774	53
130301010302	North Percha Creek	22,194	11,990	54
1303010104	*Caballo Reservoir*	*247,026*	*52,993*	*21*
130301010401	North Seco Canyon	18,465	14,044	76
130301010403	Seco Creek	37,113	3,691	10
130301010404	Holden Prong	15,707	15,707	100
130301010405	Cave Creek	16,702	3,653	22
130301010406	Headwaters Los Animas Creek	24,329	15,899	65
13030102	***El Paso-Las Cruces***	***3,542,482***	***37,572***	***1***
1303010202	*Cuervo Arroyo_Rio Grande*	*226,938*	*37,572*	*17*
130301020201	Trujillo Canyon Creek	32,304	10,652	33
130301020203	Headwaters Tierra Blanca Creek	11,273	11,094	98
130301020204	Outlet Tierra Blanca Creek	29,771	4,411	15

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
130301020207	Jaralosa Creek	18,417	2,367	13
130301020208	Headwaters Berenda Creek	24,633	9,049	37
13030202	***Mimbres***	***4,283,488***	***210,291***	***5***
1303020201	*Gallinas Canyon-Mimbres River*	*205,881*	*151,448*	*74*
130302020101	Powderhorn Canyon-Mimbres River	34,772	34,303	99
130302020102	Allie Canyon-Mimbres River	39,146	37,836	97
130302020103	Sheppard Canyon-Mimbres River	35,286	28,449	81
130302020104	Noonday Canyon	16,312	12,800	78
130302020105	Noonday Canyon-Mimbres River	28,962	12,826	44
130302020106	Gallinas Canyon	34,694	25,234	73
1303020202	*Headwaters San Vicente Draw*	*144,197*	*26,072*	*18*
130302020201	Rio de Arenas	16,527	956	6
130302020203	Pipeline Draw-San Vicente Draw	35,273	5,747	16
130302020204	Cameron Creek	35,879	19,254	54
130302020205	Cameron Creek-San Vicente Draw	31,507	114	<1
1303020203	*Outlet San Vicente Draw*	*160,634*	*1,684*	*1*
130302020302	Headwaters Whitewater Creek	29,873	852	3
130302020305	Antelope Draw-San Vicente Draw	35,466	832	2
1303020204	*Lampbright Draw*	*92,105*	*2,351*	*3*
130302020401	Headwaters Lampbright Draw	26,633	2,351	9
1303020205	*Lampbright Draw-Mimbres River*	*124,477*	*20,713*	*17*
130302020501	Gavilan Arroyo	20,663	8,270	40
130302020502	Gavilan Arroyo-Mimbres River	31,746	12,442	39
1303020208	*Macho Creek*	*213,735*	*3,641*	*2*
130302020801	Upper Macho Creek	37,240	3,641	10
1303020213	*Upper Seventysix Draw*	*114,409*	*1,313*	*1*
130302021301	Whiterock Canyon	29,085	1,313	5

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
1303020214	*Cow Spring Draw-Seventysix Draw*	*184,549*	*3,070*	*2*
130302021402	130302021402 Headwaters Cow Spring Draw	22,468	3,070	14
15020001	***Little Colorado Headwaters***	***515,246***	***13,510***	***3***
1502000103	*Coyote Creek*	*147,501*	*13,510*	*9*
150200010301	Hay Vega	7,091	2,775	39
150200010302	Canovas Creek-Coyote Creek	32,466	10,735	33
15020003	***Carrizo Wash***	***1,446,531***	***197,142***	***14***
1502000301	*Rito Creek*	*279,878*	*37,218*	*13*
150200030101	Upper Mangas Creek	36,487	21,099	58
150200030102	Middle Mangas Creek	33,664	5,757	17
150200030103	Lower Mangas Creek	28,248	2,014	7
150200030109	Escondido Creek	17,756	8,348	47
1502000302	*Upper Largo Creek*	*98,300*	*75,156*	*76*
150200030201	El Caso Spring Canyon	24,252	24,173	100
150200030202	Sawmill Canyon-Largo Creek	26,750	24,350	91
150200030203	Paradise Canyon-Largo Creek	20,420	17,327	85
150200030204	Rito Creek-Largo Creek	26,879	9,306	35
1502000305	*Agua Fria Creek*	*218,968*	*76,850*	*35*
150200030501	Harris Creek-Agua Fria Creek	30,978	27,842	90
150200030502	Demetrio Creek	16,670	9,827	59
150200030503	Demetrio Creek-Agua Fria Creek	19,684	7,222	37
150200030504	Gatlin Lake	25,404	18,441	73
150200030505	Mangitas Creek	23,062	9,453	41
150200030506	Cerro La Mula	38,056	3,751	10
150200030507	Cerro La Mula-Agua Fria Creek	17,282	314	2
1502000307	*LA Draw-Cienega Amarilla*	*160,256*	*7,918*	*5*
150200030703	Cow Springs Draw	31,273	7,918	25

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
15040001	***Upper Gila***	***1,269,561***	***1,069,298***	***84***
1504000101	*Railroad Canyon*	*89,105*	*14,046*	*16*
150400010101	Upper Railroad Canyon	35,504	1,567	4
150400010102	Middle Railroad Canyon	26,162	10,621	41
150400010103	Lower Railroad Canyon	27,439	1,858	7
1504000102	*Corduroy Draw*	*111,118*	*68,279*	*61*
150400010201	Upper Corduroy Draw	30,828	6,861	22
150400010202	South Water Canyon	24,643	19,489	79
150400010203	Middle Corduroy Draw	24,390	11,932	49
150400010204	Lower Corduroy Draw	31,256	29,997	96
1504000103	*Beaver Creek*	*147,638*	*79,799*	*54*
150400010301	Horse Camp Canyon	15,100	10,978	73
150400010302	Coyote Canyon	32,704	193	1
150400010303	O Bar O Canyon	39,489	18,176	46
150400010304	Houghton Canyon	22,043	20,296	92
150400010305	Houghton Canyon-Beaver Creek	38,302	30,156	79
1504000104	*Headwaters East Fork Gila River*	*193,943*	*192,473*	*99*
150400010401	Hoyt Creek	27,022	26,806	99
150400010402	Taylor Creek	37,997	37,531	99
150400010403	Taylor Creek-Beaver Creek	26,657	26,380	99
150400010404	Headwaters Diamond Creek	20,910	20,906	100
150400010405	South Diamond Creek	25,605	25,600	100
150400010406	Outlet Diamond Creek	24,885	24,829	100
150400010407	Diamond Creek-East Fork Gila River	30,867	30,424	99
1504000105	*Middle Fork Gila River*	*218,844*	*218,128*	*100*
150400010501	T Bar Canyon	26,574	26,490	100
150400010502	Gilita Creek	25,238	25,170	100

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
150400010503	Snow Canyon	31,354	31,347	100
150400010504	Canyon Creek	29,988	29,751	99
150400010505	Canyon Creek-Middle Fork Gila River	32,448	32,448	100
150400010506	Indian Creek Canyon	21,872	21,705	99
150400010507	Indian Creek Canyon-Middle Fork Gila River	21,408	21,408	100
150400010508	Big Bear Canyon-Middle Fork Gila River	29,963	29,810	99
1504000106	*West Fork Gila River*	*103,948*	*102,439*	*99*
150400010601	White Creek	13,961	13,961	100
150400010602	Headwaters West Fork Gila River	23,183	23,183	100
150400010603	Little Creek	26,790	26,761	100
150400010604	Outlet West Fork Gila River	40,014	38,534	96
1504000107	*Outlet East Fork Gila River*	*104,412*	*103,887*	*99*
150400010701	Tom Moore Canyon	13,535	13,530	100
150400010702	Headwaters Black Canyon	21,638	21,638	100
150400010703	Apache Creek	15,167	15,167	100
150400010704	Outlet Black Canyon	34,982	34,943	100
150400010705	Black Canyon-East Fork Gila River	19,089	18,608	97
1504000108	*Sapillo Creek*	*110,693*	*108,907*	*98*
150400010801	Rocky Canyon	15,161	15,161	100
150400010802	Rocky Canyon-Sapillo Creek	29,748	29,283	98
150400010803	Lake Roberts-Sapillo Creek	23,377	22,793	98
150400010804	Copperas Creek-Sapillo Creek	16,759	16,021	96
150400010805	Sheep Corral Canyon-Sapillo Creek	25,649	25,649	100
1504000109	*Sapillo Creek-Gila River*	*189,860*	*181,341*	*96*
150400010901	Sapillo Creek-Gila River	26,533	26,533	100
150400010902	Hells Canyon-Gila River	25,248	25,248	100
150400010903	Turkey Creek	32,976	32,936	100

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
150400010904	Upper Mogollon Creek	34,707	34,707	100
150400010905	Middle Mogollon Creek	25,232	22,115	88
150400010906	Lower Mogollon Creek	19,603	14,659	75
150400010907	Mogollon Creek-Gila River	25,562	25,143	98
15040002	***Upper Gila-Mangas***	***1,311,302***	***198,660***	***15***
1504000201	*Bear Creek*	*103,985*	*65,069*	*63*
150400020101	Upper Bear Creek	38,368	33,926	88
150400020102	Middle Bear Creek	28,809	21,224	74
150400020103	Lower Bear Creek	36,808	9,919	27
1504000202	*Duck Creek*	*144,993*	*16,862*	*12*
150400020201	Headwaters Buckhorn Wash	26,685	5,640	21
150400020203	Sacaton Creek	25,984	7,899	30
150400020204	Headwaters Duck Creek	31,673	3,323	10
1504000203	*Mangas Creek*	*130,597*	*50,698*	*39*
150400020301	Willow Creek-Mangas Creek	34,843	14,319	41
150400020302	McKeafer Canyon-Mangas Creek	28,457	8,772	31
150400020303	Ash Spring Canyon-Mangas Creek	29,292	16,256	55
150400020304	Schoolhouse Canyon-Mangas Creek	38,005	11,351	30
1504000204	*Sycamore Creek-Upper Gila River*	*121,829*	*3,601*	*3*
150400020401	Bear Creek-Upper Gila River	31,011	3,601	12
1504000205	Blue Creek	88,931	3,428	4
150400020501	Cherry Creek-Blue Creek	36,784	3,428	9
1504000206	*Blue Creek-Upper Gila River*	*186,504*	*46,732*	*25*
150400020601	Bear Canyon-Upper Gila River	26,257	23,169	88
150400020602	Swan Canyon	25,979	14,673	56
150400020603	Swan Canyon-Upper Gila River	27,903	8,140	29
150400020607	Corral Canyon	29,201	750	3

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
1504000208	*Apache Creek-Gila River*	*237,306*	*12,270*	*5*
150400020804	Apache Creek	39,084	12,270	31
15040003	***Animas Valley***	***1,449,526***	***59,574***	***4***
1504000302	*Headwaters Burro Cienega*	*109,203*	*17,666*	*16*
150400030201	Hall Draw-Burro Cienega	24,929	13,923	56
150400030203	Ninetysix Creek	31,683	3,743	12
1504000303	*Outlet Burro Cienega*	*179,037*	*291*	*<1*
150400030305	Jones Canyon-Burro Cienega	18,522	48	<1
150400030307	Walker Canyon	28,099	243	1
1504000304	*Lordsburg Draw*	*221,184*	*41,617*	*19*
150400030401	Gold Hill Canyon-Lordsburg Draw	33,208	7,043	21
150400030402	Hoodoo Canyon-Lordsburg Draw	28,024	3,762	13
150400030403	Headwaters Thompson Canyon	25,164	20,081	80
150400030404	Outlet Thompson Canyon	23,426	4,948	21
150400030405	Thompson Canyon-Lordsburg Draw	29,220	5,783	20
15040004	***San Francisco***	***1,793,569***	***1,097,383***	***61***
1504000401	*Headwaters Tularosa River*	*225,391*	*211,838*	*94*
150400040101	Sand Flat Canyon	22,395	20,457	91
150400040102	Canon Del Buey	17,597	17,556	100
150400040103	Negro Canyon-Tularosa River	35,750	33,531	94
150400040104	Whiskey Creek	28,857	26,695	93
150400040105	Hardcastle Canyon	31,732	30,025	95
150400040106	Apache Creek	28,803	26,303	91
150400040107	Apache Creek-Tularosa River	29,286	27,394	94
150400040108	Cold Springs Canyon-Tularosa River	30,971	29,877	96
1504000402	*Outlet Tularosa River*	*184,206*	*180,493*	*98*
150400040201	Long Canyon-Tularosa River	33,507	32,065	96

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
150400040202	Headwaters North Fork Negrito Creek	20,426	20,235	99
150400040203	South Fork Negrito Creek	31,698	31,227	99
150400040204	Outlet North Fork Negrito Creek	24,183	24,054	99
150400040205	Sign Camp Canyon	26,241	26,222	100
150400040206	Negrito Creek	25,674	25,415	99
150400040207	Negrito Creek-Tularosa River	22,477	21,275	95
1504000403	*Centerfire Creek-San Francisco River*	*267,108*	*207,266*	*78*
150400040302	Trout Creek	20,934	12,646	60
150400040303	Stone Creek-San Francisco River	35,769	21,849	61
150400040304	Spur Draw	26,179	21,531	82
150400040305	SA Creek	22,560	21,861	97
150400040306	Headwaters Centerfire Creek	18,536	17,581	95
150400040307	Outlet Centerfire Creek	20,591	17,861	87
150400040308	Big Canyon-San Francisco River	16,418	15,579	95
150400040309	Starkweather Canyon	25,279	24,339	96
150400040310	Largo Canyon	21,765	21,006	97
150400040311	Cienega Canyon-San Francisco River	36,089	33,014	91
1504000404	*Deep Creek-San Francisco River*	*153,321*	*149,537*	*98*
150400040401	Headwaters Saliz Canyon	26,229	26,116	100
150400040402	Outlet Saliz Canyon	14,052	13,722	98
150400040403	Saliz Canyon-San Francisco River	36,832	35,358	96
150400040404	Devils Creek	22,767	22,767	100
150400040405	Deep Creek	30,521	29,230	96
150400040406	Devils Creek-San Francisco River	22,920	22,344	97
1504000405	*Upper Blue River*	*198,049*	*27,915*	*14*
150400040502	Dry Blue Creek	25,048	19,114	76
150400040503	Campbell Blue Creek	34,218	617	2

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Total HUC Acres	Gila NF HUC Acres	Gila NF HUC %
150400040504	Centerfire Creek-Blue River	17,311	2,456	14
150400040506	Steeple Canyon-Blue River	37,760	5,728	15
1504000406	*Pueblo Creek-San Francisco River*	*226,379*	*198,993*	*88*
150400040601	Upper Pueblo Creek	21,554	21,537	100
150400040602	Lower Pueblo Creek	29,508	27,925	95
150400040603	Keller Canyon	24,804	13,875	56
150400040604	Vigil Canyon	25,883	20,241	78
150400040605	Mineral Creek	32,917	30,175	92
150400040606	Wendy Flat-San Francisco River	22,813	20,377	89
150400040607	Whitewater Creek	34,875	33,008	95
150400040608	South Dugway Creek-San Francisco River	34,025	31,855	94
1504000407	*Lower Blue River*	*198,105*	*277*	*<1*
150400040704	Little Blue Creek	25,067	277	1
1504000408	*Mule Creek-San Francisco River*	*244,422*	*121,064*	*50*
150400040801	Little Dry Creek	33,243	14,821	45
150400040802	Big Dry Creek	25,070	24,533	98
150400040803	Pine Cienega Creek	25,986	12,879	50
150400040804	Upper Mule Creek	20,283	13,499	67
150400040805	Lower Mule Creek	13,801	6,626	48
150400040806	Citizen Canyon	14,783	9,164	62
150400040807	Big Pine Canyon-San Francisco River	30,093	29,909	99
150400040808	Harden Cienega Creek	21,979	7,770	35
150400040809	Coal Creek	17,542	1,772	10
150400040811	Coalson Creek-San Francisco River	19,389	90	<1

Table D2. Extent and distribution of perennial and intermittent stream miles by subbasin, watershed and subwatershed

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Perennial Stream Miles			Intermittent Stream Miles		
			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
13020208	***Plains of San Agustin***	***11***	***0.7***	***0.5***	***76***	***No data***	***10.7***	***No data***
1302020804	*Nester Draw*	*3*	*0.2*	*0.0*	*0*	*3.8*	*0.4*	*10*
130202080401	Bear Canyon	38	0.0	0.0	0	1.4	0.4	26
130202080404	Headwaters Nester Draw	3	0.0	0.0	0	2.4	0.0	0
1302020806	*Y Canyon*	*53*	*0.0*	*0.0*	*0*	*0.0*	*0.0*	*0*
130202080601	La Jolla Canyon	99	0.0	0.0	0	0.0	0.0	0
130202080603	Y Canyon	42	0.0	0.0	0	0.0	0.0	0
1302020807	*Patterson Lake*	*38*	*0.5*	*0.5*	*100*	*18.5*	*10.3*	*56*
130202080701	Alamocito Creek	37	0.0	0.0	0	12.1	4.9	41
130202080703	West Pasture Springs	1	0.0	0.0	0	0.0	0.0	0
130202080704	Patterson Canyon	66	0.5	0.5	100	6.4	5.4	85
130202080705	Dark Canyon	42	0.0	0.0	0	0.0	0.0	0
130202080706	Patterson Lake	40	0.0	0.0	0	0.0	0.0	0
130202080707	Long Canyon	96	0.0	0.0	0	0.0	0.0	0
130202080708	T H Canyon	30	0.0	0.0	0	0.0	0.0	0
13020211	***Elephant Butte Reservoir***	***3***	***74.3***	***0.0***	***0***	***No data***	***17.2***	***No data***
1302021106	*Headwaters Alamosa Creek*	*16*	*1.4*	*0.0*	*0*	*80.3*	*17.2*	*21*
130202110603	Little Pigeon Canyon-Alamosa Creek	21	0.0	0.0	0	8.9	5.5	62
130202110606	Wahoo Canyon-Alamosa Creek	52	0.0	0.0	0	9.5	6.7	70
130202110607	Sim Yaten Canyon-Alamosa Creek	16	0.0	0.0	0	0.8	0.0	0

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			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
130202110608	Wildhorse Canyon	37	0.0	0.0	0	5.8	5.0	86
13030101	***Caballo***	***27***	***160.8***	***73.8***	***46***	***No data***	***99.1***	***No data***
1303010101	*Cuchillo Negro Creek*	*32*	*29.7*	*18.3*	*62*	*86.2*	*44.6*	*52*
130301010101	Turkey Creek	85	0.0	0.0	0	29.5	22.1	75
130301010102	Poverty Creek	48	6.9	5.4	79	12.6	11.4	90
130301010103	Chloride Creek	76	10.2	8.9	87	15.1	8.7	58
130301010104	South Fork Cuchillo Negro Creek	71	4.8	4.0	84	3.5	2.3	66
130301010105	Monument Creek	30	0.0	0.0	0	8.2	0.0	0
130301010106	Monument Creek-Cuchillo Negro Creek	20	0.0	0.0	0	11.1	0.0	0
1303010102	*Palomas Creek-Rio Grande*	*25*	*49.0*	*19.5*	*40*	*41.6*	*24.4*	*59*
130301010204	Mud Spring Canyon	100	5.5	5.3	97	0.0	0.0	0
130301010205	Circle Seven Creek	96	5.0	4.8	97	4.9	4.0	82
130301010206	North Fork Palomas Creek	56	8.7	6.0	69	14.8	8.5	58
130301010207	South Fork Palomas Creek	57	6.6	3.4	52	19.2	11.9	62
1303010103	*Percha Creek*	*32*	*34.3*	*9.9*	*29*	*16.5*	*9.1*	*55*
130301010301	South Percha Creek	53	12.1	1.7	14	6.3	5.4	85
130301010302	North Percha Creek	54	19.9	8.3	42	4.0	3.7	92
1303010104	*Caballo Reservoir*	*21*	*47.8*	*26.1*	*55*	*58.4*	*21.0*	*36*
130301010401	North Seco Canyon	76	9.9	9.4	95	20.2	9.0	45
130301010403	Seco Creek	10	0.0	0.0	0	15.8	0.0	0
130301010404	Holden Prong	100	9.2	9.2	100	4.8	4.8	100
130301010405	Cave Creek	22	0.5	0.0	0	6.2	1.6	26

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			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
130301010406	Headwaters Los Animas Creek	65	11.8	7.4	63	11.4	5.6	49
13030102	***El Paso-Las Cruces***	***1***	***116.0***	***6.6***	***6***	***No data***	***6.1***	***No data***
1303010202	*Cuervo Arroyo_Rio Grande*	*17*	21.2	6.6	31	52.2	6.1	12
130301020201	Trujillo Canyon Creek	33	0.0	0.0	0	7.4	1.9	25
130301020203	Headwaters Tierra Blanca Creek	98	4.4	4.4	100	2.0	2.0	100
130301020204	Outlet Tierra Blanca Creek	15	0.0	0.0	0	14.8	0.0	0
130301020207	Jaralosa Creek	13	0.0	0.0	0	10.0	0.0	0
130301020208	Headwaters Berenda Creek	37	2.2	2.2	100	16.9	2.2	13
13030202	***Mimbres***	***5***	***98.6***	***78.0***	***79***	***No data***	***37.2***	***No data***
1303020201	*Gallinas Canyon-Mimbres River*	*74*	*83.1*	*74.3*	*89*	*73.0*	*23.2*	*32*
130302020101	Powderhorn Canyon-Mimbres River	99	15.3	13.9	90	2.0	2.0	100
130302020102	Allie Canyon-Mimbres River	97	18.1	17.0	94	5.5	5.5	100
130302020103	Sheppard Canyon-Mimbres River	81	17.8	13.4	76	7.5	0.9	11
130302020104	Noonday Canyon	78	13.2	12.5	95	8.6	2.9	33
130302020105	Noonday Canyon-Mimbres River	44	5.0	4.0	80	12.6	2.5	20
130302020106	Gallinas Canyon	73	13.8	13.5	98	21.3	9.4	44
1303020202	Headwaters San Vicente Draw	18	4.0	3.6	89	46.5	7.3	16
130302020201	Rio de Arenas	6	0.4	0.0	0	12.8	0.0	0
130302020203	Pipeline Draw-San Vicente Draw	16	0.0	0.0	0	22.1	2.6	12
130302020204	Cameron Creek	54	3.6	3.6	100	11.6	4.7	40
130302020205	Cameron Creek-San Vicente Draw	<1	0.0	0.0	0	0.0	0.0	0
1303020203	Outlet San Vicente Draw	1	6.9	0.0	0	0.0	0.0	0

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			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
130302020302	Headwaters Whitewater Creek	3	6.4	0.0	0	0.0	0.0	0
130302020305	Antelope Draw-San Vicente Draw	2	0.5	0.0	0	0.0	0.0	0
1303020204	*Lampbright Draw*	*3*	0.0	0.0	0	**0.0**	**0.0**	**0**
130302020401	Headwaters Lampbright Draw	9	0.0	0.0	0	0.0	0.0	0
1303020205	Lampbright Draw-Mimbres River	17	0.0	0.0	0	50.1	6.2	12
130302020501	Gavilan Arroyo	40	0.0	0.0	0	7.2	0.7	09
130302020502	Gavilan Arroyo-Mimbres River	39	0.0	0.0	0	26.0	5.5	21
1303020208	Macho Creek	2	0.0	0.0	0	0.0	0.0	0
130302020801	Upper Macho Creek	10	0.0	0.0	0	0.0	0.0	0
1303020213	Upper Seventysix Draw	1	0.3	0.0	0	0.5	0.5	100
130302021301	Whiterock Canyon	5	0.3	0.0	0	0.5	0.5	100
1303020214	Cow Spring Draw-Seventysix Draw	2	0.0	0.0	0	0.0	0.0	0
130302021402	Headwaters Cow Spring Draw	14	0.0	0.0	0	0.0	0.0	0
15020001	***Little Colorado Headwaters***	***3***	***268.5***	***0.7***	***0***	***No data***	***0.3***	***No data***
1502000103	*Coyote Creek*	*9*	*32.6*	*0.7*	*0.02*	*32.4*	*0.3*	*1*
150200010301	Hay Vega	39	3.0	0.7	0.24	0.0	0.0	0
150200010302	Canovas Creek-Coyote Creek	33	24.1	0.0	0.00	11.6	0.3	2
15020003	***Carrizo Wash***	***14***	***43.6***	***14.0***	***32***	***No data***	***8.7***	***No data***
1502000301	*Rito Creek*	*13*	*6.3*	*3.7*	*59*	*10.5*	*3.9*	*37*
150200030101	Upper Mangas Creek	58	4.8	3.3	70	4.8	3.9	81
150200030102	Middle Mangas Creek	17	1.1	0.0	0	1.4	0.0	0
150200030103	Lower Mangas Creek	7	0.0	0.0	0	0.0	0.0	0

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			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
150200030109	Escondido Creek	47	0.5	0.4	82	0.0	0.0	0
1502000302	*Upper Largo Creek*	*76*	*19.3*	*6.7*	*35*	*8.2*	*2.8*	*34*
150200030201	El Caso Spring Canyon	100	0.0	0.0	0	0.6	0.6	100
150200030202	Sawmill Canyon-Largo Creek	91	9.0	3.5	39	2.5	2.2	89
150200030203	Paradise Canyon-Largo Creek	85	10.3	3.1	31	0.0	0.0	0
150200030204	Rito Creek-Largo Creek	35	0.0	0.0	0	5.1	0.0	0
1502000305	*Agua Fria Creek*	*35*	*10.6*	*3.2*	*.30*	*2.2*	*2.0*	*89*
150200030501	Harris Creek-Agua Fria Creek	90	9.5	2.7	28	0.0	0.0	0
150200030502	Demetrio Creek	59	0.6	0.0	0	0.0	0.0	0
150200030503	Demetrio Creek-Agua Fria Creek	37	0.0	0.0	0	0.0	0.0	0
150200030504	Gatlin Lake	73	0.5	0.5	100	2.2	2.0	89
150200030505	Mangitas Creek	41	0.0	0.0	0	0.0	0.0	0
150200030506	Cerro La Mula	10	0.0	0.0	0	0.0	0.0	0
150200030507	Cerro La Mula-Agua Fria Creek	2	0.0	0.0	0	0.0	0.0	0
1502000307	*LA Draw-Cienega Amarilla*	*5*	*7.4*	*0.4*	*6*	*0.0*	*0.0*	*0*
150200030703	Cow Springs Draw	25	1.8	0.4	24	0.0	0.0	0
15040001	***Upper Gila***	***84***	***504.9***	***471.0***	***93***	***No data***	***131.5***	***No data***
1504000101	*Railroad Canyon*	*16*	*0.0*	*0.0*	*0*	*0.0*	*0.0*	*0*
150400010101	Upper Railroad Canyon	4	0.0	0.0	0	0.0	0.0	0
150400010102	Middle Railroad Canyon	41	0.0	0.0	0	0.0	0.0	0
150400010103	Lower Railroad Canyon	7	0.0	0.0	0	0.0	0.0	0
1504000102	*Corduroy Draw*	*61*	*11.9*	*6.7*	*56*	*11.4*	*10.6*	*93*
150400010201	Upper Corduroy Draw	22	0.1	0.0	0	2.8	2.7	99

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			Total HUC Miles	**Gila NF HUC Miles**	**Gila NF % HUC Miles**	**Total HUC Miles**	**Gila NF HUC Miles**	**Gila NF % HUC Miles**
150400010202	South Water Canyon	79	1.0	0.9	94	4.3	3.6	85
150400010203	Middle Corduroy Draw	49	0.0	0.0	0	1.0	0.8	88
150400010204	Lower Corduroy Draw	96	10.8	5.8	053	3.4	3.4	100
1504000103	*Beaver Creek*	*54*	*0.0*	*0.0*	*0*	*5.0*	*5.0*	*100*
150400010301	Horse Camp Canyon	73	0.0	0.0	0	0.0	0.0	0
150400010302	Coyote Canyon	1	0.0	0.0	0	0.0	0.0	0
150400010303	O Bar O Canyon	46	0.0	0.0	0	0.0	0.0	0
150400010304	Houghton Canyon	92	0.0	0.0	0	5.0	5.0	100
150400010305	Houghton Canyon-Beaver Creek	79	0.0	0.0	0	0.0	0.0	0
1504000104	*Headwaters East Fork Gila River*	*99*	*68.5*	*60.2*	*88*	*41.1*	*39.3*	*96*
150400010401	150400010401 Hoyt Creek	99	8.2	7.4	90	8.3	7.2	87
150400010402	Taylor Creek	99	17.0	14.1	83	11.7	11.0	95
150400010403	Taylor Creek-Beaver Creek	99	6.2	4.7	76	6.0	6.0	100
150400010404	Headwaters Diamond Creek	100	9.9	9.9	100	5.6	5.6	98
150400010405	South Diamond Creek	100	11.1	11.1	100	6.0	6.0	100
150400010406	Outlet Diamond Creek	100	5.7	5.7	100	3.5	3.4	100
150400010407	Diamond Creek-East Fork Gila River	99	10.5	7.3	69	0.0	0.0	0
1504000105	*Middle Fork Gila River*	*100*	*96.6*	*94.1*	*97*	*18.5*	*18.4*	*100*
150400010501	T Bar Canyon	100	0.9	0.9	100	0.4	0.3	81
150400010502	Gilita Creek	100	20.1	18.7	93	6.9	6.9	100
150400010503	Snow Canyon	100	0.8	0.8	100	2.3	2.3	100
150400010504	Canyon Creek	99	4.8	4.3	91	1.5	1.5	100
150400010505	Canyon Creek-Middle Fork Gila River	100	29.3	29.3	100	0.7	0.7	100

