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# SW Jemez Mountains Landscape Assessment Report

## Santa Fe National Forest Sandoval County, New Mexico



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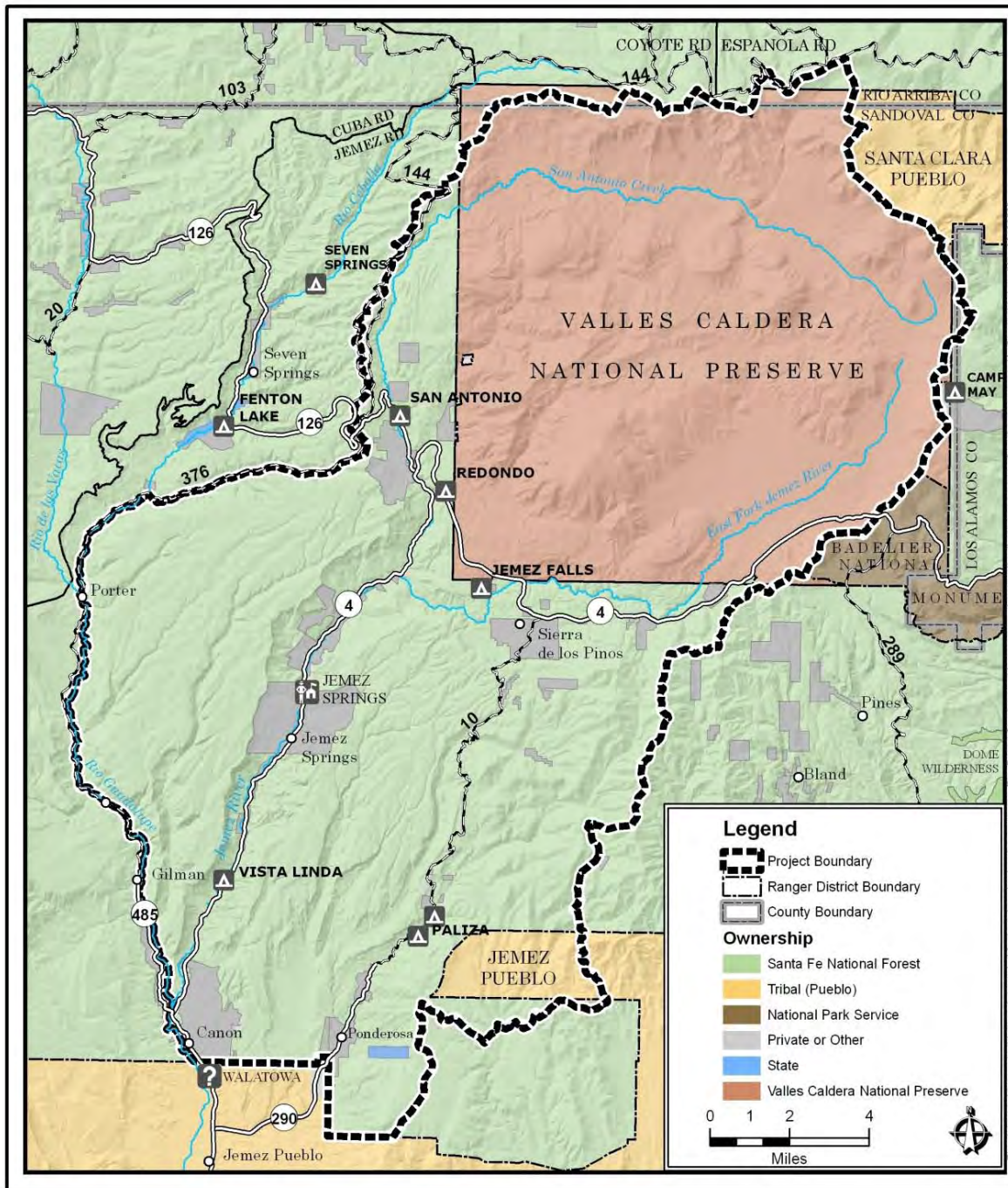


Figure 1. Assessment area and land jurisdictions

# Introduction

## Purpose and Scope

The primary purpose of this report is to identify the current ecological conditions and trends in the Southwest Jemez Mountains Assessment Area (assessment area) and compare them with “reference conditions”. The difference between existing and reference conditions is sometimes referred to as the ecological departure. Knowledge of ecological departure from a range of reference conditions provides a critical context for managing sustainable ecosystems (Swanson et al 1994). Thus, this assessment report is intended to be used as a tool for developing a landscape restoration strategy.

Reference conditions are generally defined by using the latest scientific approximation of the natural or historical range of variation (prior to European settlement), focusing on key ecological attributes of structure, composition and function. Reference conditions used in this report may also be defined as federal land management standards, based on environmental laws, regulations or policies. Those can include Forest Service directives (Forest Service Manual and Handbook-FSM/FSH), and the goals, standards, and guidelines in the Santa Fe National Forest Land Management Plan (Forest Plan). Therefore, reference conditions, as used in this report, are not synonymous with desired conditions. Desired conditions include social, cultural and economic considerations, and reference conditions do not factor in those variables. The range of reference conditions described in this report is assumed to represent the best understanding of properly functioning ecological conditions. This report does consider social and economic land use activities and the contribution of a healthy ecosystem on socio-economic values.

This assessment report is not a NEPA document. It does not propose treatments or analyze proposed treatment activities. It does not result in any land management decisions. All proposed actions on federal land must undergo an environmental analysis and decision-making process in accordance with NEPA regulations at 40 CFR 1500-1508. This report provides descriptions of ecological conditions and trends that form a basis for identifying ecosystem restoration needs in the area. It will be used to inform development of a 10-year landscape restoration treatment strategy and associated site-specific project proposals, which will be developed in collaboration with all interested stakeholders. Restoration treatments are actions aimed at improving the resilience or adaptive capacity of ecosystems that have been degraded by human intervention (Allen et al 2002).

## Scientific Data and Methods

Depending on the resource being evaluated, multiple geographic scales were used in evaluating ecosystem conditions and trends, so that important ecological processes were not missed or misrepresented. For example, the team evaluated conditions for forest vegetation cover types, biophysical settings, 6<sup>th</sup> hydrologic unit code watersheds, specific wildlife and plant species habitats, soil types, grazing allotments, urban interface areas, and other geographic scales.

The scope of this assessment focuses on Santa Fe National Forest (National Forest) land within the boundaries of the 210,000-acre multi-jurisdictional landscape. Relevant conditions on adjoining lands are also considered, where appropriate. The 210,000-acre assessment area includes the entire Valles Caldera National Preserve (Preserve), along with small portions of private and tribal land. A separate interdisciplinary (ID) team simultaneously assessed existing ecological conditions on the Preserve.

The Preserve's existing conditions report(s) will be used in conjunction with this assessment report to provide a continuous coverage of existing condition descriptions for the entire 210,000-acre landscape. The National Forest and Preserve reports will be evaluated together during the preparation of a landscape-scale "all lands" restoration strategy. Where data was consistent and available for the entire 210,000-acre area, it is displayed in this report. This assessment is based on information available in National Forest and Preserve databases from February 2009 through February 2010.

To prepare this report, the Forest Service compiled and reviewed the best available science related to the ecosystems in this area, and used the best available inventories and databases to describe current resource conditions. The Literature Cited section includes the scientific literature used, and each resource section of this report describes the scientific methodologies and data sources used. Data accuracy was variable, and attempts were made to verify and update the information where practical. Data was primarily derived from the National Forest's Geographical Information Systems (GIS), Natural Resource Information System (NRIS), Forest Service Vegetation Database (FSVEG), Forest Inventory, and Analysis Database (FACTS), Infrastructure Databases (INFRA-Roads) and other standard Forest Service databases. The LANDFIRE and FlamMap vegetation and fire analysis tools were also used, which are national standards (Stratton 2009). More information on those data sources and fire behavior computer modeling tools used are contained in each resource section.

Additional information about existing conditions was obtained from past environmental analysis documents completed in accordance with National Environmental Policy Act (NEPA regulations). The team reviewed past environmental analysis documents from over 30 vegetation and fuels management projects and aquatic habitat/stream and riparian restoration projects proposed in this area over the past 20 years, which cumulatively cover over 85,000 acres (78percent) of National Forest lands within this assessment area.

The team also used information from other broad-scale assessment reports that describe existing conditions and trends in this area. These include assessment reports for the Jemez National Recreation Area (1998), East Fork Jemez Wild and Scenic River (1999), and the Upper and Middle Jemez River Watershed (2005). Those assessments cover virtually the same landscape area that is addressed by this report, although this report provides important updates based on the latest data and science.

The team also used stream condition inventories and assessments completed for the major drainages in this area, such as for East Fork Jemez River (2002), Rio Cebolla (2003), Rio Guadalupe (2004 and 2006), and San Antonio Creek (2005). These are available in the fisheries reports link on the National Forest's website at <http://www.fs.fed.us/r3/sfe>.

The SW Jemez Mountains restoration website at: [http://www.fs.fed.us/r3/sfe/jemez\\_mtn\\_rest/index.html](http://www.fs.fed.us/r3/sfe/jemez_mtn_rest/index.html) contains over 40 maps, 13 draft specialist reports, and 28 key assessment report documents used to develop this assessment.

## **Collaboration**

Public involvement and collaboration in developing this assessment has been an on-going process, beginning in the summer of 2009. A small group of collaborators consisting of the Forest Service, Forest and Watershed Restoration Institute, The Nature Conservancy, and Valles Caldera

Trust formed a collaborative restoration group in 2008 and met nearly every month through 2009. About July 2009, this group began outreaching to all potentially interested stakeholders to expand collaboration on restoration planning in the Jemez Mountains. We used various mailing lists and email networks to reach out to interested parties. The purpose of the outreach was to determine who wanted to collaborate in defining the ecological restoration conditions and needs, and be involved in identifying and prioritizing restoration treatments across this landscape, or to be involved in subsequent project-level planning, implementation, and monitoring activities. The assessment of ecological conditions and restoration needs was identified as the initial collaborative planning step.

The process was open to anyone interested, and information was freely exchanged through a variety of phone calls, emails, meetings, field trips, workshops, and on a shared website. Below is a summary of the broader collaborative effort that got underway in the summer of 2009 and continued intensively through March 2010 to assess ecological conditions and restoration needs, and develop the restoration treatment strategy and proposal for funding under Title IV of the 2009 Omnibus Public Lands Management Act. Details are contained in files at the National Forest headquarters office and available on the SWJM restoration [website](#).

- The Forest Service, Forest and Watershed Restoration Institute, The Nature Conservancy, and Valles Caldera Trust developed a Collaboration Plan for the SW Jemez Mountains restoration planning efforts, and began to expand their collaborative forest restoration planning process to other stakeholders. The restoration strategy is a long-term collaborative effort that includes developing an assessment of ecological conditions and restoration needs as the initial planning step (US Forest Service 2009c).
- Held meetings (and then continued communications) with: NM Forest Industries Association, WildEarth Guardians, NM Department of Game and Fish, Los Alamos National Laboratory, Bandelier National Monument (NPS), Cuba Regional Economic Development Organization (CREDO), Jemez Pueblo, Santa Clara Pueblo, Los Alamos and Sandoval Counties, Firewise Homeowner Associations, and land management agencies.
- Distributed a Southwest Jemez Mountains Restoration Status Report and Map to a comprehensive mailing list of approximately 200 potentially interested parties (100 agencies/organizations and 100 individuals). The Oct/Nov Status Report described the assessment area, planning processes, timeline, and opportunities for collaboration.
- Conducted a collaborative field trip with local scientific professionals in forest restoration, fire management, wildlife and fish habitat management, water resources management, wood products utilization, and other related fields, to discuss existing and reference conditions.
- Called and talked with over 12 non-profit organizations involved in Jemez Mountains management activities, such as NM Trout & Trout Unlimited, Rocky Mountain Elk Foundation, HawksAloft, Native Plant Society, Center for Biological Diversity, OHV groups, etc.
- Developed and continuously managed a website for collaboration on the Southwest Jemez Mountains Restoration Planning, including collaboration on developing this assessment. The website included an email correspondence link, participation interest form, comment form, maps, reference documents, draft documents, and links to SW Jemez Restoration partner's websites.

- Continued to coordinate and network with over 30 key stakeholder groups and agencies, through email and phone discussions, as well as several small group meetings, such as with State Forestry, State Game & Fish, industry groups, and others.
- Collaborated with 5 leading research scientists who have a long-term partnership with land managers in the area, have conducted research in the area and published literature on forest ecology in the Jemez Mountains (Dec. 2009 to Feb. 2010).
- Held a 3-day workshop (Feb. 9-11, 2010) to collaboratively develop the SW Jemez Mountains restoration strategy, formed working groups to focus on specific elements of the strategy and proposal, and made plans for continued collaboration on the restoration work. Over 60 participants, representing over 30 different groups, agencies, and tribes participated in the workshop.
- Continued to collaborate on the restoration strategy and funding proposal with representatives from over 30 different agencies, groups, tribes, through a variety of meetings, conference calls, netmeetings, and email correspondence (Feb. to Mar. 2010).

## Area Location and Setting

The 210,000-acre Southwest Jemez Mountains landscape assessment area is located in the Jemez Mountains in the central region of New Mexico, as shown on the vicinity map (cover page). The assessment area boundary is primarily defined by the upper and middle Jemez River watersheds (5<sup>th</sup>-code hydrologic units). The assessment area was expanded just outside the southwest boundary of the middle Jemez River watershed to include the Virgin, Holiday and Schoolhouse mesa area. It was further expanded outside the southeast boundary of the watershed to include the Paliza canyon area. This assessment area boundary was developed as a result of a comprehensive forest-wide screening process to identify priority landscapes for ecological restoration, considering all the 6<sup>th</sup>-level watersheds on the National Forest (supporting documents on file).

The cities of Los Alamos and Espanola are located about 20 to 30 highway miles to the northeast of the assessment area, with Santa Fe located due east of the area, and Albuquerque and Rio Rancho about 40 to 50 miles southeast of area. Access to and through the area is primarily along New Mexico State Route 4, a 2-lane paved highway that connects this area to other major highways in north-central New Mexico. Highway 4 is the main artery of the Jemez Mountain Trail National Scenic Byway, which includes short excursions on state roads 502, 126 and 290.

Land management and ownership jurisdictions are shown in Figure 1 (page vi). The northern half of the area primarily consists of national forest system lands on the Preserve that are managed by the Valles Caldera Trust (Trust). The southern half consists of national forest system lands on the National Forest that are managed by the Forest Service. The National Forest land in this area is almost entirely on the Jemez Ranger District (99 percent). Private lands are intermingled in the area and include the communities of Canon, Jemez Springs, Ponderosa, La Cueva, Thompson Ridge, and Sierra de los Pinos. The Bandelier National Monument, managed by the National Park Service, and Pueblo of Santa Clara, are adjacent to the area on the east side of the Preserve, along with the city of Los Alamos and Los Alamos National Laboratory (a \$6 billion dollar nuclear research complex). The Pueblo of Jemez lands comprise about 2 percent of the assessment area, near Paliza Canyon. Additional Pueblo land extends south of the area. Table 1 (below) and Figure 1 (page vi) show the land jurisdictions and their percent coverage within the assessment area.

**Table 1. Land jurisdictions and percentages**

Land Jurisdiction	Acres	Percent
Forest Service	110,427	52
Valles Caldera Trust	86,200	41
Private	9,820	5
Pueblo of Jemez	3,845	2
State of New Mexico	281	< 0.2

Vegetation in the area is diverse, with upwards of 100 plant associations (Muldavin and Tonne 2003). Over 90 percent of the area is forested and the rest is grasslands and shrublands. The forested areas are comprised of approximately 50 percent ponderosa pine and dry mixed conifer forest, 26 percent woodlands (piñon, juniper and Gambel oak), and 24 percent wet mixed conifer species (white fir, spruces, limber pine and aspen). The area supports a wide variety of wildlife habitats and species, including the threatened Mexican spotted owl and a number of sensitive species. The area includes over 180 miles of perennial (year-round) streams, which support cold water fish species.

The area contains highly variable terrain, including flat-topped mesas, red rock canyons, narrow river gorges and waterfalls, the wide grasslands of the Valles Caldera, geothermal hot springs, and large granite outcrops like Battleship Rock. Elevations range from just over 11,000 feet on Redondo Peak (on the Preserve) to approximately 5,500 feet on the lower Jemez River, where it exits on the National Forest boundary near Cañon. About 20 percent of the area has steep slopes, averaging over 40 percent grade. Precipitation averages about 20 inches a year, mostly from heavy summer rains and winter snowstorms. Figure 2 shows the topography and slope, including slopes over 40 percent grade where log skidding equipment is limited by Forest Plan standards.

Recreational use of the area is high, particularly along the Jemez River's Highway 4 corridor. Dominant activities are hiking, mountain biking, camping, rock climbing, hunting, fishing, cross-country skiing, and picnicking. Special area designations include the congressionally designated Preserve, Jemez National Recreation Area, and East Fork Jemez Wild and Scenic River, along with the administratively designated Monument Canyon Research Natural Area and an unnamed Inventoried Roadless Area. In addition, this area is archaeologically one of the richest in the U.S., with exceptionally high numbers of pre-historic and historic remains and National Historic Register sites.

Commercial land use activities occur in the area under special use authorizations, such as mining for pumice, film-making, harvesting firewood and other small wood products, and providing outdoor recreation "outfitter and guide" services. The Preserve portion in particular has experienced intensive livestock grazing and timber cutting activity 15 to 30 years ago while it was a private ranch, and has historically been used by Native Americans and others for a variety of land use activities (Anscheutz and Merlan 2007).