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150400010506	Indian Creek Canyon	99	6.3	6.3	100	5.6	5.6	100
150400010507	Indian Creek Canyon-Middle Fork Gila River	100	17.9	17.9	100	0.1	0.1	100
150400010508	Big Bear Canyon-Middle Fork Gila River	99	16.7	16.0	96	1.1	1.1	100
1504000106	*West Fork Gila River*	*99*	*86.3*	*81.0*	*94*	*11.9*	*11.9*	*100*
150400010601	White Creek	100	19.9	19.9	100	4.4	4.4	100
150400010602	Headwaters West Fork Gila River	100	23.4	23.4	100	2.2	2.2	100
150400010603	Little Creek	100	11.9	11.7	98	5.3	5.3	.00
150400010604	Outlet West Fork Gila River	96	31.1	26.1	84	0.0	0.0	0
1504000107	*Outlet East Fork Gila River*	*99*	*56.4*	*53.3*	*94*	*11.5*	*11.5*	*100*
150400010701	Tom Moore Canyon	100	0.0	0.0	0	0.0	0.0	0
150400010702	Headwaters Black Canyon	100	11.0	11.0	100	6.7	6.7	100
150400010703	Apache Creek	100	5.9	5.9	100	3.3	3.3	100
150400010704	Outlet Black Canyon	100	21.8	21.7	99	1.4	1.4	100
150400010705	Black Canyon-East Fork Gila River	97	17.7	14.7	83	0.1	0.1	100
1504000108	*Sapillo Creek*	*98*	*45.3*	*40.5*	*89*	*15.8*	*14.4*	*91*
150400010801	Rocky Canyon	100	7.0	7.0	100	2.1	2.1	.00
150400010802	Rocky Canyon-Sapillo Creek	98	8.7	8.7	100	0.6	0.6	100
150400010803	Lake Roberts-Sapillo Creek	98	7.9	6.3	79	5.2	4.2	80
150400010804	Copperas Creek-Sapillo Creek	96	3.2	0.0	0	0.7	0.4	49
150400010805	Sheep Corral Canyon-Sapillo Creek	100	18.5	18.5	100	7.2	7.2	100
1504000109	*Sapillo Creek-Gila River*	*96*	*139.9*	*135.3*	*97*	*27.2*	*20.4*	*75*
150400010901	Sapillo Creek-Gila River	100	17.9	17.9	100	0.4	0.4	100

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150400010902	Hells Canyon-Gila River	100	22.6	22.6	100	3.0	3.0	100
150400010903	Turkey Creek	100	25.2	24.8	99	0.7	0.7	100
150400010904	Upper Mogollon Creek	100	34.5	34.5	100	1.6	1.6	100
150400010905	Middle Mogollon Creek	88	12.6	10.0	79	6.4	2.9	46
150400010906	Lower Mogollon Creek	75	5.3	5.3	100	10.1	7.6	75
150400010907	Mogollon Creek-Gila River	98	21.8	20.2	93	5.0	4.2	85
15040002	***Upper Gila-Mangas***	***15***	***100.9***	***22.3***	***22***	***No data***	***68.6***	***No data***
1504000201	*Bear Creek*	*63*	*10.5*	*2.8*	*26*	*70.8*	*46.2*	*65*
150400020101	Upper Bear Creek	88	2.3	1.9	81	34.0	30.3	89
150400020102	Middle Bear Creek	74	1.5	0.4	29	16.8	10.4	62
150400020103	Lower Bear Creek	27	6.7	0.4	6	20.1	5.5	27
1504000202	*Duck Creek*	*12*	*12.4*	*5.7*	*46*	*30.7*	*0.0*	*0*
150400020201	Headwaters Buckhorn Wash	21	0.0	0.0	0	3.4	0.0	0
150400020203	Sacaton Creek	30	7.2	5.7	80	10.6	0.0	0
150400020204	Headwaters Duck Creek	10	0.0	0.0	0	3.1	0.0	0
1504000203	*Mangas Creek*	*39*	*0.4*	*0.4*	*100*	*31.6*	*6.0*	*19*
150400020301	Willow Creek-Mangas Creek	41	0.0	0.0	0	5.4	2.0	36
150400020302	McKeafer Canyon-Mangas Creek	31	0.0	0.0	0	5.2	0.4	8
150400020303	Ash Spring Canyon-Mangas Creek	55	0.0	0.0	0	6.5	3.4	52
150400020304	Schoolhouse Canyon-Mangas Creek	30	0.4	0.4	100	14.4	0.2	1
1504000204	*Sycamore Creek-Upper Gila River*	*3*	*17.1*	*1.1*	*6*	*0.5*	*0.4*	*94*
150400020401	Bear Creek-Upper Gila River	12	8.7	1.1	012	0.4	0.4	100

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1504000205	Blue Creek	4	*20.6*	*0.0*	*0*	*0.0*	*0.0*	*0*
150400020501	Cherry Creek-Blue Creek	9	16.7	0.0	0	0.0	0.0	0
1504000206	*Blue Creek-Upper Gila River*	*25*	*33.5*	*11.7*	*35*	*42.1*	*11.1*	*26*
150400020601	Bear Canyon-Upper Gila River	88	10.3	8.9	87	8.2	6.8	83
150400020602	Swan Canyon	56	0.0	0.0	0	1.2	0.5	43
150400020603	Swan Canyon-Upper Gila River	29	8.7	2.8	32	8.9	3.8	43
150400020607	Corral Canyon	3	0.0	0.0	0	0.0	0.0	0
1504000208	*Apache Creek-Gila River*	*5*	*1.4*	*0.7*	*49*	*125.0*	*4.9*	*4*
150400020804	Apache Creek	31	1.4	0.7	49	30.1	4.9	16
15040003	***Animas Valley***	***4***	***4.2***	***2.2***	***52***	***No data***	***2.1***	***No data***
1504000302	*Headwaters Burro Cienega*	*16*	*0.0*	*0.0*	*0*	*8.2*	*0.1*	*1*
150400030201	Hall Draw-Burro Cienega	56	0.0	0.0	0	2.6	0.1	3
150400030203	Ninetysix Creek	12	0.0	0.0	0	0.0	0.0	0
1504000303	*Outlet Burro Cienega*	*<1*	*0.0*	*0.0*	*0*	*0.0*	*0.0*	*0*
150400030305	Jones Canyon-Burro Cienega	<1	0.0	0.0	0	0.0	0.0	0
150400030307	Walker Canyon	1	0.0	0.0	0	0.0	0.0	0
1504000304	*Lordsburg Draw*	*19*	*4.2*	*2.2*	*53*	*2.0*	*2.0*	*100*
150400030401	Gold Hill Canyon-Lordsburg Draw	21	1.3	0.0	0	0.0	0.0	0
150400030402	Hoodoo Canyon-Lordsburg Draw	13	0.0	0.0	0	0.0	0.0	0
150400030403	Headwaters Thompson Canyon	80	1.9	1.9	100	1.7	1.7	100
150400030404	Outlet Thompson Canyon	21	0.3	0.3	100	0.4	0.4	100
150400030405	Thompson Canyon-Lordsburg Draw	20	0.6	0.0	0	0.0	0.0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Perennial Stream Miles			Intermittent Stream Miles		
			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
15040004	***San Francisco***	***61***	***759.8***	***287.5***	***38***	***No data***		***No data***
1504000401	*Headwaters Tularosa River*	*94*	*39.3*	*10.5*	*27*	*25.3*	*18.4*	*73*
150400040101	Sand Flat Canyon	91	1.8	1.0	58	0.3	0.1	16
150400040102	Canon Del Buey	100	0.0	0.0	0	3.1	3.1	00
150400040103	Negro Canyon-Tularosa River	94	5.9	1.3	22	1.1	1.0	90
150400040104	Whiskey Creek	93	3.7	2.0	54	3.8	1.1	30
150400040105	Hardcastle Canyon	95	2.1	0.1	3	5.6	3.1	56
150400040106	Apache Creek	91	16.7	5.2	31	9.4	8.1	86
150400040107	Apache Creek-Tularosa River	94	6.7	0.4	7	0.0	0.0	0
150400040108	Cold Springs Canyon-Tularosa River	96	2.5	0.5	18	2.0	2.0	100
1504000402	*OutletTularosa River*	*98*	*54.6*	*39.4*	*72*	*8.2*	*8.2*	*100*
150400040201	Long Canyon-Tularosa River	96	6.7	3.9	59	2.6	2.6	100
150400040202	Headwaters North Fork Negrito Creek	99	0.0	0.0	0	0.0	0.0	0
150400040203	South Fork Negrito Creek	99	12.7	11.9	94	5.6	5.6	100
150400040204	Outlet North Fork Negrito Creek	99	7.8	7.3	93	0.0	0.0	0
150400040205	Sign Camp Canyon	100	0.0	0.0	0	0.0	0.0	0
150400040206	Negrito Creek	99	13.0	11.0	84	0.0	0.0	0
150400040207	Negrito Creek-Tularosa River	95	14.4	5.3	37	0.0	0.0	0
1504000403	*Centerfire Creek-San Francisco River*	*78*	*145.9*	*64.0*	*44*	*119.8*	*41.1*	*34*
150400040302	Trout Creek	60	24.6	14.7	60	23.1	3.0	13
150400040303	Stone Creek-San Francisco River	61	28.8	11.4	40	31.6	4.2	13
150400040304	Spur Draw	82	0.9	0.6	71	1.9	1.9	100

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Perennial Stream Miles			Intermittent Stream Miles		
			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
150400040305	SA Creek	97	7.0	6.6	94	11.1	9.5	86
150400040306	Headwaters Centerfire Creek	95	6.1	3.1	50	5.6	5.2	94
150400040307	Outlet Centerfire Creek	87	7.6	0.5	7	4.1	2.7	66
150400040308	Big Canyon-San Francisco River	95	7.6	5.7	75	2.5	2.5	100
150400040309	Starkweather Canyon	96	2.1	1.5	68	2.2	2.2	100
150400040310	Largo Canyon	97	9.3	7.1	77	7.0	5.6	81
150400040311	Cienega Canyon-San Francisco River	91	24.1	12.8	53	4.4	4.3	97
1504000404	*Deep Creek-San Francisco River*	*98*	*60.6*	*49.1*	*81*	*20.1*	*19.3*	*96*
150400040401	Headwaters Saliz Canyon	100	3.8	3.8	100	4.2	4.2	100
150400040402	Outlet Saliz Canyon	98	7.3	5.1	70	0.0	0.0	0
150400040403	Saliz Canyon-San Francisco River	96	15.4	11.3	73	0.0	0.0	0
150400040404	Devils Creek	100	2.1	2.1	100	3.2	3.2	100
150400040405	Deep Creek	96	18.4	16.9	92	12.7	11.8	93
150400040406	Devils Creek-San Francisco River	97	13.6	10.0	74	0.0	0.0	0
1504000405	*Upper Blue River*	*14*	*172.3*	*9.7*	*6*	*372.3*	*8.7*	*2*
150400040502	Dry Blue Creek	76	16.3	8.5	52	12.4	3.9	31
150400040503	Campbell Blue Creek	2	32.1	0.4	1	76.0	0.0	0
150400040504	Centerfire Creek-Blue River	14	16.1	0.4	2	34.8	1.6	5
150400040506	Steeple Canyon-Blue River	15	27.0	0.4	2	82.5	3.2	4
1504000406	*Pueblo Creek-San Francisco River*	*88*	*81.7*	*63.5*	*78*	*76.5*	*52.9*	*69*
150400040601	Upper Pueblo Creek	100	9.1	9.1	100	5.9	5.9	100
150400040602	Lower Pueblo Creek	95	2.5	2.5	100	20.5	20.3	99
150400040603	Keller Canyon	56	0.0	0.0	100	13.0	6.3	48

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Perennial Stream Miles			Intermittent Stream Miles		
			Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles	Total HUC Miles	Gila NF HUC Miles	Gila NF % HUC Miles
150400040604	Vigil Canyon	78	0.1	0.0	0	15.9	5.0	32
150400040605	Mineral Creek	92	18.9	16.7	89	13.8	11.4	82
150400040606	Wendy Flat-San Francisco River	89	11.1	1.9	17	0.8	0.8	90
150400040607	Whitewater Creek	95	26.2	24.9	95	6.5	3.3	50
150400040608	South Dugway Creek-San Francisco River	94	13.8	8.4	61	0.0	0.0	0
1504000407	*Lower Blue River*	*<1*	*90.0*	*0.0*	*0*	*410.0*	*0.5*	*0*
150400040704	Little Blue Creek	1	5.7	0.0	0	62.1	0.5	1
1504000408	*Mule Creek-San Francisco River*	*50*	*82.7*	*51.3*	*62*	*161.1*	*15.4*	*10*
150400040801	Little Dry Creek	45	3.1	2.8	90	0.8	0.1	14
150400040802	Big Dry Creek	98	18.8	18.8	100	10.1	7.7	76
150400040803	Pine Cienega Creek	50	0.2	0.0	0	14.8	2.4	16
150400040804	Upper Mule Creek	67	13.9	7.0	51	2.7	0.0	0
150400040805	Lower Mule Creek	48	8.8	4.3	49	0.0	0.0	0
150400040806	Citizen Canyon	62	1.3	0.0	0	14.5	3.9	27
150400040807	Big Pine Canyon-San Francisco River	99	18.8	18.3	97	0.0	0.0	100
150400040808	Harden Cienega Creek	35	0.4	0.0	0	26.7	0.0	0
150400040809	Coal Creek	10	0.0	0.0	0	36.4	1.4	4
150400040811	Coalson Creek-San Francisco River	<1	14.8	0.0	0	27.8	0.0	0

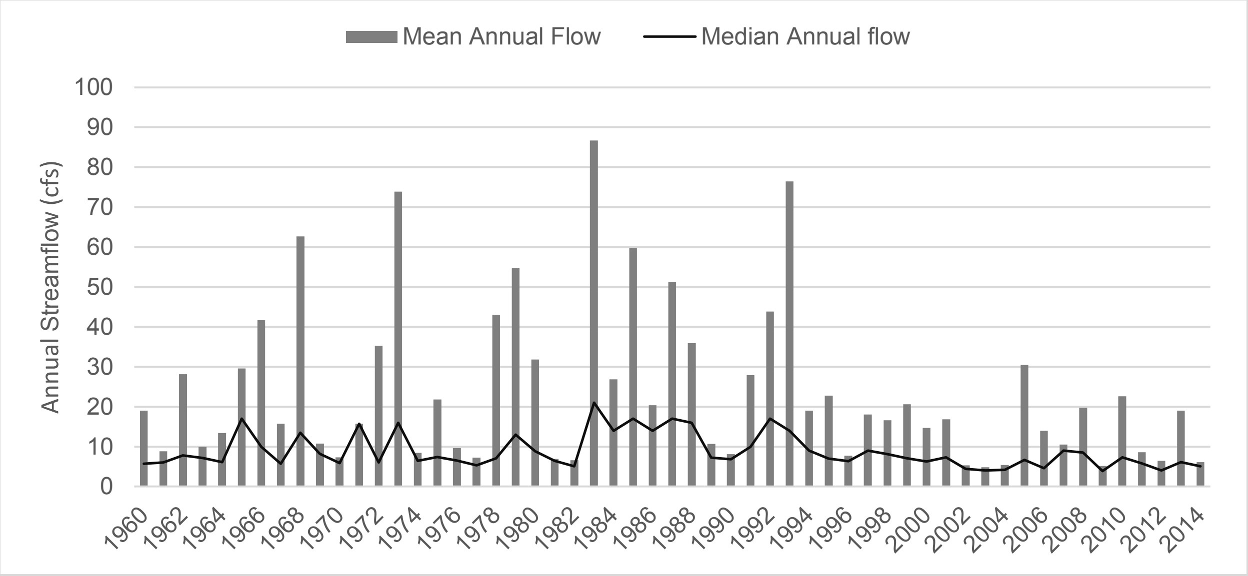

Figure D1. Annual streamflow metrics at the San Francisco gage near Reserve, period of record 1960-2014

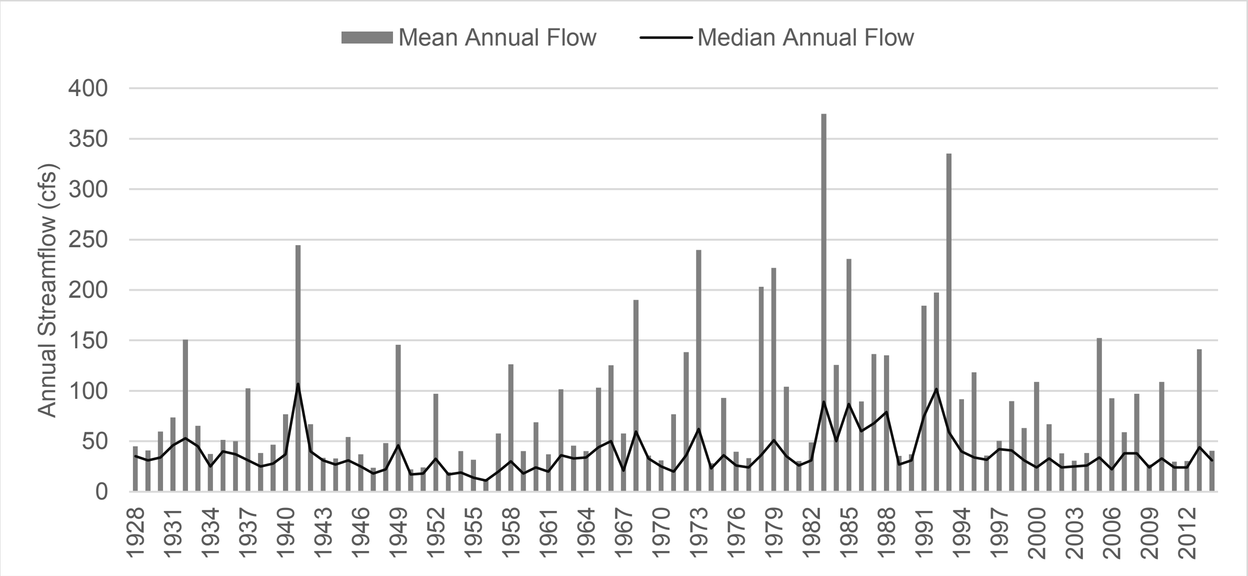

Figure D2. Annual streamflow metrics at the San Francisco gage near Glenwood, period of record 1928-2014

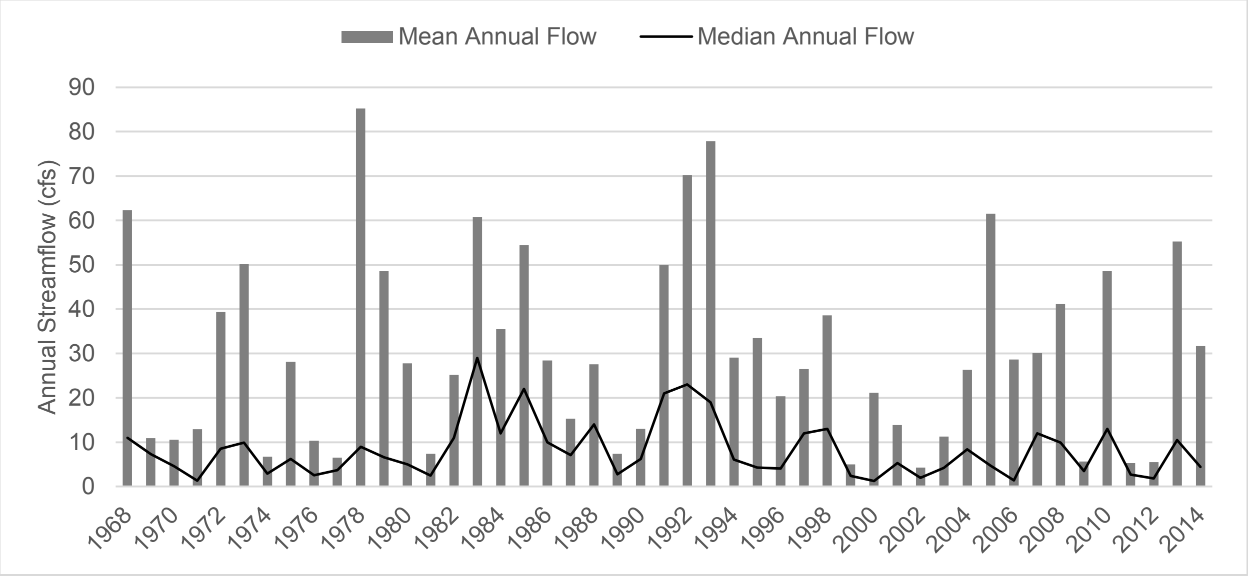

Figure D3. Annual streamflow metrics at the Mogollon Creek gage near Cliff, period of record 1968-2014

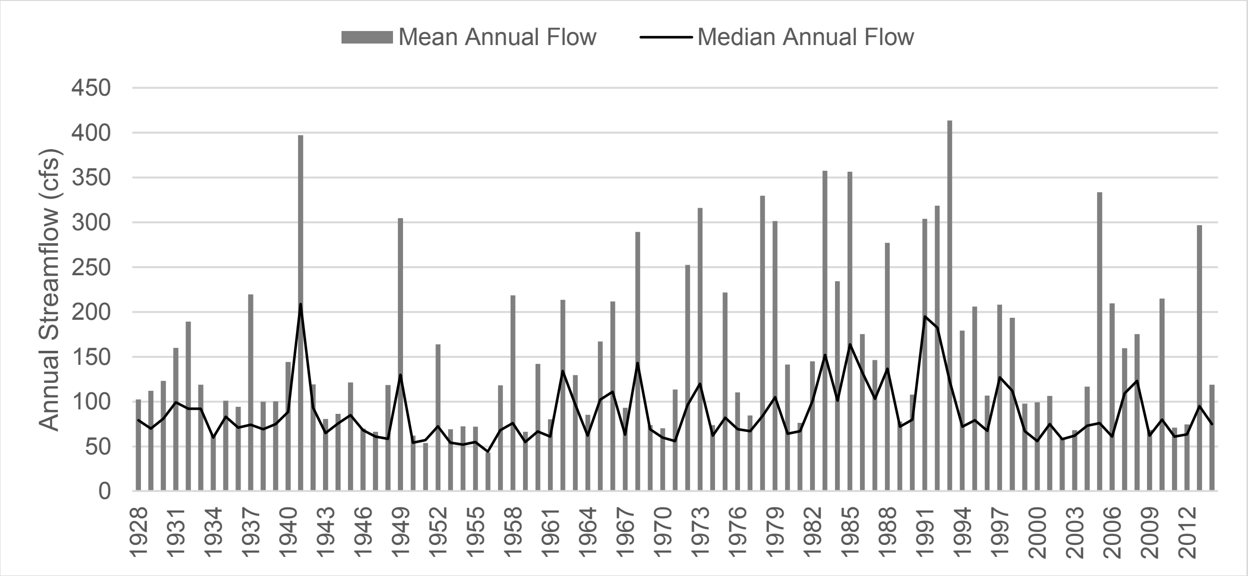

Figure D4. Annual streamflow metrics at the Gila River gage near Gila, period of record 1928-2014

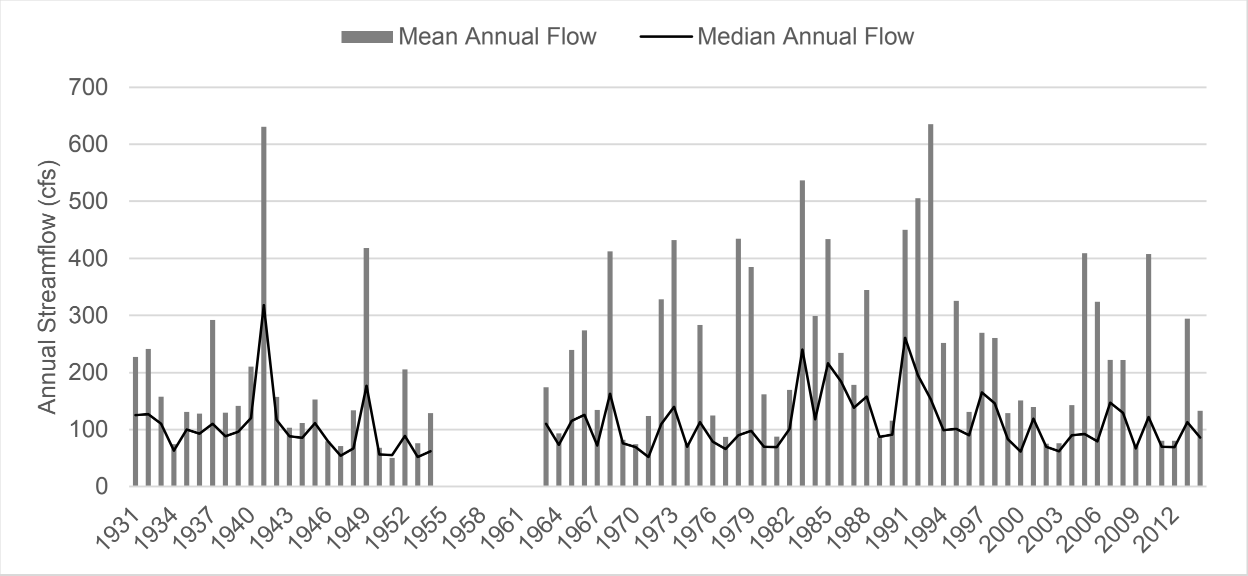

Figure D5. Annual streamflow metrics at the Gila River gage near Redrock, period of record 1931-2014 with missing data during 1955-1962

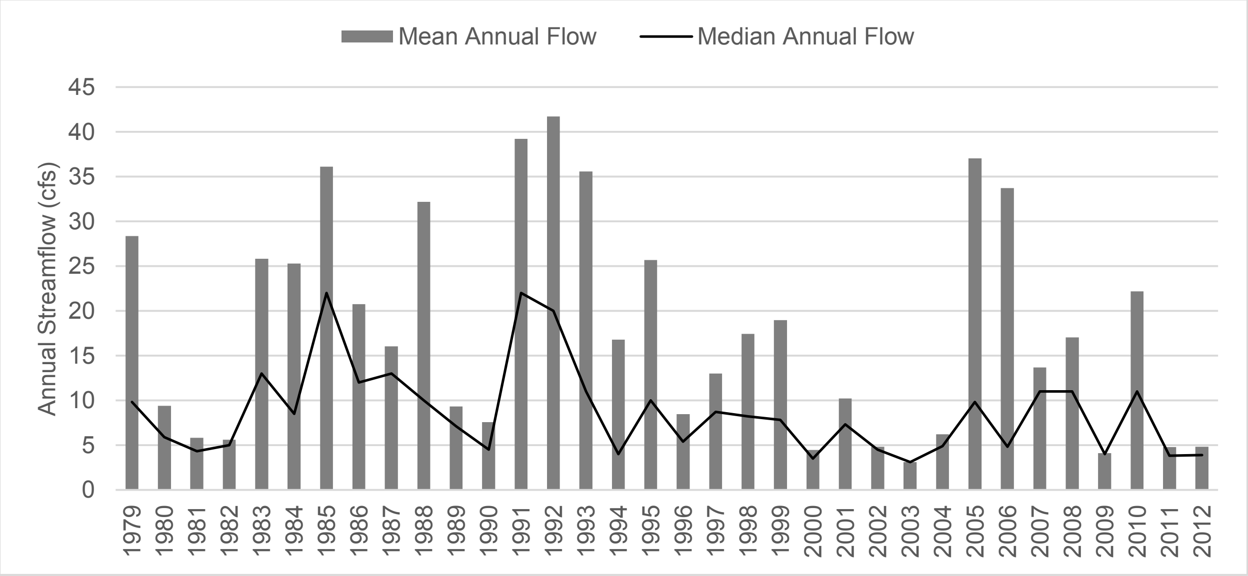

Figure D6. Annual streamflow metrics at the Mimbres River gage near Mimbres, period of record 1979-2012

Table D3. Mean monthly flow at the USGS gages within the plan and context areas

			Mean Monthly Streamflow (cfs)											
USGS Gage Number	USGS Gage Name	Period of Record	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
9442680	San Francisco River near Reserve, NM	1960-2014	19.4	35.3	63.9	44.0	16.4	5.8	7.7	16.7	18.8	23.7	16.2	17.3
9444000	San Francisco River near Glenwood, NM	1928-2014	97.9	125.7	178.8	133.5	69.5	27.2	37.4	80.1	72.6	81.7	50.2	78.9
9430600	Mogollon Creek near Cliff, NM	1968-2014	37.3	56.5	65.3	48.7	22.2	2.7	9.9	21.6	29.3	20.0	15.7	34.9
9430500	Gila River near Gila, NM	1928-2014	173.6	238.5	300.7	212.4	131.8	56.1	65.4	150.3	177.9	115.2	99.1	158.0
9431500	Gila River near Redrock, NM	1931-2014	271.6	359.1	418.3	274.3	159.0	54.4	79.6	206.1	236.9	159.6	130.9	233.5
8477110	Mimbres River at Mimbres, NM	1979-2012	22.6	26.9	24.6	20.7	13.2	7.2	10.3	31.4	15.8	11.6	10.0	19.5