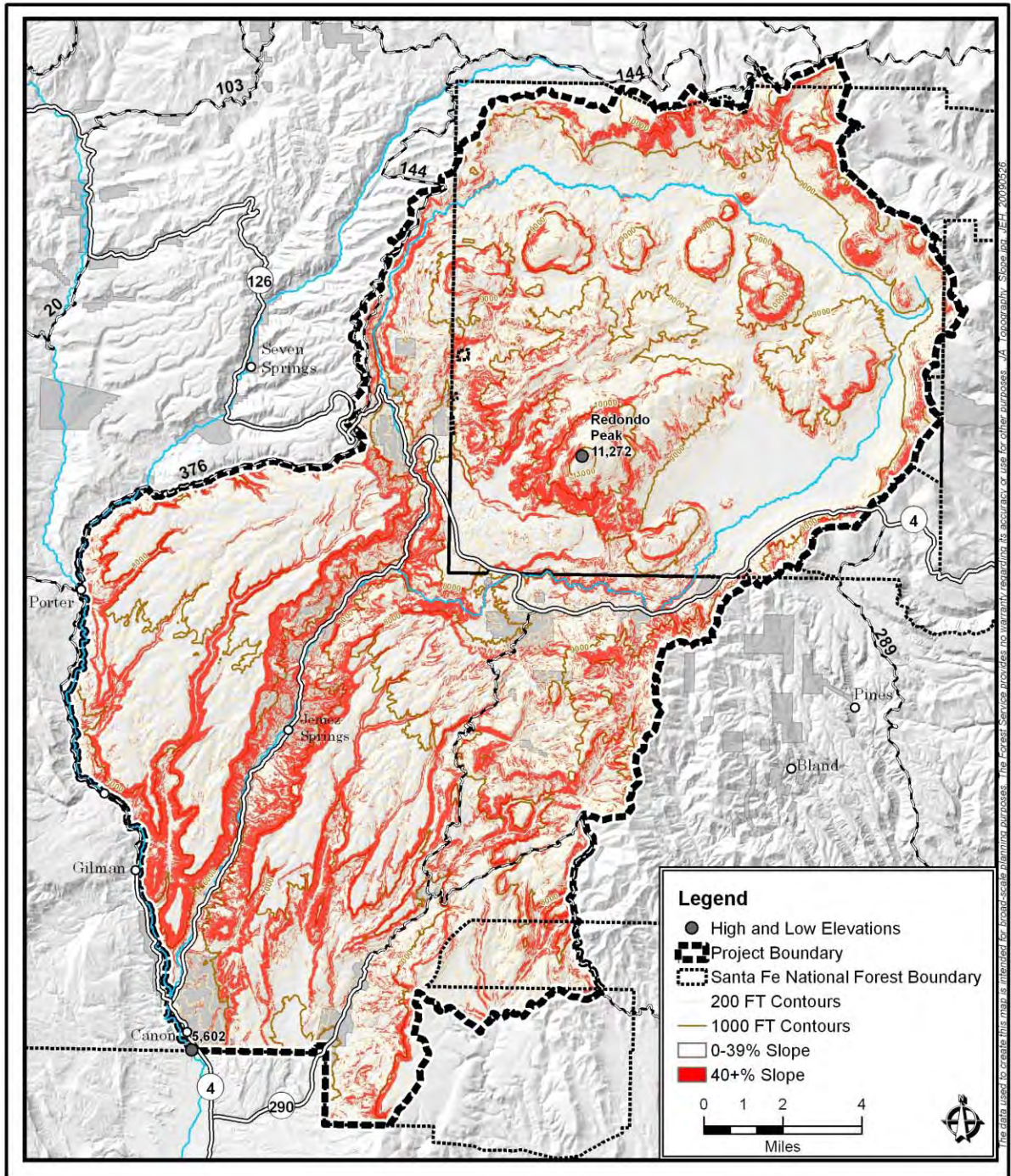


Figure 2. Topography and slope, including slopes over 40 percent

## Management Direction

### Santa Fe National Forest

Nearly half the assessment area is within the Jemez Ranger District of the National Forest. The Forest Plan provides broad, programmatic management direction for how to manage these national forest lands (US Forest Service 1987a). Management direction in the Forest Plan is in the form of forest-wide goals, standards and guidelines, as well as management area-specific objectives, standards and guidelines. The National Forest land in the assessment area covers portions of 11 different Forest Plan management areas (Figure 3, page 22). Management direction on approximately 60 percent of those National Forest acres emphasizes primarily cultural resources protection and management (areas I, P, R, S), with 36 percent emphasizing primarily recreation resources (areas C, E, F/X, L, X). The remaining 4 percent emphasizes wildlife (area N) and research (area M). Figure 3 displays where these management areas lie within the assessment area. Management area I is not shown on that map due to the sensitivity of the cultural resources and potential for disrupting sites in that area (36 CFR 296.18).

Table 2 summarizes the management emphasis (objectives) for each management area located within the assessment area. It also identifies the percent of the assessment area covered by each management area. Two smaller management areas, F (East Fork Jemez Wild and Scenic River) and M (Monument Canyon Research Natural Area) are within an overlapping management area X (Jemez National Recreation Area). Where management areas overlap, authorized activities must be compatible with both sets of management area direction. If there is any conflicting management direction, the most environmentally conservative direction applies.

**Table 2. Forest Plan management areas and their emphasis**

Management Area and Percent of Assessment Area	Management Emphasis
X = 26% Jemez National Recreation Area	Conserve, protect and restore the recreational, ecological, cultural, religious, and wildlife resource values for which the JNRA was designated. Timber harvesting and livestock grazing may occur where compatible with the values for which the JNRA was designated.
R = 26% Cultural Resources/ Wildlife-Timber	Cultural resource location, inventory, nomination, and protection are emphasized. The emphasis is also on wildlife habitat improvement and essential habitat protection and enhancement. Grazing and timber harvest activities occur where compatible with the primary emphasis of this area.
P = 14% Cultural Resources/ Timber-Wildlife	Cultural resource location, inventory, nomination, and protection are emphasized here. Provides primary wildlife habitat. Emphasis is also on enhancement of wildlife habitat diversity and timber production where consistent with other resource integration and the primary emphasis.
I = 14% Cultural Resources2	Emphasis is on providing active management of cultural resources including protection, stabilization, interpretation, evaluation, and opportunities for research. Use restrictions will be imposed as necessary to protect the cultural values. No timber harvest is allowed unless necessary to protect or enhance the cultural resources.

**Table 2. Forest Plan management areas and their emphasis**

Management Area and Percent of Assessment Area	Management Emphasis
S = 7% Cultural Resources/ Wildlife-Range	Cultural resource site location, inventory, nomination, and protection are emphasized in these lower elevation areas. Emphasis in this area is also on key wildlife habitat protection, habitat improvement, and forage and firewood production. Recreational opportunities are dispersed and consist primarily of firewood and Christmas tree gathering.
E = 5% Dispersed Recreation-Visual/ Timber	Providing a broad range of dispersed recreation opportunities or minor developed sites. Providing scenic backdrops; maintaining visual quality. Providing timber and firewood production and enhancement of wildlife habitat diversity. Grazing activities vary in intensity.
F (F/X) = 3 % Wild and Scenic River <sup>1</sup>	Preserve and protect the outstandingly remarkable values for which the river was congressionally designated, for the benefit and enjoyment of present and future generations. The outstandingly remarkable values for this wild and scenic river are: scenery, recreation, geology, ecology, fisheries and wildlife. The Jemez National Recreation Area (X) overlaps this Wild and Scenic River management area F.
N = 2% Threatened- Endangered Species Habitat	Protect and enhance essential wildlife habitat, especially for threatened and endangered species. Not included in the suitable timber base although certain timber management activities as well as grazing, firewood, and fire management may occur when consistent with the protection emphasis of this area. Predominantly remaining in a natural condition.
C = 2% Recreation-Visual/ Wildlife-Timber	Enhancement of visual quality and developed recreation opportunities while protecting essential wildlife habitat and riparian zones. Grazing and timber activities occur where they are consistent with the emphasis of this area.
M (M/X) = 0.3% Research Natural Areas <sup>1</sup>	Research Natural Areas (RNAs) will be managed to provide opportunities for non-disruptive research and education. Management includes allowing natural processes to occur and the protection of natural features. Use restrictions will be imposed as necessary to keep areas in their natural or unmodified condition. No harvest of timber or firewood, nor any livestock grazing. Monument Canyon RNA is a 640-acre section of ponderosa pine forest. The Jemez National Recreation Area (X) overlaps this RNA management area M.
L = 0.4% Semi-Primitive Non- Motorized Recreation	Providing outstanding opportunities for semi-primitive non-motorized recreation. Primarily unroaded. Timber harvest and road building are not consistent, but wildlife, range, and fuels management may occur where consistent with emphasis. Will receive priority in dispersed pre-recreation management, trail, and trailhead development, and trail maintenance.

Sources: Santa Fe National Forest Plan (US Forest Service 1987a) and Santa Fe National Forest Geodatabase (May 2009)

<sup>1</sup> F/X is where the East Fork Jemez Wild and Scenic River corridor (F) lies within the Jemez National Recreation Area (X).

M/X is where the Monument Canyon Research Natural Area (M) lies within the Jemez National Recreation Area (X).

There is also a small parcel is where the cultural resource protection area (I) lies within a threatened and endangered species protection area (N).

<sup>2</sup> Management area I locations may not be disclosed on public maps due to the sensitivity of these resources and potential for disrupting sites, in accordance with regulations at 36 CFR 296.18.

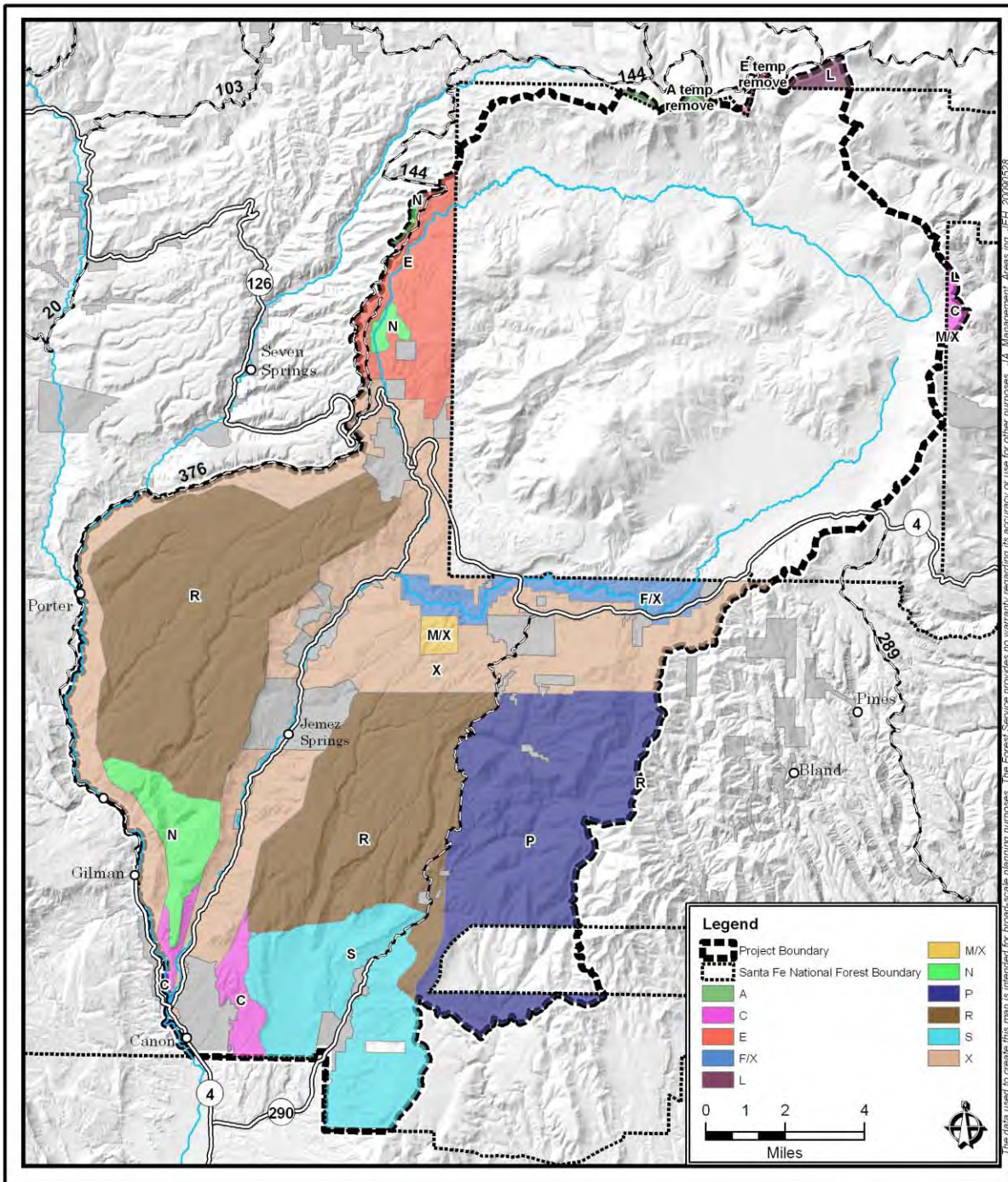


Figure 3. Forest Plan management areas

## Valles Caldera Trust and Preserve

The Valles Caldera Trust was created by the Valles Caldera Preservation Act of 2000 (Public Law 106-248) to preserve and protect the 89,000-acre area formerly known as the Baca Ranch. The Act states that the purposes of the Preserve are “... *to protect and preserve the scientific, scenic, geologic, watershed, fish, wildlife, historic, cultural, and recreational values of the Preserve, and to provide for multiple use and sustained yield of renewable resources.*” In August 2002, the Trust began managing the Preserve as an experiment in public land management, with a goal of financial self sufficiency along with ecological sustainability. The Master Plan for Interpretation (VCT 2005) and Strategic Plan (VCT 2006) provide an interim interpretive plan and strategic plan to guide the Trust’s management of the Preserve while comprehensive land management plans are being developed. An existing conditions report for the Preserve’s landscape restoration management plan was developed concurrently with this assessment report to consider ecological conditions across jurisdictional boundaries within the 210,000-acre landscape.

Refer to the [Preserve web site](#) for more details, and for their Existing Conditions Reports that cover the Preserve’s block of land within this assessment area.

## Local Communities

The assessment area contains one incorporated municipality— the Village of Jemez Springs— with a population of approximately 375 residents (U.S. Census 2000). Other small rural communities are scattered throughout the area, including Ponderosa, La Cueva, Thompson Ridge, and Sierra de los Pinos. They are all managed in part through homeowner associations. Most local businesses in the area are based on tourism and recreation-related activities. (Refer to socio-economic section).

Management of hazardous fuels on private properties in the assessment area is facilitated in part by an interagency program called Firewise USA ([www.firewise.org](http://www.firewise.org)). Communities in this area participate in Firewise as the Eastern Greater Jemez Wildland Urban Interface (WUI) Corridor group. These groups and others also worked with on the Sandoval County Community Wildfire Protection Plan (Sandoval County 2008), which identifies all the communities in this area at high risk of damage or loss from wildfire. Both the Jemez WUI assessment and CWPP are available on the SWJM restoration website.

The Eastern Greater Jemez WUI Corridor group and others involved in developing the CWPP evaluated the WUI communities in the Jemez Mountains assessment area, identified wildfire hazards and risks, and defined ways that private property owners could reduce hazardous fuels and the ignitability of their structures, and improve fire response capabilities. Over the past several years, the Forest Service completed fuels reduction treatments around the WUIs in this assessment area. The WUI working group also worked with State Forestry, Natural Resources Conservation Service, the local Soil and Resource Conservation District and willing landowners in the area to reduce hazardous fuels and wildfire risk to over 50 private properties in the area, and 20 more just outside the area. The CWPP highlighted the need for additional activities on both public and private lands to reduce the negative impacts that wildfires may have on these communities. Further information about fire and fuels management is in the vegetation, fuels and fire section of this report.

## **Pueblo of Jemez**

The Pueblo of Jemez (also known as Jemez Pueblo) is a sovereign nation with an independent government and tribal court system. The Governor convenes tribal council meetings and executes the decisions of the tribal council. The Pueblo is a federally recognized tribe with over 3,500 tribal member residents. The Pueblo has a Department of Resource Protection that works with tribal leaders to protect, preserve and manage the Pueblo's natural and cultural resources. The Pueblo developed and now manages the Walatowa Woodlands Initiative—a program that provides forest thinning and restoration services and custom lumber by-products. The Pueblo, Valles Caldera Trust, and Forest Service are working collaboratively to create an integrated strategy for forest restoration and hazardous fuel reduction in this multi-jurisdictional landscape.

# Climate

## Climate Patterns

Summers stay fairly cool in this high mountainous area, with a mean July temperature of 70 to 73 degrees F. Rainfall is most frequent in July and August, in the form of short-duration high-intensity storms. The mean January temperature is 32 to 34 degrees F, and winters accumulate prolonged snow packs on the mountain peaks. Average annual precipitation is 15 to 18 inches per year (Western Regional Climate Center 2009)

The climate in the Jemez Mountains is influenced by two general patterns. The first is a high-pressure system off the coast of California that produces a general pattern of wet winters and dry summers. The second is an Atlantic sub-tropical high-pressure system that extends into the Gulf of Mexico creating a flow of moist air onto the plains and eastern Rockies throughout the summer, creating the so-called “monsoon” season (Arnell and Richards 1986). The July and August monsoon season is characterized by intense short rainstorms accompanied by thunder and lightning. The climate or weather patterns that occur in the assessment area have a direct relationship to the plant and animal species in the area. The complex terrain in terms of slope, aspect and elevation results in a wide range of microclimates.

The Jemez Springs weather station has a sufficient length of record to establish climatology for the assessment area. The Wolf Canyon and Los Alamos weather stations that lie outside the assessment area at different elevations were also used to help establish the full range of climate variability within the area. The figure (map) in the Air Quality section displays the climate stations in the area, as well as the air quality monitoring sites.

Additionally, there are five Campbell-style meteorological stations operating on the Preserve, along with a NOAA Climate Reference Network (CRN) station. The Preserve’s climate stations collect year-round precipitation (rain and snow), air temperature, wind speed and direction, relative humidity, total solar radiation, and soil temperature and moisture (TDR probes) at three soil depths (data on-line at [Preserve web site](#)).