Table D4. A comparison of annual streamflow metrics and climatic variables between the reference and current time periods

Variable	Pre-1990	Post 1990	Post 1990 Change from pre-1990	Post 2000	Post 2000 Change from pre-1990
San Francisco River near Reserve, NM					
Mean Annual Flow (cfs)	28.5	18.0	-37%	12.6	-56%
Median Annual Flow (cfs)	8.5	6.7	-21%	5.4	-36%
High Flow Days (number of days/total days in period of record)	19/10,959	2/9,130	-87%	0/5,478	-100%
Low Flow Days (number of days/total days in period of record)	382/10,959	798/9,130	+151%	543/5,478	+184%
Southwestern Mountains Climate Division					
Mean Annual Precipitation (in)	15.6	15.4	-1%	14.3	-8%
Mean Annual Temperature (°F)	48.6	49.8	+1.2	50.1	+1.5
San Francisco River near Glenwood, NM					
Mean Annual Flow	84.1	90.6	+8%	70.8	-16%
Median Annual Flow	30	32	+7%	28	-7%
High Flow Days (number of days/total days in period of record)	28/22,645	23/9,130	+104%	12/5,478	+77%
Low Flow Days (number of days/total days in period of record)	1,713/22,645	322/9,130	-53%	239/5,478	-42%

			Post 1990		Post 2000	
	Variable	**Pre-1990**		**Change from pre-1990**		**Change from pre-1990**
Southwestern Mountains Climate Division						
	Mean Annual Precipitation (in)	15.1	15.4	+2%	14.3	-5%
	Mean Annual Temperature (°F)	48.6	49.8	+1.2	50.1	+1.5
Mogollon Creek near Cliff, NM						
	Mean Annual Flow	30.1	30.3	+1%	26.3	-13%
	Median Annual Flow	6.6	5.4	-18%	4.4	-33%
	High Flow Days (number of days/total days in period of record)	1/8,035	2/9,130	+193%	2/5,478	+193%
	Low Flow Days (number of days/total days in period of record)	613/8,035	834/9,130	+20%	632/5,478	+51%
Southwestern Mountains Climate Division						
	Mean Annual Precipitation (in)	15.7	15.4	-2%	14.3	-9%
	Mean Annual Temperature (°F)	48.7	49.8	+1.1	50.1	+1.4
Gila River near Gila, NM						
	Mean Annual Flow	149.6	172.5	+15%	144.7	-3%
	Median Annual Flow	72	77	+7%	68	-6%
	High Flow Days (number of days/total days in period of record)	77/22,645	58/9,130	+87%	28/5,478	+50%
	Low Flow Days (number of	1,040/22,645	589/9,130	+40%	455/5,478	+81%

			Post 1990		Post 2000	
	Variable	Pre-1990		Change from pre-1990		Change from pre-1990
	days/total days in period of record)					
Southwestern Mountains Climate Division						
	Mean Annual Precipitation (in)	15.1	15.4	+2%	14.3	-5%
	Mean Annual Temperature (°F)	48.6	49.8	+1.2	50.1	+1.5
Gila River near Redrock, NM						
	Mean Annual Flow	204.1	236.2	+16%	188.7	-8%
	Median Annual Flow	90	95	+6%	86	-8%
	High Flow Days (number of days/total days in period of record)	22/18,627	22/9,130	+104%	9/5,478	+<1%
	Low Flow Days (number of days/total days in period of record)	998/18,627	513/9,130	+5%	405/5,478	+38%
Southern Desert Climate Division						
	Mean Annual Precipitation (in)	11.8	12.2	+3%	11.4	-3%
	Mean Annual Temperature (°F)	59.2	60.1	+0.9	60.4	+1.2
Mimbres River at Mimbres, NM						
	Mean Annual Flow	19.5	17.0	-13%	12.8	-35%
	Median Annual Flow	8.5	6.9	-19%	5.4	-35%
	High Flow Days (number of days/total days in period of record)	6/4,017	9/8,400	-28%	6/4,748	-15%

Variable	Pre-1990	Post 1990		Post 2000	
			Change from pre-1990		Change from pre-1990
Low Flow Days (number of days/total days in period of record)	94/4,017	556/8,400	+183%	441/4,478	+299%
Southwestern Mountains Climate Division					
Mean Annual Precipitation (in)	16.0	15.5	-3%	14.3	-11%
Mean Annual Temperature (°F)	49.0	49.7	+0.7	50.1	+1.1

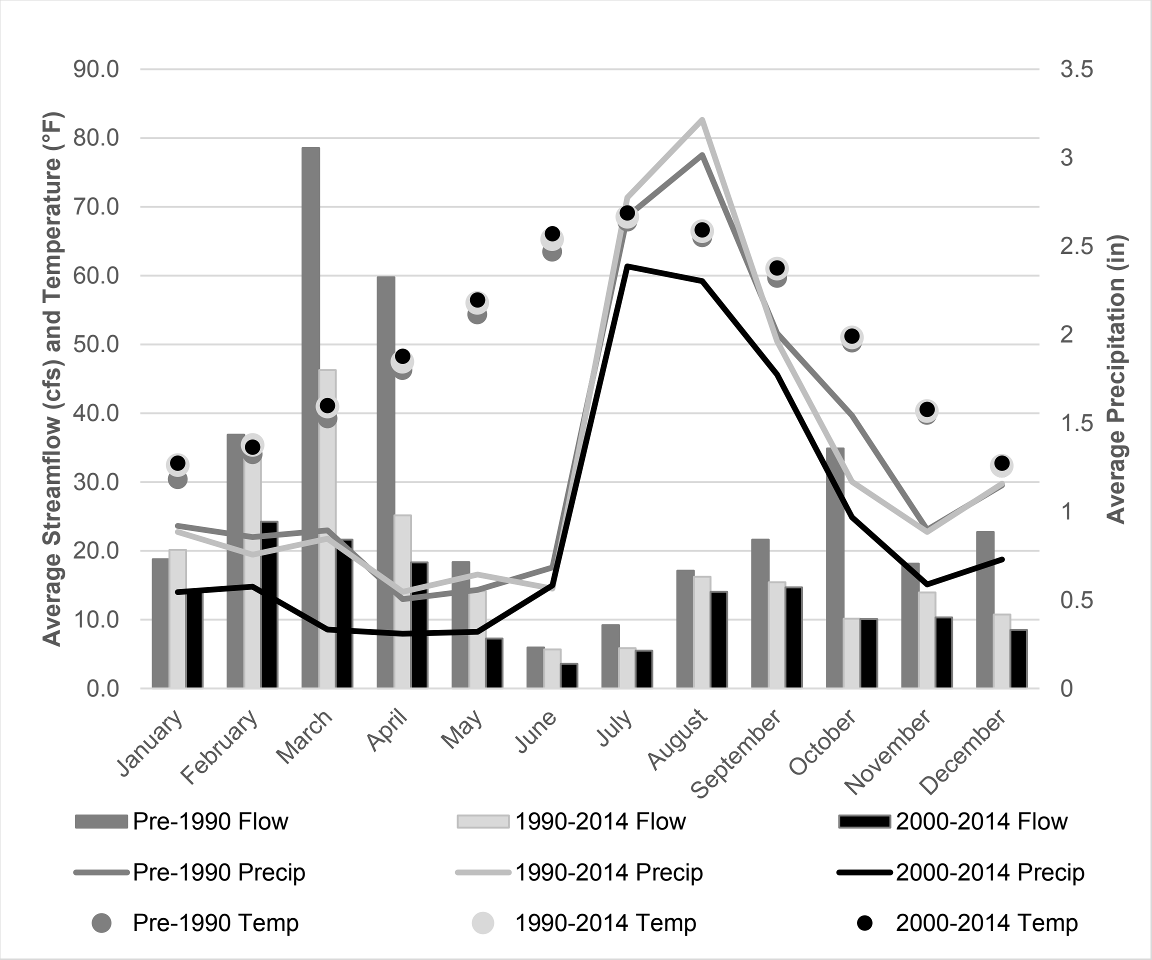

Figure D7. Monthly metrics at the San Francisco gage near Reserve, period of record 1960-2014; Southwestern Mountains climate division

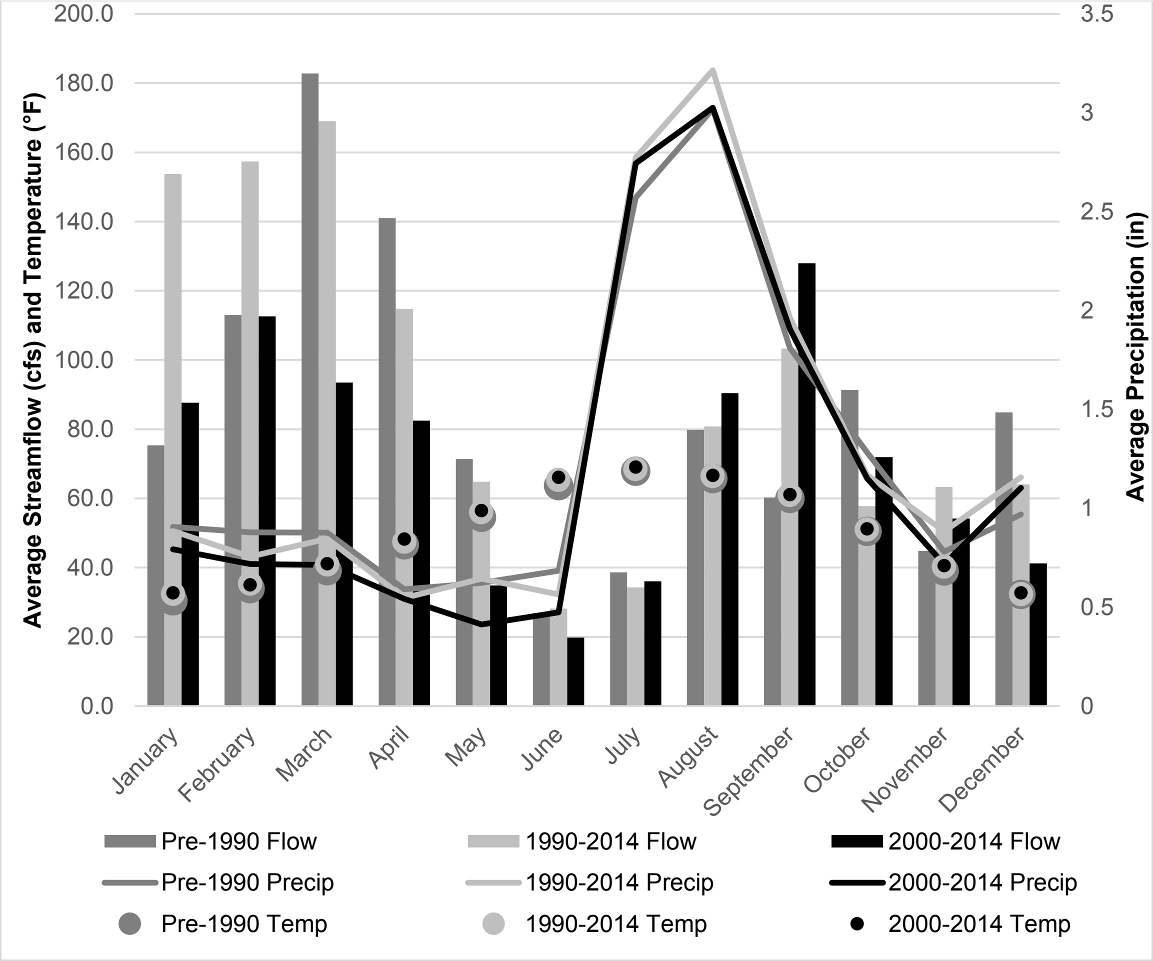

Figure D8. Monthly metrics at the San Francisco gage near Glenwood, period of record 1928-2014; Southwestern Mountains climate division

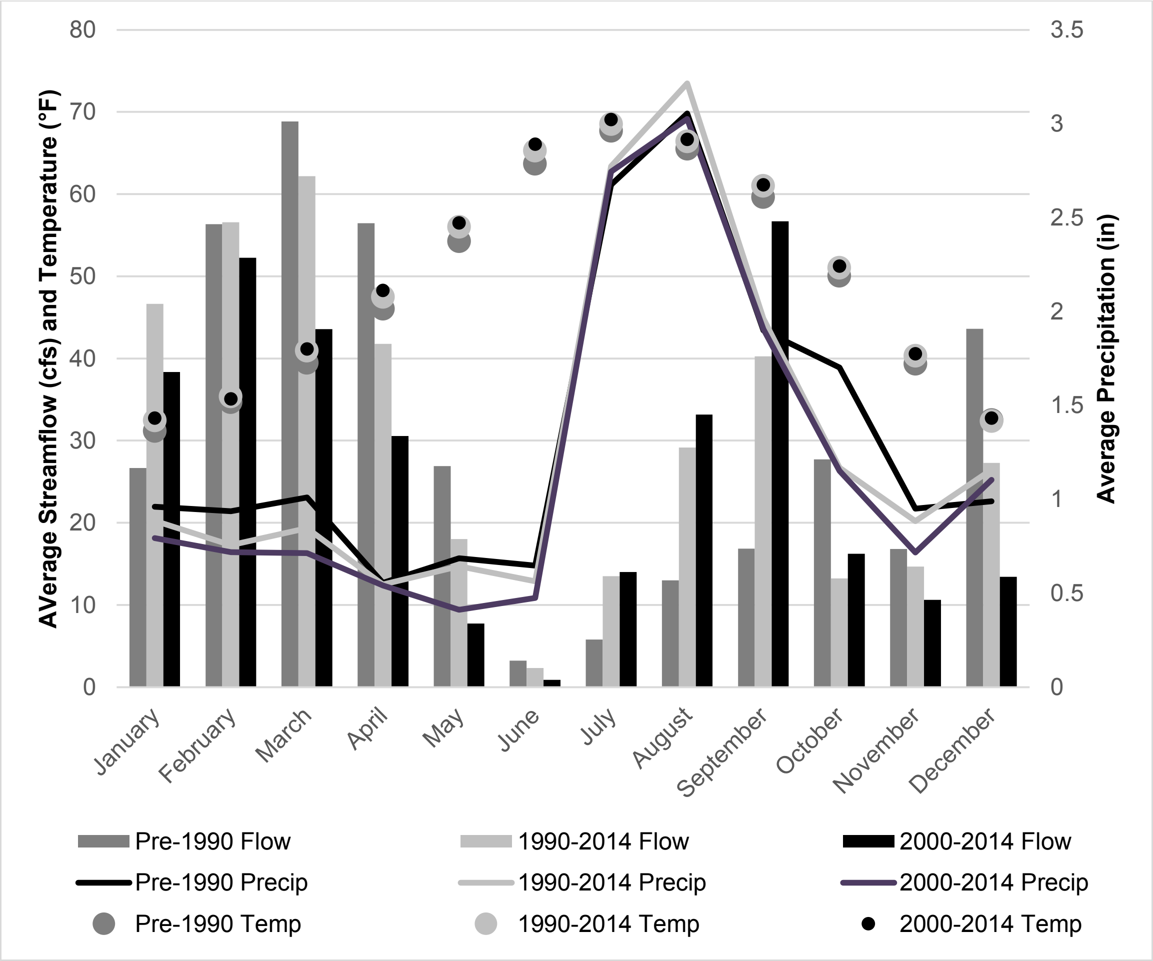

Figure D9. Monthly metrics at the Mogollon Creek gage near Cliff, period of record 1968-2014; Southwestern Mountains climate division

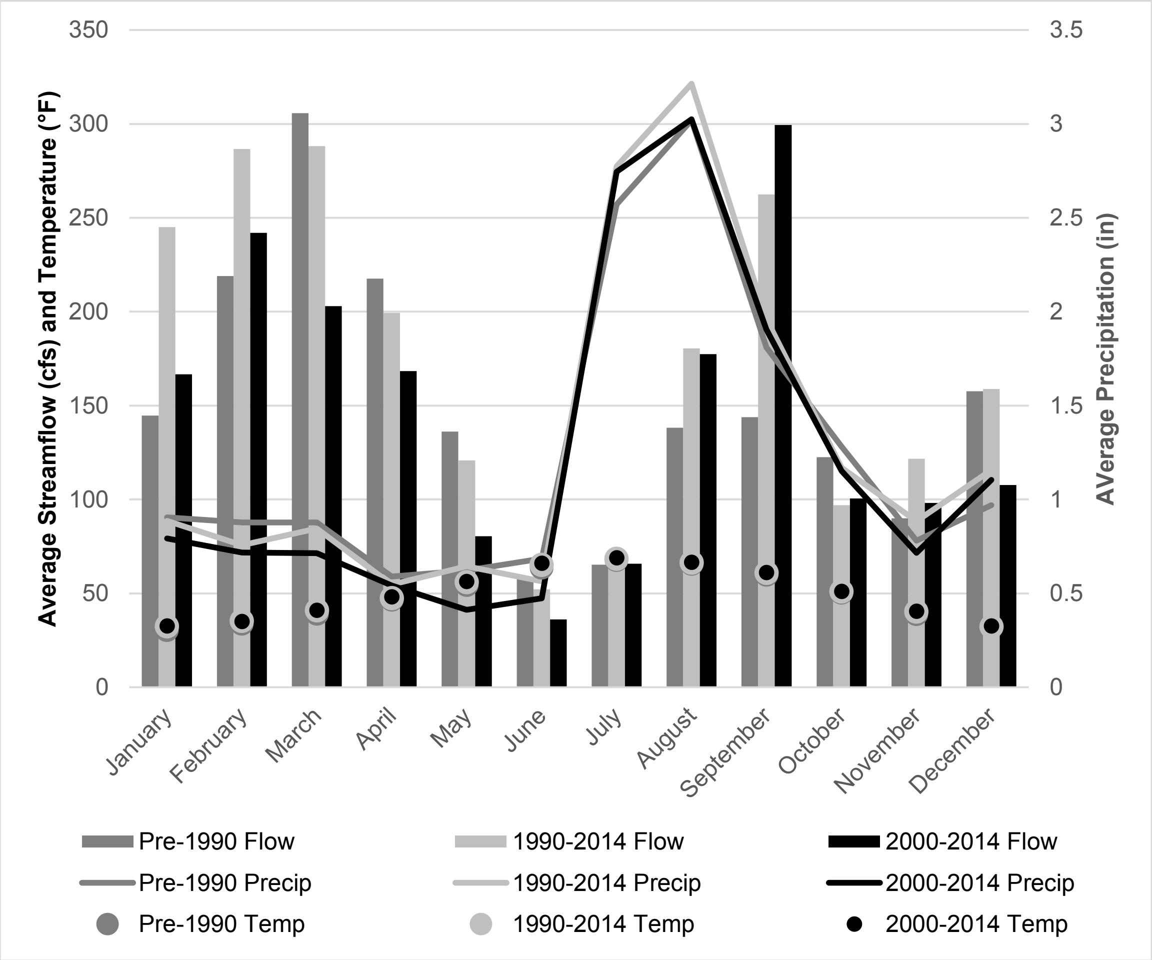

Figure D10. Monthly metrics at the Gila River gage near Gila, period of record 1928-2014; Southwestern Mountains climate division

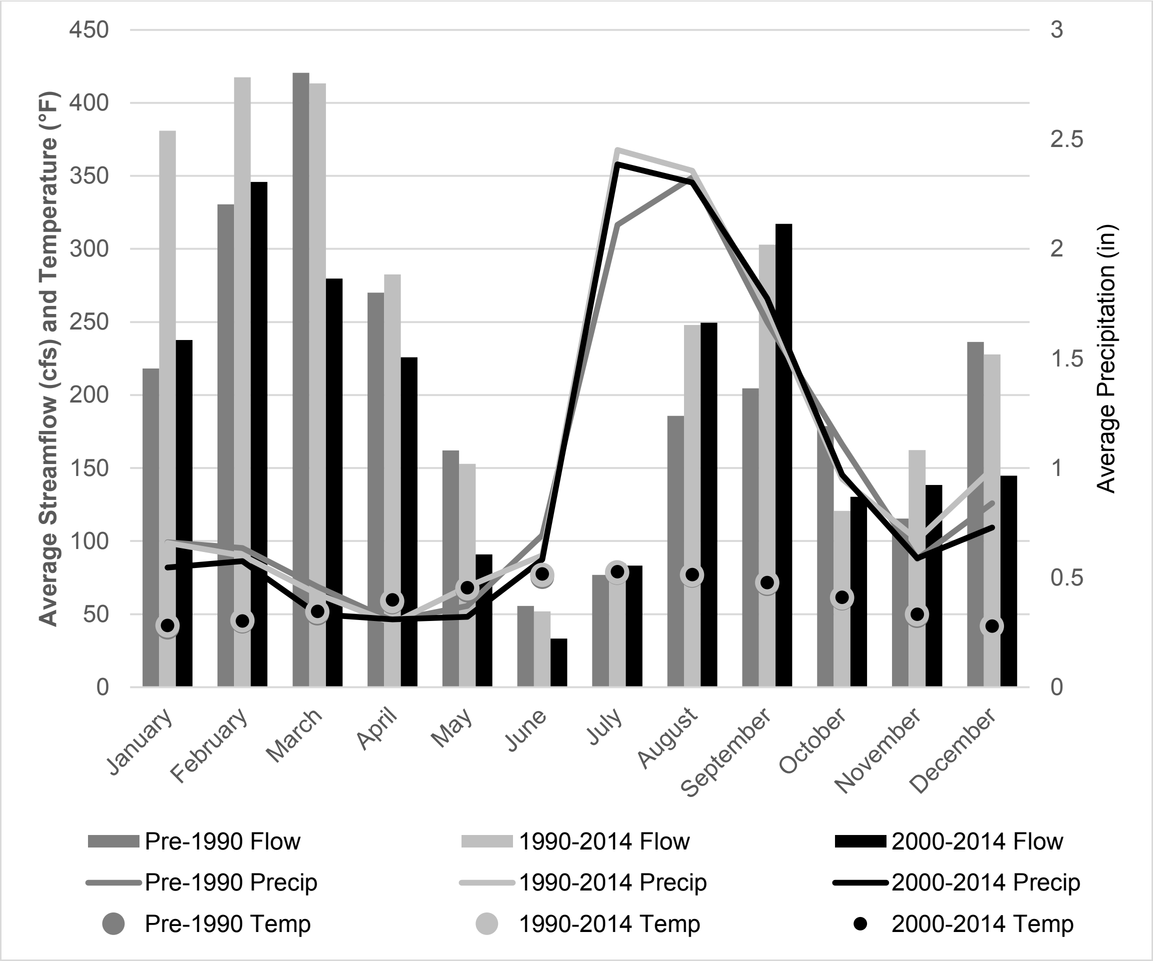

Figure D11. Monthly streamflow metrics at the Gila River gage near Redrock, period of record 1931-2014 with missing data during 1955-1962; Southern Desert climate division

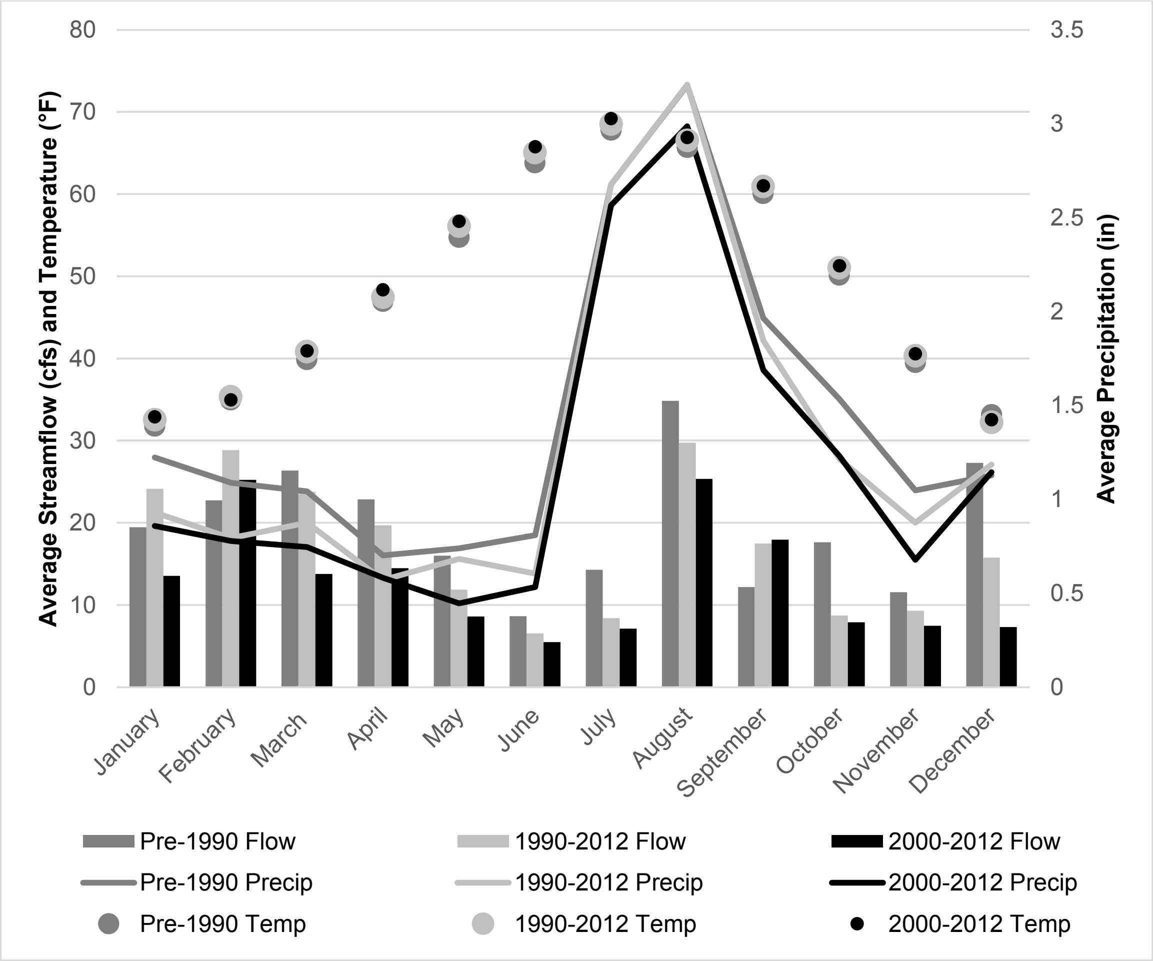

Figure D12. Monthly metrics at the Mimbres River gage near Mimbres, period of record 1979-2012; Southwestern Mountains climate division

Table D5. Extent and distribution of waterbodies and wells by subbasin, watershed and subwatershed

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
13020208	***Plains of San Agustin***	***11***	***531***	***89***	***17***	***602***	***12***	***2***
1302020804	*Nester Draw*	*3*	*110*	*5*	*5*	*272*	*5*	*2*
130202080401	Bear Canyon	38	7	3	43	9	5	56
130202080404	Headwaters Nester Draw	3	13	2	15	103	0	0
1302020806	*Y Canyon*	*53*	*51*	*28*	*55*	*14*	*2*	*14*
130202080601	La Jolla Canyon	99	22	20	91	2	0	0
130202080603	Y Canyon	42	17	8	47	11	2	18
1302020807	*Patterson Lake*	*38*	*116*	*56*	*48*	*37*	*5*	*14*
130202080701	Alamocito Creek	37	20	8	40	5	2	40
130202080703	West Pasture Springs	1	11	0	0	3	0	0
130202080704	Patterson Canyon	66	27	16	59	3	0	0
130202080705	Dark Canyon	42	10	4	40	3	0	0
130202080706	Patterson Lake	40	16	7	44	5	1	20
130202080707	Long Canyon	96	16	15	94	3	2	67
130202080708	T H Canyon	30	12	6	50	13	0	0
13020211	***Elephant Butte Reservoir***	***3***	***629***	***51***	***8***	***411***	***1***	***0***
1302021106	*Headwaters Alamosa Creek*	*16*	*180*	*51*	*28*	*33*	*1*	*3*
130202110603	Little Pigeon Canyon-Alamosa Creek	21	46	12	26	2	0	0
130202110606	Wahoo Canyon-Alamosa Creek	52	44	30	68	3	1	33
130202110607	Sim Yaten Canyon-Alamosa Creek	16	14	6	43	1	0	0
130202110608	Wildhorse Canyon	37	28	3	11	8	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
13030101	***Caballo***	***27***	***398***	***21***	***5***	***1523***	***17***	***1***
1303010101	*Cuchillo Negro Creek*	*32*	*83*	*12*	*14*	*301*	*12*	*4*
130301010101	Turkey Creek	85	2	1	50	8	3	38
130301010102	Poverty Creek	48	26	8	31	28	5	18
130301010103	Chloride Creek	76	5	3	60	38	1	3
130301010104	South Fork Cuchillo Negro Creek	71	0	0	0	11	2	18
130301010105	Monument Creek	30	1	0	0	7	1	14
130301010106	Monument Creek-Cuchillo Negro Creek	20	12	0	0	30	0	0
1303010102	*Palomas Creek-Rio Grande*	*25*	*145*	*0*	*0*	*843*	*1*	*0*
130301010204	Mud Spring Canyon	100	0	0	0	0	0	0
130301010205	Circle Seven Creek	96	0	0	0	0	0	0
130301010206	North Fork Palomas Creek	56	5	0	0	0	0	0
130301010207	South Fork Palomas Creek	57	2	0	0	3	1	33
1303010103	*Percha Creek*	*32*	*53*	*6*	*11*	*73*	*3*	*4*
130301010301	South Percha Creek	53	16	3	19	35	3	9
130301010302	North Percha Creek	54	3	3	100	2	0	0
1303010104	*Caballo Reservoir*	*21*	*119*	*3*	*3*	*306*	*1*	*0*
130301010401	North Seco Canyon	76	2	2	100	0	0	0
130301010403	Seco Creek	10	20	1	5	18	0	0
130301010404	Holden Prong	100	0	0	0	0	0	0
130301010405	Cave Creek	22	2	0	0	1	0	0
130301010406	Headwaters Los Animas Creek	65	0	0	0	1	1	100
13030102	***El Paso-Las Cruces***	***1***	***1,084***	***27***	***2***	***8931***	***0***	*0*