Table 3 shows the period of record for each of the RAWS stations. Data for Jemez Springs was analyzed through 2007 because there is insufficient data available for 2008 from which to compare trends at nearby stations. Los Alamos station data was available prior to 1946, but with significant amounts of missing data, including entire years during the World War II era. Therefore, Los Alamos data is only analyzed after 1946 for precipitation and 1948 for temperature.

## Temperature

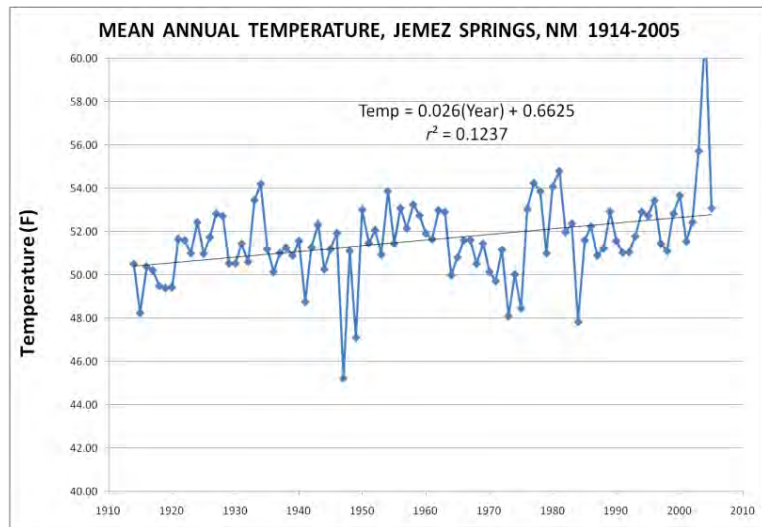
Average annual temperatures for the past 10, 20, 30, and 50 years are presented in Table 3, as are the coolest and warmest year during the period of record. It is interesting to note that 1991 was the coolest year recorded at both Wolf Canyon and Los Alamos weather stations over the past 50 years. This may have been influenced by the eruption of Mt. Pinatubo in the Philippines in June of that year, however below average temperatures occurred in months both before and after the eruption.

**Table 3. Average and extreme temperatures in the Jemez Mountains**

Location	Period of Record	Elevation (feet)	Temperature (degrees F)				Coolest (year)	Warmest (year)
			50 yr avg	30 yr avg	20 yr avg	10 yr avg		
Jemez Springs	1914-2007	6,260	52.2	52.6	52.6	53.1	48.3 (1915)	54.9 (2007)
Los Alamos	1948-2008	7,360	48.1	48.3	48.4	49.2	46.1 (1991)	53.6 (1950)
Wolf Canyon	1953-2008	8,220	40.4	40.3	40.2	40.8	38.3 (1991)	43.2 (1954)

Source: Western Regional Climate Center 2009

Each of the three stations shows a warming trend beginning in about 1992, although Los Alamos and Wolf Canyon have leveled off in the past few years. Current temperatures trends are not outside the historic range of variability although in 2007 Jemez Springs recorded its warmest year since 1914. Overall, the Jemez Mountains have experienced significant warming and drying trends over the past 100 years. Data shows summer temperatures increasing faster than winter temperatures, resulting in longer and warmer summer wildfire seasons. Figure 4 shows the warming trend graphically, based on mean annual temperatures since 1914.



**Figure 4. Mean annual temperature for Jemez Springs, 1914-2005**

**Precipitation**

Table 4 summarizes precipitation data. There is a wide range of variability in temperature with periods of drought occurring on a multi-decadal scale. The driest year of record is 1956. The 10-year average is lower than the 20 to 50 year averages, influenced by the drought conditions in the early 2000a. While recent precipitation levels are up, the precipitation trend since 1914 is downward.

**Table 4. Average and extreme precipitation in the Jemez Mountains**

Location	Period of Record	Elevation (feet)	Precipitation (inches)				Driest (year)	Wettest (year)
			50yr avg	30 yr avg	20 yr avg	10 yr avg		
Jemez Spgs	1914-2007	6,260	16.8	17.6	16.8	14.7	6.2 (1956)	28.7 (1957)
Los Alamos	1946-2008	7,360	18.5	18.7	18.3	16.0	6.8 (1956)	28.4 (1952)
Wolf Cyn.	1953-2008	8,220	23.2	24.2	23.6	21.4	11.2 (1956)	34.0 (1990 & 91)

Source: Source: Western Regional Climate Center 2009

## Wind

The prevailing winds in this area are from the southwest to northwest but may shift to easterly during the summer monsoon (rainy) season. Local winds are strongly influenced by terrain variations and may be channeled by canyons. Prevailing winds have driven wildfires in this area toward the northeast, and could drive a crown fire from the forests in the assessment area into Los Alamos and Bandelier National Monument.

## Climate Change

In its 2007 report, the Intergovernmental Panel on Climate Change found that “warming of the climate system is unequivocal” (IPCC 2007). The Panel reported that “most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (human-caused) greenhouse gas concentrations” (IPCC 2007). Exactly how these changes will translate to the local level remains at the cutting edge of science. Global climate change models are pointing toward warming and drying for the U.S. Southwest (IPCC 2007). However, the models are not yet able to account for climatic variability from factors such as the El Niño/La Niña oscillations (unusually warm or cool Pacific Ocean currents that affect climate), the Southwest monsoon, and the Pacific Decadal Oscillation (a pattern of Pacific climate variability that shifts phases at least every 20 to 30 years).

A study published by The Nature Conservancy (Enquist and Gori 2008) looked at recent climate change in New Mexico. A baseline period from 1961 to 1990 was compared to a 15-year period from 1991 to 2005 and a six year period from 2000-2005. In both cases the Jemez Mountains were found to be warmer and drier than the baseline. The results should be viewed with some caution, however, because of an extreme drought during the 2000 to 2005 period. Also, while the Jemez Mountains were at the extreme end of warm and dry during the 1991 to 2005 period, large areas of New Mexico were wetter than the baseline period.

The long-term temperature record for Jemez Springs (Table 4) indicates an overall warming trend in spite of significant periods of variability. Examination of the precipitation trend (Table 3 and Figure 4), on the other hand, raises the question of whether the recent drying (1984 to 2004) is due to global climate change or a reflection of the apparently cyclical nature of precipitation in this area.

# Geological and Paleontological Resources

Geological resources include groundwater, caves, paleontology (fossils), and geologic hazards such as earthquakes and landslides. The New Mexico Bureau of Geology and Mineral Resources recently completed the geologic mapping (at the 1:2,400 7 ½ ° quad scale) of most of the project area (Gardner et al. 2006; Goff et al. 2005; Goff et al. 2006a; Goff et al. 2006b; Kelley et al. 2003; Kempter et al. 2007; Lynch et al. 2005; Osburn et al. 2002). These maps, along with the statewide geological map (Stoeser et al. 2005) and the Jemez Mountain geologic map (Smith et al. 1970) were used as the basis of this assessment.

The Jemez Mountains were formed by volcanic activity beginning in the early Tertiary period and extending to the Pliocene. The volcanoes intruded up through earlier sediments, shale, sandstone and limestone. The oldest rocks in the area are much older pre-Cambrian-age granitics. The volcanic rock formations, pyroclastic rhyolites, andesite and basalt flows are interbedded in places with coarse gravel. Fans of eroded material from the rising volcanoes skirt the lower slopes of the Jemez Mountains. The pre-volcanic sedimentary rocks are exposed largely in the southwest portion of the assessment area along the main stem Jemez River valley, and then up the deeply eroded valleys of San Antonio Creek and Rio Guadalupe (Kelley and Dunbar 2008).

The Valles Caldera was created about 1.25 million years ago during an explosive volcanic event or series of events that obliterated the earlier Toledo Caldera and widely deposited the Upper Bandelier Tuff, a rhyolitic ash flow that overlaid older volcanic deposits around the rim of the caldera (Muldavin and Tonn 2003). The Redondo Peak dome followed the creation of the caldera by about 27,000 years. Rhyolitic domes such as South Mountain, Cerro la Jara and Cerro del Medio formed long after caldera creation (0.5 million years ago) along the caldera ring fracture (U.S. Geological Survey 1970). The uplifting volcanic domes created a dense array of faulting that profoundly affected valley development and channel morphology. Episodes of lake formation occurred such as when the East Fork of the Jemez River was blocked by landslides. The valley fill of the caldera created a complex of lake, alluvium and landslide deposits, including mudstones, siltstones, and conglomerates of pumice, tuff and lava.

The head waters of the East Fork Jemez River, San Antonio River, and Redondo Creek are within the boundaries of the Preserve, and the caldera rim encircles the Preserve's outstanding valleys, such as Valle Grande, Valle San Antonio, Valle Jaramillo, Valle Seco, and Redondo Meadow. The valleys are broad grassy plains with moderate gradients of about 0.5 percent. Surface deposits are mostly alluvium from surrounding hills, but also low ridges of lacustrine sediment, particularly in Valle San Antonio.

## Caves and Karst

Two geologic units have the potential to contain caves within the assessment area – the Madera limestone and the Tertiary lava flows. The Madera is known to contain extensive solution caves outside of the study area, but none are mapped within the study area. The lava flows present within the study area are known to contain lava tubes outside the study area, but no tubes have been identified within the assessment area.

The desired or reference conditions for caves are found in *The Federal Cave Resources Protection Act of 1988* and in regulations at 36 CFR 290. The Act and regulations require

protection of significant caves, and define *significant* caves based on biotic, cultural, mineralogic, paleontologic, geologic, hydrologic, recreational, educational, or scientific characteristics or values. All of the caves on the National Forest should be reviewed to determine if they meet the significance criteria, and significant cave resources should be protected when ground-disturbing projects are planned and implemented (Forest Service Manual, FSM 2800).

## **Groundwater**

The U.S. Geological Survey does not identify major aquifers in the assessment area (Robson and Banta 1995). However, the New Mexico Office of the State Engineer identifies approximately 312 wells in the area, so groundwater is present (OSE 2009). Well depths range from 8 to 660 feet, with the average depth to groundwater of 160 feet.

There was extensive research on the numerous natural hot springs in the study area. A description of the geothermal energy resource is included in the minerals section.

The desired or reference conditions for groundwater are described in New Mexico State Regulations (standards) for groundwater resources.

## **Geological Disturbances**

At least five earthquakes with a magnitude between 2 and 3 occurred between 1962 and 1998 along the Nacimiento Fault zone, which lies along the southwestern edge of the assessment area (Sanford et al. 2000). Magnitude 3 can be felt by residents but would not cause damage. There has been no seismic activity with a magnitude of 2 or greater within the Valle Caldera during this period. There is a 10 percent probability than an earthquake with a maximum horizontal ground motion of 8 to 10 percent of earth's gravity will occur in the area within the next 50 years (Sanford et al 2000). A horizontal ground acceleration of 20 percent of earth's gravity can do considerable damage, for example, chimneys broken at roof lines, but not major destruction.

Mass wasting or landslide potential (moderate, high, severe hazard ratings) occurs on approximately 60,000 acres (28 percent) of the 210,000-acre assessment area, according to the Terrestrial Ecosystem Unit (TEU) Inventory of the Santa Fe National Forest (US Forest Service 1993). Figure 5 shows these potential mass wasting areas from the TEU inventory, along with 87 old landslides (Quaternary age, less than 1.8 million years old) that cover 4,273 acres. The old landslides were identified during the geological mapping of the assessment area.

Volcanic activity potential is low, despite the volcanic activity in the past that formed the Valle Caldera and much of the Jemez Mountains (Kelley and Dunbar 2008).

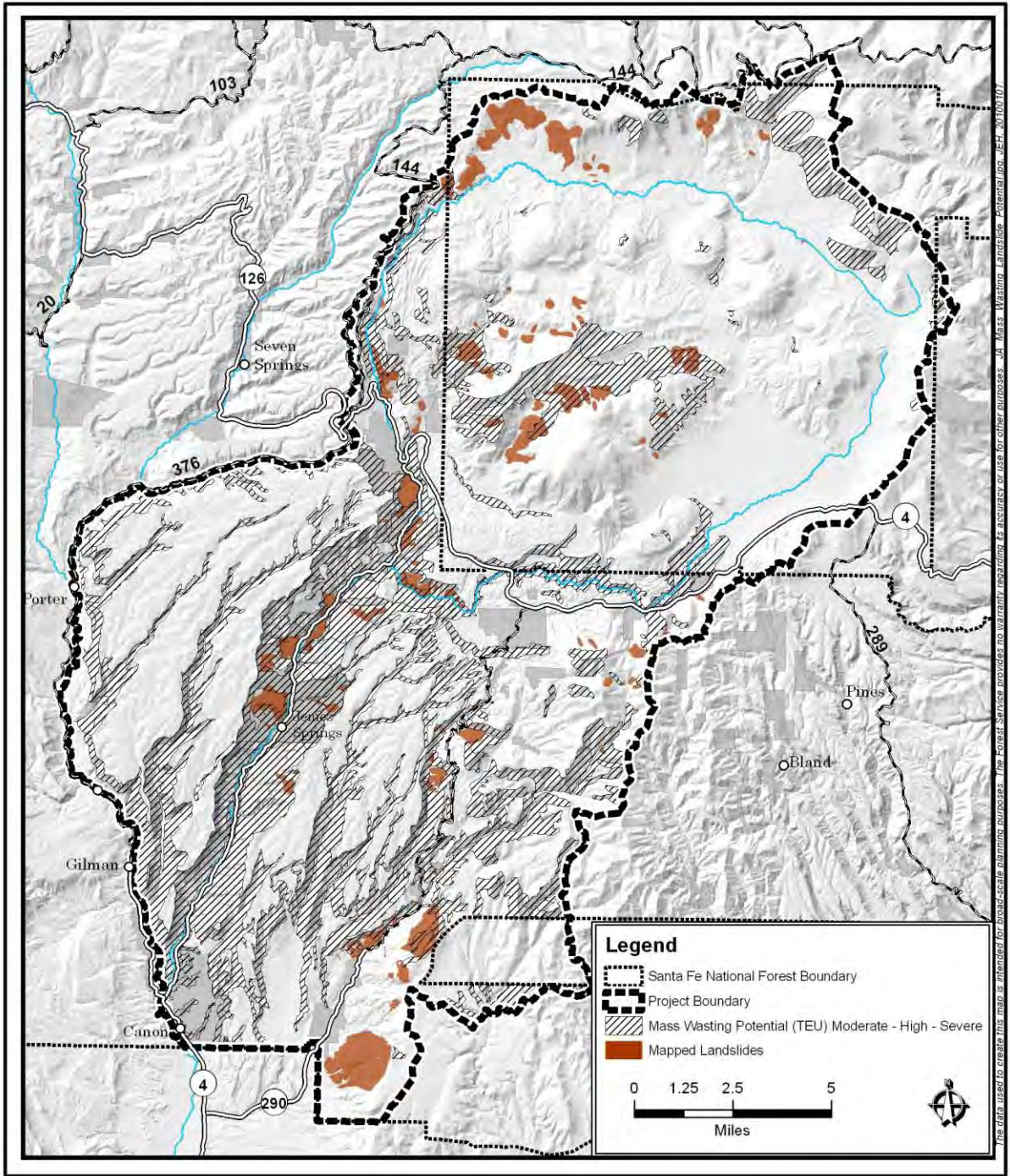


Figure 5. Mass wasting potential and past landslides

## Paleontology (Fossils)

Numerous fossilized plants, invertebrates and vertebrates are located throughout the assessment area. The vertebrate fossil sites are considered to be significant under the Paleontological Resource Protection Act. Within the area, the vertebrate sites range from shark teeth and other vertebrate remains in the Pennsylvanian Madera Formation (about 300 million years old) to the fossil horse found in the Pleistocene stream terraces along the Jemez River (about 20 million years old).

For planning purposes, agency policy recommends using the Probable Fossil Yield Classification system (US Forest Service 2009a, US Geological Survey 2009a). Of the five classes, class 1 has the lowest potential to contain fossils and class 5 has the highest potential. These classes are described in the table below, and shown spatially in the following figure. Probable or potential fossil yield classification values were assigned to geologic map units in the assessment area based on empirical data gathered through research and field surveys by Forest Service geologists, as shown in Table 5.

**Table 5. Probable fossil yield classes and geologic map units**

Probable Fossil Yield Class	Geologic Map Unit
1 – Igneous or metamorphic rocks not likely to contain fossils	6 units
2 – Sedimentary and volcanoclastic units not likely to contain fossils	3 units (Quaternary alluvium, Bandelier Tuff, and Yeso)
3 – Fossiliferous sedimentary units in which the fossils vary in significance, abundance, and predictability	4 units (Madera, San Andres/ Glorieta Formations, Chinle Group, and piedmont alluvium). The Madera Formation limestone contains common invertebrate marine fossils. The piedmont alluvium has at least one significant fossil but it appears such fossils are rare. The other units have no recorded fossils.
4 – Highly fossiliferous units which regularly and predictably produce significant fossils, with a low potential for human or natural degradation	0 units, because the entire assessment area has a high potential for human or natural disturbance
5 – Highly fossiliferous units which regularly and predictably produce significant fossils, with a significant potential for human or natural degradation	1 unit (Abo Formation). This unit has yielded numerous vertebrate fossils

Reference conditions (management direction) for paleontological resources management are contained within the *Paleontological Resources Protection Act (Public Law 111-11, subtitle D)*. Regulations to implement this law are still being developed by the Department of Interior and Department of Agriculture. Forest Service directives require protection of paleontological resources during land management activities, and formation of scientific and educational partnerships for managing paleontological geological resources (FSM 2882; US Geological Survey 2009a).