Hydrologic Unit Code (HUC)	**Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name**	**Gila NF HUC %**	**Waterbodies (Number)**			**Wells (Number)**		
			Total HUC	**Gila NF HUC**	**Gila NF % HUC**	**Total HUC**	**Gila NF HUC**	**Gila NF % HUC**
1303010202	*Cuervo Arroyo_Rio Grande*	*17*	*197*	*27*	*14*	*320*	*0*	*0*
130301020201	Trujillo Canyon Creek	33	65	13	20	14	0	0
130301020203	Headwaters Tierra Blanca Creek	98	1	1	100	0	0	0
130301020204	Outlet Tierra Blanca Creek	15	28	3	11	7	0	0
130301020207	Jaralosa Creek	13	16	10	63	36	0	0
130301020208	Headwaters Berenda Creek	37	8	0	0	60	0	0
13030202	***Mimbres***	***5***	***2,709***	***107***	***4***	***5608***	***25***	***0***
1303020201	*Gallinas Canyon-Mimbres River*	*74*	*197*	*81*	*41*	*397*	*14*	*4*
130302020101	Powderhorn Canyon-Mimbres River	99	16	16	100	7	6	86
130302020102	Allie Canyon-Mimbres River	97	34	34	100	84	6	7
130302020103	Sheppard Canyon-Mimbres River	81	28	14	50	25	0	0
130302020104	Noonday Canyon	78	5	2	40	23	0	0
130302020105	Noonday Canyon-Mimbres River	44	59	9	15	174	2	1
130302020106	Gallinas Canyon	73	24	6	25	31	0	0
1303020202	Headwaters San Vicente Draw	18	*216*	*9*	*4*	*856*	*6*	*1*
130302020201	Rio de Arenas	6	22	1	5	148	2	1
130302020203	Pipeline Draw-San Vicente Draw	16	43	3	7	503	2	0
130302020204	Cameron Creek	54	28	5	18	76	2	3
130302020205	Cameron Creek-San Vicente Draw	<1	57	0	0	30	0	0
1303020203	Outlet San Vicente Draw	1	*158*	*0*	*0*	*219*	*1*	*0*
130302020302	Headwaters Whitewater Creek	3	45	0	0	102	1	1
130302020305	Antelope Draw-San Vicente Draw	2	32	0	0	44	0	0
1303020204	*Lampbright Draw*	*3*	*143*	*3*	*2*	*94*	*0*	*0*
130302020401	Headwaters Lampbright Draw	9	42	3	7	81	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
1303020205	Lampbright Draw-Mimbres River	17	*99*	*11*	*11*	*116*	*0*	*0*
130302020501	Gavilan Arroyo	40	4	2	50	2	0	0
130302020502	Gavilan Arroyo-Mimbres River	39	37	9	24	25	0	0
1303020208	Macho Creek	2	*136*	*2*	*1*	*80*	*1*	*1*
130302020801	Upper Macho Creek	10	17	2	12	7	1	14
1303020213	Upper Seventysix Draw	1	*45*	*0*	*0*	*53*	*3*	*6*
130302021301	Whiterock Canyon	5	11	0	0	48	3	6
1303020214	Cow Spring Draw-Seventysix Draw	2	*107*	*1*	*1*	*95*	*0*	*0*
130302021402	Headwaters Cow Spring Draw	14	15	1	7	57	0	0
15020001	***Little Colorado Headwaters***	***3***	***838***	***26***	***3***	***1814***	***0***	***0***
1502000103	*Coyote Creek*	*9*	*169*	*26*	*15*	*123*	*0*	*0*
150200010301	Hay Vega	39	10	4	40	6	0	0
150200010302	Canovas Creek-Coyote Creek	33	49	22	45	19	0	0
15020003	***Carrizo Wash***	***14***	***1,470***	***146***	***10***	***722***	***16***	***2***
1502000301	*Rito Creek*	*13*	*254*	*19*	*7*	*303*	*1*	*0*
150200030101	Upper Mangas Creek	58	32	14	44	26	1	4
150200030102	Middle Mangas Creek	17	33	0	0	19	0	0
150200030103	Lower Mangas Creek	7	15	2	13	8	0	0
150200030109	Escondido Creek	47	17	3	18	0	0	0
1502000302	*Upper Largo Creek*	*76*	*91*	*66*	*73*	*25*	*8*	*32*
150200030201	El Caso Spring Canyon	100	21	21	100	3	3	100
150200030202	Sawmill Canyon-Largo Creek	91	40	36	90	3	0	0
150200030203	Paradise Canyon-Largo Creek	85	10	8	80	6	4	67

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150200030204	Rito Creek-Largo Creek	35	20	1	5	13	1	8
1502000305	*Agua Fria Creek*	*35*	*202*	*43*	*21*	*69*	*7*	*10*
150200030501	Harris Creek-Agua Fria Creek	90	19	12	63	31	5	16
150200030502	Demetrio Creek	59	16	4	25	2	0	0
150200030503	Demetrio Creek-Agua Fria Creek	37	28	1	4	3	1	33
150200030504	Gatlin Lake	73	37	17	46	18	1	6
150200030505	Mangitas Creek	41	13	8	62	2	0	0
150200030506	Cerro La Mula	10	23	1	4	4	0	0
150200030507	Cerro La Mula-Agua Fria Creek	2	21	0	0	0	0	0
1502000307	*LA Draw-Cienega Amarilla*	*5*	*225*	*18*	*8*	*51*	*0*	*0*
150200030703	Cow Springs Draw	25	55	18	33	2	0	0
15040001	***Upper Gila***	***84***	***628***	***418***	***67***	***225***	***72***	***32***
1504000101	*Railroad Canyon*	*16*	*52*	*6*	*12*	*5*	*0*	*0*
150400010101	Upper Railroad Canyon	4	27	1	4	1	0	0
150400010102	Middle Railroad Canyon	41	10	5	50	2	0	0
150400010103	Lower Railroad Canyon	7	15	0	0	2	0	0
1504000102	*Corduroy Draw*	*61*	*100*	*44*	*44*	*3*	*2*	*67*
150400010201	Upper Corduroy Draw	22	21	3	14	0	0	0
150400010202	South Water Canyon	79	30	16	53	0	0	0
150400010203	Middle Corduroy Draw	49	23	4	17	1	0	0
150400010204	Lower Corduroy Draw	96	26	21	81	2	2	100
1504000103	*Beaver Creek*	*54*	*113*	*54*	*48*	*5*	*0*	*0*
150400010301	Horse Camp Canyon	73	11	7	64	0	0	0
150400010302	Coyote Canyon	1	35	0	0	0	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400010303	O Bar O Canyon	46	25	10	40	4	0	0
150400010304	Houghton Canyon	92	15	14	93	0	0	0
150400010305	Houghton Canyon-Beaver Creek	79	27	23	85	1	0	0
1504000104	*Headwaters East Fork Gila River*	*99*	*91*	*87*	*96*	*12*	*5*	*42*
150400010401	150400010401 Hoyt Creek	99	6	5	83	3	1	33
150400010402	Taylor Creek	99	20	17	85	1	1	100
150400010403	Taylor Creek-Beaver Creek	99	17	17	100	0	0	0
150400010404	Headwaters Diamond Creek	100	1	1	100	0	0	0
150400010405	South Diamond Creek	100	10	10	100	0	0	0
150400010406	Outlet Diamond Creek	100	15	14	93	4	1	25
150400010407	Diamond Creek-East Fork Gila River	99	23	23	100	4	2	50
1504000105	*Middle Fork Gila River*	*100*	*115*	*105*	*91*	*45*	*42*	*93*
150400010501	T Bar Canyon	100	13	12	92	0	0	0
150400010502	Gilita Creek	100	19	11	58	42	41	98
150400010503	Snow Canyon	100	20	20	100	1	1	100
150400010504	Canyon Creek	99	19	19	100	1	0	0
150400010505	Canyon Creek-Middle Fork Gila River	100	3	3	100	0	0	0
150400010506	Indian Creek Canyon	99	11	10	91	1	0	0
150400010507	Indian Creek Canyon-Middle Fork Gila River	100	5	5	100	0	0	0
150400010508	Big Bear Canyon-Middle Fork Gila River	99	25	25	100	0	0	0
1504000106	*West Fork Gila River*	*99*	*22*	*16*	*73*	*57*	*5*	*9*

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400010601	White Creek	100	0	0	0	0	0	0
150400010602	Headwaters West Fork Gila River	100	0	0	0	0	0	0
150400010603	Little Creek	100	4	4	100	0	0	0
150400010604	Outlet West Fork Gila River	96	18	12	67	57	5	9
1504000107	*Outlet East Fork Gila River*	*99*	*42*	*41*	*98*	*6*	*3*	*50*
150400010701	Tom Moore Canyon	100	12	12	100	1	1	100
150400010702	Headwaters Black Canyon	100	0	0	0	0	0	0
150400010703	Apache Creek	100	9	9	100	0	0	0
150400010704	Outlet Black Canyon	100	9	9	100	0	0	0
150400010705	Black Canyon-East Fork Gila River	97	12	11	92	5	2	40
1504000108	*Sapillo Creek*	*98*	*50*	*43*	*86*	*84*	*12*	*14*
150400010801	Rocky Canyon	100	3	3	100	0	0	0
150400010802	Rocky Canyon-Sapillo Creek	98	22	20	91	13	2	15
150400010803	Lake Roberts-Sapillo Creek	98	13	10	77	54	8	15
150400010804	Copperas Creek-Sapillo Creek	96	5	3	60	17	2	12
150400010805	Sheep Corral Canyon-Sapillo Creek	100	7	7	100	0	0	0
1504000109	*Sapillo Creek-Gila River*	*96*	*43*	*22*	*51*	*8*	*3*	*38*
150400010901	Sapillo Creek-Gila River	100	3	3	100	0	0	0
150400010902	Hells Canyon-Gila River	100	10	10	100	0	0	0
150400010903	Turkey Creek	100	2	2	100	0	0	0
150400010904	Upper Mogollon Creek	100	0	0	0	4	1	25
150400010905	Middle Mogollon Creek	88	17	4	24	3	1	33
150400010906	Lower Mogollon Creek	75	9	1	11	1	1	100
150400010907	Mogollon Creek-Gila River	98	2	2	100	0	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
15040002	***Upper Gila-Mangas***	***15***	***1,319***	***106***	***8***	***2706***	***33***	***1***
1504000201	*Bear Creek*	*63*	*43*	*16*	*37*	*210*	*11*	*5*
150400020101	Upper Bear Creek	88	14	8	57	97	8	8
150400020102	Middle Bear Creek	74	10	6	60	25	2	8
150400020103	Lower Bear Creek	27	19	2	11	88	1	1
1504000202	*Duck Creek*	*12*	*306*	*18*	*6*	*234*	*0*	*0*
150400020201	Headwaters Buckhorn Wash	21	47	12	26	4	0	0
150400020203	Sacaton Creek	30	40	2	5	2	0	0
150400020204	Headwaters Duck Creek	10	65	4	6	13	0	0
1504000203	*Mangas Creek*	*39*	*178*	*23*	*13*	*409*	*12*	*3*
150400020301	Willow Creek-Mangas Creek	41	59	3	5	177	5	3
150400020302	McKeafer Canyon-Mangas Creek	31	39	6	15	170	4	2
150400020303	Ash Spring Canyon-Mangas Creek	55	28	6	21	27	2	7
150400020304	Schoolhouse Canyon-Mangas Creek	30	52	8	15	35	1	3
1504000204	*Sycamore Creek-Upper Gila River*	*3*	*222*	*1*	*0*	*275*	*1*	*0*
150400020401	Bear Creek-Upper Gila River	12	60	1	2	161	1	1
1504000205	Blue Creek	4	*67*	*7*	*10*	*5*	*0*	*0*
150400020501	Cherry Creek-Blue Creek	9	40	7	18	1	0	0
1504000206	*Blue Creek-Upper Gila River*	*25*	*157*	*34*	*22*	*67*	*8*	*12*
150400020601	Bear Canyon-Upper Gila River	88	18	15	83	8	5	63
150400020602	Swan Canyon	56	9	7	78	14	3	21
150400020603	Swan Canyon-Upper Gila River	29	28	11	39	13	0	0
150400020607	Corral Canyon	3	31	1	3	1	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
1504000208	*Apache Creek-Gila River*	*5*	*174*	*7*	*4*	*737*	*1*	*0*
150400020804	Apache Creek	31	22	7	32	48	1	2
15040003	***Animas Valley***	***4***	***991***	***24***	***2***	***962***	***1***	***0***
1504000302	*Headwaters Burro Cienega*	*16*	*84*	*7*	*8*	*15*	*0*	*0*
150400030201	Hall Draw-Burro Cienega	56	15	5	33	2	0	0
150400030203	Ninetysix Creek	12	22	2	9	6	0	0
1504000303	*Outlet Burro Cienega*	*<1*	*87*	*0*	*0*	*137*	*0*	*0*
150400030305	Jones Canyon-Burro Cienega	<1	2	0	0	2	0	0
150400030307	Walker Canyon	1	21	0	0	51	0	0
1504000304	*Lordsburg Draw*	*19*	*143*	*17*	*12*	*166*	*1*	*1*
150400030401	Gold Hill Canyon-Lordsburg Draw	21	13	1	8	41	0	0
150400030402	Hoodoo Canyon-Lordsburg Draw	13	26	3	12	48	0	0
150400030403	Headwaters Thompson Canyon	80	13	3	23	2	1	50
150400030404	Outlet Thompson Canyon	21	26	6	23	27	0	0
150400030405	Thompson Canyon-Lordsburg Draw	20	21	4	19	37	0	0
15040004	***San Francisco***	***61***	***2,277***	***1,354***	***59***	***1991***	***167***	***8***
1504000401	*Headwaters Tularosa River*	*94*	*185*	*149*	*81*	*170*	*28*	*16*
150400040101	Sand Flat Canyon	91	27	23	85	10	0	0
150400040102	Canon Del Buey	100	14	14	100	0	0	0
150400040103	Negro Canyon-Tularosa River	94	17	16	94	41	3	7
150400040104	Whiskey Creek	93	23	19	83	7	1	14
150400040105	Hardcastle Canyon	95	38	31	82	2	0	0
150400040106	Apache Creek	91	34	25	74	39	6	15
150400040107	Apache Creek-Tularosa River	94	24	14	58	31	8	26

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400040108	Cold Springs Canyon-Tularosa River	96	8	7	88	40	10	25
1504000402	*OutletTularosa River*	*98*	*148*	*133*	*90*	*61*	*14*	*23*
150400040201	Long Canyon-Tularosa River	96	30	28	93	48	9	19
150400040202	Headwaters North Fork Negrito Creek	99	14	13	93	2	0	0
150400040203	South Fork Negrito Creek	99	38	26	68	3	1	33
150400040204	Outlet North Fork Negrito Creek	99	20	20	100	0	0	0
150400040205	Sign Camp Canyon	100	22	22	100	0	0	0
150400040206	Negrito Creek	99	15	15	100	2	1	50
150400040207	Negrito Creek-Tularosa River	95	9	9	100	6	3	50
1504000403	*Centerfire Creek-San Francisco River*	*78*	*432*	*230*	*53*	*708*	*32*	*5*
150400040302	Trout Creek	60	56	36	64	10	0	0
150400040303	Stone Creek-San Francisco River	61	49	16	33	130	8	6
150400040304	Spur Draw	82	47	27	57	4	1	25
150400040305	SA Creek	97	54	52	96	4	1	25
150400040306	Headwaters Centerfire Creek	95	19	18	95	2	0	0
150400040307	Outlet Centerfire Creek	87	38	19	50	14	3	21
150400040308	Big Canyon-San Francisco River	95	18	15	83	26	0	0
150400040309	Starkweather Canyon	96	24	16	67	25	4	16
150400040310	Largo Canyon	97	23	17	74	10	4	40
150400040311	Cienega Canyon-San Francisco River	91	26	14	54	64	11	17
1504000404	*Deep Creek-San Francisco River*	*98*	*93*	*86*	*92*	*70*	*14*	*20*
150400040401	Headwaters Saliz Canyon	100	19	18	95	1	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400040402	Outlet Saliz Canyon	98	6	6	100	10	1	10
150400040403	Saliz Canyon-San Francisco River	96	22	18	82	47	9	19
150400040404	Devils Creek	100	11	11	100	0	0	0
150400040405	Deep Creek	96	12	11	92	7	2	29
150400040406	Devils Creek-San Francisco River	97	23	22	96	5	2	40
1504000405	*Upper Blue River*	*14*	*134*	*11*	*8*	*100*	*1*	*1*
150400040502	Dry Blue Creek	76	21	10	48	32	1	3
150400040503	Campbell Blue Creek	2	55	0	0	5	0	0
150400040504	Centerfire Creek-Blue River	14	7	0	0	13	0	0
150400040506	Steeple Canyon-Blue River	15	13	1	8	26	0	0
1504000406	*Pueblo Creek-San Francisco River*	*88*	*511*	*410*	*80*	*241*	*70*	*29*
150400040601	Upper Pueblo Creek	100	0	0	0	0	0	0
150400040602	Lower Pueblo Creek	95	10	10	100	0	0	0
150400040603	Keller Canyon	56	98	70	71	4	0	0
150400040604	Vigil Canyon	78	163	150	92	1	1	100
150400040605	Mineral Creek	92	27	14	52	56	26	46
150400040606	Wendy Flat-San Francisco River	89	97	85	88	33	3	9
150400040607	Whitewater Creek	95	22	9	41	75	10	13
150400040608	South Dugway Creek-San Francisco River	94	94	72	77	72	30	42
1504000407	*Lower Blue River*	*<1*	*96*	*0*	*0*	*11*	*0*	*0*
150400040704	Little Blue Creek	1	5	0	0	0	0	0
1504000408	*Mule Creek-San Francisco River*	*50*	*611*	*335*	*55*	*121*	*8*	*7*
150400040801	Little Dry Creek	45	74	29	39	7	1	14

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Waterbodies (Number)			Wells (Number)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400040802	Big Dry Creek	98	15	12	80	11	2	18
150400040803	Pine Cienega Creek	50	62	20	32	21	1	5
150400040804	Upper Mule Creek	67	50	32	64	53	1	2
150400040805	Lower Mule Creek	48	50	26	52	1	0	0
150400040806	Citizen Canyon	62	31	28	90	0	0	0
150400040807	Big Pine Canyon-San Francisco River	99	112	112	100	4	1	25
150400040808	Harden Cienega Creek	35	126	73	58	8	2	25
150400040809	Coal Creek	10	34	3	9	13	0	0
150400040811	Coalson Creek-San Francisco River	<1	21	0	0	2	0	0

Table D6. Plan area assessed stream miles by subbasin, watershed, subwatershed and water quality status[1,2].

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
13020208	***Plains of San Agustin***	***11***	***0***	***0***	***0***	***0***	***0***	***0***
1302020804	*Nester Draw*	*3*	*0*	*0*	*0*	*0*	*0*	*0*
130202080401	Bear Canyon	38	0	0	0	0	0	0
130202080404	Headwaters Nester Draw	0	0	0	0	0	0	0
1302020806	*Y Canyon*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
130202080601	La Jolla Canyon	0	0	0	0	0	0	0
130202080603	Y Canyon	0	0	0	0	0	0	0
1302020807	*Patterson Lake*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
130202080701	Alamocito Creek	0	0	0	0	0	0	0
130202080703	West Pasture Springs	0	0	0	0	0	0	0
130202080704	Patterson Canyon	0	0	0	0	0	0	0
130202080705	Dark Canyon	0	0	0	0	0	0	0
130202080706	Patterson Lake	0	0	0	0	0	0	0
130202080707	Long Canyon	96	0	0	0	0	0	0
130202080708	T H Canyon	30	0	0	0	0	0	0
13020211	***Elephant Butte Reservoir***	***3***	***37.0***	***0***	***37.0***	***0***	***0***	***0***
1302021106	*Headwaters Alamosa Creek*	*16*	*0.1*	*0*	*0.1*	*0*	*0*	*0*
130202110603	Little Pigeon Canyon-Alamosa Creek	21	0	0	0	0	0	0
130202110606	Wahoo Canyon-Alamosa Creek	52	0	0	0	0	0	0
130202110607	Sim Yaten Canyon-Alamosa Creek	16	0	0	0	0	0	0
130202110608	Wildhorse Canyon	37	0	0	0	0	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
13030101	***Caballo***	***27***	***110.8***	***10.8***	***62.5***	***0***	***48.3***	***10.8***
1303010101	*Cuchillo Negro Creek*	*32*	*1.2*	*0*	*1.2*	*0*	*0*	*0*
130301010101	Turkey Creek	85	0	0	0	0	0	0
130301010102	Poverty Creek	48	0	0	0	0	0	0
130301010103	Chloride Creek	76	0	0	0	0	0	0
130301010104	South Fork Cuchillo Negro Creek	71	0	0	0	0	0	0
130301010105	Monument Creek	30	0	0	0	0	0	0
130301010106	Monument Creek-Cuchillo Negro Creek	20	0	0	0	0	0	0
1303010102	*Palomas Creek-Rio Grande*	*25*	*38.5*	*0*	*23.8*	*0*	*14.7*	*0*
130301010204	Mud Spring Canyon	100	0	0	0	0	0	0
130301010205	Circle Seven Creek	96	0	0	0	0	0	0
130301010206	North Fork Palomas Creek	56	0.1	0	0.1	0	0	0
130301010207	South Fork Palomas Creek	57	0.1	0	0.1	0	0	0
1303010103	*Percha Creek*	*32*	*24.7*	*0*	*24.7*	*0*	*0*	*0*
130301010301	South Percha Creek	53	5.9	0	5.9	0	0	0
130301010302	North Percha Creek	54	0	0	0	0	0	0
1303010104	*Caballo Reservoir*	*21*	*62.7*	*10.8*	*12.9*	*0*	*49.8*	*10.8*
130301010401	North Seco Canyon	76	0	0	0	0	0	0
130301010403	Seco Creek	10	0	0	0	0	0	0
130301010404	Holden Prong	100	3.5	3.5	0	0	3.5	3.5
130301010405	Cave Creek	22	<0.1	0	0	0	<0.1	0
130301010406	Headwaters Los Animas Creek	65	16.8	7.4	0	0	16.8	7.4

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			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
13030102	***El Paso-Las Cruces***	***1***	***159.7***	***9.1***	***86.5***	***9.1***	***73.2***	***0***
1303010202	*Cuervo Arroyo_Rio Grande*	*17*	*48.8*	*9.1*	*36.8*	*9.1*	*12.0*	*0*
130301020201	Trujillo Canyon Creek	33	0	0	0	0	0	0
130301020203	Headwaters Tierra Blanca Creek	98	8.5	7.9	8.5	7.9	0	0
130301020204	Outlet Tierra Blanca Creek	15	25.2	1.2	25.2	1.2	0	0
130301020207	Jaralosa Creek	13	0	0	0	0	0	0
130301020208	Headwaters Berenda Creek	37	0	0	0	0	0	0
13030202	***Mimbres***	***5***	***154.2***	***67.0***	***84.0***	***47.7***	***70.2***	***19.3***
1303020201	*Gallinas Canyon-Mimbres River*	*74*	*93.4*	*60.6*	*45.8*	*43.0*	*47.6*	*17.6*
130302020101	Powderhorn Canyon-Mimbres River	99	17.3	29.2	12.1	11.6	41.1	17.6
130302020102	Allie Canyon-Mimbres River	97	29.4	24.8	23.7	22.5	5.7	2.3
130302020103	Sheppard Canyon-Mimbres River	81	13.4	8.9	10.0	8.9	3.4	0
130302020104	Noonday Canyon	78	0	0	0	0	0	0
130302020105	Noonday Canyon-Mimbres River	44	6.6	0	0	0	6.6	0
130302020106	Gallinas Canyon	73	20.2	11.9	0	0	20.2	11.9
1303020202	Headwaters San Vicente Draw	18	*5.4*	*0*	*3.5*	*0*	*1.9*	*0*
130302020201	Rio de Arenas	6	0	0	0	0	0	0
130302020203	Pipeline Draw-San Vicente Draw	16	5.4	0	3.5	0	1.9	0
130302020204	Cameron Creek	54	0	0	0	0	0	0
130302020205	Cameron Creek-San Vicente Draw	<1	0	0	0	0	0	0
1303020203	Outlet San Vicente Draw	1	*24.2*	*<0.1*	*24.2*	*<0.1*	*0*	*0*
130302020302	Headwaters Whitewater Creek	3	18.2	<0.1	18.2	<0.1	0	0
130302020305	Antelope Draw-San Vicente Draw	2	0	0	0	0	0	0

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			Total HUC	**Gila NF HUC**	**Total HUC**	**Gila NF HUC**	**Total HUC**	**Gila NF HUC**
1303020204	*Lampbright Draw*	*3*	*0*	*0*	*0*	*0*	*0*	*0*
130302020401	Headwaters Lampbright Draw	9	0	0	0	0	0	0
1303020205	Lampbright Draw-Mimbres River	17	*31.4*	*6.5*	*10.5*	*4.8*	*20.9*	*1.7*
130302020501	Gavilan Arroyo	40	0	0	0	0	0	0
130302020502	Gavilan Arroyo-Mimbres River	39	22.8	6.5	10.5	4.8	12.3	1.7
1303020208	Macho Creek	*0*	*0*	*0*	*0*	*0*	*0*	*0*
130302020801	Upper Macho Creek	10	0	0	0	0	0	0
1303020213	Upper Seventysix Draw	1	*0*	*0*	*0*	*0*	*0*	*0*
130302021301	Whiterock Canyon	5	0	0	0	0	0	0
1303020214	Cow Spring Draw-Seventysix Draw	2	*0*	*0*	*0*	*0*	*0*	*0*
130302021402	Headwaters Cow Spring Draw	14	0	0	0	0	0	0
15020001	***Little Colorado Headwaters***	***3***	***234.4***	***0***	***185.3***	***0***	***49.1***	***0***
1502000103	*Coyote Creek*	*9*	0	0	0	0	0	0
150200010301	Hay Vega	39	0	0	0	0	0	0
150200010302	Canovas Creek-Coyote Creek	33	0	0	0	0	0	0
15020003	***Carrizo Wash***	***14***	***88.6***	***11.6***	***77***	***11.6***	***0***	***0***
1502000301	*Rito Creek*	*13*	*0*	*0*	*0*	*0*	*0*	*0*
150200030101	Upper Mangas Creek	58	0	0	0	0	0	0
150200030102	Middle Mangas Creek	17	0	0	0	0	0	0
150200030103	Lower Mangas Creek	7	0	0	0	0	0	0
150200030109	Escondido Creek	47	0	0	0	0	0	0
1502000302	*Upper Largo Creek*	*76*	*32.7*	*11.6*	*32.7*	*11.6*	*0*	*0*
150200030201	El Caso Spring Canyon	100	0	0	0	0	0	0

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			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
150200030202	Sawmill Canyon-Largo Creek	91	12.8	8.7	12.8	8.7	0	0
150200030203	Paradise Canyon-Largo Creek	85	11.1	2.9	11.1	2.9	0	0
150200030204	Rito Creek-Largo Creek	35	8.7	0	8.7	0	0	0
1502000305	*Agua Fria Creek*	*35*	*0*	*0*	*0*	*0*	*0*	*0*
150200030501	Harris Creek-Agua Fria Creek	90	0	0	0	0	0	0
150200030502	Demetrio Creek	59	0	0	0	0	0	0
150200030503	Demetrio Creek-Agua Fria Creek	37	0	0	0	0	0	0
150200030504	Gatlin Lake	73	0	0	0	0	0	0
150200030505	Mangitas Creek	41	0	0	0	0	0	0
150200030506	Cerro La Mula	10	0	0	0	0	0	0
150200030507	Cerro La Mula-Agua Fria Creek	2	0	0	0	0	0	0
1502000307	*LA Draw-Cienega Amarilla*	*5*	*0*	*0*	*0*	*0*	*0*	*0*
150200030703	Cow Springs Draw	25	0	0	0	0	0	0
15040001	***Upper Gila***	***84***	***388.6***	***339.3***	***103.1***	***96.6***	***285.5***	***242.7***
1504000101	*Railroad Canyon*	*16*	*<0.1*	*0*	*0*	*0*	*<0.1*	*0*
150400010101	Upper Railroad Canyon	4	0	0	0	0	0	0
150400010102	Middle Railroad Canyon	41	0	0	0	0	0	0
150400010103	Lower Railroad Canyon	7	<0.1	0	0	0	<0.1	0
1504000102	*Corduroy Draw*	*61*	*0*	*0*	*0*	*0*	*0*	*0*
150400010201	Upper Corduroy Draw	22	0	0	0	0	0	0
150400010202	South Water Canyon	79	0	0	0	0	0	0
150400010203	Middle Corduroy Draw	49	0	0	0	0	0	0
150400010204	Lower Corduroy Draw	96	0	0	0	0	0	0
1504000103	*Beaver Creek*	*54*	*24.6*	*2.4*	*0*	*0*	*24.6*	*2.4*