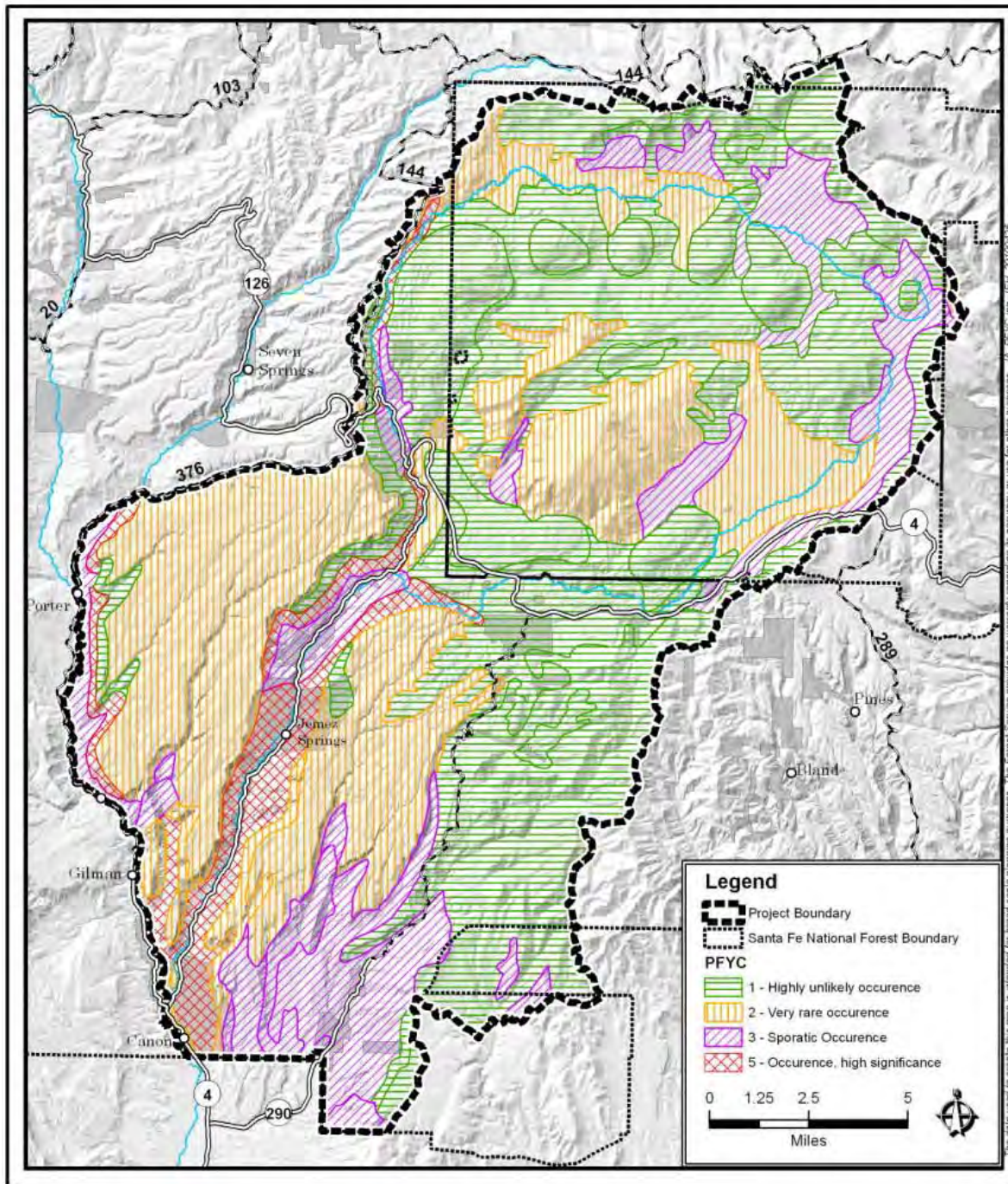


Figure 6. Potential fossil yield map units

# Soil

## Introduction and Methodologies

This chapter evaluates and compares the existing and reference conditions of the soil resource within the assessment area. Soil loss and erosion hazard were two key factors used to compare existing soil conditions with the reference conditions. Reference conditions for soil erosion and loss are the range of variability in potential natural soil loss rates. The existing and reference conditions are based primarily on the soil inventory database for the National Forest (Terrestrial Ecosystem Unit Inventory), which describes potential, natural, current and tolerance soil loss rates as well as relative erosion hazard. This assessment also used soil condition analyses contained in several NEPA documents for range allotments, such as those for San Diego, Vallecitos, V-Double Slash, Cebolla-San Antonio, and Ponderosa. Refer to the range section of this report for more about the grazing allotments.

## Soil Types

Soils in the assessment area are formed about equally from: (1) volcanic ash flows and lavas, and (2) sandstones, siltstones, shales, and carbonates. Soil conditions are influenced by many factors, including parent material (geology), slope and aspect. The higher elevation forests have deeper, moister soils with more organic matter and are fair growing environments. The mesa tops made from largely sedimentary rock have more arid soils with profound clay layers in the subsurface. The montane hillslopes are also fairly harsh environments. The steeper hillslopes tend to have shallower soils. The more granite-based soils in the area are sandy, more erodible and less fertile. The soils in the higher elevations of this Jemez River Watershed (in the Preserve) have more volcanic ash material that generally increases their productivity. Soil creep and sheetwash are very common given the concentrated high intensity rainfall here. Table 6 and Figure 7 show the distribution of soil taxonomic groups in the assessment area.

## Soil Erosion and Loss

Soil loss rate is an important factor affecting soil condition and long-term productivity and sustainability. A comparison of current soil loss rate to a “tolerance” reference condition provides a means of classifying soil condition as Satisfactory, Unsatisfactory, and Unsuitable. Satisfactory soil loss is where the soil loss rate (tons/acre/year) is less than the soil tolerance (T) threshold defined for each soil type (TEUI unit). Soils in the assessment area are generally in satisfactory condition as their loss rates are below the tolerance (upper threshold). This indicates that long-term soil productivity is being maintained. Small, localized areas show unsatisfactory soil loss rates, due to human-caused disturbances such as: camping, driving and parking, and in areas where cattle use is concentrated. In these localized bare soil areas, soil compaction and erosion are a concern, due to loss of top soil, organic matter, and soil productivity. Excess soil erosion loss rates often lead to excess stream sedimentation. Some soil types are classified as “unsuitable” because they are inherently unstable; a condition that land managers cannot change. Historically (pre-European settlement), and without human-caused disturbances, soil loss would probably have been in satisfactory soil loss condition where it is not unsuitable (inherently unstable).

**Table 6. Distribution of soil taxonomic groups in the assessment area**

<b>Soil Class</b>	<b>Acres</b>	<b>Percent</b>
Eutric Glossoboralfs	40,517	19.6
Andic Dystrochrepts	35,059	17.0
Typic Eutroboralfs	30,080	14.5
Typic Ustorthents	26,624	12.9
Mollic Eutroboralfs	14,046	6.8
Andeptic Udorthents	11,682	5.7
Cumulic Haplaquolls	11,854	5.7
Typic Haplustalfs	11,223	5.4
Pachic Argiborolls	5,262	2.5
Mollic Vitrandepts	4,305	2.1
Entic Cryandepts	2,606	1.3
Typic Ustochrepts	2,710	1.3
Aquic Ustifluvents	2,407	1.2
Pachic Cryoborolls	2,448	1.2
Lithic Haplustalfs	2,314	1.1
Typic Cryochrepts	1,545	0.7
Dystric Cryochrepts	968	0.5
Typic Cryoboralfs	580	0.3
Lithic Udorthents	237	0.1
Typic Ustifluvents	238	0.1
Pachic Paleborolls	33	0.0

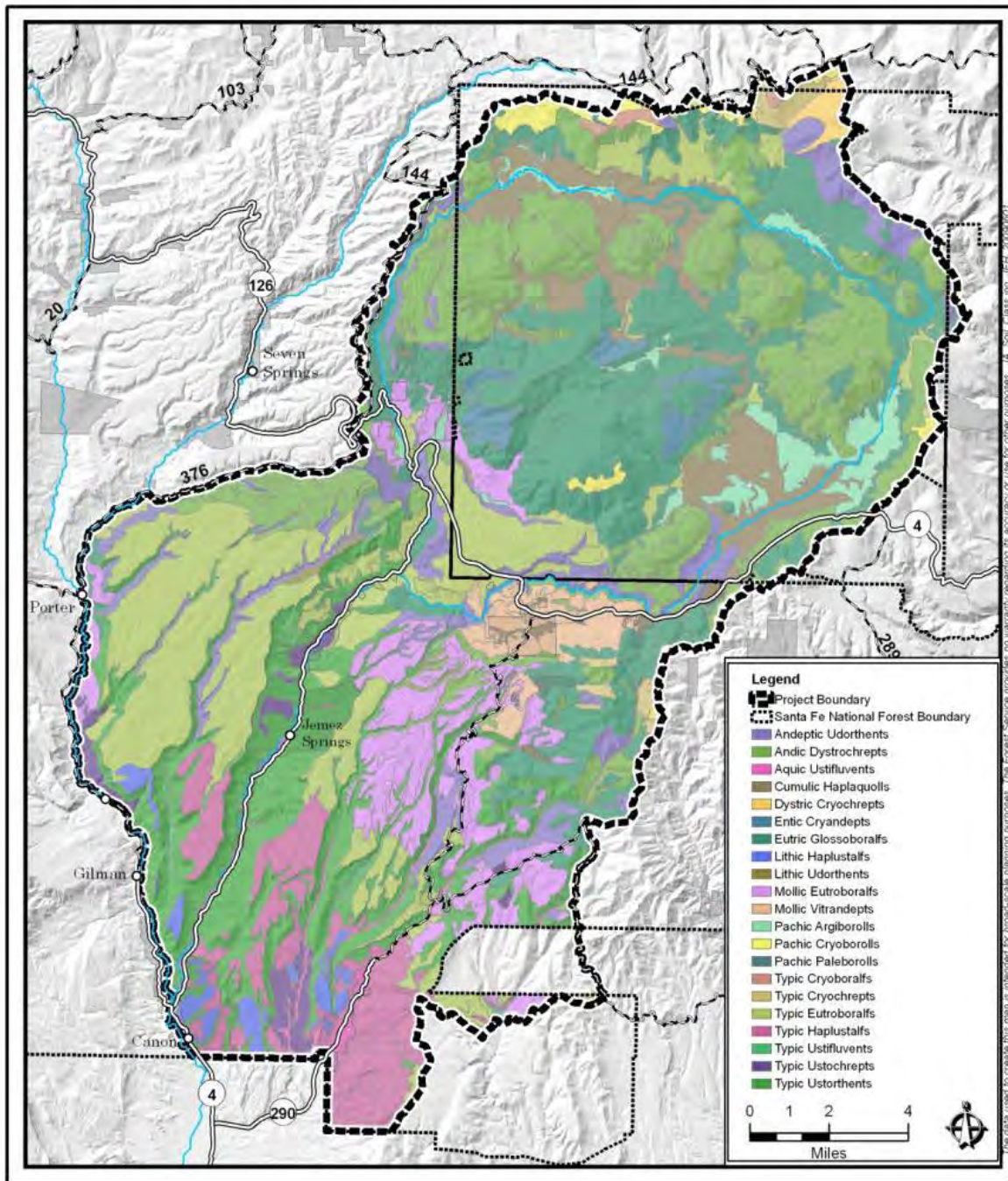


Figure 7. Distribution of soil taxonomic groups (soil types)

Based on the soil analysis, past NEPA analyses, monitoring, and field observations, the piñon-juniper woodlands have the greatest amount of localized unsatisfactory soil loss, or impaired soils approaching the unsatisfactory soil loss level. The worst conditions occur where the piñon-juniper canopy cover approaches or exceeds about 40 percent, resulting in reduced herbaceous understory vegetation, a high amount of bare soil, accelerated soil erosion, and loss of surface organic matter. In these portions of the woodlands, soil erosion and loss are outside their natural range of variability and at risk of not maintaining long-term soil productivity. Where this unsatisfactory soil loss condition occurs, the soil is unable to provide favorable ecosystem and habitat diversity conditions and sustain species that rely on this woodland habitat for survival. It reduces the soil's ability to nourish and support natural tree and plant growth and ecosystem resilience.

The majority of the assessment area is in a satisfactory soil loss condition, particularly in the ponderosa pine, mixed conifer, aspen and riparian vegetation, other than where bare soil patches occur as a result of recreational, vehicular, or livestock uses. Higher elevation forest types have the greatest amount of soil in satisfactory condition and have a higher capacity to maintain long-term soil productivity.

Livestock grazing contributes to reducing herbaceous vegetative ground cover, which contributes to accelerated soil loss, soil compaction and declined soil productivity (especially during periods of drought). However, the extent and amount of current livestock grazing in the assessment area is relatively low, managed within Forest Plan standards and is not impairing long-term soil productivity. Grazing pastures have been removed from riparian areas, although cattle are allowed to trail through riparian areas to get from one pasture to another.

In addition to land management activities such as tree harvesting and public recreation activities such as off-road vehicle use, roads contribute the most to loss of soil productivity and impacts to water quality. The 2008 travel management analysis process identified approximately 400 miles of roads and trails on the National Forest land in the assessment area. These excess roads and trails contribute to the long-term loss of soil productivity and channeling sediment runoff into streams. Most roads in the area are unsurfaced, primitive dirt roads with little or no drainage control. Many roads run along canyon bottoms, and criss-cross drainage channels. The travel management analysis shows that most of these roads pose a risk to water quality, soil, wildlife, and other resources. Density of Forest Service roads in the area averages 2 to 3 miles per square mile, although the number of unauthorized roads and trails doubles that density.

Erosion hazard is a rating given to soils based on a number of attributes such as inherent soil and terrain properties, defined in the agency's Terrestrial Ecosystem Inventory database. Erosion hazard indicates the chance of soil loss exceeding threshold rates as a result of complete removal of vegetation and topsoil. Current erosion hazard is estimated to be equal to historic erosion hazard, and is not compared to a historic or reference hazard rating.

The biggest cause of severe erosion and loss of productivity is high-severity wildfire, as it consumes the vegetation and organic layer of the soil and results in excess erosion rates. Maintaining a protective layer of vegetation is essential in reducing soil erosion and maintaining productivity. Thus, if a soil classified as having a moderate or severe erosion hazard, and a high-intensity fire consumes the vegetation on that soil, on-site erosion may be likely to exceed tolerable limits. Approximately 97 percent of the soils in the assessment area are rated as moderate to severe erosion hazard. These soils have a moderate to high probability of lowering site productivity when vegetation is removed or killed in a fire. In these vulnerable areas, the

post-fire runoff of topsoil, soil litter and organic matter, woody material and ash, can wreck havoc on the natural and human environment downstream. The economic costs for rehabilitation of the environment and residential communities would also be exorbitant. The more live and dead fuel there is, the longer the residence time of a fire on the soil and the more severe the effects of the fire will be. For example, a deep layer of needles, branches and logs generally supports long fire residence times which may result in significant impacts to soil, runoff, and the vegetation community (Ice 2004).

Figure 8 and Table 7 show the extent of the erosion hazard ratings in the assessment area. Figure 9 and Table 8 show where moderate and severe soil erosion hazard occurs in areas that support crown fire behavior, indicating the areas at most risk of watershed degradation following wildfires.

**Table 7. Soil erosion hazard ratings and percent of assessment area**

Erosion Hazard	Percent & (Acres)
Severe	48% (97,218)
Moderate	51% (103,491)
Slight	0% (237)
Unknown	1% (5,818)

**Table 8. Risk of severe soil loss following high-severity crown fire, by watershed**

6th Code Watershed	Watersheds in Assessment Area (acres)	Crown Fire Risk (acres)	Crown Fire & Erosion Hazard Risk (acres)	Crown Fire & Erosion Hazard Risk (% of watershed)
Rio Guadalupe	14,456	3,472	1,512	10
Virgin Canyon	11,447	2,855	1,076	9
Church Cyn- Jemez River	23,310	6,978	3,418	15
Canon de la Canada	14,411	2,288	975	7
Vallecita Ck	26,662	8,894	5,956	22
Outlet San Antonio Ck	14,801	8,269	6,325	43
Sulfur Ck	16,079	8,744	7,485	47
Headwaters San Antonio Ck	36,217	16,079	11,511	32
East Fork Jemez River	38,036	16,208	9,789	26