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			Total HUC	**Gila NF HUC**	**Total HUC**	**Gila NF HUC**	**Total HUC**	**Gila NF HUC**
150400010301	Horse Camp Canyon	73	0	0	0	0	0	0
150400010302	Coyote Canyon	1	15.0	0	0	0	15.0	0
150400010303	O Bar O Canyon	46	0.2	0	0	0	0.2	0
150400010304	Houghton Canyon	92	0	0	0	0	0	0
150400010305	Houghton Canyon-Beaver Creek	79	9.4	2.4	0	0	9.4	2.4
1504000104	*Headwaters East Fork Gila River*	*99*	*88.8*	*79.3*	*45.6*	*43.4*	*43.2*	*35.9*
150400010401	Hoyt Creek	99	19.9	18.1	19.9	18.1	0	0
150400010402	Taylor Creek	99	22.4	19.5	0	0	22.4	19.5
150400010403	Taylor Creek-Beaver Creek	99	11.4	10.0	0	0	11.4	10.0
150400010404	Headwaters Diamond Creek	100	12.6	12.6	12.6	12.6	0	0
150400010405	South Diamond Creek	100	0	0	0	0	0	0
150400010406	Outlet Diamond Creek	100	13.0	12.7	13.0	12.7	0	0
150400010407	Diamond Creek-East Fork Gila River	99	9.4	6.4	<0.1	<0.1	9.4	6.4
1504000105	*Middle Fork Gila River*	*100*	*84.7*	*81.6*	*20.3*	*20.3*	*64.4*	*61.3*
150400010501	T Bar Canyon	100	0	0	0	0	*0*	*0*
150400010502	Gilita Creek	100	20.0	18.7	6.6	6.6	*13.5*	*12.1*
150400010503	Snow Canyon	100	0.8	0.8	0.8	0.8	<0.1	<0.1
150400010504	Canyon Creek	99	14.1	13.1	0	0	*14.1*	*13.1*
150400010505	Canyon Creek-Middle Fork Gila River	100	25.4	25.4	13.0	13.0	12.4	12.4
150400010506	Indian Creek Canyon	99	9.1	9.1	0	0	9.1	9.1
150400010507	Indian Creek Canyon-Middle Fork Gila River	100	0	0	0	0	0	0

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			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
150400010508	Big Bear Canyon-Middle Fork Gila River	99	24.2	19.8	0	0	24.2	19.8
1504000106	*West Fork Gila River*	*99*	*61.8*	*57.2*	*25.4*	*25.2*	*36.4*	*32.0*
150400010601	White Creek	100	9.0	9.0	9.0	9.0	0	0
150400010602	Headwaters West Fork Gila River	100	12.2	12.2	<0.1	<0.1	12.2	12.2
150400010603	Little Creek	100	16.4	16.2	16.4	16.2	0	0
150400010604	Outlet West Fork Gila River	96	24.2	19.8	<0.1	0	24.2	19.8
1504000107	*Outlet East Fork Gila River*	*99*	*41.8*	*39.0*	0	0	41.8	39.0
150400010701	Tom Moore Canyon	100	0	0	0	0	0	0
150400010702	Headwaters Black Canyon	100	8.3	8.3	0	0	8.3	8.3
150400010703	Apache Creek	100	0	0	0	0	0	0
150400010704	Outlet Black Canyon	100	16.9	16.9	0	0	16.9	16.9
150400010705	Black Canyon-East Fork Gila River	97	16.7	14.0	0	0	16.7	14.0
1504000108	*Sapillo Creek*	*98*	*11.8*	*7.6*	*11.8*	*7.6*	0	0
150400010801	Rocky Canyon	100	0	0	0	0	0	0
150400010802	Rocky Canyon-Sapillo Creek	98	0.1	0.1	0.1	0.1	0	0
150400010803	Lake Roberts-Sapillo Creek	98	1.3	0	1.3	0	0	0
150400010804	Copperas Creek-Sapillo Creek	96	2.9	<0.1	2.9	<0.1	0	0
150400010805	Sheep Corral Canyon-Sapillo Creek	100	7.6	7.6	7.6	7.6	0	0
1504000109	*Sapillo Creek-Gila River*	*96*	*75.2*	*72.2*	*<0.1*	*<0.1*	75.2	72.2
150400010901	Sapillo Creek-Gila River	100	16.4	16.4	<0.1	0	16.4	16.4
150400010902	Hells Canyon-Gila River	100	9.2	9.2	0	0	9.2	9.2
150400010903	Turkey Creek	100	16.9	16.6	0	0	16.9	16.6
150400010904	Upper Mogollon Creek	100	13.4	13.4	0	0	13.4	13.4

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			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
150400010905	Middle Mogollon Creek	88	3.3	2.2	0	0	3.3	2.2
150400010906	Lower Mogollon Creek	75	0	0	0	0	0	0
150400010907	Mogollon Creek-Gila River	98	15.9	14.4	0	0	15.9	14.4
15040002	***Upper Gila-Mangas***	***15***	***200.8***	***20.6***	***93.9***	***9.3***	***106.9***	***11.3***
1504000201	*Bear Creek*	*63*	*30.4*	*8.3*	*30.4*	*8.3*	*0*	*0*
150400020101	Upper Bear Creek	88	11.0	8.1	11.0	8.1	0	0
150400020102	Middle Bear Creek	74	5.1	0.2	5.1	0.2	0	0
150400020103	Lower Bear Creek	27	14.4	0	14.4	0	0	0
1504000202	*Duck Creek*	*12*	*0*	*0*	*0*	*0*	*0*	*0*
150400020201	Headwaters Buckhorn Wash	21	0	0	0	0	0	0
150400020203	Sacaton Creek	30	0	0	0	0	0	0
150400020204	Headwaters Duck Creek	10	0	0	0	0	0	0
1504000203	*Mangas Creek*	*39*	*24.9*	*1.0*	*18.5*	*0.9*	*6.4*	*0.1*
150400020301	Willow Creek-Mangas Creek	41	7.9	0	7.9	0	0	0
150400020302	McKeafer Canyon-Mangas Creek	31	3.4	0.1	3.4	0.1	0	0
150400020303	Ash Spring Canyon-Mangas Creek	55	3.4	0.8	3.4	0.8	0	0
150400020304	Schoolhouse Canyon-Mangas Creek	30	10.2	0.1	3.8	0	6.4	0.1
1504000204	*Sycamore Creek-Upper Gila River*	*3*	*8.4*	*1.0*	*0.1*	*0*	*8.3*	*1.0*
150400020401	Bear Creek-Upper Gila River	12	*8.4*	*1.0*	*0.1*	*0*	*8.3*	*1.0*
1504000205	Blue Creek	*4*	*28.7*	*0*	*28.7*	*0*	*<0.1*	*0*
150400020501	Cherry Creek-Blue Creek	9	11.0	0	11.0	0	0	0
1504000206	*Blue Creek-Upper Gila River*	*25*	*28.8*	*10.2*	*0*	*0*	*28.8*	*10.2*
150400020601	Bear Canyon-Upper Gila River	88	9.0	7.5	0	0	9.0	7.5

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			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
150400020602	Swan Canyon	56	0.4	0	0	0	0.4	0
150400020603	Swan Canyon-Upper Gila River	29	8.0	2.7	0	0	8.0	2.7
150400020607	Corral Canyon	3	0	0	0	0	0	0
1504000208	*Apache Creek-Gila River*	*5*	28.2	0	0	0	28.2	0
150400020804	Apache Creek	31	0	0	0	0	0	0
15040003	***Animas Valley***	***4***	***52.0***	***1.2***	***9.0***	***1.2***	***0***	***0***
1504000302	*Headwaters Burro Cienega*	*16*	*5.6*	*1.2*	*5.6*	*1.2*	*0*	*0*
150400030201	Hall Draw-Burro Cienega	56	5.6	1.2	5.6	1.2	0	0
150400030203	Ninetysix Creek	12	0	0	0	0	0	0
1504000303	*Outlet Burro Cienega*	*<1*	*3.4*	*0*	*3.4*	*0*	*0*	*0*
150400030305	Jones Canyon-Burro Cienega	<1	2.1	0	2.1	0	0	0
150400030307	Walker Canyon	1	1.3	0	1.3	0	0	0
1504000304	*Lordsburg Draw*	*19*	*0*	*0*	*0*	*0*	*0*	*0*
150400030401	Gold Hill Canyon-Lordsburg Draw	21	0	0	0	0	0	0
150400030402	Hoodoo Canyon-Lordsburg Draw	13	0	0	0	0	0	0
150400030403	Headwaters Thompson Canyon	80	0	0	0	0	0	0
150400030404	Outlet Thompson Canyon	21	0	0	0	0	0	0
150400030405	Thompson Canyon-Lordsburg Draw	20	0	0	0	0	0	0
15040004	***San Francisco***	***61***	***654.4***	***202.6***	***460.5***	***123.4***	***193.9***	***79.2***
1504000401	*Headwaters Tularosa River*	*94*	*28.7*	*9.1*	*26.5*	*8.7*	*2.2*	*0.4*
150400040101	Sand Flat Canyon	91	0	0	0	0	0	0
150400040102	Canon Del Buey	100	<0.1	<0.1	<0.1	<0.1	0	0
150400040103	Negro Canyon-Tularosa River	94	11.5	7.0	11.5	7.0	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
			Total HUC	**Gila NF HUC**	**Total HUC**	**Gila NF HUC**	**Total HUC**	**Gila NF HUC**
150400040104	Whiskey Creek	93	0	0	0	0	0	0
150400040105	Hardcastle Canyon	95	0	0	0	0	0	0
150400040106	Apache Creek	91	8.7	1.3	8.7	1.3	0	0
150400040107	Apache Creek-Tularosa River	94	6.3	0.4	6.3	0.4	<0.1	<0.1
150400040108	Cold Springs Canyon-Tularosa River	96	2.1	0.4	0	0	2.1	0.4
1504000402	*OutletTularosa River*	*98*	*55.0*	*41.1*	*8.3*	*7.9*	*46.7*	*33.2*
150400040201	Long Canyon-Tularosa River	96	6.2	3.7	0	0	6.2	3.7
150400040202	Headwaters North Fork Negrito Creek	99	0	0	0	0	0	0
150400040203	South Fork Negrito Creek	99	14.4	13.7	0	0	14.4	13.7
150400040204	Outlet North Fork Negrito Creek	99	28.3	7.9	28.3	7.9	<0.1	<0.1
150400040205	Sign Camp Canyon	100	0	0	0	0	0	0
150400040206	Negrito Creek	99	12.4	10.5	<0.1	<0.1	12.4	10.5
150400040207	Negrito Creek-Tularosa River	95	13.6	5.2	0	0	13.6	5.2
1504000403	*Centerfire Creek-San Francisco River*	*78*	*133.3*	*53.2*	*83.2*	*25.6*	*50.1*	*27.6*
150400040302	Trout Creek	60	15.3	13.6	15.3	13.6	<0.1	<0.1
150400040303	Stone Creek-San Francisco River	61	20.8	5.1	12.2	0	8.6	5.1
150400040304	Spur Draw	82	<0.1	0	0	0	<0.1	0
150400040305	SA Creek	97	13.6	11.9	13.6	11.9	<0.1	0
150400040306	Headwaters Centerfire Creek	95	11.1	7.7	0	0	11.1	7.7
150400040307	Outlet Centerfire Creek	87	4.9	0.3	0	0	4.9	0.3
150400040308	Big Canyon-San Francisco River	95	6.1	4.2	0	0	6.4	4.2
150400040309	Starkweather Canyon	96	<0.1	0	0	0	<0.1	0
150400040310	Largo Canyon	97	0	0	0	0	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
150400040311	Cienega Canyon-San Francisco River	91	19.9	10.4	0	0	19.9	10.4
1504000404	*Deep Creek-San Francisco River*	*98*	*27.6*	*20.6*	*21.0*	*17.6*	6.6	3.0
150400040401	Headwaters Saliz Canyon	100	0	0	0	0	0	0
150400040402	Outlet Saliz Canyon	98	<0.1	<0.1	<0.1	<0.1	0	0
150400040403	Saliz Canyon-San Francisco River	96	14.8	11.0	8.2	8.0	6.6	3.0
150400040404	Devils Creek	100	0	0	0	0	0	0
150400040405	Deep Creek	96	0	0	0	0	0	0
150400040406	Devils Creek-San Francisco River	97	12.8	9.6	12.8	9.6	0	0
1504000405	*Upper Blue River*	*14*	*176.1*	*9.1*	*167.0*	*9.1*	*0*	*0*
150400040502	Dry Blue Creek	76	9.2	8.7	0	0	0	0
150400040503	Campbell Blue Creek	2	0	0	0	0	0	0
150400040504	Centerfire Creek-Blue River	14	37.8	0.4	37.8	0.4	0	0
150400040506	Steeple Canyon-Blue River	15	36.6	0	36.6	0	0	0
1504000406	*Pueblo Creek-San Francisco River*	*88*	*70.3*	*47.6*	*50.2*	*37.4*	*20.1*	*10.2*
150400040601	Upper Pueblo Creek	100	0	0	0	0	0	0
150400040602	Lower Pueblo Creek	95	0	0	0	0	0	0
150400040603	Keller Canyon	56	0	0	0	0	0	0
150400040604	Vigil Canyon	78	0	0	0	0	0	0
150400040605	Mineral Creek	92	29.4	22.3	29.4	22.3	<0.1	0
150400040606	Wendy Flat-San Francisco River	89	8.0	1.8	1.5	0	6.5	1.8
150400040607	Whitewater Creek	95	19.4	15.1	19.4	15.1	<0.1	0
150400040608	South Dugway Creek-San Francisco River	94	32.9	23.5	19.4	15.1	13.5	8.4

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Assessed Stream Miles		Miles Meeting All Water Quality Standards		Impaired Miles [303(d) listed]	
			Total HUC	Gila NF HUC	Total HUC	Gila NF HUC	Total HUC	Gila NF HUC
1504000407	*Lower Blue River*	*<1*	*33.4*	*0*	*8.1*	*0*	*25.3*	*0*
150400040704	Little Blue Creek	1	5	0	0	0	0	0
1504000408	*Mule Creek-San Francisco River*	*50*	*98.4*	*22.2*	*87.1*	*17.2*	*11.3*	*5.0*
150400040801	Little Dry Creek	45	0	0	0	0	0	0
150400040802	Big Dry Creek	98	0	0	0	0	0	0
150400040803	Pine Cienega Creek	50	<0.1	0	0	0	<0.1	0
150400040804	Upper Mule Creek	67	1.8	0	0	0	1.8	0
150400040805	Lower Mule Creek	48	8.6	4.2	0	0	8.6	4.2
150400040806	Citizen Canyon	62	0	0	0	0	0	0
150400040807	Big Pine Canyon-San Francisco River	99	18.4	17.9	17.6	17.2	0.8	0.7
150400040808	Harden Cienega Creek	35	0	0	0	0	0	0
150400040809	Coal Creek	10	0.6	0	0.6	0	0	0
150400040811	Coalson Creek-San Francisco River	<1	68.8	0	68.8	0	0	0

[1] *Stream miles do not include miles through reservoirs or lakes*

[2] *All 0 values indicate there are no impaired stream miles or waterbodies present*

Table D6. Causes of water quality impairment by subbasin

Watershed Name	Total Impaired Stream Miles	Impaired Stream Miles by Cause of Impairment: Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Plains of San Agustin Subbasin																					
Nester Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y Canyon	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Patterson Lake	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elephant Butte Reservoir Subbasin																					
Headwaters Alamosa Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caballo Subbasin																					
Cuchillo Negro Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Watershed Name	**Total Impaired Stream Miles**	**Impaired Stream Miles by Cause of Impairment**																			
		Aluminum		**Benthic Macroinvertebrate Community**		**Cadmium and Lead**		**Conductance**		**Dissolved Oxygen**		***E. coli* bacteria**		**Nutrients and Eutrophication**		**Temperature**		**Turbidity or Suspended Sediment Concentration**		**Sediment**	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Palomas Creek-Rio Grande	14.7	-	-	-	-	-	-	-	-	14.7	0	-	-	-	-	-	-	-	-	-	-
Percha Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caballo Reservoir	33.6	-	-	16.2	10.8	-	-	-	-	6.6	0	-	-	-	-	-	-	-	-	-	-
El Paso-Las Cruces Subbasin																					
Cuervo Arroyo-Rio Grande	11.9	-	-	-	-	-	-	-	-	-	-	11.9	0	-	-	-	-	-	-	-	-
Mimbres Subbasin																					
Gallinas Canyon-Mimbres River	47.4	-	-	-	-	-	-	-	-	-	-	11.9	0	8.7	11.9	21.6	5.6	-	-	-	-

Watershed Name	Total Impaired Stream Miles	Impaired Stream Miles by Cause of Impairment: Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Headwaters San Vincente Draw	1.9	-	-	-	-	-	-	-	-	-	-	-	-	1.9	0	-	-	-	-	-	-
Outlet San Vincente Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampbright Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampbright Draw-Mimbres River	20.9	-	-	-	-	5.9	1.7	-	-	-	-	13.3	0	-	-	13.3	0	-	-	-	-
Macho Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Seventysix Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Cow Spring Draw-Seventysix Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Colorado Headwaters Subbasin																					
Coyote Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carrizo Wash Subbasin																					
Rito Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Largo Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agua Fria Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Draw-Cienega Amarilla	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Upper Gila Subbasin																					
Railroad Canyon[1]	<0.1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1*	0	-	-	-	-
Corduroy Canyon	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beaver Creek	24.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.2	2.4	-	-	-	-
Headwaters East Fork Gila River	43.2	-	-	3.0	6.4	-	-	-	-	-	-	-	-	2.9	19.5	4.3	29.5	-	-	-	-
Middle Fork Gila River	64.4	1.4	5.8	-	-	-	-	-	-	-	-	-	-	1.0	13.1	2.1	48.2	-	-	-	-
West Fork Gila River	36.4	-	-	0	<0.1	-	-	-	-	-	-	-	-	-	-	4.4	32.0	-	-	-	-

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Outlet East Fork Gila River	41.8	-	-	2.7	14.0	-	-	-	-	-	-	-	-	-	-	0.1	25.0	-	-	-	-
Sapillo Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sapillo Creek-Gila River	75.2	1.1	15.6	-	-	-	-	-	-	-	-	-	-	-	-	1.9	56.6	-	-	-	-
Upper Gila Subbasin																					
Bear Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duck Creek	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mangas Creek	6.4	-	-	-	-	-	-	-	-	-	-	-	-	6.3	0.1	6.3	0.1	-	-	-	-
Sycamore Creek-Upper Gila River	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.9	1.0	-	-	-	-

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Blue Creek	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	0	-	-	-	-
Blue Creek-Upper Gila River	28.8	-	-	-	-	-	-	-	-	-	-	-	-	9.4	10.2	18.6	10.2	-	-	-	-
Apache Creek-Gila River	28.2	-	-	-	-	-	-	-	-	-	-	28.2	0	-	-	-	-	6.6	0	-	-
Animas Valley Subbasin																					
Headwaters Burro Cienega	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outlet Burro Cienega	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lordsburg Draw	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Watershed Name	Total Impaired Stream Miles	**Impaired Stream Miles by Cause of Impairment** Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
San Francisco Subbasin																					
Headwaters Tularosa River	2.2	-	-	-	-	-	-	-	-	-	-	1.8	0.4	-	-	1.8	0.4	1.8	0.4	-	-
Outlet Tularosa River	46.7	-	-	-	-	-	-	-	-	-	-	11.6	22.7	-	-	13.5	33.2	10.9	8.9	-	-
Centerfire Creek-San Francisco River	50.6	-	-	5.4	9.3	-	-	8.1	8.0	-	-	17.6	18.3	8.1	8.0	19.2	30.6	13.8	18.3	8.1	8.0
Deep Creek-San Francisco River	6.6	-	-	-	-	-	-	-	-	-	-	3.6	3.0	-	-	-	-	-	-	-	-
Upper Blue River	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Impaired Stream Miles by Cause of Impairment

Watershed Name	Total Impaired Stream Miles	Aluminum		Benthic Macroinvertebrate Community		Cadmium and Lead		Conductance		Dissolved Oxygen		*E. coli* bacteria		Nutrients and Eutrophication		Temperature		Turbidity or Suspended Sediment Concentration		Sediment	
		Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF	Off Gila NF	On Gila NF
Pueblo Creek-San Francisco River	20.1	-	-	4.3	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5	8.9
Lower Blue River	25.3	-	-	-	-	-	-	-	-	-	-	25.3	0	-	-	-	-	-	-	-	-
Mule Creek-San Francisco River	11.3	-	-	0.1	0.7	-	-	-	-	6.3	4.2	-	-	-	-	-	-	-	-	-	-
Total	**658.1**	**2.5**	**21.4**	**31.7**	**42.5**	**5.9**	**1.7**	**8.1**	**8.0**	**27.6**	**4.2**	**113.3**	**44.4**	**38.3**	**62.8**	**144.2**	**232.6**	**33.1**	**27.6**	**13.6**	**16.9**

Table D7. The extent and distribution of springs and seeps and non-riverine wetlands by subbasin, watershed and subwatershed

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Springs and Seeps (Number)			Non-Riverine Wetlands (Acres)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
13020208	***Plains of San Agustin***	*11*	***83***	***14***	***17***	***18***	***0***	***0***
1302020804	*Nester Draw*	*3*	*32*	*0*	*0*	*0*	*0*	*0*
130202080401	Bear Canyon	38	5	0	0	0	0	0
130202080404	Headwaters Nester Draw	3	6	0	0	0	0	0
1302020806	*Y Canyon*	*53*	*3*	*2*	*67*	*0*	*0*	*0*
130202080601	La Jolla Canyon	99	3	2	67	0	0	0
130202080603	Y Canyon	42	0	0	0	0	0	0
1302020807	*Patterson Lake*	*38*	*30*	*12*	*40*	*18*	*0*	*0*
130202080701	Alamocito Creek	37	14	3	21	0	0	0
130202080703	West Pasture Springs	1	3	0	0	0	0	0
130202080704	Patterson Canyon	66	5	5	100	18	0	0
130202080705	Dark Canyon	42	1	0	0	0	0	0
130202080706	Patterson Lake	40	2	0	0	0	0	0
130202080707	Long Canyon	96	2	2	100	0	0	0
130202080708	T H Canyon	30	2	2	100	0	0	0
13020211	***Elephant Butte Reservoir***	*3*	***115***	***0***	***0***	***11,787***	***0***	***0***
1302021106	*Headwaters Alamosa Creek*	*16*	*19*	*0*	*0*	*0*	*0*	*0*
130202110603	Little Pigeon Canyon-Alamosa Creek	21	0	0	0	0	0	0
130202110606	Wahoo Canyon-Alamosa Creek	52	0	0	0	0	0	0
130202110607	Sim Yaten Canyon-Alamosa Creek	16	0	0	0	0	0	0
130202110608	Wildhorse Canyon	37	0	0	0	0	0	0

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Springs and Seeps (Number)			Non-Riverine Wetlands (Acres)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
13030101	***Caballo***	***27***	***133***	***82***	***62***	***4,062***	***90***	***2***
1303010101	*Cuchillo Negro Creek*	*32*	*33*	*21*	*64*	*7*	*0*	*0*
130301010101	Turkey Creek	85	8	8	100	0	0	0
130301010102	Poverty Creek	48	1	0	0	0	0	0
130301010103	Chloride Creek	76	5	5	100	0	0	0
130301010104	South Fork Cuchillo Negro Creek	71	5	5	100	0	0	0
130301010105	Monument Creek	30	5	1	20	0	0	0
130301010106	Monument Creek-Cuchillo Negro Creek	20	5	2	40	0	0	0
1303010102	*Palomas Creek-Rio Grande*	*25*	*40*	*22*	*55*	*1,548*	*21*	*1*
130301010204	Mud Spring Canyon	100	3	3	100	0	0	100
130301010205	Circle Seven Creek	96	1	1	100	19	19	100
130301010206	North Fork Palomas Creek	56	15	13	87	0	0	0
130301010207	South Fork Palomas Creek	57	7	5	71	2	2	100
1303010103	*Percha Creek*	*32*	*25*	*18*	*72*	*85*	*0*	*0*
130301010301	South Percha Creek	53	15	14	93	22	0	0
130301010302	North Percha Creek	54	5	4	80	37	0	0
1303010104	*Caballo Reservoir*	*21*	*35*	*21*	*60*	*2,423*	*68*	*3*
130301010401	North Seco Canyon	76	4	4	100	8	8	100
130301010403	Seco Creek	10	5	2	40	8	1	11
130301010404	Holden Prong	100	3	3	100	1	1	100
130301010405	Cave Creek	22	8	6	75	0	0	100
130301010406	Headwaters Los Animas Creek	65	8	6	75	61	59	96

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Springs and Seeps (Number)			Non-Riverine Wetlands (Acres)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
13030102	***El Paso-Las Cruces***	***1***	***58***	***25***	***43***	***1,310***	***0***	***0***
1303010202	*Cuervo Arroyo_Rio Grande*	*17*	*39*	*25*	*64*	*195*	*0*	*0*
130301020201	Trujillo Canyon Creek	33	16	15	94	23	0	0
130301020203	Headwaters Tierra Blanca Creek	98	6	6	100	0	0	0
130301020204	Outlet Tierra Blanca Creek	15	5	2	40	26	0	0
130301020207	Jaralosa Creek	13	4	0	0	3	0	0
130301020208	Headwaters Berenda Creek	37	4	2	50	2	0	0
13030202	***Mimbres***	***5***	***164***	***102***	***62***	***1,408***	***39***	***3***
1303020201	*Gallinas Canyon-Mimbres River*	*74*	*67*	*64*	*96*	*468*	*39*	*8*
130302020101	Powderhorn Canyon-Mimbres River	99	10	10	100	39	39	100
130302020102	Allie Canyon-Mimbres River	97	20	19	95	0	0	0
130302020103	Sheppard Canyon-Mimbres River	81	10	8	80	59	0	0
130302020104	Noonday Canyon	78	7	7	100	11	0	0
130302020105	Noonday Canyon-Mimbres River	44	5	5	100	138	0	0
130302020106	Gallinas Canyon	73	15	15	100	21	0	0
1303020202	Headwaters San Vicente Draw	18	*29*	*23*	*79*	*0*	*0*	*0*
130302020201	Rio de Arenas	6	2	0	0	0	0	0
130302020203	Pipeline Draw-San Vicente Draw	16	3	2	67	0	0	0
130302020204	Cameron Creek	54	22	21	95	0	0	0
130302020205	Cameron Creek-San Vicente Draw	<1	2	0	0	0	0	0
1303020203	Outlet San Vicente Draw	1	*9*	*1*	*11*	*0*	*0*	*0*
130302020302	Headwaters Whitewater Creek	3	6	1	17	0	0	0
130302020305	Antelope Draw-San Vicente Draw	2	2	0	0	0	0	0

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			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
1303020204	*Lampbright Draw*	3	*5*	*0*	*0*	*0*	*0*	*0*
130302020401	Headwaters Lampbright Draw	9	3	0	0	0	0	0
1303020205	Lampbright Draw-Mimbres River	17	*19*	*12*	*63*	*896*	*0*	*0*
130302020501	Gavilan Arroyo	40	5	4	80	20	0	0
130302020502	Gavilan Arroyo-Mimbres River	39	11	8	73	188	0	0
1303020208	Macho Creek	2	*13*	*0*	*0*	*37*	*0*	*0*
130302020801	Upper Macho Creek	10	13	0	0	37	0	0
1303020213	Upper Seventysix Draw	1	*3*	*2*	*67*	*0*	*0*	*0*
130302021301	Whiterock Canyon	5	3	2	67	0	0	0
1303020214	Cow Spring Draw-Seventysix Draw	2	*1*	*0*	*0*	*0*	*0*	*0*
130302021402	Headwaters Cow Spring Draw	14	1	0	0	0	0	0
15020001	***Little Colorado Headwaters***	***3***	***168***	***5***	***3***	***1,016***	***0***	***0***
1502000103	*Coyote Creek*	*9*	*16*	*5*	*31*	*52*	*0*	*1*
150200010301	Hay Vega	39	3	1	33	0	0	0
150200010302	Canovas Creek-Coyote Creek	33	7	4	57	30	0	1
15020003	***Carrizo Wash***	***14***	***118***	***54***	***46***	***285***	***0***	***0***
1502000301	*Rito Creek*	*13*	*35*	*21*	*60*	*107*	*0*	*0*
150200030101	Upper Mangas Creek	58	18	15	83	0	0	0
150200030102	Middle Mangas Creek	17	6	0	0%	0	0	0
150200030103	Lower Mangas Creek	7	1	0	0%	0	0	0
150200030109	Escondido Creek	47	6	6	100%	0	0	0
1502000302	*Upper Largo Creek*	*76*	*16*	*9*	*56%*	*7*	*0*	*0*
150200030201	El Caso Spring Canyon	100	5	3	60%	0	0	0

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			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150200030202	Sawmill Canyon-Largo Creek	91	8	5	63%	7	0	0
150200030203	Paradise Canyon-Largo Creek	85	0	0	0%	0	0	0
150200030204	Rito Creek-Largo Creek	35	3	1	33%	0	0	0
1502000305	*Agua Fria Creek*	*35*	*29*	*21*	*72%*	*5*	*0*	*0*
150200030501	Harris Creek-Agua Fria Creek	90	10	7	70%	1	0	0
150200030502	Demetrio Creek	59	5	4	80%	0	0	0
150200030503	Demetrio Creek-Agua Fria Creek	37	0	0	0%	0	0	0
150200030504	Gatlin Lake	73	12	9	75%	0	0	0
150200030505	Mangitas Creek	41	1	0	0%	0	0	0
150200030506	Cerro La Mula	10	1	1	100%	4	0	0
150200030507	Cerro La Mula-Agua Fria Creek	2	0	0	0%	0	0	0
1502000307	*LA Draw-Cienega Amarilla*	*5*	*16*	*3*	*19%*	*34*	*0*	*0*
150200030703	Cow Springs Draw	25	8	3	38%	0	0	0
15040001	***Upper Gila***	***84***	***196***	***184***	***94%***	***1,914***	***1,791***	***94***
1504000101	*Railroad Canyon*	*16*	*10*	*8*	*80%*	*0*	*0*	*0*
150400010101	Upper Railroad Canyon	4	1	0	0%	0	0	0
150400010102	Middle Railroad Canyon	41	3	2	67%	0	0	0
150400010103	Lower Railroad Canyon	7	2	2	100%	0	0	0
1504000102	*Corduroy Draw*	*61*	*10*	*8*	*100%*	*0*	*0*	*0*
150400010201	Upper Corduroy Draw	22	1	0	60%	0	0	0
150400010202	South Water Canyon	79	3	2	100%	0	0	0
150400010203	Middle Corduroy Draw	49	2	2	0%	0	0	0
150400010204	Lower Corduroy Draw	96	4	4	50%	0	0	0
1504000103	*Beaver Creek*	*54*	*5*	*3*	*60%*	*0*	*0*	*0*

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			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400010301	Horse Camp Canyon	73	2	2	100%	0	0	0
150400010302	Coyote Canyon	1	0	0	0%	0	0	0
150400010303	O Bar O Canyon	46	1	0	0%	0	0	0
150400010304	Houghton Canyon	92	0	0	0%	0	0	0
150400010305	Houghton Canyon-Beaver Creek	79	2	1	50%	0	0	0
1504000104	*Headwaters East Fork Gila River*	*99*	*32*	*30*	*94%*	*153*	*140*	*91*
150400010401	150400010401 Hoyt Creek	99	8	8	100%	0	0	0
150400010402	Taylor Creek	99	8	6	75%	0	0	0
150400010403	Taylor Creek-Beaver Creek	99	2	2	100	0	0	0
150400010404	Headwaters Diamond Creek	100	5	5	100	1	1	100
150400010405	South Diamond Creek	100	2	2	100	3	3	100
150400010406	Outlet Diamond Creek	100	1	1	100	44	44	100
150400010407	Diamond Creek-East Fork Gila River	99	6	6	100	105	92	87
1504000105	*Middle Fork Gila River*	*100*	*26*	*24*	*92*	*716*	*705*	*98*
150400010501	T Bar Canyon	100	0	0	0	0	0	0
150400010502	Gilita Creek	100	4	4	100	21	21	100
150400010503	Snow Canyon	100	6	6	100	8	8	100
150400010504	Canyon Creek	99	3	3	100	6	6	100
150400010505	Canyon Creek-Middle Fork Gila River	100	1	1	100	263	263	100
150400010506	Indian Creek Canyon	99	3	2	67	9	9	96
150400010507	Indian Creek Canyon-Middle Fork Gila River	100	3	3	100	98	98	100

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			Total HUC	**Gila NF HUC**	**Gila NF % HUC**	**Total HUC**	**Gila NF HUC**	**Gila NF % HUC**
150400010508	Big Bear Canyon-Middle Fork Gila River	99	6	5	83	310	300	97
1504000106	*West Fork Gila River*	*99*	*23*	*21*	*91*	*312*	*275*	*88*
150400010601	White Creek	100	6	6	100	11	11	100
150400010602	Headwaters West Fork Gila River	100	2	2	100	15	15	100
150400010603	Little Creek	100	3	3	100	2	2	94
150400010604	Outlet West Fork Gila River	96	12	10	83	284	247	87
1504000107	*Outlet East Fork Gila River*	*99*	*19*	*18*	*95*	*413*	*384*	*93*
150400010701	Tom Moore Canyon	100	0	0	0	1	1	100
150400010702	Headwaters Black Canyon	100	4	4	100	7	7	100
150400010703	Apache Creek	100	1	1	100	1	1	100
150400010704	Outlet Black Canyon	100	2	2	100	29	29	100
150400010705	Black Canyon-East Fork Gila River	97	12	11	92	376	346	92
1504000108	*Sapillo Creek*	*98*	*25*	*24*	*96*	*19*	*19*	*100*
150400010801	Rocky Canyon	100	6	6	10	10	10	100
150400010802	Rocky Canyon-Sapillo Creek	98	4	4	100	8	8	100
150400010803	Lake Roberts-Sapillo Creek	98	7	6	86	0	0	100
150400010804	Copperas Creek-Sapillo Creek	96	8	8	100	1	1	100
150400010805	Sheep Corral Canyon-Sapillo Creek	100	0	0	0	1	1	100
1504000109	*Sapillo Creek-Gila River*	*96*	*56*	*56*	*100*	*301*	*269*	*89*
150400010901	Sapillo Creek-Gila River	100	9	9	100	88	88	100
150400010902	Hells Canyon-Gila River	100	5	5	100	59	59	100
150400010903	Turkey Creek	100	2	2	100	9	7	75
150400010904	Upper Mogollon Creek	100	3	3	100	1	1	100

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			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400010905	Middle Mogollon Creek	88	11	11	100	0	0	100
150400010906	Lower Mogollon Creek	75	23	23	100	6	0	3
150400010907	Mogollon Creek-Gila River	98	3	3	100	138	114	83
15040002	***Upper Gila-Mangas***	***15***	***235***	***114***	***49***	***1,941***	***308***	***16***
1504000201	*Bear Creek*	*63*	*56*	*46*	*82*	*1*	*0*	*0*
150400020101	Upper Bear Creek	88	23	21	91	0	0	0
150400020102	Middle Bear Creek	74	18	14	78	0	0	0
150400020103	Lower Bear Creek	27	15	11	73	1	0	0
1504000202	*Duck Creek*	*12*	*4*	*4*	*100*	*3*	*0*	*0*
150400020201	Headwaters Buckhorn Wash	21	0	0	0	0	0	0
150400020203	Sacaton Creek	30	4	4	100	0	0	100
150400020204	Headwaters Duck Creek	10	0	0	0	0	0	0
1504000203	*Mangas Creek*	*39*	*32*	*21*	*66*	*5*	*0*	*0*
150400020301	Willow Creek-Mangas Creek	41	11	8	73	0	0	0
150400020302	McKeafer Canyon-Mangas Creek	31	4	4	100	0	0	0
150400020303	Ash Spring Canyon-Mangas Creek	55	9	6	67	0	0	0
150400020304	Schoolhouse Canyon-Mangas Creek	30	8	3	38	5	0	0
1504000204	*Sycamore Creek-Upper Gila River*	*3*	*8*	*3*	*38*	*709*	*41*	*6*
150400020401	Bear Creek-Upper Gila River	12	4	3	75	436	41	9
1504000205	Blue Creek	*4*	*7*	*0*	*0*	*3*	*0*	*0*
150400020501	Cherry Creek-Blue Creek	9	6	0	0	0	0	0
1504000206	*Blue Creek-Upper Gila River*	*25*	*56*	*26*	*46*	*742*	*267*	*36*
150400020601	Bear Canyon-Upper Gila River	88	20	20	100	326	264	81

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			Total HUC	**Gila NF HUC**	**Gila NF % HUC**	**Total HUC**	**Gila NF HUC**	**Gila NF % HUC**
150400020602	Swan Canyon	56	5	3	60	4	0	0
150400020603	Swan Canyon-Upper Gila River	29	14	3	21	62	3	5
150400020607	Corral Canyon	3	0	0	0	1	0	0
1504000208	*Apache Creek-Gila River*	*5*	*62*	*14*	*23*	*252*	*0*	*0*
150400020804	Apache Creek	31	19	14	74	0	0	0
15040003	***Animas Valley***	***4***	***29***	***19***	***66***	***2***	***0***	***0***
1504000302	*Headwaters Burro Cienega*	*16*	*2*	*1*	*50*	*0*	*0*	*0*
150400030201	Hall Draw-Burro Cienega	56	1	1	100	0	0	0
150400030203	Ninetysix Creek	12	0	0	0	0	0	0
1504000303	*Outlet Burro Cienega*	*<1*	*1*	*0*	*0*	*0*	*0*	*0*
150400030305	Jones Canyon-Burro Cienega	<1	0	0	0	0	0	0
150400030307	Walker Canyon	1	0	0	0	0	0	0
1504000304	*Lordsburg Draw*	*19*	*20*	*18*	*90*	*0*	*0*	*0*
150400030401	Gold Hill Canyon-Lordsburg Draw	21	3	3	100	0	0	0
150400030402	Hoodoo Canyon-Lordsburg Draw	13	4	4	100	0	0	0
150400030403	Headwaters Thompson Canyon	80	9	8	89	0	0	0
150400030404	Outlet Thompson Canyon	21	1	1	100	0	0	0
150400030405	Thompson Canyon-Lordsburg Draw	20	3	2	67	0	0	0
15040004	***San Francisco***	***61***	***912***	***319***	***35***	***2,836***	***490***	***17***
1504000401	*Headwaters Tularosa River*	*94*	*68*	*51*	*75*	*351*	*29*	*8*
150400040101	Sand Flat Canyon	91	2	2	100	3	0	0
150400040102	Canon Del Buey	100	3	1	33	0	0	0
150400040103	Negro Canyon-Tularosa River	94	6	5	83	11	0	0

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			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400040104	Whiskey Creek	93	17	8	47	0	0	0
150400040105	Hardcastle Canyon	95	8	4	50	0	0	0
150400040106	Apache Creek	91	12	11	92	17	12	70
150400040107	Apache Creek-Tularosa River	94	4	4	100	298	8	3
150400040108	Cold Springs Canyon-Tularosa River	96	16	16	100	21	9	40
1504000402	*OutletTularosa River*	*98*	*44*	*42*	*95*	*133*	*37*	*28*
150400040201	Long Canyon-Tularosa River	96	8	8	100	25	11	42
150400040202	Headwaters North Fork Negrito Creek	99	10	9	90	0	0	0
150400040203	South Fork Negrito Creek	99	5	5	100	0	0	0
150400040204	Outlet North Fork Negrito Creek	99	2	2	100	0	0	0
150400040205	Sign Camp Canyon	100	10	10	100	0	0	0
150400040206	Negrito Creek	99	3	3	100	1	0	22
150400040207	Negrito Creek-Tularosa River	95	6	5	83	107	27	25
1504000403	*Centerfire Creek-San Francisco River*	*78*	*185*	*84*	*45*	*537*	*91*	*17*
150400040302	Trout Creek	60	17	6	35	1	0	0
150400040303	Stone Creek-San Francisco River	61	25	11	44	72	3	4
150400040304	Spur Draw	82	3	3	100	0	0	0
150400040305	SA Creek	97	12	12	100	0	0	0
150400040306	Headwaters Centerfire Creek	95	3	3	100	35	1	3
150400040307	Outlet Centerfire Creek	87	11	9	82	50	4	9
150400040308	Big Canyon-San Francisco River	95	5	4	80	116	5	4
150400040309	Starkweather Canyon	96	11	10	91	5	0	0
150400040310	Largo Canyon	97	9	8	89	0	0	0

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			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
150400040311	Cienega Canyon-San Francisco River	91	20	18	90	258	78	30
1504000404	*Deep Creek-San Francisco River*	*98*	*39*	*38*	*97*	*120*	*86*	*72*
150400040401	Headwaters Saliz Canyon	100	18	18	100	0	0	100
150400040402	Outlet Saliz Canyon	98	0	0	0	1	1	100
150400040403	Saliz Canyon-San Francisco River	96	5	4	80	44	36	81
150400040404	Devils Creek	100	0	0	0	0	0	0
150400040405	Deep Creek	96	16	16	100	0	0	0
150400040406	Devils Creek-San Francisco River	97	0	0	0	74	49	66
1504000405	*Upper Blue River*	*14*	*128*	*4*	*3*	*607*	*0*	*0*
150400040502	Dry Blue Creek	76	17	2	12	0	0	0
150400040503	Campbell Blue Creek	2	10	0	0	138	0	0
150400040504	Centerfire Creek-Blue River	14	8	1	13	141	0	0
150400040506	Steeple Canyon-Blue River	15	20	1	5	215	0	0
1504000406	*Pueblo Creek-San Francisco River*	*88*	*52*	*44*	*85*	*245*	*175*	*71*
150400040601	Upper Pueblo Creek	100	7	7	100	24	24	100
150400040602	Lower Pueblo Creek	95	8	8	100	126	126	100
150400040603	Keller Canyon	56	4	1	25	0	0	100
150400040604	Vigil Canyon	78	5	2	40	3	0	0
150400040605	Mineral Creek	92	6	5	83	0	0	0
150400040606	Wendy Flat-San Francisco River	89	0	0	0	38	7	19
150400040607	Whitewater Creek	95	11	10	91	0	0	100
150400040608	South Dugway Creek-San Francisco River	94	11	11	100	54	17	32

Hydrologic Unit Code (HUC)	Subbasin (HUC8, 4th Code), Watershed (HUC10, 5th Code) & Subwatershed (HUC12, 6th Code) Name	Gila NF HUC %	Springs and Seeps (Number)			Non-Riverine Wetlands (Acres)		
			Total HUC	Gila NF HUC	Gila NF % HUC	Total HUC	Gila NF HUC	Gila NF % HUC
1504000407	*Lower Blue River*	*<1*	*215*	*0*	*0*	*240*	*0*	*0*
150400040704	Little Blue Creek	1	18	0	0	0	0	0
1504000408	*Mule Creek-San Francisco River*	*50*	*118*	*56*	*47*	*402*	*71*	*18*
150400040801	Little Dry Creek	45	4	3	75	0	0	0
150400040802	Big Dry Creek	98	6	6	100	1	1	100
150400040803	Pine Cienega Creek	50	2	2	100	0	0	0
150400040804	Upper Mule Creek	67	11	9	82	0	0	0
150400040805	Lower Mule Creek	48	1	1	100	0	0	0
150400040806	Citizen Canyon	62	22	4	18	20	0	0
150400040807	Big Pine Canyon-San Francisco River	99	32	30	94	72	70	98
150400040808	Harden Cienega Creek	35	1	0	0	17	0	0
150400040809	Coal Creek	10	2	1	50	0	0	0
150400040811	Coalson Creek-San Francisco River	<1	31	0	0	186	0	0

Table D8. Average annual precipitation by subbasin and watershed

	Watershed Area			Average Annual Precipitation (inches)		
Watershed Name	**Total (acres)**	**Gila NF (acres)**	**% Gila NF**	**Watershed Average**	**Gila NF Watershed Average**	**Percent of Average on Gila NF**
Plains of San Agustin Subbasin			11	15.0	17.6	13
Nester Draw	169,190	5,328	3	15.6	19.7	4
Patterson Lake	207,398	78,514	38	15.2	17.4	44
Y Canyon	97,476	52,140	38	17.0	17.7	60
Elephant Butte Reservoir Subbasin[1]			3	40,451	3	13.0
Headwaters Alamosa Creek	257,399	40,451	16	16.1	17.4	17
Caballo Subbasin			27	14.8	20.3	37
Caballo Reservoir	247,026	52,993	21	15.2	23.4	34
Cuchillo Negro Creek	236,142	76,046	32	14.5	17.8	41
Palomas Creek-Rio Grande	234,606	57,833	25	13.5	17.9	33
Percha Creek	77,379	24,763	32	18.1	25.5	48
El Paso-Las Cruces Subbasin			1	10.9	21.4	5
Cuervo Arroyo-Rio Grande	226,938	37,572	17	14.2	21.4	26
Mimbres Subbasin[1]			5	13.1	24.0	14
Cow Spring Draw-Seventysix Draw	184,549	3,070	2	12.1	19.5	3
Gallinas Canyon-Mimbres River	205,881	151,448	74	23.2	24.9	80
Headwaters San Vicente Draw	144,197	26,072	18	17.5	21.2	25
Lampbright Draw	92,105	2,351	3	16.0	21.2	4
Lampbright Draw-Mimbres River	124,477	20,713	17	16.5	23.0	23
Macho Creek	213,735	3,641	2	12.4	20.3	3
Outlet San Vicente Draw	160,634	1,684	1	15.1	21.5	2

	Watershed Area			Average Annual Precipitation (inches)		
Watershed Name	**Total (acres)**	**Gila NF (acres)**	**% Gila NF**	**Watershed Average**	**Gila NF Watershed Average**	**Percent of Average on Gila NF**
Upper Seventysix Draw	114,409	1,313	1	12.5	19.0	2
Little Colorado Headwaters Subbasin			3	17.9	20.5	3
Coyote Creek	147,501	13,510	9	14.5	20.5	13
Carrizo Wash Subbasin			14	13.3	16.4	18
Agua Fria Creek	218,968	76,850	35	14.9	16.7	41
LA Draw-Cienega Amarilla	160,256	7,918	5	14.0	22.0	8
Rito Creek	279,878	37,218	13	14.2	15.7	16
Upper Largo Creek	98,300	75,156	76	15.2	15.8	85
Upper Gila Subbasin			84	20.6	21.2	89
Beaver Creek	147,638	79,799	54	17.8	18.0	67
Corduroy Draw	111,118	68,279	61	17.4	18.2	66
Headwaters East Fork Gila River	193,943	192,473	99	21.1	21.1	99
Middle Fork Gila River	218,844	218,128	>99	21.7	21.7	99
Outlet East Fork Gila River	104,412	103,887	99	21.8	21.8	99
Railroad Canyon	89,105	14,046	16	17.0	17.0	16
Sapillo Creek	110,693	108,907	98	22.4	22.4	99
Sapillo Creek-Gila River	189,860	181,341	96	22.5	22.6	97
West Fork Gila River	103,948	102,439	99	21.6	21.6	>99
Upper Gila-Mangas Subbasin			15	15.8	19.0	19
Apache Creek-Gila River	237,306	12,270	5	14.8	18.8	7
Bear Creek	103,985	65,069	63	20.2	21.6	70
Blue Creek	88,931	3,428	4	16.4	20.0	5
Blue Creek-Upper Gila River	186,504	46,732	25	14.9	16.1	28

	Watershed Area			Average Annual Precipitation (inches)		
Watershed Name	**Total (acres)**	**Gila NF (acres)**	**% Gila NF**	**Watershed Average**	**Gila NF Watershed Average**	**Percent of Average on Gila NF**
Duck Creek	144,993	16,862	12	18.1	22.3	15
Mangas Creek	130,597	50,698	39	17.3	17.4	42
Sycamore Creek-Upper Gila River	121,829	3,601	3	16.8	17.9	4
Animas Valley Subbasin			4	13.6	16.6	5
Headwaters Burro Cienega	109,203	17,666	16	14.2	17.0	20
Lordsburg Draw	221,184	41,617	19	13.8	16.4	23
Outlet Burro Cienega	179,037	291	<1	13.2	16.3	<1
San Francisco Subbasin			61	20.7	20.6	64
Centerfire Creek-San Francisco River	267,108	207,266	78	20.5	19.8	81
Deep Creek-San Francisco River	153,321	149,537	98	21.1	21.1	98
Headwaters Tularosa River	225,391	211,838	94	17.3	17.3	94
Lower Blue River	198,105	277	<1	20.3	23.8	<1
Mule Creek-San Francisco River	244,422	121,064	50	19.8	20.8	53
OutletTularosa River	184,206	180,493	98	22.9	22.9	98
Pueblo Creek-San Francisco River	226,379	198,993	88	22.4	22.4	92
Upper Blue River	198,049	27,915	14	23.4	21.8	13
Subbasin Totals			17	14.5	20.4	24
Watershed Totals	8,388,553	3,271,497	39	17.3	20.4	46

[1] *PRISM does not cover Mexico; precipitation values reflect only the portion of the subbasin within the United States*

Appendix E. Economic Contribution Analysis Methods and Data

The economic contribution analysis uses IMPLAN Professional Version 3.0 with 2014 data. IMPLAN is an input-output model that uses linkages in a regional economy to estimate the economic impact of an event or policy change. The economic contribution analysis also uses Apheleia, a Forest Service tool that serves as an interface with IMPLAN. Apheleia translates resource inputs (e.g., AUMs and recreation visits) into economically-meaningful units for consistency with IMPLAN.

Recreation

The recreation section of the economic contribution analysis uses visit estimates from the third round of the National Visitor Use Monitoring program (NVUM) survey for the Gila NF. These data were collected in fiscal year 2011. The NVUM data are the best available information on recreational use of National Forest System (NFS) lands. The total number of recreation visits are from round 3 (FY11) data, however, segment shares were not reported in the Gila NF's round 3 NVUM report. Therefore, round 2 (FY06) segment shares are combined with round 3 (FY11) local and non-local visitation data to estimate segment shares. The segment shares used in the economic contribution analysis are listed in Table E1.

Table E1. Visitation by type on the Gila NF

Visit Type	Number of Visits	Share
Local Day	237,470	46%
Local Overnight - on NF	36,750	7%
Local Overnight - off NF	8,480	2%
Non-Local Day	69,390	14%
Non-Local Overnight - on NF	55,510	11%
Non-Local Overnight - off NF	37,010	7%
Non-primary	69,390	13%
Total	514,000	100%

The segment shares are necessary for the economic contribution analysis because visitor spending varies between local and non-local visitors as well as between day and overnight use. Forest Service visitor expenditure estimates are from White et al 2013.

Average visitor spending (per trip) in 2014 dollars is:

- Local day visitors: $36.54
- Local overnight visitors, lodging on public land: $179.82
- Local overnight visitors, lodging off public land: $235.72
- Non-local day visitors: $69.34
- Non-local overnight visitors, lodging on public land: $258.35
- Non-local overnight visitors, lodging off public: $569.08

Dollar values were converted from their original 2009 dollars to 2014 dollars using the Bureau of Labor Statistics' consumer price index calculator (BLS 2014).

Grazing

Livestock grazing data were retrieved from the Forest Service's Natural Resource Manager (NRM) database. Three-year averages of animal unit months (AUMs), by livestock category, were used to minimize the effect of short-term variations in authorized livestock grazing use. Table E2 contains the livestock grazing data used in the economic contribution analysis.

Table E2. Annual number of Animal Unit Months on the Gila NF

Year	Authorized Cattle AUMs	Authorized Horse & Burro AUMs	Authorized Sheep & Goat AUMs
2015	227,903	3,217	0
2014	213,317	3,657	0
2013	247,378	3,861	0

Note: from NRM's RMSTR11L report on 12/4/15.

To estimate the economic contributions of livestock grazing on the Gila National Forest, we follow the methodology developed and used by the BLM as part of the annual Department of the Interior economic report (DOI 2014). This method uses data from the Census of Agriculture, American Community Survey, and IMPLAN to improve the accuracy of employment and income estimates. In particular, this method enables the consideration of unpaid family labor, which would not be included in a typical IMPLAN analysis. See DOI 2014 for additional details on the methodology.

Minerals

Minerals data are compiled by the Forest Service's Washington Office – Ecosystem Management Coordination group. The most recent data are from fiscal year 2013. Three-year averages are used to minimize the effect of short-term variations in mineral removal. Therefore, the economic contribution analysis uses the average of 2011 – 2013 mineral removal.

Table E3. Mineral removal on the Gila NF

Mineral	Units	2013	2012	2011
Crushed stone	Short tons	6,171	9,923	32,822
Construction sand and gravel	Short tons	93	745	273

Mineral price data are from the U.S. Geological Survey (USGS). The USGS annually updates commodity price statistics. In 2014, a metric ton of crushed stone was $10.15 (a metric ton is equivalent to 1.1 short tons). A short ton of construction sand and gravel as $7.70 (USGS 2015). Due to small quantities of minerals removed from the Gila National Forest, these activities do not result in measurable economic contributions.

Timber

Forest Service timber harvest data are contained in cut and sold reports, which are updated quarterly. The economic contribution analysis used the average timber harvest between 2013 and 2015, by timber class. Table E4 displays the timber data used in the Gila NF's economic contribution analysis.

Table E4. Timber harvested on the Gila NF

Timber Class	2015	2014	2013
Softwood Sawtimber (CCF)	18,534	2,375	4,616
Softwood Pulp (CCF)	8,885	44	132
Hardwood Sawtimber (CCF)	N/A	N/A	N/A
Hardwood Pulp (CCF)	N/A	N/A	N/A
Poles/Latillas (CCF)	2,961	170	119
Posts/Vigas (CCF)	437	4,201	5,627
Fuelwood (CCF)	7,147	6,146	6,266
All products by bushel (limbs, boughs, needles)	130	41	308
Pinyon nuts (Lbs.)	1,500	750	0
Plants (each)	136	253	129

In addition to harvest volumes, information on who removes the timber and how it is processed are inputs to the economic contribution analysis. Tables E5 and E6 provide this information for the Gila National Forest.

Table E5. Percent of timber products harvested

		% Distribution by Sector of Timber Harvested in Study Area for each Product					
		Softwood					All
Description	**Types of Products Shipped**	**Sawtimber**	**Pulp**	**Poles**	**Posts**	**Fuelwood**	**Other Products**
Logging Camps and Logging Contractors (How much is removed by those outside of the study area? This number should equal the percent removed by all contractors minus share removed by those outside the study area.)	logs/pulp exported out of area, untreated posts/poles	99.9%	100%	0%	0%	0%	0%
Households (How much is removed by those households in the study area? This number should equal the percent removed by all households minus share removed by those outside the study area.)	personal use	.1%	0%	100%	100%	100%	100%

Table E6. Types of products shipped from harvested timber

		% Distribution by Sector of Timber Processed in the Study Area for each Product					
		Softwood					**All**
Description	**Types of Products Shipped**	**Sawtimber**	**Pulp**	**Poles**	**Posts**	**Fuelwood**	**Other Products**
Sawmills and Planing Mills, General	lumber/cants, bolts, woodchips	100				0	0
Wood Preservation	all treated pdts			0	0	0	0
Reconstituted Wood Products	particleboard, fiberboard, hardboard, OSB		0			0	0
Veneer and Plywood	veneer, plywood	0				0	0
Engineered Wood Members	trusses, arches	0				0	0
Wood Windows and Doors		0				0	0
Cut Stock	molding, doors, shutters	0				0	0
Other millwork, including flooring	furniture/flooring dimension stock, handle blanks	0				0	0
Wood Containers	wood boxes, flats, baskets, casks, crates and pallets	0				0	0
Prefabricated Wood Buildings	residential/ farm bldgs, sections, & panels	0				0	0
Miscellaneous Wood Product Manufacturing	wood dowels, wood handles, toothpicks	0				0	0
Pulp Mills	pulp only		0			0	0
Paper and Paperboard Mills	paper of all types		0			0	0
Paperboard Container Manufacturing	paper boxes, containers, cartons, tubes		0			0	0

Payments to States and Counties

The Gila National Forest makes payments to states and counties through two chief mechanisms – Payments-in-Lieu-of-Taxes (PILT) and the Secure Rural Schools (SRS) program. Table E7 displays payments by program and county between 2013 and 2015. SRS data for 2015 were not available at the time of this analysis, therefore, only 2013 and 2014 data are displayed.

The Department of the Interior compiles PILT information (DOI 2015). The Forest Service compiles SRS data (USFS 2015). The SRS figures presented here include Titles I, II, and III funding from ASR 18-01. The Catron County figures include both the proclaimed Gila National Forest and Apache National Forest, which is administered in New Mexico by the Gila National Forest.

Table E7. Amount of annual payments by county and type

	2015	2014	2013
PILT	Catron County: $619,691 Grant County: $2,078,740 Hidalgo County: $745,488 Sierra County: $1,205,512 **Total:** $4,649,431	Catron County: $636,506 Grant County: $2,061,555 Hidalgo County: $768,743 Sierra County: $1,203,605 **Total:** $4,670,409	Catron County: $593,448 Grant County: $1,837,491 Hidalgo County: $703,549 Sierra County: $1,056,769 **Total:** $4,191,257
SRS	Catron County: ND Grant County: ND Hidalgo County: ND Sierra County: ND **Total:**	Catron County: $2,107,965.31 Grant County: $796,473.35 Hidalgo County: $5,184.47 Sierra County: $313,147.03 **Total:** $3,222,770.16	Catron County: $2,283,200.24 Grant County: $822,643.85 Hidalgo County: $6,770.79 Sierra County: $344,739.29 **Total:** $3,457,354.17

PILT and SRS funds are distributed to the schools and general government sectors in IMPLAN to calculate the employment and income contributions.