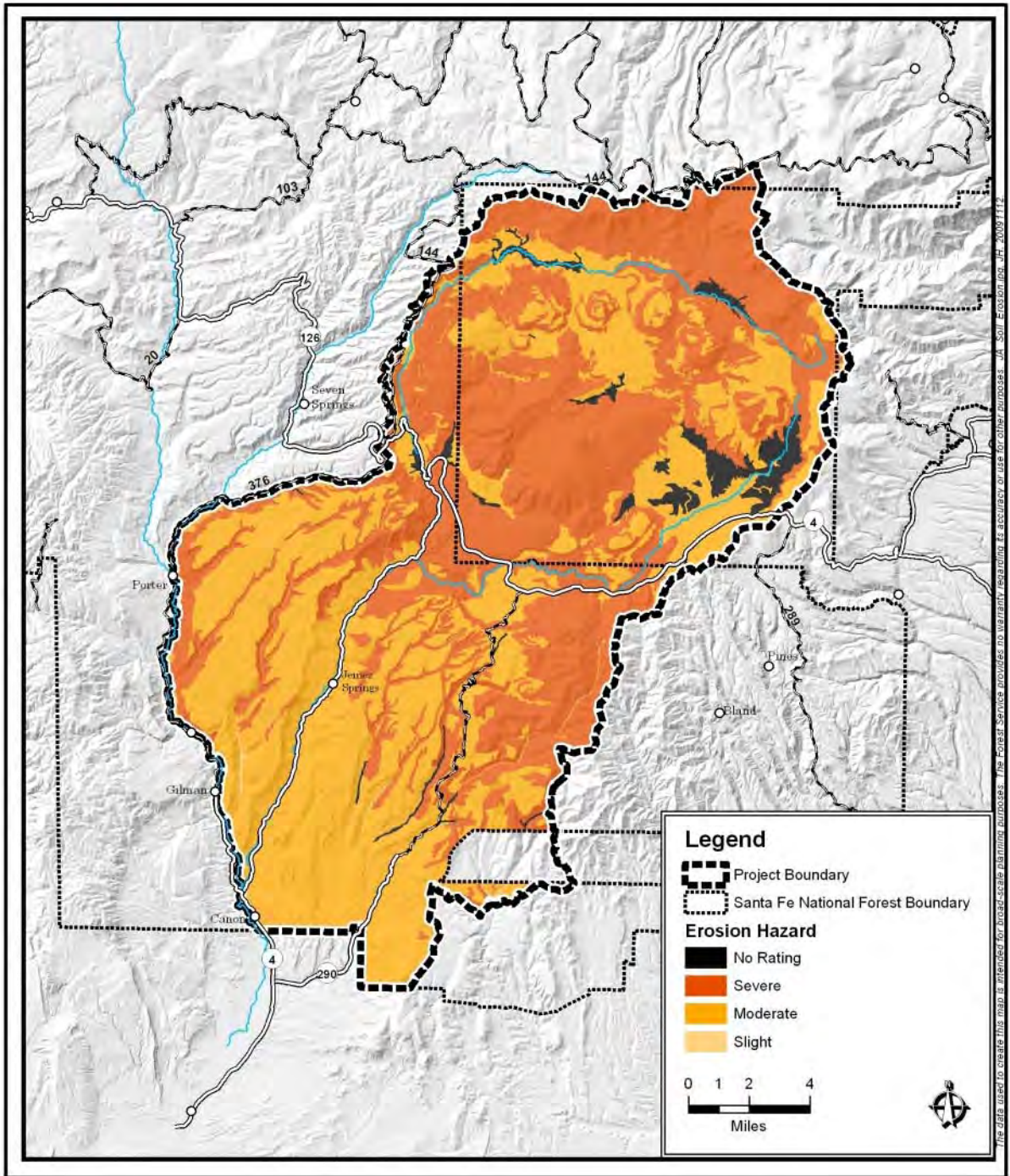


Figure 8. Soil erosion hazard ratings

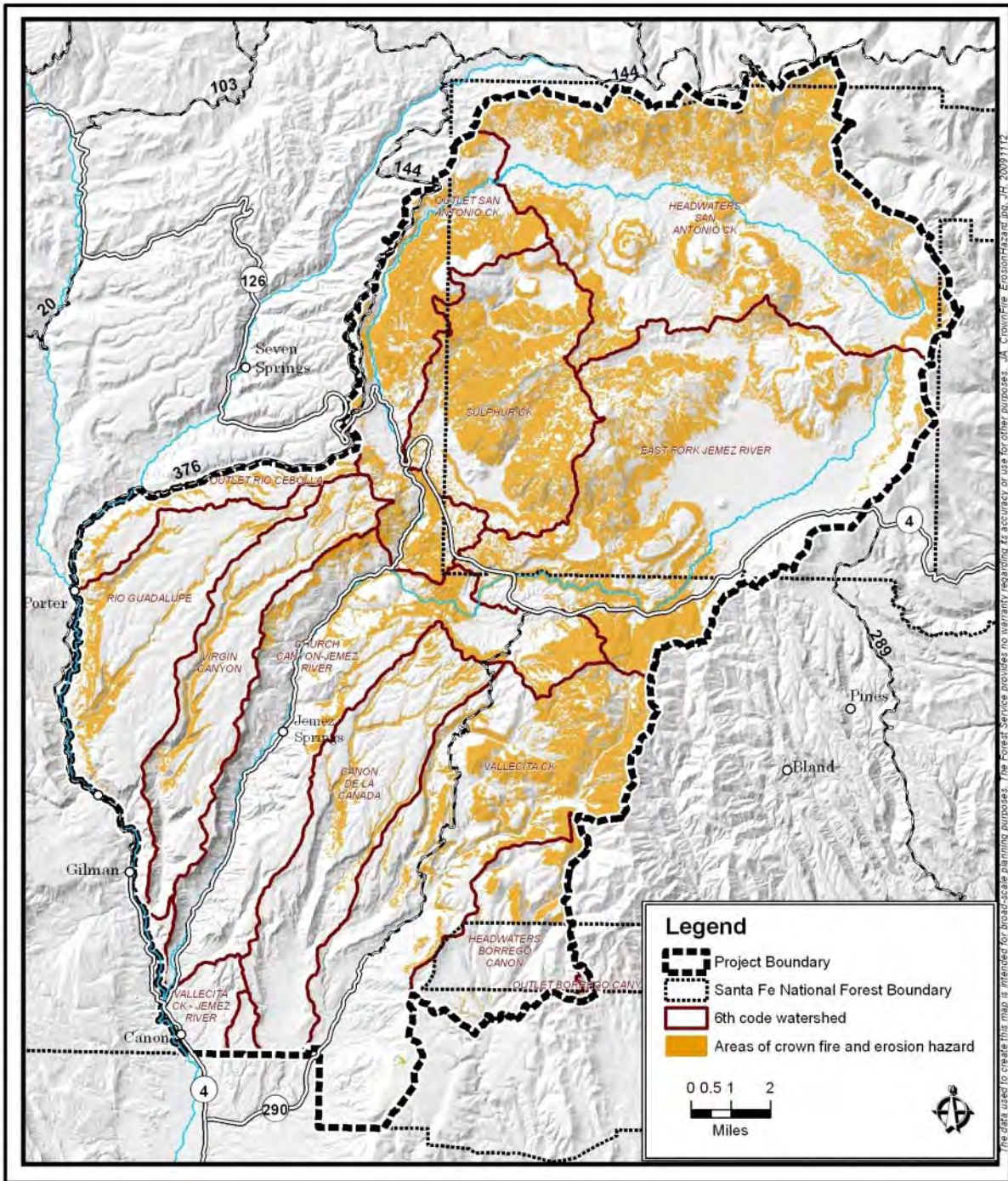


Figure 9. Areas of high crown fire risk and moderate to severe erosion hazard

# Water

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of water resources within the assessment area. It describes stream flows, channel morphology and water quality, which are all strongly influenced by the geology, soils, and climate patterns previously described in this assessment report. Additional information about streams and water quality are described in the Fisheries and Aquatic Habitat section of this report.

Information for this report was primarily derived from comprehensive stream condition inventory reports and hydrologic condition assessments completed by the Santa Fe National Forest and available on their website at <http://www.fs.fed.us/r3/sfe/fish/fishreports.htm>. These reports include the following: Rio Guadalupe Stream Inventory Report, 2006; Upper and Middle Jemez River Watershed Assessment, 2005; San Antonio Creek Stream Inventory Report, 2005; Rio Guadalupe Hydrologic Condition Assessment, 2004; Rio Cebolla Stream Inventory Report, 2003; and East Fork Jemez River Stream Inventory Report, 2002. Water quality data and information on impaired (non-attainment) stream reaches was obtained from the New Mexico Environment Department, Surface Water Quality Bureau's Clean Water Act 303d-305b report, 2008 to 2010, online at <http://www.nmenv.state.nm.us/swqb/303d-305b/2008-2010>. Stream flow data gathered by stream gauges on the Jemez River, Rio Guadalupe drainages, and Redondo Creek is from the U.S. Geological Survey website <http://waterdata.usgs.gov/nm/nwis/rt>. Existing conditions within the Preserve was from stream surveys and field observations made by hydrologists in 2007 to 2009.

The assessment area is primarily comprised of the Upper and Middle Jemez River watersheds (5<sup>th</sup> hydrologic code). This report particularly focuses on conditions in the headwaters of the Jemez River watersheds, which strongly influence watershed and stream conditions downstream. Figure 10 displays the 6<sup>th</sup> code watersheds and Figure 11 displays the major streams (by name) in the assessment area.

## Stream Flow

The headwaters of the Jemez River and most of its tributaries begin in the Preserve, on volcanic domes and slopes of the caldera rim (US Geological Survey 1970, 2008, 2009). These areas are drained largely by swale-like draws that typically lack active scour channels. Surface flow is infrequent and present as dispersed wet areas and seepy ground. With few exceptions the upland slopes of the caldera are hydrologically connected with the valley bottoms only through gullied swales or degraded first order draws that dissect large alluvial and colluvial fan deposits that skirt the base of the slopes. Exceptions to this pattern are the fault-oriented valleys of Redondo Creek and Rito de los Indios, which contained steep gradient perennial streams with cobble and boulder-dominated beds. Because of their confined valleys, there is considerable influence from roads, which constrain the channels and deliver sediment.

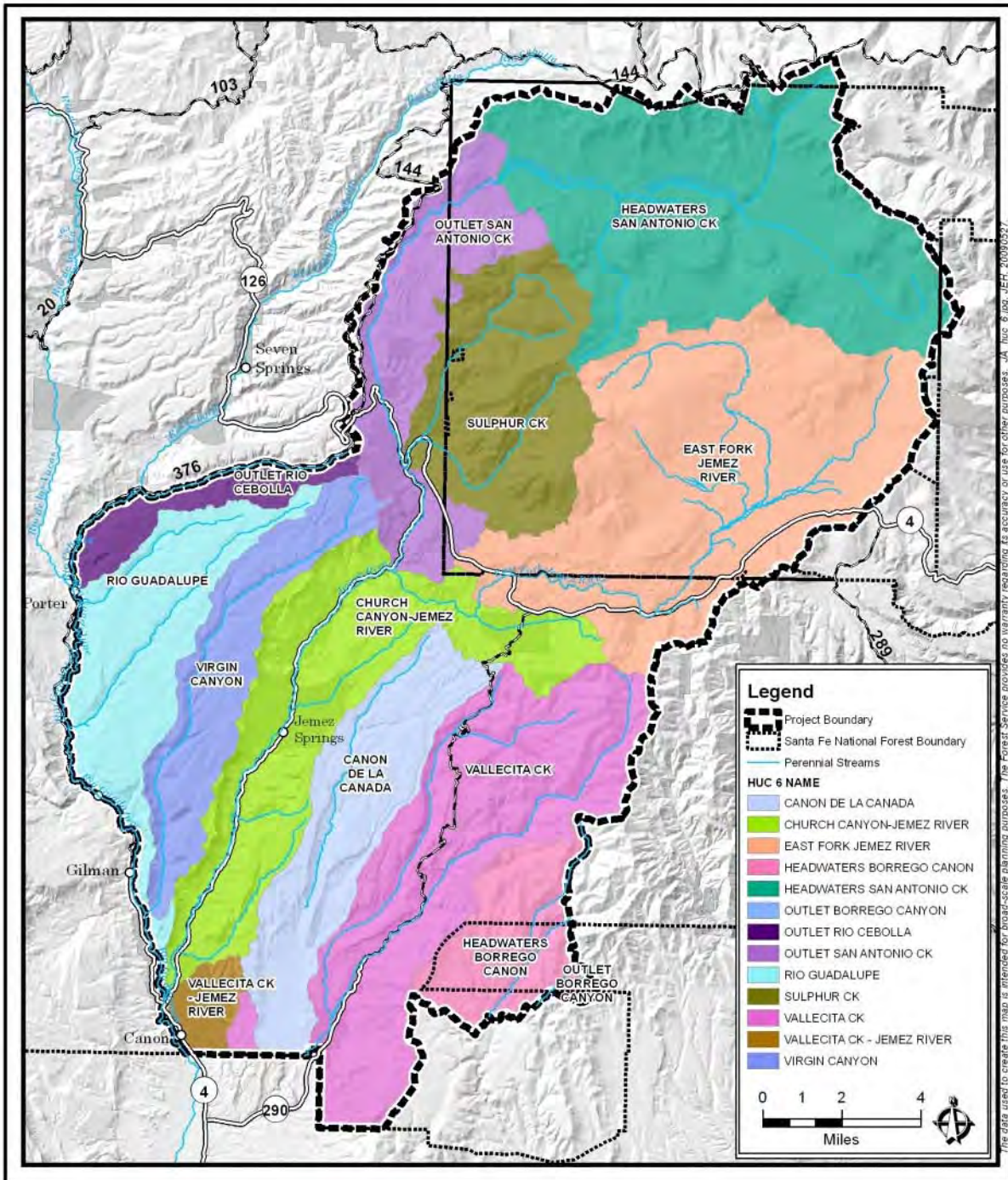


Figure 10. Watersheds - 6<sup>th</sup> hydrologic unit code (HUC)

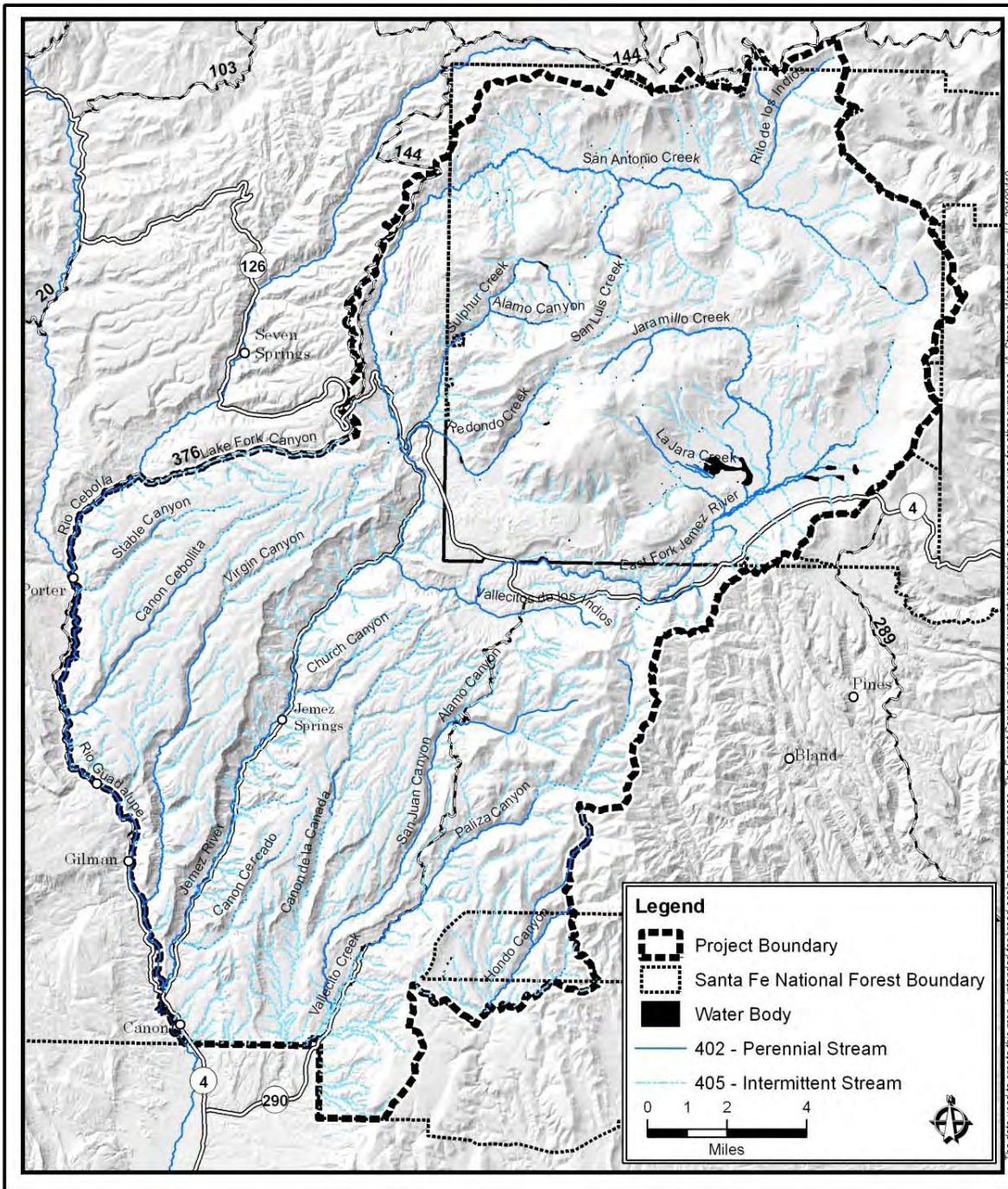


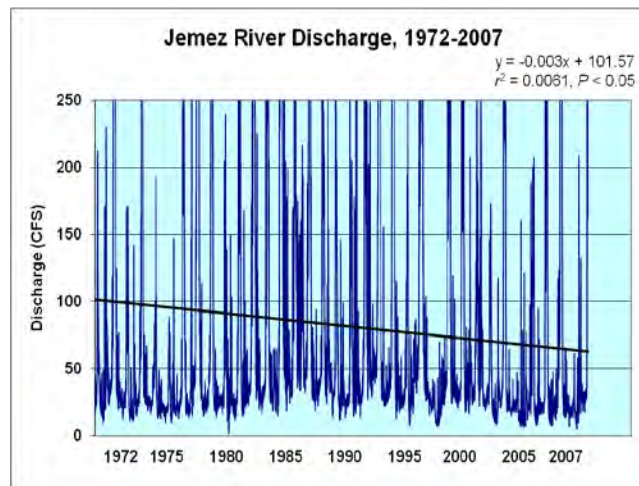
Figure 11. Streams and waterbodies

Aerial photographs from 1935 of the Preserve, on file at the Preserve office, show most if not virtually all of the present gullies were actively eroding, in part due to thousands of sheep that grazed this area. Industrial logging took place in the 1960s and 1970s on the Preserve, which was then a privately owned ranch. The gullies that were actively scouring in the past appear to show marked signs of stabilizing. Comparison of the 1935 photographs with 1996 images give more evidence that erosion was far more prevalent in the past. Sheep grazing was at a magnitude far greater than any of the cattle grazing numbers over the past 50 years.

Road density is very high in the caldera in general and on the domes in particular, although there are relatively few instances of deep or persistent rilling on the steeper slopes. The mountainsides erode almost entirely by weathering of parent material into a mantle of overburden that moves down slope under influence of gravity and pore water as soil creep or larger slumps, accumulating in large fans. Within these fans occur the gullies within swales and shallow draws. In addition, logging roads run up many swales and connect to the uplands through radiating skidding trails. Also, many larger swales have stock tanks and roads that subsequently were used for logging may have been originally placed as access to the tank site.