Forest Service Expenditures

The Forest Service spends budget allocations on employee and contractor salaries, goods, and services needed to manage national forests. Table E8 provides information on the number of employees (both full-time equivalents and other than full-time equivalents) in 2015 as well as salary and non-salary expenditures between 2013 and 2015.

Table E8. Number of employees and expenditures (salary and non-salary) on the Gila NF

	2015	2014	2013
# FTEs	148		
# other than FTE	70		
Salary expenditures	$13,631,134	$12,693,355	$12,580,947
Non-salary expenditures	$ 7,386,329	$ 7,013,031	$ 6,817,892

The economic contributions of these expenditures are modeled in IMPLAN using both a range of household spending patterns and government spending.

Appendix F. Mineral Withdrawals

Table F1. List of mineral withdrawals on the Gila National Forest

Name	Number	Acres	District	Legal
Antelope AS	PLO 2830 NM 094303	30	7	S34, T17S R13W
Apache Adm. Site #1	NM 43867	40	3	S28, T5S R17W
Apache Adm. Site #2	PLO 2830 NM 094303	20	4	S36, T11S R18W
Bearwallow Lookout Adm. Site	PLO 1890 NM 023643	20	4	S11, T10S R18W
Beaverhead Adm. Airstrip	PLO 2830 NM 094303	160	2	S25, 26, T10S R13W
Beaverhead Adm. Site	PLO 1413 NM 024939	34.39	2	S7, Lots 3,4, T10S, R12W S12, T10S R13W
Beaverhead Work Center	PLO 2830 NM 094303	100	2	S19, T10S R12W
Ben Lilly Monument & Recreation Area	PLO 1119 NM 012318	40	7	S24, T16S R14W
Ben Lilly Recreation Area	PLO 1119 NM 012318	80	7	S33, 34, T10S, R17W
Black Mountain Adm. Site	PLO 4643 NM 0556981	20	2	S6, T11S R13W
Black Range Adm. Site	PLO 1413 NM 024939	145.33	2	Lots 8-11, T16S R8W
Bob Cat Adm. Site	PLO 1230 NM 016370	20	7	S7, T7S R12W
Bursum Campground	PLO 4643 NM 0556981	40	4	S2, T11S R18W
Cat Springs Lookout	PLO 1230 NM 016370	80	3	S16, 21, T3S, R15W
Cherry Creek Recreation Area	PLO 1038 NM 015227	152.5	7	S8, 17, 18, T16S R13W
Copperas-Cliff Dwellings Roadside Zone	PLO 4643 NM 0556981		5	S8, 16, 17, 20, 21, 28, 32, 33, T13S R13W S4, 5, 8, 9, 20, 29, 32, T14S R13W S25, 25, 36, T12S R14W
Cottonwood Canyon	PLO 1230			S10, T8S

Name	Number	Acres	District	Legal
Forest Camp	NM 016370	40	6	R20W
Eagle Peak Lookout	PLO 1230 NM 016370	40	6	S22, T7S R17W
East Fork Recreation Area	PLO 4643 NM 0556981	60	5	S8, T13S R13W
El Caso Lookout	PLO 1230 NM 016370	40	3	S27, T2S R16W
Emory Pass Recreation Area	PLO 1890 NM 023643	20	2	S15, T16S R9W
Escudillo Ranger Station Administrative Site	PLO 1230 NM 016370	120	3	S26, T4S R21W
Forks Recreation Area	PLO 4643 NM 0556981	100	5	S8, T13S R13W
Fort Bayard Adm. Site	PLO 1290 NM 021067	155.7	7	Tracts A & B, T17S R13W
Fox Mountain Lookout	PLO 1230 NM 016370	40	3	S3, T3S R18W
Gila River Bird Area	PLO 5513 NM 12720	2495.93	7	S9, 10, 16, 17, 21, 27, 28, 32, 33, T17S R17W
Gila Riverside Streamside Zone	PLO 4643 NM 0556981	291	7	S25, T12S R14W S4, 8, 17, 20, T13S R13W
Glenwood Ranger Station Adm. Site #31	SO 11/26/1906 PLO 1119 NM 012318 PLO 1393	114.73	4	S26, 27, 34, T11S R20W
Granite Peak Adm. Site	PLO 2830 NM 094303	40	5	S10, T13S R15W
Grapevine Recreation Area	PLO 4643 NM 0556981	20	5	S8, T13S R13W
Grouse Mountain Adm. Site	PLO 2830 NM 094303	20	4	S20, 21, T11S R18W
Hillsboro Lookout	PLO 2830 NM 094303	25	2	S4, T16S R9W
Hinkle Park Adm. Site	PLO 1230 NM 016370	40	4	S5, 8, T8S R21W
Hood Adm. Site & Addition	PLO 3768 NM 46841	450.08	6	S11, T7S R19W
Holt Adm. Site	PLO 2830 NM 094303	20	4	S2, T12S R19W
Hwy 12, Roadside Zone	PLO 1230 NM 016370	1014	3 & 6	S34-36, T4S R16W S3, 4, 9, T5S R16W S2, 10,11, T6S R18W S36, T6S R19W S1,3,4,8,11, 17, 18, T7S R19W

Name	Number	Acres	District	Legal
				S27-30, T4S R15W S25, T4S R16W S7, T5S R16W S13, 14, 21, 22, 28, 31-33, T5S R17W
Hwy 180, Roadside Zone	PLO 1230 NM 016370	3 & 6	3, 4, 6	S13, 24, 25, T6S R21W S34, T7S R20W S5-7, 17, 18 20, 29, 32, T9S R20W S31, 32, T6S R20W S5, 6, 8-11, 13, 14, 24-26, 35, T7S R20W S21, 22, 28, 32, 33, T8S R20W
Hwy 32, Roadside Zone	PLO 1230 NM 0163370	3 & 6	3, 6	S16, 21, 28, 33, T1S R17W S13, 24, 25, 36, T3S R18W S1,12, 13, 23, 25, T4S R18W S5, 8, T5S R17W S17, 20, 21, T5S R17W
Indian Creek Recreation Area	PLO 1119 NM 012318	160	6	S28, 29, 32, T10S R17W
Iron Creek Recreation Area	PLO 1119 NM 012318	130	7	S17-20, T16S R9W
Jewett Ranger Station Adm. Site	PLO 1230 NM 016370	80	3	S8, T4S R17W
John Kerr Lookout	PLO 1230 NM 016370	100	6	S10, T6S R16W
Kingston Recreation Area	PLO 1038 NM 015227	16	2	S18, T16S R8W
Lake Roberts Recreation Area	PLO 4643 NM 0556981	718.56	5	S35, T14S, R13W S1, 2, T15S R13W
Little Walnut Picnic Ground Recreation Area	PLO 1119 NM 012318	160	7	S3, 10, T17S R14W
Lookout Mountain Adm. Site	PLO 2830 NM 094303	20	2	S18, T11S, R9W
Luna Ranger Station #1	SO 11/26/1907	37.5	3	S32, T5S R20W
Luna Ranger Station #2	SO 11/26/1906 PLO 1230 NM 46826	160	3	S32, T5S R20W
Mangas Mountain Lookout	PLO 1230 NM 016370	40	3	S16, T3S, R14W
Mangas Ranger Station	PLO 1230			

Name	Number	Acres	District	Legal
Adm. Site	NM 016370	40	3	S36, T2S R15W
McKnight Adm. Site	PLO 2830 NM 094303	20	5	S35, T14S, R10W
Mimbres Administrative Site	PLO 1413 NM 024939 PLO 3768	80	5	S7, T16S R11W
Mimbres Summer Home & Recreation Area	PLO 1038 NM 024939	160	5	S31, 32, T15S R11W
Mogollon Baldy Adm. Site	PLO 2830 NM 094303	40	5	S10, T12S, R17W
Negrito Administrative Airstrip	PLO 1413 NM 024939	200	6	S13, T9S R17W
Negrito Tower Picnic Ground & Recreation Area	PLO 1119 NM 012318 PLO 3768	20	6	S2, T10S R17W
Nursery Station #66	SO 1/30/1907 NM 46830	158	7	S2, T11S R19W
O Bar O Administrative Site	PLO 1413 NM 024939	40	6	S2, 3, T11S R15W
Pine Flat Recreation Area	PLO 1119 NM 012318	40	7	S29, T15S R13W
Power Site Classification	No. 327, 8/18/41	771	4	S2-4, 23, 26, 35, T11S R20W
Pueblo Park Forest Camp	PLO 1230 NM 016370	80	4	S24, T8S R21W
Reeds Peak Adm. Site	PLO 2830 NM 094303	40	2	S23, T13S R10W
Reserve Adm. Airstrip	PLO 2830 NM 094303	120	6	S18, T7S R18W S13, T7S R20W
Reserve Ranger Station Adm. Site	PLO 1230 NM 094303 PLO 3768	27.52	6	S11, T7S R19W
Rocky Canyon Recreation Area	PLO 1038 NM 015227	160	5	S7, 8, T14S R11W
Saddle Mountain Lookout	PLO 1230 NM 015227	160	4	S15, 16, T8S R21W
San Carlos Indian Irrigation Project		2382	7	S5-8, 18, T18S R17W
Scorpion Corral Recreation Area	PLO 4643 NM 0556981	120	5	S26, T12S R14W
Signal Peak Adm. Site	PLO 1119 NM 012318	40	7	S15, T18S R13W
Snow Creek Adm. Site	PLO 1119 NM 012318	40	7	S18, T15S R14W
Southwestern Congregational Churches Camp and Recreation Area	PLO 1038 NM 015227	160	5	S36, T15S R12W

Name	Number	Acres	District	Legal
TJ Administrative Site	PLO 2655 NM 070229	107	5	S25, T12S R14W
Tularosa Administrative Camp Site	PLO 1230 NM 016370	120	6	S32, 33, T5S R17W
Upper and Lower Black Canyon Campground Recreational Area	PLO 1119 NM 012318	206.44	5	S7, T13S R11W S12, T12S R12W
Upper End Campground (Lake Roberts RA)	PLO 5511 NM 10953	80	5	S2, T15S R13W
Walnut Creek Administrative Site	PLO 1218 NM 01813	240	7	S10, T17S R14W
White Creek Administrative Site	PLO 1119 NM 012318 PLO 3788	40	5	S1, T12S R16W
Whitewater Forest Camp and Recreation Area	PLO 1119 NM 012318	155.05	4	S4, 5, 6, T11S, R19W
White Water Forest Camp and Extension (Catwalk)	PLO 4643 NM 0556981	751.512	4	S4, 5, 6, T11S R19W
Willow Creek Administrative Site	PLO 1119 NM 012318	110	6	S34, T10S R17W
Willow Creek Recreation Area	PLO 1119 NM 012318	250	6	S26, 34, 35, T10S R17W
Wright's Cabin Forest Camp and Recreation Area	PLO 1119 NM 012318	120	5	S16, T16S R9W
Water Power		28046	4 & 7	S19-21, 25-31, 35, 36, T10S R19W S3-10, 15, T11S R19W S18, 19, 30, 31, 32, T12S R13W S13, 22-26, 36, T12S R14W S3-10, 17-20, 30, 32, 33, T13S R13W S24-27, 33-36, T13S, R14W S3-5, 7-10, 15-21, 28-30, 32, 33 T14S R14W S7, 13-29, T14S R15W S11-16, 19-24, 28, 29, T14S R16W S32, T17S R17W S5-8, 18, T18S R17W

Appendix G. Species Justifications

Species of Conservation Concern – Considered but do not merit inclusion as a species of conservation concern on Gila NF

Information on the 55 species listed below shows that the best available scientific information indicates there is not substantial concern about the species' capability to persist over the long term in the plan area.

Justifications

Birds

Northern Goshawk (*Accipiter gentilis*) occurs in ponderosa pine forest to mixed-conifer with aspen ERUs. The species is a forest habitat generalist that uses a wide variety of forest ages, structural conditions, and successional stages that is well distributed across Gila NF north to south, and east to west. Threats include timber harvest practices, uncharacteristic fires, fire suppression, and predation. Current management practices have alleviated threats from timber removal and are designed to help improve habitat through the northern goshawk guidelines. These guidelines will be carried forward into the new forest plan. It occurs within ERUs that are highly departed; however, there is approximately 1,478,614 acres of these ERUs present on the Gila NF, most of which contain suitable habitat conditions for the goshawk. Local trends for the species shows that it is stable on Gila NF (USDA FS Gila NF 2012), and relatively stable to increasing in the western United States (Sauer 2014). Although the species occurs in ERUs that are highly departed, there is a large amount of suitable habitat and local trends show that the population is stable to increasing and therefore not considered at risk for persistence on the Forest.

American Peregrine Falcon (*Falco peregrinus anatum*) occurs in rock/talus/scree/cliffs from shrubland to mixed-conifer. This species is relatively well distributed across the Gila NF occupying rough cliff habitat, particularly in wilderness areas. It is protected from most threats through wilderness designations as well as inaccessible cliff habitat. Threats may include environmental toxins, habitat loss through mining or mineral development, human disturbance, and illegal take (falconry) (NatureServe 2016). Legal take is permitted for New Mexico residents with a Master Falconers license (NMDGF 2012). Wilderness area designations and cliff habitat provide protections from most threats and cliff habitat has not likely departed from reference conditions, plus trend is relatively stable to slightly increasing (NatureServe 2016, Sauer 2014), therefore the species is not considered at risk for persistence on the Forest.

Bald Eagle (*Haliaeetus leucocephalus*) utilizes large trees or cliffs near lakes or reservoirs. Only one nesting pair is known on the Gila NF at Quemado Lake. Prior to this nesting pair, they were only known to be common winter residents on the Gila NF. Threats to the species include biocide contamination, human disturbance, reduced food supply, and illegal shooting. Bald eagles are known to tolerate human disturbance so long as it is not directed at them. They have nested and successfully fledged young at Quemado Lake in spite of human activities, as the District has put use restrictions in the area of the nesting pair during the breeding season. Populations are relatively stable to increasing (IUCN 2016, NatureServe 2016, Sauer 2014) and is a common winter resident on the Gila NF, so this species is not considered at risk for persistence on the Forest.

Abert's Towhee (*Melozone aberti*) occurs in desert woodlands/chaparral. Preferred habitat consists of woodlands and thickets usually along rivers and streams, such as the brushy understory of cottonwood-willow gallery forests and mesquite bosques (Tweit and Finch 1994). ERUs that could provide habitat include Arizona alder-willow, desert willow, sycamore-Fremont cottonwood, Fremont cottonwood-oak, and Fremont cottonwood-shrub. These ERUs are in low to moderate departure. There is no evidence this species has ever been found outside its current range in NM (BISON-M 2016). The species has rarely been found along the Gila River at the Gila Bird Area, which is near the northern limit for this species (BISON-M 2016). Threats to the species include habitat loss, modification, and fragmentation through agricultural development and other human uses. They can be heavily parasitized by brown-headed cowbirds. The Gila Bird Area and Gila River Research Natural Area may offer some protections from management activities and other threats. Trend appears to be relatively stable (NatureServe 2016) to slightly increasing (Sauer 2014) range-wide, and ERUs are in low to moderate departure therefore not considered to be at risk for persistence on the Forest.

Common Black Hawk (*Buteogallus anthracinus*) occurs in mature, well developed riparian forests near permanent streams, particularly areas with mature cottonwoods. ERUs that could provide habitat include Arizona alder-willow, desert willow, Arizona walnut, sycamore-Fremont cottonwood, Fremont cottonwood-oak, and Fremont cottonwood-shrub. These ERUs are in low to moderate departure. The species is relatively well distributed at lower elevations of the major river systems of the Gila NF including the San Francisco, Gila, and Mimbres River drainages, as well as the east side of the Black Range in Animas and Seco Creeks. Threats include loss of perennial streams and riparian habitat, particularly cottonwood bosques. Many of these areas are already provided protection for the management of threatened and endangered species that often occur within these habitat types. Populations have increased since the 1970s and reproductive success from 2000 to 2011 has increased (Shook and Walkup 2012). Populations appear to be stable to increasing (IUCN 2016, NatureServe 2016, Shook and Walkup 2012). Because of the reasons mentioned above, this species is not considered at risk for persistence on the Gila NF.

Bank Swallow (*Riparia riparia*) occurs in riparian corridors with banks suitable for building burrows. ERUs that could provide habitat include Arizona alder-willow, desert willow, Arizona walnut, sycamore-Fremont cottonwood, Fremont cottonwood-oak, and Fremont cottonwood-shrub. These ERUs are in low to moderate departure. Threats include habitat alteration/elimination from flood and erosion control projects (riprap), streamflow regulation, and climate change may exclude NM from summer habitation (NatureServe 2016). Populations appear to be slightly increasing in the western US since 1996, but there is no Breeding Bird Survey data specifically for New Mexico (Sauer 2014). These birds are rare transients on the Gila NF (Zimmerman 1995), and they may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing open or partly open areas, usually near flowing water (NatureServe 2016) or riparian ERUs. Since these ERUs are in low to moderate departure and the species only passes through to its breeding grounds, then it is not considered at risk for persistence on the Gila NF.

Bell's Vireo (*Vireo bellii*) occurs in desert shrubland/woodlands in lowland stream courses. ERUs that could provide habitat include Arizona alder-willow, desert willow, Arizona walnut, sycamore-Fremont cottonwood, Fremont cottonwood-oak, and Fremont cottonwood-shrub. These ERUs are in low to moderate departure. This species has been found in the lower Gila and lower San Francisco valleys. Threats include loss or fragmentation of dense shrubby/woody riparian habitats from urbanization, agriculture, grazing, firewood cutting, flood control, and reservoir construction, as well as high rates of brood parasitism and predation (NatureServe 2016). There are currently protections for threatened and endangered species habitat where this species occurs that would also benefit this species which has likely alleviated some threats. Population trend for this species appears stable to slightly increasing (Sauer 2014), and Shook (2015) shows a significant increase of this species in the Gila Bird Area. Therefore, this species is not considered at risk for persistence on the Gila NF.

Blue-throated Hummingbird (*Lampornis clemenciae*) occurs in open stands of creosote and large succulents, as well as within cottonwoods along desert stream courses. ERUs that could provide habitat include semi-desert grassland, Arizona alder-willow, desert willow, Arizona walnut, sycamore-Fremont cottonwood, Fremont cottonwood-oak, and Fremont cottonwood-shrub. These ERUs are in low to moderate departure with the exception of semi-desert grassland that is highly departed from reference conditions. They are rare summer residents of the Gila NF (Zimmerman 1995). No major impacts are documented for this species, but habitat degradation from logging, grazing, mining, water diversion or introduction of non-native plants may affect their habitat. These threats are offset due to the species commonly nesting in altered habitats by placing nests on buildings or other structures (NatureServe 2016). Species has been found from the town of Mogollon, southeast to the Mimbres Valley and Pinos Altos (e-Bird 2016). Population trends show relatively stable to increasing range-wide (NatureServe 2016, IUCN 2016). Therefore, this species is not considered at risk for persistence on the Gila NF.

American goldfinch (*Spinus tristis*) is a fairly common winter resident on Gila NF (Zimmerman 2011; NatureServe 2016). This species inhabits weedy cultivated lands, grasslands, shrublands, woodlands, and riparian areas (NatureServe 2016). The grassland, shrubland, woodland and riparian ERUs this species may inhabit are in low to moderate departure except for the Colorado Plateau-Great Basin Grasslands ERU which is highly departed from reference conditions. The habitat is distributed throughout the Gila NF with species detections occurring from the town of Kingston in the southeast, west and north to the village of Reserve (e-Bird 2016). This species uses the Gila NF during the winter and is showing an increasing population trend in New Mexico (Sauer et al. 2014). Habitat is well distributed and suitable for wintering birds, and the population in New Mexico appears to be increasing. Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Eastern bluebird (*Sialia sialis*) is a rare winter resident on the Gila NF (Zimmerman 1995). It tends to use forest edges, open woodlands, and partly open situations with scattered trees (NatureServe 2016). On the Gila NF, it utilizes piñon/juniper woodlands, piñon/juniper grassland, and riparian ERUs that are in low to moderate departure. These ERUs are well distributed across the Gila NF with detections near the southern and eastern periphery of the forest boundary (e-Bird 2016). Habitat is well distributed and suitable for wintering birds, and the population appears to be fairly stable in the western region and increasing survey-wide (Sauer 2014). Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Ferruginous hawk (*Buteo regalis*) is an uncommon winter resident on the Gila NF (Zimmerman 1995; NatureServe 2016). It uses open country like prairies, plains, grasslands, and the periphery of piñon-juniper and other woodlands, while tending to avoid dense vegetation (NatureServe 2016). On the Gila NF, this translates into use of grassland and woodland ERUs. These ERUs are in low to moderate departure from reference conditions, except for Colorado Plateau-Great Basin and Semi-Desert Grasslands which are highly departed from reference conditions. These ERUs are well distributed across the Gila NF and there are detections across the forest (e-Bird 2016). Habitat is well distributed and suitable for wintering birds, and the population is increasing in New Mexico (Sauer 2014). Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Lincoln's sparrow (*Melospiza lincolnii*) is an uncommon winter resident and common transient through the Gila NF (Zimmerman 1995; NatureServe 2016). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing herbaceous wetlands, riparian areas, and shrubby woodland areas (NatureServe 2016). This would include several woodland, shrubland, and riparian ERUs, all of which are in low to moderate departure. Habitat is well distributed and suitable for wintering or transient birds and the population in New Mexico is increasing (Sauer 2014). Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Northern harrier (*Circus cyaneus*) is an uncommon winter resident and transient through the Gila NF (Zimmerman 1995, NatureServe 2016)). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing herbaceous wetlands, grasslands, meadows, or cultivated fields (NatureServe 2016). Woodland and grassland ERUs this species would utilize are in low to moderated departure, except for Colorado Plateau and Semi-Desert grasslands which are highly departed. Habitat is well distributed and suitable for wintering or transient birds, and the population in New Mexico is stable to slightly increasing (Sauer 2014). Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Savannah sparrow (*Passerculus sandwichensis*) is identified as an uncommon winter resident and a fairly common transient through the Gila NF (Zimmerman 1995; NatureServe 2016). It uses grasslands, herbaceous wetlands, and riparian areas, and tend to avoid areas with extensive tree cover (NatureServe 2016). This species utilizes grassland and riparian ERUs on the Gila NF that are in low to moderate departure from reference conditions, with the exception of Colorado Plateau-Great Basin Grassland ERU that is highly departed. Habitat is well distributed and suitable for wintering or transient birds. Although the population in New Mexico is slightly decreasing (Sauer 2014), there is sufficient suitable habitat for the birds to use during the winter and for birds passing through the Gila NF. The species is present when they are normally not subject to impacts from management activities and therefore not considered to be at risk for persistence on the Gila NF.

Wilson's warbler (*Wilsonia pusilla*) are common transients through the Gila NF (Zimmerman 1995; NatureServe 2016). Habitat includes semi-open areas in moist woodlands, bogs with scattered trees, willow and alder thickets, and areas with similar vegetation structure. Winter habitats include semi-open or lightly wooded areas, such as the canopy, openings, and edges of forests, second growth, brushy fields, and yards (NatureServe 2016). They may use the Gila NF as a stop over on their way to summer breeding grounds, utilizing riparian or woodland ERUs that are in low to moderate departure. Habitat is well distributed and suitable for transient birds. Although the population in New Mexico is slightly decreasing (Sauer 2014), there is sufficient suitable habitat for the birds to use for birds passing through the Gila NF. The species pass through over a short period of time and are normally not subject to impacts from management activities and therefore not considered to be at risk for persistence on the Gila NF.

Marsh wren (*Cistothorus palustris*), Wilson's phalarope (*Phalaropus tricolor*) are species that are strongly associated with herbaceous wetlands as important habitat. Marsh wren is a non-breeding winter resident while Wilson's phalarope is identified as a rare transient through the Gila NF (NatureServe 2016; Zimmerman 1995). The herbaceous wetland ERU has low departure from reference conditions on the 2,485 acres occurring on the Gila NF. Neither of these species has trend data available for the State of New Mexico, but nationwide they have a stable to increasing trend (Sauer 2014). In general, these species are mostly observed migrating through or using the Gila NF during the winter and are not normally subject to impacts from management activities. Therefore, these species are not considered to be at risk for persistence on the Gila NF.

Black swift (*Cypseloides niger*), Osprey (*Pandion haliaetus*), and Ring-necked duck (*Aythya collaris*) are all species that are strongly associated with water as an important part of their habitat. Black swift tend to occupy sites in bare rock or cliffs near waterfalls (NatureServe 2016). This habitat is not likely departed from reference conditions. The Breeding Bird Survey (Sauer 2014) does not have trend data specifically for New Mexico, but shows that this species is declining in all areas nation-wide except for the Northern Rockies region. Osprey and ring-necked duck require larger and deeper bodies of water as part of their habitat. Neither species has trend data specifically for New Mexico, but they both show an upward trend across the western United States (Sauer 2014). All of these species are either transient species or non-breeding residents on the Gila NF (NatureServe 2016; Zimmerman 1995). In general, these species are mostly observed migrating through or using the Gila NF during the winter and are not normally subject to impacts from management activities. Therefore, these species are not considered to be at risk for persistence on the Gila NF.

Brown-crested flycatcher (*Myiarchus tyrannulus*) is fairly well distributed in the San Francisco, Gila, and Mimbres River drainages (e-Bird 2016). Habitat it uses may consist of open woodland, situations with scattered trees, plantations, riparian woodland, second growth, scrub and mangroves, primarily in arid or semi-arid habitats (NatureServe 2016). It may occur in several of the woodland and riparian ERUs, all of which are in low to moderate departure from reference conditions on the Gila NF. Population trends show an increase in the western United States (Sauer 2014), with a significant increase in numbers on the Gila NF in the Gila Birding Area (Shook 2015). For these reasons, this species is not considered to be at risk for persistence on the Gila NF.

Gray vireo (*Vireo vicinior*) are found in hot, arid regions, most often associated with juniper trees (*Juniperus* spp.), piñon pine (*Pinus edulis*), or oak (*Quercus* spp.) in piñon-juniper savannahs and woodlands (NMDGF 2007). All woodland ERUs on the Gila NF provide habitat for the species which amounts to 1,282,507 acres well distributed across the forest, and are in low to moderate departure. The species has been documented from the Burro Mountains, north to Quemado Lake (e-Bird 2016). Threats to the species have been identified as habitat alteration through a variety of different activities that facilitate tree removal, as this species will not use areas lacking trees (NMDGF 2007). Brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) is a threat for Gray Vireo nests, and may well be a major limiting factor of the vireo in New Mexico, as cited by (Barlow et al. 1999; DeLong and Williams 2006; Hanna 1944; Friedmann 1963) in NMDGF 2007. In four studies in New Mexico, cowbird brood-parasitism of Gray Vireos ranged from 24 – 71% of nests, of which three quarters of the nests were abandoned (DeLong and Williams 2006 in NMDGF 2007). While this species is a rare summer resident on the Gila NF (Zimmerman 2011), their population trend on the Gila NF and in the region are stable to increasing (Sauer 2014). Habitat is abundant and well distributed across the Gila NF and population trends are stable to increasing on the Gila NF and in the region. Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Pinyon jay (*Gymnorhinus cyanocephalus*) is widely distributed across the Gila NF (e-Bird 2016) and commonly found (Zimmerman 1995; e-Bird 2016). Pinyon Jays are predominantly associated with piñon-juniper habitat, due to the species' tightly co-evolved relationship with piñon pines. In New Mexico, Pinyon Jays are associated primarily with Colorado pinyon (*Pinus edulis*). The species may be found in foothills throughout the state, wherever large blocks of piñon-juniper woodland habitat are present (NMPIF 2007). It occurs in woodlands with piñon pine, but may also occur in pine/oak woodlands as well as shrubland ERUs on the Gila NF which amount to 1,763,121 acres well distributed across the Gila NF. All of these ERUs are in low to moderate departure (Chapter 2: Upland Vegetation). Balda (2002 as cited in PIF 2007) suggests major declines in numbers may have occurred 40-70 years ago due to habitat conversion. These declines in numbers have been associated with legacy actions (i.e. chaining) that are no longer practiced on the Gila NF. Habitat may also be degraded by poorly planned woodland thinning and tree removal efforts. Overall decline of this habitat may be due to drought and bark beetle infestation (NMPIF 2007), but Insect and Disease Surveys for the Gila NF in 2016 showed bark beetle mortality was fairly low with most mortality to ponderosa pine and most prevalent to post-fire effects within the recent large fires. Although the species population is experiencing declines rangewide, it is still common across the Gila NF, habitat is abundant, well distributed, in low to moderate departure, and legacy actions are no longer practiced. At this time this species is not considered to be at risk for persistence on the Gila NF. However, continued monitoring of the species on Gila NF lands should be carried forward into the new forest plan as a possible monitoring item.

Yellow-eyed junco (*Junco phaeonotus*) has been found in the Burro Mountains (e-Bird 2016; Zimmerman pers. comm. 2016), where it is believed to be breeding since the mid 2000s. However, there is a belief that they may be hybrids between yellow-eyed junco and dark-eyed junco (e-Bird 2016). They tend to occupy mixed-coniferous forest and ponderosa pine forest, including areas with pine-oak associations. They are generally found at higher elevations, but may be found at mid-elevations where conifer forest is present in canyons (NMPIF 2007). In winter, they often move to lower elevations and flock in foothill woodland and scrublands (NMPIF 2007). The ERUs this species could use include all the shrubland and woodland ERUs in the winter, plus Ponderosa Pine-Evergreen Oak Forest, Ponderosa Pine Forest, Mixed-Conifer with Frequent Fire, and Mixed-Conifer with Aspen the rest of the year. These ERUs are in low to moderate departure, except for Ponderosa Pine Forest that is highly departed. The majority of the Gila NF provides habitat for this species, but the species northern extent occurs in the Burro Mountains. Threats to the species has been identified as loss or degradation to its breeding habitat, with a particular vulnerability to catastrophic wildfire (NMPIF 2007). There is no data on population trends in the United States, but this species appears to be expanding its range as it was only known from the Animas and Peloncillo Mountains in the bootheel of New Mexico (BISON-M 2016) until relatively recently. Habitat is abundant and well distributed across the Gila NF. Because of these reasons, this species is not considered to be at risk for persistence on the Gila NF.

Fish

Desert Sucker (*Catostomus clarkia*) typical habitat consists of small to medium rivers with pools and riffles; individuals occur mainly over bottoms of gravel-rubble with sandy silt in interstices (Sublette et al. 1990). These suckers avoid or are unable to persist in reservoirs and lakes (Minckley and Marsh 2009). In New Mexico threats include stream/river dewatering and invasion of non-native fish, particularly red shiner (NatureServe 2016, IUCN 2016), flathead catfish, and smallmouth bass (J. Monzingo pers. comm. 2016). This species is well distributed and still occurs in most streams it was present in historically in the Gila and San Francisco River drainages. Even though their trend appears to be declining over the last 10 years (Paroz et al. 2006) on the Gila NF, this species was the third most collected fish species during this study. This decline could be attributed to a multitude of factors including prolonged drought, ash flows and increased sediment from wildfires, non-native predatory fish, scouring floods, and flood control structures (Paroz et al.2006). In New Mexico their trend is categorized as stable (Sublette et al. 1990, NatureServe 2016, IUCN 2016). Although there appears to be a decline in the species over the last 10 years on the Gila NF, this species is ubiquitous in its historic drainages and not considered at risk for persistence on the Forest.

Sonora Sucker (*Catostomus insignis*) is typically found in gravelly or rocky pools of creeks and small to medium rivers (Page and Burr 2011). Threats to this species include alteration of historic flow regimes, reservoir construction, increased sedimentation eliminating pool habitat, nonnative species, post fire effects, and stream diversions (J. Monzingo pers. comm. 2016). This species is well distributed and still occurs in most streams it was present in historically in the Gila and San Francisco River drainages. Even though their trend appears to be declining over the last 10 years (Paroz et al. 2006) on the Gila NF, this species was the second most collected fish species during this study. The short term trend in New Mexico shows a decline of <30% to relatively stable, and long-term decline of <30% to an increase of 25% (NatureServe 2016). Although there appears to be a decline in the species over the last 10 years on the Gila NF, this species is ubiquitous in its historic drainages and not considered at risk for persistence on the Forest.

Rio Grande Cutthroat Trout (*Oncorhynchus clarki virginalis*) occurs only in Animas Creek. The species is currently extirpated from the creek because of the 2013 Silver Fire ash flows and scouring floods, but there are plans to repatriate the stream in the next few years. Threats generally include reduced streamside cover due to grazing, timber activities, uncharacteristic wildfire, hybridization with non-native salmonids, habitat fragmentation, stream intermittency, and competition. Once the stream is repatriated with this species, most threats will have been largely reduced or eliminated for the species on the Gila NF. Populations should then begin to increase and stabilize once repatriated as there will be no competition or hybridization occurring. Upon repatriation, with most threats reduced or eliminated, this species should not be considered at risk for persistence on the Forest.

Invertebrates

Dashed Ringtail (dragonfly) (*Erpetogomphus heterodon*) occurs in clear, rocky, mountain streams and rivers. Only the adult form of this species has been found in 2 rivers in southwestern New Mexico. It is not known what the larvae look like or any life functions or habitat requirements are for this species (NatureServe 2016). Specific threats are not known, but likely include anything that can destabilize stream flow (NatureServe 2016). Nothing is known about abundance, distribution, or trends for this species on the Gila NF. Information for this species is lacking to evaluate whether or not the species is at risk for persistence on the Gila NF.

Mayfly (*Leucrocuta petersi*) has been found in warm, medium sized rivers. It occurs in rivers with silt covered rocks and sandy bottoms, and is known from the Gila River drainage (NatureServe 2016). Specific threats are not known, but likely anything that can destabilize stream flow (NatureServe 2016). Nothing is known about abundance, distribution, or trends for this species on the Gila NF. Information for this species is lacking to evaluate whether or not the species is at risk for persistence on the Gila NF.

Notodontid Moth (*Oligocentria delicata*) has been historically found in oak/juniper/pine woodlands. This species is a regional endemic species that occurs mostly on the Coronado NF, with a few populations occurring in neighboring New Mexico (NatureServe 2016). There is a historic record of the species occurring in Grant County, but there is no specific location given (Lott and Naberhaus 2015). Nothing is known about abundance, distribution, or trends for this species on the Gila NF. Information for this species is lacking to evaluate whether or not the species is at risk for persistence on the Gila NF.

Arizona Snaketail (dragonfly) (*Ophiogomphus arizonicus*) occurs in pine woodland streams. It has been found in swift mountain streams with silt that provide larval habitat. The species is reasonably widespread and locally common throughout its range (NatureServe 2016). It has been found in the Gila and San Francisco River drainages. Specific threats are not known but may include anything that causes stream destabilization; however, National Forests have some level of protection from threats (NatureServe 2016). Abundance and trend on the Gila NF is not known, but populations range-wide appear to be relatively stable to stable (IUCN 2016, NatureServe 2016), and there is no indication of population decline (IUCN 2016). In summary, range-wide populations appear stable, species is reasonably widespread, they can be locally common, and National Forests have some level of protection from threats. Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Four-spotted Skipperling Skipper (butterfly) (*Piruna polingii*) occurs in moist meadows and streamside in conifer woodlands. ERUs this species may occur in include upper montane conifer/willow, herbaceous wetland, narrowleaf cottonwood/shrub, ponderosa pine forest, mixed-conifer with frequent fire, mixed-conifer with aspen, and spruce-fir forest. Ponderosa pine forest is highly departed, while the rest of the ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). This species has been found from Emory Pass, north and west, to Willow Creek on Reserve RD, and south to the Pinos Altos Range. Threats may include uncharacteristic wildfire or management activities that could dry out sites. The species is not well studied and much is not known about the life functions or habitat requirements including what host plant the larvae use (Zimmerman 2001). Range-wide trend for this species shows a decline of <30% to relatively stable (NatureServe 2016). Nothing is known about abundance or trends for this species on the Gila NF. Information for this species is lacking to evaluate whether or not the species is at risk for persistence on the Gila NF, particularly since the larval host plant is not known.

Dry Creek Woodlandsnail (*Ashmunella tetrodon tetrodon*) is found in Dry Creek Canyon in the southwestern portion of the Mogollon Mountains from 6,000-7,000 ft. The species is limited to deep canyons along creek bottoms where deciduous trees produce abundant leaf litter where snails occur under and around stones and logs (Metcalf and Smartt 1997). Threats may include degradation or destruction of riparian vegetation producing deciduous leaves, such as uncharacteristic fire or flood events. The Whitewater-Baldy Fire burned through many of the uplands of known occupied canyons. While there have been some high flows through Dry Creek Canyon, habitat in known occupied canyons is still in good condition containing all the components necessary for life functions including deciduous riparian vegetation and down woody debris (D. Myers pers. comm 2016). Little is known about the distribution of the species as several canyons that may contain habitat have likely not been surveyed. Abundance and trend are unknown on the Gila NF, but trend is likely stable as populations discovered in early 1900s were still found in mid-1990s (Metcalfe and Smartt 1997). Information for this species is lacking to evaluate whether or not the species is at risk for persistence on the Gila NF.

Cross Snaggletooth (snail) (*Gastrocopta quadridens*) is found in western and central parts of the state, Sacramento and Mogollon Mountains, and northward to Utah. Fossils of this species have been found in the Caballo Mountains. This species habitat consists of forest openings comprised of calcareous bedrock (Metcalfe and Smartt 1997). Threats may include uncharacteristic wildfire, mineral exploration and development, road construction and maintenance, and climate change. This species appears to be quite abundant along the Sandia Crest and in a few localities in the Capitan Mountains. Distribution, abundance and trend on the Gila NF is unknown but the trend is likely stable as populations discovered in early 1900s were still found in mid-1990s (Metcalfe and Smartt 1997). This combined with the fact that calcareous bedrock habitat this species uses is not likely departed from reference conditions suggests that this species is not likely at risk for persistence on the Gila NF.

Monarch butterfly (*Danaus plexippus plexippus*) is widely distributed across the Gila NF, although it is rarely common. Records for the region extend from April through November, although most are between June to October (Zimmerman 2001). There appear to be no records of breeding on the Gila NF and have been noted by Zimmerman (2001) to be moving through, presumably to their wintering grounds. There was positive 90-day finding by USFWS (2014). Based on subsequent review of the petition and sources cited in the petition, it was found that the petition presents substantial information that the petitioned action may be warranted for the monarch butterfly (*Danaus plexippus plexippus*) based on factors A, B, C, and E. Further, review of the petition did not indicate that an emergency situation exists. However, if at any time conditions change and we determine emergency listing is necessary, an emergency rule may be developed (USFWS 2014). Drastic reduction in milkweed species within their breeding areas through pesticide use, land conversions, development, and climate change are listed as reasons for listing. Adults use a wide variety of flowering plants for nectar in their adult stage, which are plentiful on the Gila NF. In general, this species is mostly observed migrating through using the Gila NF only temporarily and is not normally subject to impacts from management activities. Therefore, this species is not considered to be at risk for persistence on the Gila NF.

Plants

Threadleaf Giant-hyssop (*Agastache rupestris*) occurs on protected north slopes, often times in cliff faces, from oak savannah to ponderosa pine (4,500-7,000 ft). ERUs in which this species may occur include piñon-juniper woodland, piñon-juniper grass woodland, ponderosa pine-evergreen oak, ponderosa pine forest, and mixed-conifer with frequent fire. Ponderosa pine forest is highly departed, while the other ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). The amount of habitat for this species comes to approximately 2,627,921 acres across the forest. The species has been collected from between Reserve and Wall Lake, south to Pinos Altos (SEINet 2016). This plant is relatively well distributed on the Gila NF. Threats to the species would likely include uncharacteristic wildfire, but authors make no note of threats or make reference to rarity (NMRPTC 1999). Abundance and trend on the Gila NF are not known, but habitat is quite abundant and the majority is in low to moderate departure from reference conditions. Since habitat is abundant on the Gila NF, with the majority not highly departed, then the species is not considered to be at risk for persistence on the Gila NF.

Villous Groundcover Milkvetch (*Astragalus humistratus var. crispulus*) occurs in xeric pine forest on sandy volcanic soils (NMRPTC 1999). ERUs in which this species may occur include Colorado Plateau/Great Basin grassland, juniper-grass woodland, piñon-juniper grass woodland, and ponderosa pine-evergreen oak forest. Total acreage on the Gila NF for these ERUs is 865,844 acres with the majority of these acres in low to moderate departure. Colorado Plateau/Great Basin grassland is highly departed, while the other ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). Specimens have been taken from Reserve to Quemado (SEINet 2016). This species is fairly well distributed on the Gila NF, it can occur within several ERUs, often occurs in disturbed areas such as road cuts, and is locally common (NatureServe 2016). Specific threats have not been identified for the species but may include uncharacteristic wildfire or road maintenance activities. There is no known information about abundance or trends of the species on the Gila NF. However, habitat is abundant and well distributed across the Gila NF, so it is likely that the species is not at risk for persistence on the Gila NF.

Nutrioso Milkvetch (*Astragalus nutriosensis*) occurs on mesa tops at 7000-8000 ft elevation in open grassland or occasionally among piñon pine and juniper, and it occurs in soils that are volcanic silty-clays. The location where the species was found is in the Colorado Plateau/Great Basin grassland ERU, but it may also find suitable habitat where this ERU intercedes with the juniper-grass woodland ERU. The Colorado Plateau/Great Basin grassland ERU is highly departed, while the juniper-grass woodland ERU is in low (on Forest) to moderate (in context area) departure from reference conditions (Chapter 2: Upland Vegetation). There has been only one documented occurrence in 1995 at the extreme NE corner of the Gila NF (SEINet 2016). The most recent description of the species by Isely (1998) does not record the species in NM. SEINet has since updated its database in 2017 and no longer shows this species occurring on the Gila NF. This species is a narrow endemic to the Rio Nutrioso drainage in AZ (NMRPTC 1999, NatureServe 2016). This species is not palatable to livestock because it may be poisonous as this is a close relative of *A. mollissimus* var. *mathewsii* which is known to be poisonous. However, it may be subject to weed eradication programs for that reason (NMRPTC 1999). There are no other specific threats documented. This species not known from the Gila NF and is thus removed from consideration as an SCC.

Gila Thistle (*Cirsium gilense*) occurs in moist areas or mountain meadows in montane coniferous forest between 7,000-8,000 ft. elevation. ERUs in which this species may occur include ponderosa pine forest and mixed-conifer with frequent fire. Ponderosa pine forest is highly departed while mixed-conifer with frequent fire is moderately departed from reference conditions (Chapter 2: Upland Vegetation). Much of the mixed conifer burned in large wildfires over the last 5 years. This species is found in the Mogollon Mountains on the Gila NF, and nearby in the White Mountains of Arizona. The species is not threatened by prevailing land uses within its range, and it is known to increase with disturbance (NMRPTC 1999). This species occurs within the Whitewater-Baldy Fire perimeter and is not likely impacted or possibly even positively impacted by the fire and experiencing few, if any, alterations to its habitats from direct impacts of the fire or post-fire impacts (Roth 2016). Surveys conducted after the fire by Roth (2016) show that the thistle is distributed throughout the area and is frequently found along roadsides, streams, drainage bottoms, moist north-facing slopes, but also thrives in disturbed and burned areas, regardless of fire severity. The species was previously under-documented and is considered secure despite the disturbances to its habitat (Roth 2016). Trend and abundance appear to be increasing on the Gila NF therefore its persistence on the Forest is not considered at risk.

Mogollon Whitlowgrass (Draba) (*Draba mogollonica*) occurs on cool, moist north slopes of montane forests between 5,000-9,000 ft elevation in volcanic soils of the Mogollon Mountains. It occurs from piñon-juniper woodlands all the way up to mixed-conifer with aspen, but is associated with rocky/cliffy habitat which has not likely changed from reference conditions. Much of the area this plant occurs is inaccessible and current land uses pose no threat to the species (NMRPTC 199). This species is well distributed across the Gila NF, from Reserve, south to Silver City, and from the AZ state line all the way east to the Forest boundary, and further east to the San Mateo Mountains. This plant is often found in large populations throughout its range, and it may be more abundant than is now known because of the relative inaccessibility of its habitat (NMRPTC 1999). Threats to the species may include uncharacteristic wildfire and mineral exploration. The trend of this species on the Gila NF is not known; however, given that this species is well distributed across Gila NF, current land uses pose no threat to species because habitat is relatively inaccessible, and the plant is often found in large populations throughout its range, this species is not considered to be at risk for persistence on the Gila NF.

Winn Falls Fleabane (*Erigeron scopulinus*) occurs on cliff faces on rhyolitic rock between 5,900 - 9,200 ft. elevation that has not likely changed from reference conditions. The species is well distributed east to west across Gila NF from Hwy 180 to Diamond Peak, and further east to the San Mateo Mountains. Populations of this plant are sporadic and disjunct, but can be locally very abundant, and the cliff habitat that it occupies effectively removes threats to this species (NMRPTC 1999). Threats may include uncharacteristic wildfire and mineral exploration and development. Trend for this species on the Gila NF is unknown. Given that this species is well distributed across Gila NF, current land uses pose no threat to species because habitat is relatively inaccessible, and the plant can be locally abundant, this species is not considered to be at risk for persistence on the Gila NF.

Horned Spurge (*Euphorbia brachycera*) is found from open grasslands into ponderosa pine forests. ERUs this species may occur in include Colorado Plateau/Great Basin grasslands, all the way up in elevation through ponderosa pine forests. This comes to total of 2,612,363 acres within these ERUs that range from low to high departure from reference conditions, with the majority in low to moderate departure (Chapter 2: Upland Vegetation). This species is widely distributed across the Gila NF and much of the interior west, and is considered globally secure (G5). There is no known information about threats, trends, abundance, or habitat requirements for this species on the Gila NF, but people may target the species with weed eradication programs as it looks similar to the noxious leafy spurge (*E. esula*). Since habitat is abundant on the Gila NF, with the majority not highly departed, then this species is not considered to be at risk for persistence on the Gila NF.

New Mexican Gumweed (*Grindelia arizonica* var. *neomexicana*) occurs on rocky slopes and ledges in piñon-juniper to lower montane coniferous forest, and is considered an endemic species to southwestern New Mexico (NatureServe 2016). ERUs in which this plant may occur include piñon-juniper woodland, ponderosa pine-evergreen oak, ponderosa pine forest, and mixed-conifer with frequent fire. Ponderosa pine forest ERU is highly departed while the other ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). Total acreage within these ERUs is approximately 2,325,212 acres. The species is relatively well distributed on the Gila NF from Quemado Lake, south to Silver City, and east to Emory Pass, occurring in the Pinos Altos Range, Black Range, and Mimbres Mountains. There are no known threats to the species, and abundance and trends are not known on the Gila NF. Since the species is relatively well distributed and habitat is quite abundant on the Gila NF, with the majority not highly departed, then the species is not considered to be at risk for persistence on the Gila NF.

Goodding's Bladderpod (*Lesquerella gooddingii*) occurs on rocky slopes and ravines in piñon-juniper and ponderosa pine at elevations between 6,000-7,500 ft., often near streams and springs in Gila conglomerate soils. ERUs in which this species may occur include piñon-juniper grass woodlands, piñon-juniper woodlands, mountain mahogany shrubland, ponderosa pine-evergreen oak, and ponderosa pine forest. This equates to approximately 2,121,774 acres across the Gila NF. Ponderosa pine forest ERU is highly departed while the majority of the ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). The species is relatively well distributed on the Gila NF from the Arizona border near Reserve, east to Poverty Creek on the Black Range. This species is not threatened by prevailing land uses within its range, but it does occur occasionally along highway rights-of-way where some populations could be susceptible to disturbance (NMRPTC 1999). Abundance and trend for this species on the Gila NF are not known, but habitat across the forest is quite abundant. Since the species is relatively well distributed and habitat is quite abundant on the Gila NF, with the majority not highly departed, then this species is not considered to be at risk for persistence on the Gila NF.

White Mountain Groundsel (*Packera cynthioides*) occurs in openings on igneous soils in piñon-juniper to upper montane conifer forest between 7,000-9,500 ft. elevation. ERUs in which this species may occur include piñon-juniper grassland, piñon-juniper woodland, ponderosa pine-evergreen oak, ponderosa pine forest, mixed-conifer with frequent fire, and mixed-conifer with aspen. Total acreage within these ERUs is approximately 2,729,155 acres. Ponderosa pine forest is highly departed while the majority of acreage within other ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). This species is well distributed from Mule Creek near the Arizona border, east through the Black Range, and north into the San Mateo Mountains. Prevailing land uses do not threaten the species, but this species sometimes occupies road cuts where some populations could be impacted by road maintenance operations (NMRPTC 1999). There are no other known threats, but the effects from timber harvest and fire has not been studied (NMRPTC 1999). Abundance and trend for this species on the Gila NF are not known. Since the species is well distributed, prevailing land uses do not threaten the species, and habitat is quite abundant on the Gila NF, with the majority not highly departed, then this species is not considered to be at risk for persistence on the Gila NF.

Metcalfe's Groundsel (*Packera neomexicana* var. *metcalfei*) occurs in piñon-juniper woodland and lower montane coniferous forest between 7,000-8,000 ft. elevation. The ERUs in which this species may occur include piñon-juniper woodland, ponderosa pine-evergreen oak, ponderosa pine forest, and mixed-conifer with frequent fire, which contain approximately 2,325,212 acres across the Gila NF. Ponderosa pine is highly departed while the other ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). The species appears to be fairly well distributed across the Gila NF from near Mangas Mountain on the Quemado RD, south to near Emory Pass, and west to the Arizona state line. There appear to be no significant land use threats to the species or its habitat, and it is quite common within its limited range (NMRPTC 1999). Trend for the species on the Gila NF is not known, but habitat appears to be quite abundant. There are few external threats impacting its populations and/or their habitat, and habitat is quite abundant across the Gila NF, therefore its persistence on the Forest is not considered at risk.

Mt. Graham Beardtongue (*Penstemon deaveri*) occurs on rocky slopes from ponderosa pine to above timberline between 7,500-11,000 ft. elevation. ERUs in which this species may occur include ponderosa pine-evergreen oak, ponderosa pine forest, mixed-conifer with frequent fire, mixed-conifer with aspen, and spruce-fir forest, which make up approximately 1,601,785 acres across the Gila NF. Ponderosa pine forest is highly departed and spruce-fir forest is moderately departed but modelled to be highly departed in the future as much of the spruce-fir forest ERU has burned in wildfires within the last 5 years. Rocky slopes where this species grows may protect it from fire effects. The other ERUs are moderately departed from reference conditions. The species is fairly well distributed on the Gila NF and is found in the Burro

Mountains, north to Jewett Gap near Quemado, and east into Arizona. Current land uses apparently pose no threats to the species (NMRPTC 1999). Abundance and trend for this species on the Gila NF are not known, but habitat is abundant across the forest. Given that this species is fairly well distributed across Gila NF, current land uses apparently pose no threat to this species, and habitat is abundant across the forest, this species is not considered to be at risk for persistence on the Gila NF.

Silver Mock Orange (*Philadelphus argenteus*) is an upper elevation shrub found on dry, rocky slopes. ERUs in which this species may occur include Madrean piñon -oak woodland, ponderosa pine-evergreen oak, ponderosa pine forest, and mixed-conifer with frequent fire, which contain approximately 1,494,133 acres across the Gila NF. Ponderosa pine forest is highly departed while the other ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). The species is fairly well distributed on the Gila NF and is found just south of Glenwood RD boundary by Yellowjacket peak, northeast to Wall Lake, and in the Black Range from near Emory Pass, west into Upper Gallinas Canyon. Little known about threats or abundance, and nothing is known about specific habitat requirements for this species on the Gila NF, but the amount of acreage within the ERUs in which it may occur is abundant. This species is globally secure and it is not considered a rare plant by NMRPTC (1999). Since the species is fairly well distributed, and amount of acreage within ERUs it may occur in is abundant on the Gila NF, with the majority not highly departed, then this species is not considered to be at risk for persistence on the Gila NF.

Blumer's dock (*Rumex orthoneurus*) occurs near perennial springs, in unshaded meadows or along stream sides in canyons, in moist, organic soils (NatureServe 2016). This species is relatively well distributed across the Gila NF (SEINet 2016). Riparian ERUs that this species may occur within are in low to moderate departure. Range has expanded as plants previously thought to have been *R. occidentalis* were identified as *R. orthoneurus*, and the species is only considered sensitive in AZ (Regional Foresters Region 3 Sensitive Species List 2013). Threats to the species may include trampling from the species occurring within areas heavily used for recreation (camping and hiking), grazing, and possibly from mining and road construction (NatureServe 2016). Since the species is relatively well distributed, range has been expanded, and the riparian ERUs in which this species may occur are in low to moderate departure from reference conditions, then the species is not considered to be at risk for persistence on the Gila NF.

Wright's Catchfly (campion) (*Silene wrightii*) occurs on cliffs and rocky outcrops in conifer forests between 6,800-8,000 ft. elevation (NMRPTC 1999). The cliff habitat in which the species occurs is not likely departed from reference conditions. The species is fairly well distributed on the Gila NF from near the town of Mogollon, east to just north of the town of Kingston on the Black Range. Current land uses apparently pose no threats to this species as the cliff/crevice habitat it occupies is relatively inaccessible and offers considerable protection (NMRPTC 1999). Abundance and trend for this species on the Gila NF are not known. Given that this species is fairly well distributed across Gila NF, current land uses apparently pose no threat to the species because habitat is relatively inaccessible, and cliff habitat is not likely departed from reference conditions, this species is not considered to be at risk for persistence on the Gila NF.

Mammals

Spotted Bat (*Euderma maculatum*) occurs in cliff habitat from desert to montane coniferous forest. Cliff habitat features are not likely departed from reference conditions. The cliff habitat this species occupies effectively protects it from most threats. The fungal infection known as white-nose syndrome that affects bats is not very likely to affect this species as they are not known to hibernate in groups. Roosting habitat is extensive, remote, and mostly not vulnerable to destruction or excessive disturbance (NatureServe 2016). There are no current threats to cliff and crevice habitat they occupy, although rock climbing may disturb isolated individuals/populations (NatureServe 2016). This bat is fairly well distributed on the Gila NF and has been documented between Lake Roberts and further to the northwest to Willow Creek.

Population trend and abundance are not known on the Gila NF, but range-wide trend for this species appears to be relatively stable both short and long-term in terms of distribution and abundance (NatureServe 2016). Since habitat is not likely departed from reference conditions, inaccessible, and overall population trends are relatively stable, this species is not considered at risk for persistence on the Gila NF.

Hooded Skunk (*Mephitis macroura*) occurs in rock/talus scree, low riparian, desert, low grasslands, and low woodlands. The ERUs in which this species may occupy include Arizona alder-willow, desert willow, Arizona walnut, sycamore-Fremont cottonwood, Fremont cottonwood-oak, Fremont cottonwood-shrub, semi-desert grassland, Madrean piñon-oak woodland, piñon-juniper grass woodland, and mountain mahogany shrubland. Semi-desert grassland is highly departed while the rest of the ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). This species is relatively well distributed and found fairly common on Gila NF. Specimens have been collected from Lilley Park in the Negrito watershed, south to the Burro Mountains, and 7 miles north of Mimbres (BISON-M 2016). This species is listed as an unprotected furbearer in the New Mexico hunting regulations as skunks are not differentiated, so threats likely include shooting, trapping and vehicle collisions. The species thrives in areas where there is human disturbance (IUCN 2016). Animal damage control practices may impact a few individuals, but the number is very low (BISON-M 2016). Population trends show that the species' numbers are increasing (BISON-M 2016). This species is not considered at risk for persistence on the Gila NF.

White-nosed Coati (*Nasua narica*) occurs in riparian areas near croplands/hedgerows, and woodlands. ERUs in which this species may occupy include Arizona alder-willow, desert willow, Arizona walnut, sycamore-Fremont cottonwood, Fremont cottonwood-oak, and Fremont cottonwood-shrub. These ERUs are in low to moderate departure from reference conditions (Chapter 2: Upland Vegetation). They are relatively well distributed on the Gila NF and have been found from Cassidy Spring in the geographic center of the Gila NF, west to the San Francisco Valley, and south into the Burro Mountains. Threats include indiscriminant killing through illegal shooting or trapping, even though coatis are classified as protected furbearers and cannot be legally taken in New Mexico which alleviates shooting threats to a certain extent (NMDGF 2016c). Also, vehicle collisions are a possible threat. Distribution has increased on the Gila NF since the 1970s, so it is likely that abundance has also increased. This species is not considered at risk for persistence on the Gila NF.

Arizona gray squirrel (*Sciurus arizonensis arizonensis*) and Rocky Mountain Bighorn Sheep (*Ovis canadensis*) - According to the New Mexico Department of Game and Fish, gray squirrel and Rocky Mountain bighorn sheep are huntable within New Mexico (NMDGF 2016c). However, the New Mexico Comprehensive Wildlife Conservation Strategy specifically states that Arizona gray squirrels are "Not a harvested species". The New Mexico hunting regulations say that gray squirrels are legal to harvest without differentiating that Arizona gray squirrels are not supposed to be harvested. Frey et al. (2008) notes that Arizona gray squirrel occupies mid-elevation riparian areas, distributed well across the Gila NF, and has experienced no expansion or contraction of their distribution. Population trends for Rocky Mountain bighorn sheep within the Gila NF decreased from 2004 - 2012, but have been on the increase since 2013 with a large jump in the San Francisco population in 2014 (NMDGF 2016b). Domestic sheep and goats can carry diseases that are lethal to bighorn sheep (BISON-M 2016). However, there are no domestic sheep or goat allotments on the Gila NF, nor are they used for brush or invasive species control. Rocky Mountain bighorn sheep and Arizona gray squirrel appear to be secure within the Gila NF, and their continued long-term persistence is not at risk because they are managed at numbers that allow them to be a huntable species.

Summary of At-Risk Determinations

At-risk species decisions are based on the best available scientific information. Unfortunately, many species lack specific information on current population status, distribution, or abundance making it difficult to determine risk. Another confounding issue is scale. Although some species information indicate increase or a decline on a large geographic scale (i.e. nationwide or statewide), Forest-wide expertise may not suggest a similar determination. Should any new information become available the plan can be amended to accommodate the new information.