When rain falls on the caldera rim and domes (recharge areas), it infiltrates into the soil and flows underground into fan deposits until some of it surfaces further down near the valley floors. It often surfaces in the form of distinct seeps and springs. Inflow into channels from direct surface runoff is rare except on ground that is naturally impervious or bare of cover.

Six stream flow gauges monitor flows in the Jemez River system (U.S. Geological Survey 2009), including two gauges along Jemez River, two along Rio Guadalupe, one on Redondo Creek and one on Rio de las Vacas. Although the monitoring period of record on these gauges is variable, they all have recorded flows during the past 30 to 70 years. Analysis of stream flow gauge recordings show that the Jemez River system is driven much more by snowmelt runoff and recharge than summer rains. Spring snowmelt runoff and peak stream flows occur from early March through early June. Minor peaks in flows also occasionally occur during the summer monsoon rain season, July through September. Hydrograph analysis indicates that most streams in the assessment area have a steady decline in surface flow in the summer months due to limited groundwater storage. A few others, like the Jemez River and Rio Guadalupe, have little decline in surface flows during the summer months due to larger groundwater storage capacity in the broad valleys. Stream gauge measurements of surface flow rates (discharge) in the Jemez River show flows have declined by 40 percent over the past 50 years. This is likely the result of less precipitation coupled with increased stand density and snow sublimation (Figure 12); (US Geological Survey 2008-9).



**Figure 12. Jemez River surface flow discharge rates, 1972-2007**

## **Stream Channel Morphology and Aquatic Habitat**

Sinuuous channels wind through broad grassy valleys of the Valle San Antonio and Valle Grande within the Preserve, and the long meadow reaches of the upper Rio Cebolla. The Rio Cebolla channel changes further downstream, where it cuts through steep bedrock and flows through steep-gradient gorges of the Guadalupe Box and the reach above Jemez Falls.

In the broad meadow valleys the channel gradient is shallow to moderate (0.1 to 1.5 percent), with narrow and deep channel cross sections and a bed of sand and gravel. Within the narrower reaches, channel gradient is typically steep; two to three times that of the meadow reaches. Channels are wide and shallow, with a bed of cobble and boulders, and frequent cascades, chutes and falls (US Forest Service 2002a, 2003a-b, 2004a-c, 2005b and 2006a).

Large woody debris and pool habitat are deficient on East Fork Jemez River and San Antonio Creek, which also have a high proportion of fines in riffles (US Forest Service 2002a and 2005b). Given the obvious degree of bank retreat it seems likely that the fines still entrained in the channel are largely from bank erosion. Large woody debris and pool habitat are also deficient in most reaches of the Rio Guadalupe and Rio Cebolla (US Forest Service 2003b and 2006a). Large portions of the San Antonio, Rio Cebolla, and East Fork Jemez River are in broad meadow valleys (69, 76 and 40 percent, respectively). The Rio Guadalupe is steep and confined throughout most of its length, and yet large woody debris and pool habitat still do not meet agency standards. Those stream reaches within grassy valleys have little to no forest cover on the banks from which large woody debris can be recruited. In addition, long meadow reaches will exert some influence on down stream conditions, whatever the forest cover.

Sand size or smaller particles constitute over 20 percent, which exceeds standards on the East Fork Jemez River, Rio Cebolla and San Antonio Creek (US Forest Service 2002a, 2003a, and 2005b). Excessive amounts of fines are another cause of under-developed pool habitat. Again the Rio Guadalupe is an exception as cobble and gravel are the dominant substrate on that stream.

Excessive width to depth ratio (a stream overly wide and shallow) characterized one reach on both East Fork Jemez River and San Antonio Creek and two reaches on the Rio Guadalupe (US Forest Service 2002a, 2005b and 2006a). In the reaches on East Fork and San Antonio, excessive width to depth ratio corresponds to bank instability within the reach. Width to depth ratio was within standard for the Rio Cebolla (US Forest Service 2003b). Incidence of unstable banks on the Rio Guadalupe was very low, as the larger cobbles and boulders tend to stabilize stream banks. Bank stability in East Fork Jemez River and San Antonio Creek ranged from 80 to 95 percent.

Channel degradation including some widening and straightening of channel form has occurred primarily as a result of past livestock grazing and trampling in the meadow reaches of the Preserve. Today however, most of the previously slumped and denuded banks have re-vegetated and stabilized with grasses or forbs. Sediment deposit areas in the channels have filled in with sedges, which help in capturing sediments and reducing channel scouring and widening. There is very limited scouring of channels in the headwaters of this watershed. This may be due to the larger bed material and shallower flow column for a given volume of water, which impede flow velocity. Limited channel downcutting has maintained stream flow connection with the valley bottom floodplains, contributing to maintenance of riparian vegetation. Recovery of a narrower channel form and function has occurred in the headwaters area, although these channels remain sensitive to livestock trampling because of their form (undercut banks). If vegetation cover is

removed from the stream banks, high intensity summer rains are likely to cause increased surface runoff, stream flow volumes and channel scouring. Currently, surveys indicate the headwater stream channels are in an upward trend with regards to bank stability. They appear to be recovering from their degraded condition and are becoming narrower, deeper and more sinuous.

Outside the Preserve, highly degraded channel forms are mostly confined to the upper half of the Rio Cebolla, from about the Schoolhouse Canyon tributary. The degree of entrenchment of the channel has been more severe typically than in the Preserve, although not as pervasive, with many reaches having good width to depth ratio and robust woody bank vegetation and beaver presence. Overall, stream gradients in meadow reaches on the Rio Cebolla are steeper than other similar reaches on streams in the Preserve, and grazed reaches have greater potential for scour (US Forest Service 2003b). The upper Rio Cebolla follows the trend of a large geologic fault, whereas other streams valleys are cut perpendicularly by faults, which provide strong checks on grade (New Mexico Bureau of Geology and Mineral Resources 2005 and 2007; U.S. Geological Survey 1970).

In a turn from the above scenario, 1935 photographs of the Lower Jaramillo Creek valley show a broad wet bottom with multiple and barely discernible dark channel traces indicating a very dispersed flow through many very slightly incised channels, and as much flow likely occurring as ground interflow as on the surface. In 1996 digital photographs, the valley section has a single, large channel. Ground observations have shown that this reach of creek is recovering from an over-widened, aggraded state. Similar evolutions in channel morphology were found in the upper section of San Antonio valley. The 1935 photos again reveal wetland-like valley bottoms with slight channeling compared to the incised channeling in the 1996 photographs.

These observations suggest the possibility that the extent of perennial wet valley bottoms in the Preserve (fens do still exist) was much greater, and surface flow was more dispersed. Thus, though existing single channel reaches show much recovery, the very pattern of a single channel reach is a degraded form from an original, pre-settlement wetland of highly dispersed flow through multiple shallow channels.

## **Water Quality**

Stream temperature monitoring sites on four streams in the Jemez River Watershed found temperatures exceeded the properly functioning condition standard for coldwater fisheries habitat. On a seven day average during summer months, more than half of the sites on all the streams were not properly functioning, and the rest were at risk on a three day average.

Temperatures exceeded water quality standards most often (10 to 20 percent) on stream reaches dominated by broad meadow valleys, such as East Fork Jemez River, Jaramillo Creek, and San Antonio Creek. Temperatures exceeded water quality standards less frequently (1 to 2 percent) for Redondo Creek and Rito de los Indios, which are steep gradient, fast running streams in narrow, steep-sided valleys (New Mexico Environment Dept. 2006b).

The temperature of most stream waters in the Jemez River basin may be naturally warmed. It appears evident from observations of steam pattern and spot measurements and data from monitoring sites, that the warm water temperature of the perennial streams of the Preserve may be influenced by bedrock source area (New Mexico Environment Dept. 2006b; US Forest Service 2002—2006). Similarly, the Rio Guadalupe and its tributary of Rio Cebolla on the National

Forest have strong fault control, and bedrock reaches and temperatures often exceed standards for cold water fishery, even in high elevation headwater areas with good forest cover. On the other hand, Vallecito Creek south of the Preserve is largely derived from slope deposits, indicated by elongated drainage pattern, which was field verified. Spot sampling stream temperatures during field visits showed temperatures only half the temperatures of other streams draining the caldera and its rim.

Water appears noticeably cloudy in the East Fork Jemez River, San Antonio Creek and Jaramillo Creek in observations of springs along the margins of Valle San Antonio and Valle Grande, in September 2007. This condition is possibly from colloidal particles that progressively increase in downstream reaches. Conversely, Rito de los Indios and Redondo Creek run clear. The difference may be the extensive fill of the main valleys containing particles of volcanic ash. While this material is present on the domes and Redondo Peak, the residence time of the water as groundwater before emerging as surface water is undoubtedly much less than in the lower valleys. Spring water coming from hillslopes appeared clear, with no observable turbidity.

Turbidity standards are occasionally exceeded on the East Fork Jemez River, San Antonio Creek and Redondo Creek (New Mexico Environment Department 2002, 2006b). Table 9 shows the selected dates in 1998 where the turbidity value for one or more of these streams exceeded the water quality standard for turbidity. The standard is 25 NTUs (nephelometric turbidity units).

**Table 9. Turbidity values for streams when the standard was exceeded in 1998**

<b>Dates</b>	<b>E.F. Jemez River NTUs</b>	<b>San Antonio Creek NTUs</b>	<b>Redondo Creek NTUs</b>
April 22, 1998	18.6	<b>26.5</b>	17.2
April 23, 1998	20.0	<b>27.5</b>	<b>29.5</b>
July 13, 1998	<b>42.6</b>	8.4	<b>42.1</b>
November 2, 1998	<b>31.5</b>	<b>34.7</b>	11.9

On the April 1998 dates shown in Table 9, stream flow volume on the East Fork Jemez River was 109 cubic feet per second (cfs), well above the average annual peak flow of 54.7 cfs at that gauging station (New Mexico Environment Department 2002). The unusually high flow was probably driven by snow melt runoff at that time. No flow data was recorded at that gauging station for the July and November 1998 dates shown in Table 9. According to the monitoring field crews, the turbidity in the East Fork Jemez River appeared to be from lacustrine (lake-based) sediment from the floor of Valle Grande.

In 2001 and 2002, water quality sampling was conducted on East Fork of the Jemez River, Jaramillo, La Jara, Redondo, Rita de los Indios, San Antonio and Sulphur Creeks within the Preserve (New Mexico Environment Department 2006b). Water quality in these mostly headwaters portion of the Jemez River Watershed does not frequently rate as impaired, although there are instances where standards for specific water quality parameters were exceeded. Dissolved aluminum, an element which is naturally high in the rock type of the caldera, was consistently found to be in exceedence of state water quality standards in all the streams. There were also numerous exceedences of dissolved oxygen, water temperature and pH standards. Dissolved oxygen and pH are controlled by growth rate and respiration of aquatic plants, which in

turn is somewhat controlled by relatively high levels of phosphorus that were measured. The turbidity standard was exceeded in Jaramillo Creek, East Fork Jemez River and Sulphur Creek, but not in the other streams. Water temperature exceeded standards on all streams to some extent, but was highest on East Fork Jemez River, Jaramillo Creek and San Antonio Creek. Table 10 summarizes results of the surveys.

**Table 10. Percent of water quality samples that exceeded standards in 2001-2002**

Watershed	Parameters			
	Turbidity	Temperature	pH	Dissolved Oxygen
Jaramillo	40	10	0	14
E.F. Jemez R.	14	21	37	35
La Jara	0	N/A	N/A	N/A
Redondo	5	2	0	0
Indios	1	1	0	0
San Antonio	1	23	51	39
Sulphur	11	N/A	N/A	N/A

Figure 13 shows the stream reaches in the assessment area currently listed as impaired (not meeting the water quality standard for one or more elements). However, much of the impairment status reflects natural causes rather than impairment due to human activity. Several reaches are de-listed after further investigation. In the State's 2008 integrated 303(d)/305(b) report, several streams on Forest land were de-listed as impaired for sedimentation: Rio Cebolla, Rio Guadalupe and main stem Jemez River. Also delisted for water temperature was the upper Rio Cebolla (above Fenton Lake) and Redondo Creek

On National Forest land, total mean daily loads (TMDLs) remain for Rio Guadalupe for aluminum, San Antonio Creek for water temperature and turbidity, and the Jemez River below the Rio Guadalupe for aluminum and turbidity. Vallecito Creek is listed as impaired for coldwater aquatics, the probable cause being a naturally high level of aluminum. On the Preserve, several streams are listed as impaired for coldwater aquatics due to aluminum, water temperature and turbidity. East Fork Jemez River (within the Preserve), and Jaramillo Creek has TMDL for water temperature and turbidity (New Mexico Environment Department 2006a, 2006b).

It is worth noting that most of the listed impaired reaches on the National Forest and Preserve are due to designation of probable inappropriate use. For example, coldwater aquatic habitat may be unattainable due to naturally high water temperatures and high concentrations of aluminum. These streams are under review by the state of New Mexico. The only reaches in the assessment area which are considered impaired due to probable pollutant sources are the reach of the East Fork Jemez River with the Preserve and the Jemez River below Jemez Springs (New Mexico Environment Department 2008).

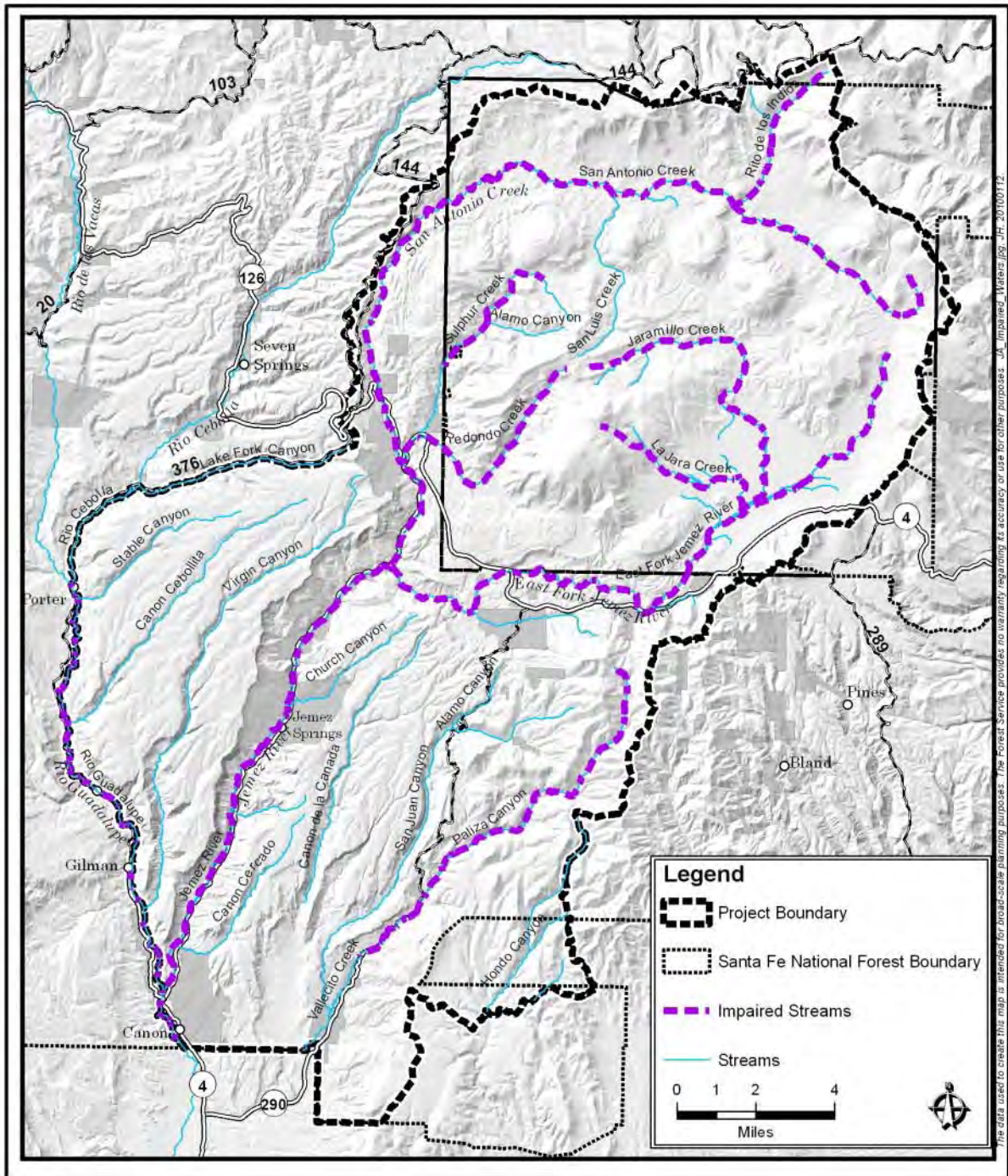


Figure 13. Streams listed as impaired (New Mexico Environment Dept. 2008)

# Air

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of the air resource within the assessment area. Reference conditions refer to the national and state standards for managing air quality.

Three air quality monitors were used in this assessment. Two are visibility monitors established for protection of Class 1 areas at San Pedro Parks Wilderness, 15 miles northwest of the assessment area and at Bandelier National Park, 10 miles southeast of the assessment area (Interagency Monitoring for Protection of Visual Environments or IMPROVE 2009). The third is a monitor for ozone and particulate matter (PM<sub>2.5</sub>), located 3 miles south of the assessment area on tribal land. Two other air quality monitoring sites in Sandoval County are strongly influenced by emissions in the Albuquerque metropolitan area, so they are not considered representative for the assessment area. There are no air quality monitors in Rio Arriba or Los Alamos Counties, and those in Santa Fe County are too far upwind and not representative due to their urban location.

Figure 14 displays the air quality monitors, climate monitoring stations, smoke sensitive areas and class 1 airsheds in the assessment area.

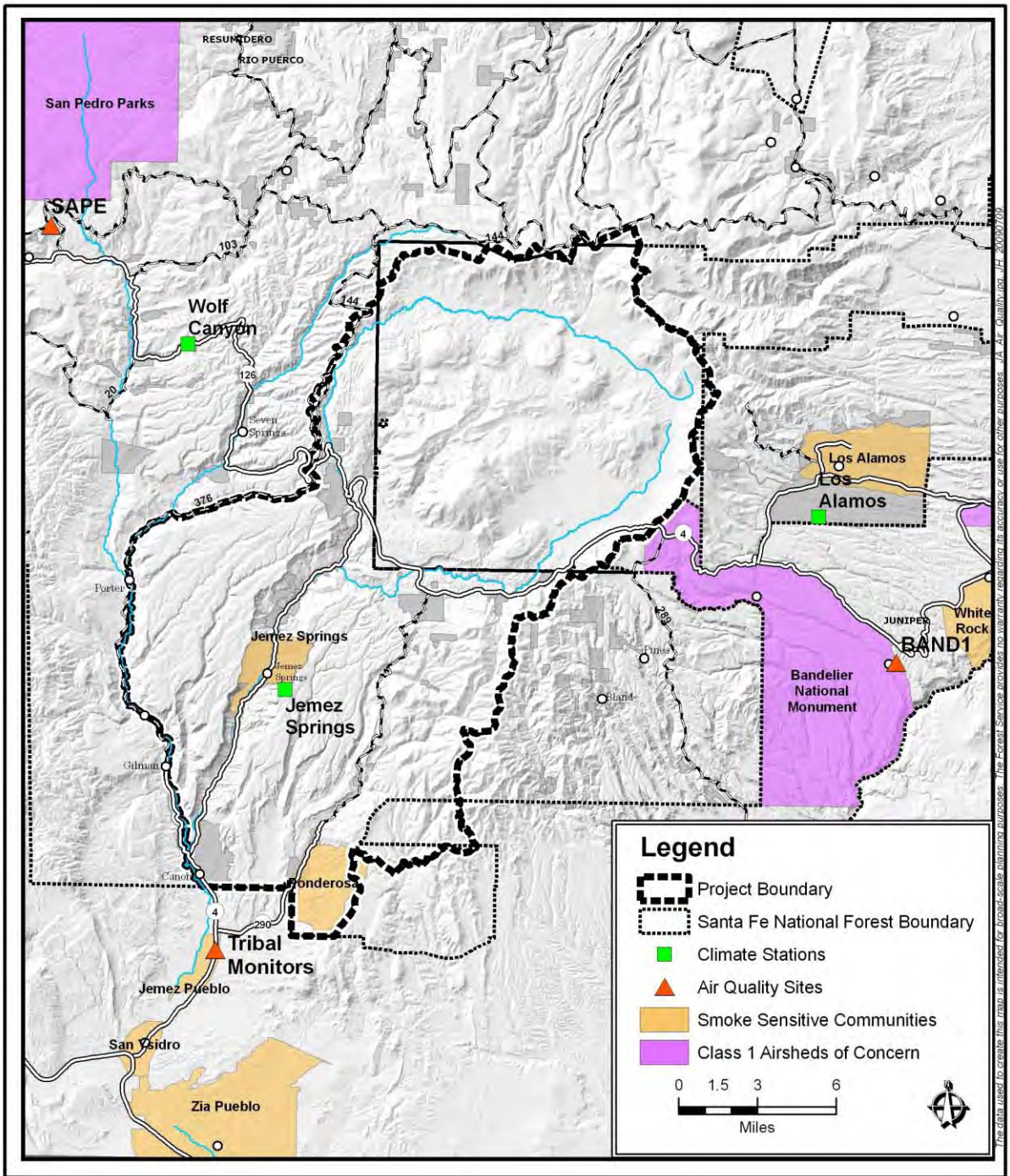
## Air Quality

Under the Clean Air Act, the Environmental Protection Agency (EPA) establishes National Ambient Air Quality Standards for pollutants that pose a threat to human health and welfare, and the State of New Mexico regulates the federal and state air quality standards within the State.

The reference condition is for all criteria pollutants to remain below (within) the EPA's air quality standards. The criteria pollutants of concern are ozone and PM<sub>2.5</sub>, which are being monitored in the assessment area. Currently, all national air quality standards are being met within the assessment area and in surrounding areas. Thus, the airshed is in attainment status. Additionally, levels of criteria pollutants have shown some improvement (been reduced) in the last 2 to 3 years. There has been some concern for elevated ozone levels in northwestern New Mexico.

## Ozone

Ozone is a secondary pollutant that forms as a result of chemical reactions in the atmosphere when the primary pollutants of nitrogen oxides (NO<sub>x</sub>) and Volatile Organic Compounds (VOC) are exposed to sunlight. The precursors to ozone are generally produced as emissions from combustion of fossil fuels. Sources in this area include two power plants near Farmington in San Juan County, engine exhaust from oil and gas development, and mobile sources including cars, trucks and recreational vehicles.



**Figure 14. Air quality sites, climate stations, smoke sensitive areas and Class 1 Airsheds of Concern**

Ozone levels have been monitored at Jemez Pueblo since 2004. Table 11 shows the 1<sup>st</sup> through 4<sup>th</sup> maximum value for 8-hour ozone for each year. Data for 2008 are incomplete but represent all data available from EPA as of June 9, 2009. The ozone standard is 0.075 ppm or less (for the 3-year average of the 4<sup>th</sup> highest value of 8-hour ozone).

Although standards are being met, the current ozone level has the potential to damage to species such as aspen and ponderosa pine.

**Table 11. First through 4th maximum value for ozone at Jemez Pueblo, 2004-2008 (ppm)**

Year	1 <sup>st</sup> Maximum	2 <sup>nd</sup> Maximum	3 <sup>rd</sup> Maximum	4 <sup>th</sup> Maximum
2004	0.069	0.069	0.068	0.067
2005	0.078	0.078	0.076	0.076
2006	0.075	0.075	0.072	0.072
2007	0.069	0.068	0.067	0.067
2008	0.069	0.066	0.065	0.065

## Particulate Matter

Particulate matter less than 2.5 micrometers in diameter is a criteria pollutant. Two redundant monitors located at Jemez Pueblo in the same location as the ozone monitor have been in operation since 2000. PM<sub>2.5</sub> is produced by all types of burning including power plants, combustion engines, woodstoves, and wildland fire. Table 12 shows maximum values recorded for 2000 to 2007. It also shows the values recorded during 98<sup>th</sup> percentile concentrations. The standard for PM<sub>2.5</sub> requires the 98<sup>th</sup> percentile of the 24-hour average concentration to be at or below 35ug/m<sup>3</sup>. That standard was only exceeded at one monitor one time in 7 years of monitoring, in 2005, as shown in the following table.

## Visibility

Visibility relates to conditions that allow humans to see and appreciate the inherent beauty of the landscape features, and these conditions can be greatly impacted by particular matter and gasses that are in smoke or dust (Malm 2000). Visibility and other air quality standards are most stringent within designated Class 1 areas, such as in wilderness areas over 5000 acres and national parks over 6000 acres. Thus, most air quality visibility monitoring is conducted in the Class 1 arisheds, shown on the map.

The IMPROVE network was established in 1985. The IMPROVE site monitors at Bandelier National Park and the San Pedro Parks station measure aerosols and particulate matter that can contribute to reduced visibility and identify the chemicals and emissions responsible for human-caused visibility impairment (FLAG 2002).

**Table 12. Monitored values of PM2.5 at Jemez Pueblo, 2000-2007 (ug/m<sup>3</sup>)**

Year	Monitor No.	Maximum PM2.5	98th Percentile PM2.5
2000	1	26.1	23.9
2000	2	29.9	27.3
2001	1	46.3	28.3
2001	2	46.3	27
2002	1	31.3	29.1
2002	2	32	25.2
2003	1	26.6	26.2
2003	2	27.3	26
2004	1	13.1	13.1
2004	2	13.2	13.2
2005	1	35.5	27.1
2005	2	43.1	<b>43.1</b>
2006	1	46.6	28.2
2006	2	45.2	21.3
2007	1	24.9	24.9
2007	2	26.8	26.8

The Regional Haze Rule sets a goal to return these areas to natural visibility conditions by 2064. Figure 15 and Figure 16 show the glide path that must be attained in order to return visibility conditions to normal by 2064 at Bandelier National Park and San Pedro Parks Wilderness. As of 2007, both Class 1 areas were slightly ahead of schedule but further improvements will be needed to meet the national visibility goal.

Figure 17 and Figure 18 show the average visibility conditions at Bandelier National Park and San Pedro Parks Wilderness (Class 1 airsheds) on the 20 percent worst and 20 percent best days. Measurements are in deciviews (an index that approximates the amount of visibility change that can be observed by the human eye) and beta extinction (a more scientific measure of light reduction). Worst days are shown in the top two lines, best days are the bottom two lines. For both Bandelier and San Pedro Parks, the absolute worst days for visibility in 2000 are attributed to smoke from the Cerro Grande Fire. (Visibility Information Exchange WebSystem 2009)

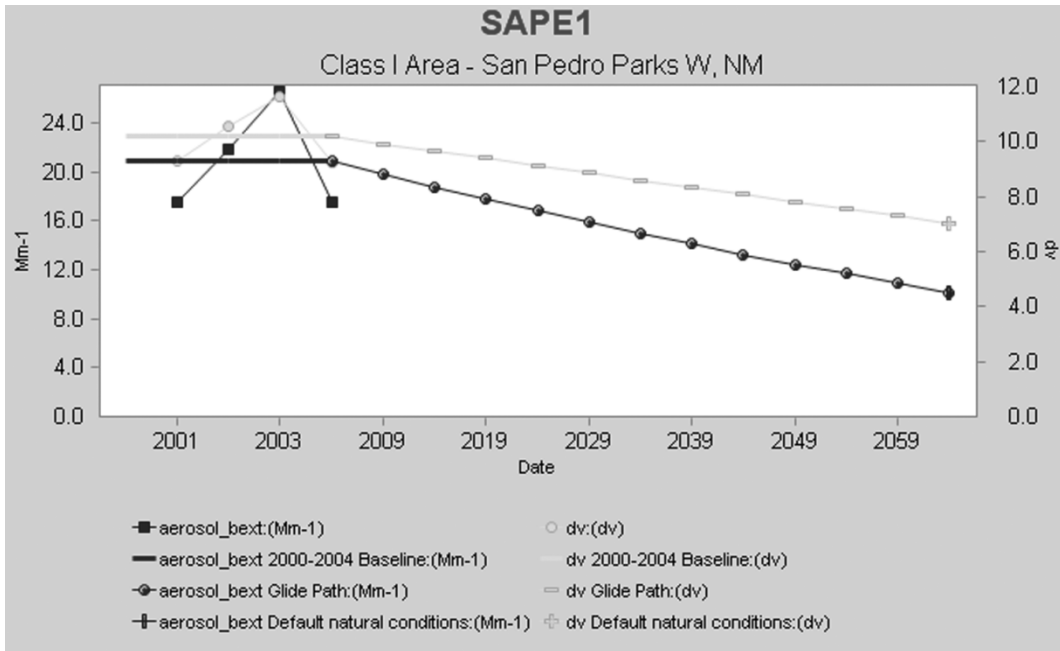


Figure 15. Visibility goals for San Pedro Parks Wilderness

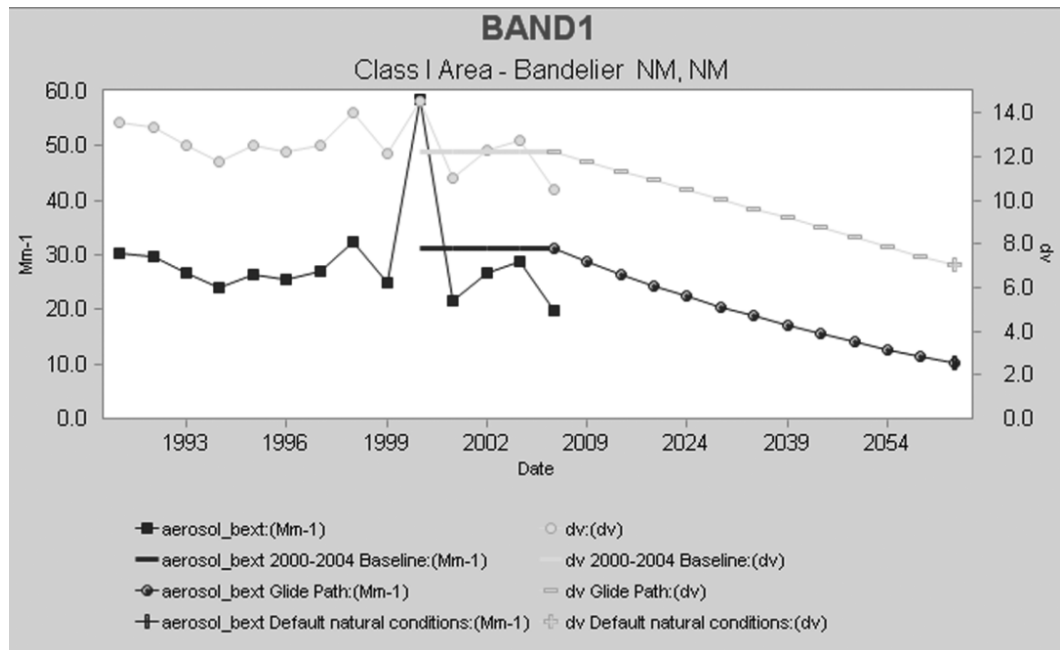


Figure 16. Visibility goals for Bandelier National Park

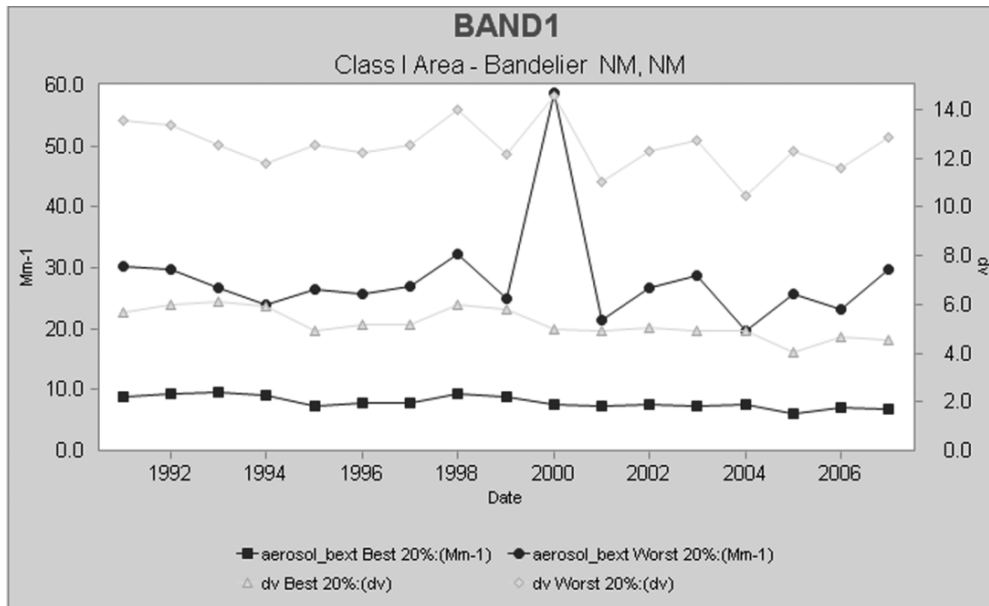


Figure 17. Visibility impairment at Bandelier National Park, 1988-2007

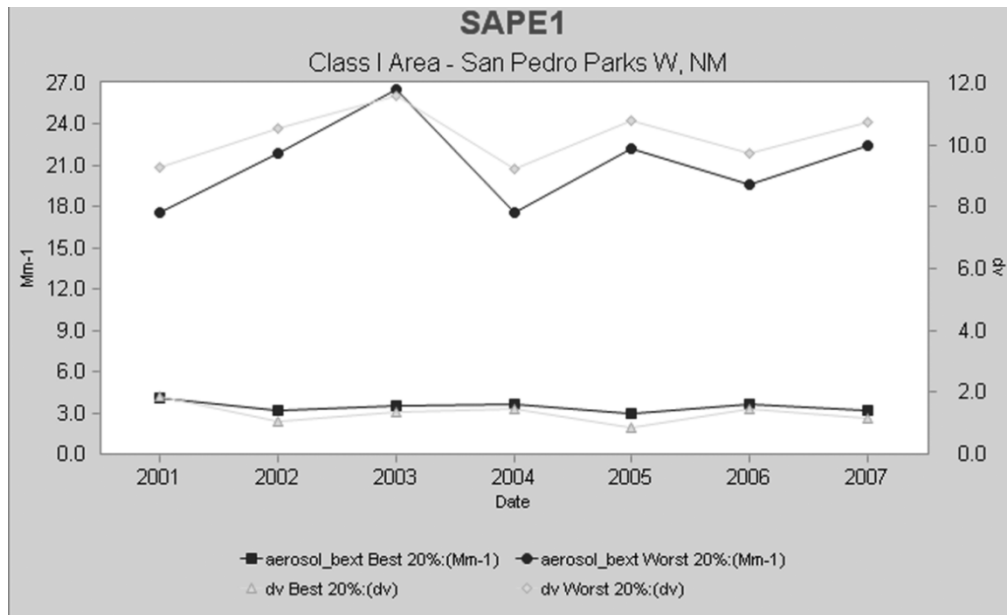


Figure 18. Visibility reduction at San Pedro Parks Wilderness, 2001-2007

# Vegetation

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of forest vegetation within the assessment area. Conditions are described in terms of the forest structural characteristics, species composition, and disturbance processes including fire, insects, diseases, and human activities.

Research and other reliable data sources used to illustrate the departure from reference conditions consisted of forest inventory data from National Forest databases such as Natural Resource Information System Field Sampled Vegetation (NRIS FSVeg; US Forest Service 2009b), Forest Service Activity Tracking System (FACTS), and Geographic Information System (GIS). Field reconnaissance in May and June of 2009 was used to help verify and update this information. Consideration was also given to information compiled in several past assessments completed for this area, plus monitoring results and environmental analysis documents completed in accordance with National Environmental Policy Act (NEPA). Vegetation on the National Forest has been mapped using aerial photo interpretation together with stand examinations and other field data collection methods. Stand exams have been conducted throughout the assessment area, and sampled stands were stratified to similar stands in the area using standard protocols. Most of the stand exam data on the National Forest is from the 1980s and 1990s, although additional stand exams were conducted in 2009, and most stand exam data on the Preserve was collected in 2008.

## Factors Affecting Current Conditions

This assessment area is considered one of the most naturally diverse areas in the Southern Rocky Mountains Ecoregion (Muldavin and Tonne 2003). However, past land uses like logging, livestock grazing and wildfire suppression have caused a downward trend in the natural diversity of the ecosystems in this area. Table 13 summarizes the vegetative cover types in the assessment area. In the early 1900s, many of the desirable stands in the area, particularly ponderosa pine, were logged. Intensive railroad logging occurred throughout the Jemez Mountains from 1924 to 1941. Virgin, Holiday and Stable mesas were logged between 1934 and 1936. Selective logging of individual trees, particularly the largest trees, continued, until the Forest Service started to actively manage the forest vegetation, starting in the 1960s (Elliott 1997). These activities greatly reduced the amount of old growth forest. Ponderosa pine was the commercially favored species since the earliest logging, so other species such as Douglas-fir and white fir were often left in the stands.

In the past 20 to 30 years, the Forest Service emphasized thinning, firewood cutting and prescribed burning to reduce the abundance of smaller size trees and shade-tolerant fir species, increase the proportion of old growth, and help restore resilient and sustainable ecosystem conditions. In the Preserve, intensive logging continued under private ownership until 2000, when the land was acquired through Federal appropriations and conveyed into the national forest system under a unique system of management by a Board of Trustees (Valles Caldera Trust).

Climate, livestock grazing, and fire suppression also strongly influenced current conditions in the assessment area. The climate in the early 1900s yielded generally favorable moisture regimes in the Jemez Mountains that increased conifer tree regeneration. Historically, high numbers of sheep

and cattle that grazed the Jemez Mountains reduced the amount of grasses available to carry a surface fire or to compete with tree seedlings. Over 100 years of active fire suppression added to the elements that allowed tree seedlings and saplings to thrive unchecked, without frequent fires to thin them out.

## Major Ecosystems

Major ecosystems described in this report, also referred to as vegetation cover types, are defined by the dominant overstory vegetation. Table 13 and Figure 19 show the estimated vegetation cover type distribution in the assessment area based upon stand examination data and aerial photo interpretations.

**Table 13. Vegetative cover type percentages**

Vegetation cover type (ecosystem)	Percent of entire assessment area	Percent of National Forest land in the area
Ponderosa pine	38.0	49.5
Mixed conifer	22.3	15.3
Piñon-juniper	18.0	28.4
Grassland	7.9	1.3
Spruce-fir	6.3	2.7
Aspen	5.8	1.3
Non-vegetation	0.7	0.8
Riparian forest	0.5	0.0
Shrubland	0.4	0.7

Source: National Forest GIS database 2009

### Ponderosa Pine Ecosystem

Currently, ponderosa pine (*Pinus ponderosa*) is the dominant forest type, comprising 38 percent of the assessment area and 50 percent of the National Forest lands. Ponderosa pine stands range from lower elevation, dry sites where they are transitional with piñon-juniper woodlands, to higher elevation, moist sites where ponderosa pine grades into mixed conifer. Between the extremes, ponderosa pine is the climax tree (mature, end-point species) on some sites and the seral tree (early pioneer species) on the mixed conifer sites where Douglas-fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*) become more dominant.

Species and structural composition has been significantly altered in most of the historic ponderosa pine stands in the Jemez Mountains. The proportion of shade-tolerant fir species has increased due to the amount of logging of ponderosa pine and the lack of surface fires (Taylor and Skinner 2003). Fire suppression reduced the evolutionary advantage of ponderosa pine, which is better able to survive low to moderate intensity surface fires than the shade-tolerant tree species. Historically, ponderosa pine forests were maintained as open stands with a grassy surface fuel bed by frequent 2 to 40-year fire return intervals.

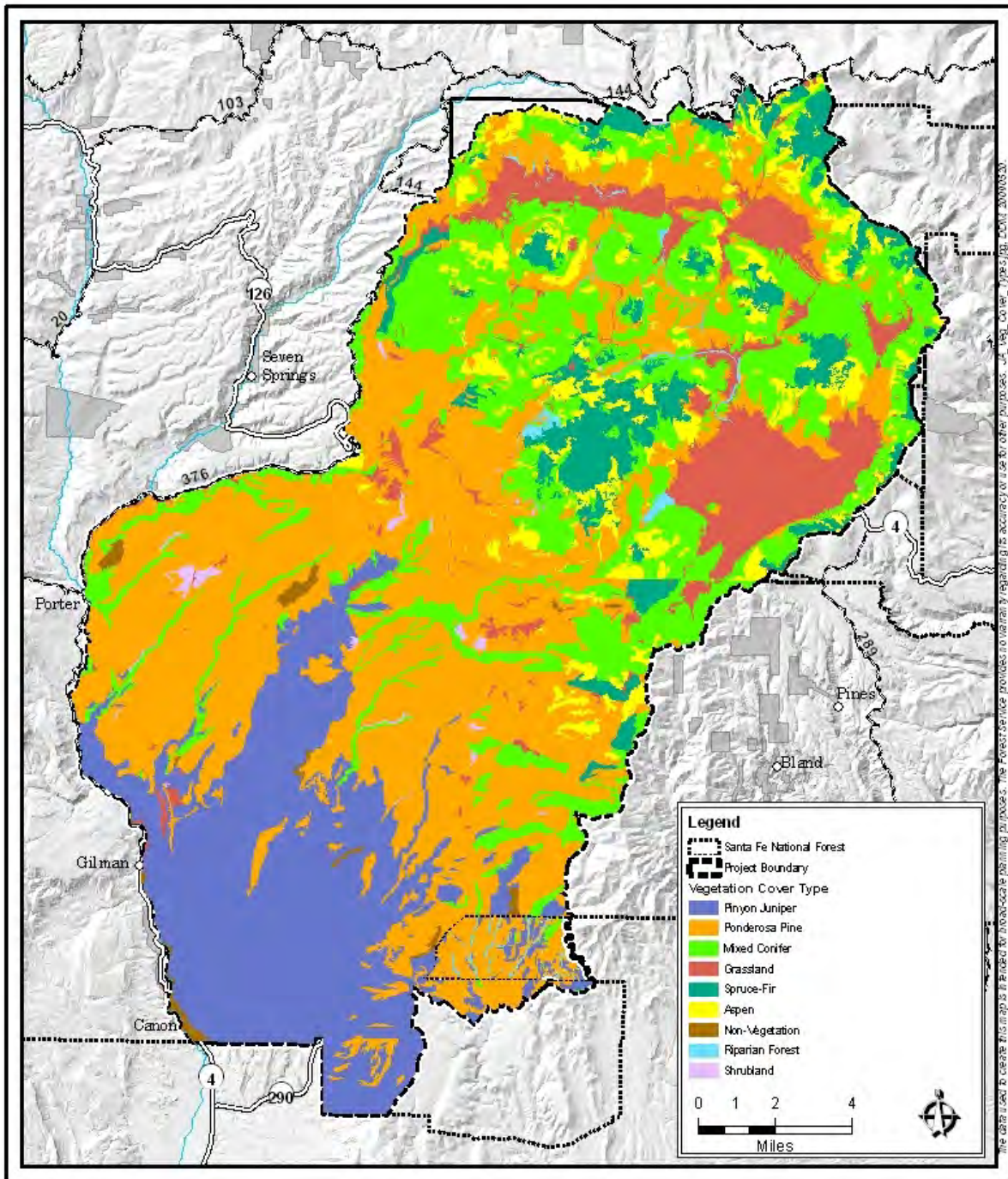


Figure 19. Vegetation cover types based on dominant overstory trees

As a result of human-caused alterations in natural fire regimes, many ponderosa pine dominated stands have shifted to become mixed conifer stands. Johnson (1993) documented an 81 percent increase in mixed conifer dominated stands across Arizona and New Mexico from 1962 to 1986. In addition, ponderosa pine stands typically form a dense and continuous blanket of pole-size trees, having lost their natural clumpiness and age-class diversity. Herbaceous plant cover in most stands has decreased (Covington and Moore 1994b); replaced by heavy accumulation of conifer needles. Without periodic fires to thin out the smaller trees, the number of trees has become unnaturally high. The excessive number of trees has greatly increased the competition between trees for light, moisture and nutrients, which has resulted in reduced tree growth and vigor. This has lowered the ponderosa pine forest’s resilience, or its ability to survive fires or outbreaks of insects or diseases.

Thus, the representation of different vegetation structural stages (VSS classes) has become less diverse. Vegetation structural stage is a generalized description of forest growth and aging stages based on the size class of trees comprising the majority of basal area in the stand. Forest Plan guidelines call for managing for diverse VSS class distributions in ponderosa pine ecosystems based on guidelines for managing northern goshawk habitat in the Southwestern U.S. (Reynolds et al. 1992). Those management guidelines are based on the dominant VSS classes within clumps and patches, totaled across large watershed-size areas. Table 14 shows the target or reference condition VSS class distribution in comparison with the existing VSS class distribution for ponderosa pine stands in the assessment area.

**Table 14. Vegetative structural stage (VSS) and canopy cover for ponderosa pine stands on the National Forest lands**

VSS Class	Existing VSS	Reference VSS	Existing Canopy Cover	Reference Canopy Cover
VSS 1 (< 1") grass/forb/shrub	6%	10%	NA	NA
VSS 2 (1-4.9") Seedling/sapling	8%	10%	NA	NA
VSS 3 (5-11.9") Young forest	51%	20%	NA	NA
VSS 4 (12-17.9") Mid-age forest	21%	20%	48%	40%
VSS 5 (18-23.9") Mature forest	11%	20%	46%	40%
VSS 6 (>= 24") Old forest	3%	20%	45%	40%

Existing condition source: Forest RMRIS database 2009 and Forest Vegetation Simulator

As shown in the table, there is currently a significant excess of mid-age, pole-size trees in the 5 to 12-inch diameter class. There is a significant deficit of larger, older trees (VSS 5 and 6, or over 18 inches in diameter). The number of large snags (dead standing trees) is slightly below the Forest Plan standard, although it has been increasing over the past decade due to mortality from fires, insects and diseases. There is an average of about 1.7 snags per acre that are at least 12-inches DBH (diameter at breast height) and 15 feet tall. Approximately 41 percent of those snags

are at least 18-inch DBH and 30 feet tall, which is the reference size according to the Forest Plan and northern goshawk guidelines. Most of this data was collected in the 1980s and 1990s, so the current number of snags is likely a little higher due to the increase in insect and disease mortality in the mid-2000s (US Forest Service 2007a).

Historical reference conditions of the Southwestern ponderosa pine ecosystem have been thoroughly studied. Covington and Moore (1994a) evaluated numerous studies that found pre-settlement ponderosa pine densities typically ranged from 15 to 56 trees per acre in Arizona and New Mexico, including 26 to 47 trees per acre on the Carson National Forest, adjacent to the Santa Fe National Forest.

Table 15 shows the current basal area per acre (square feet of wood volume per acre) within the ponderosa pine type in the assessment area, along with the density in terms of number of trees per acre (TPA), in trees over 1 inch and over 5 inches in diameter. There is an increased stand density and canopy cover relative to historical reference conditions in the ponderosa pine type.

Although canopy cover within clumps or groups may be similar to historic conditions, the openings between the clumps or groups are fewer and narrower than what historically occurred in ponderosa pine. Historically, ponderosa pine stands were horizontally diverse, with scattered openings and even-age clumps of trees. Clumps ranged from a few trees to clumps of about 0.75 acre in size (Covington and Moore 1994a). Historically, average canopy cover across the variable-density landscape was generally less than 30 percent though canopy cover at the clump level was much denser (Pearson 1923). Frequent low-intensity surface fires promoted an abundance of grasses and forbs while reducing the numbers of tree seedlings and saplings.

**Table 15. Basal area (BA), quadratic mean diameter (QMD), and trees per acre (TPA) for ponderosa pine stands on National Forest Land**

Ponderosa Pine	Minimum Stand Average	Maximum Stand Average	Assessment Area Average
BA 5"+	20	250	92
QMD 5"+	7.3	25.1	10.0
TPA 1"+	6	2224	537
TPA 5"+	6	438	178

Source: RMRIS database, Santa Fe National Forest

### Mixed Conifer Ecosystem

The mixed conifer forest type comprises only 15 percent of the National Forest land within the assessment area. It consists of a variety of species including Douglas-fir, white fir, ponderosa pine, blue spruce, aspen, southwestern white pine (*Pinus strobiformis*), limber pine (*Pinus flexilis*) and minor amounts of Rocky Mountain juniper (*Juniperus scopulorum*), Engelmann spruce (*Picea engelmannii*) and corkbark fir (*Abies lasiocarpa* var. *arizonica*). Mixed conifer is a transitional forest type that ranges from warm, dry to cool, moist. For consistency with wildlife habitat analysis, the definition of mixed conifer according to the Mexican spotted owl recovery plan is used in this report (USDI 1995). This definition includes stands within Douglas-fir, white fir, limber pine and blue spruce series, except those (1) considered “pure” for a species other than

Douglas-fir, white fir, limber pine, southwestern white pine or blue spruce, or (2) stands with more than 50 percent of the basal area in quaking aspen.

Warm, dry mixed conifer is associated with the lower elevations and dryer southerly aspects within the Douglas-fir and white fir ranges. Many stands that are currently classified as dry mixed conifer stands were historically open-canopy ponderosa pine-dominated stands (Allen et al. 2002). Due to the lack of frequent fires and other influences, the warm, dry mixed conifer today often has a dense and dominant understory of shade-tolerant white fir (Taylor and Skinner 2003). There are still typically larger ponderosa pine and Douglas-fir in the overstory. Other species are minor components. Historically, the dry mixed conifer stands were more open than they are today and supported high frequency, low severity fire regimes. As such, the understory of grass and other non-woody vegetation was more productive and diverse than current times.

Cool, moist mixed conifer is found between the warm, dry mixed conifer at the lower elevations and subalpine types at the higher elevations. This moist mixed conifer type has less ponderosa pine than dry mixed conifer. Douglas-fir and white fir are the predominant species, and blue spruce may be common, especially in drainages and riparian areas. Aspen may be a major or minor seral component. Fires are less frequent than in ponderosa pine, and fire severity is mixed, with stand replacing crown fire usually occurring in patches (Touchan et al. 1996). The composition of these stands has not changed drastically from historic conditions. However, the mixed conifer forest structure is typically denser and less diverse than it was (Muldavin and Tonne 2003), similar to the altered conditions described for the ponderosa pine ecosystem.

Currently, the mixed conifer type in the assessment area includes both even-aged and uneven-aged stands. Historically, these stands were all-aged due to disturbance. Heavy regeneration events, periodic harvesting, and reduced natural fire disturbances have created stand conditions in many cases dominated by one or two age classes. Species composition has been altered as well. Aspen, ponderosa pine and other shade intolerant tree species were historically maintained in mixed conifer forests through disturbances such as fires. The lack of fire occurrence has resulted in an over-representation of shade tolerant trees within mixed conifer stands, and a decline in patches of young aspen (Touchan and Swetnam 1995).

For most mixed conifer stands on National Forest land in the assessment area, average basal area ranges from 80 to 250 square feet, with a mean of 150. The average density of trees is 600 trees per acre, with tree density ranging from 250 to 1600 trees per acre (trees larger than 1 inch DBH). Regionally, historical basal areas were 40 to 45 percent of current levels and trees per acre 20 to 25 percent of current numbers (Smith 2006). Table 16 illustrates average basal area, average diameter, and average trees per acre for mixed conifer in the assessment area based on stand exam data collected in the 1980s and 1990s. This same data was used to evaluate the occurrence of snags in mixed conifer stands. Based on dead trees sampled during stand inventories, approximately 7.4 snags per acre at least 12 inch DBH and 15 feet tall are scattered in mixed conifer stands in the assessment area. Only 24 percent of those snags are at least 18 inches DBH and 30 feet tall, due to the overall lack of large trees in the area. The Douglas-fir bark beetle mortality that peaked in the mid-2000s likely increased the amount of large snags. Ongoing data collection will provide a more accurate representation in the near future.

**Table 16. Basal area (BA), quadratic mean diameter (QMD), and trees per acre (TPA) for mixed conifer stands on National Forest Land**

Mixed Conifer	Minimum Stand Average	Maximum Stand Average	Assessment Area Average
BA 5"+	70	240	135
QMD 5"+	8.2	16.3	10.6
TPA 1"+	254	1690	622
TPA 5"+	95	450	226

Source: RMRIS database, Santa Fe National Forest

### **Piñon-Juniper Woodland Ecosystem**

Piñon-juniper woodlands are one of the most prominent vegetation types, covering 18 percent of the total land and 28 percent of National Forest land in the assessment area, all of it in the southern portion. It is a diverse type that ranges from open savannas to dense-canopy woodlands, influenced by many factors including biogeophysical factors, climate, as well as past and current land use. Three piñon-juniper types can be found in this area (Romme et al. 2007). The distribution of these three types is not quantified for the assessment area.

1. On lower elevations with deeper soils and gentle topography, piñon-juniper savannas maintain sparse canopy cover and relatively continuous grass cover. The grass cover historically supported frequent, low-severity fires. Some of these savannas were previously grasslands, but have successfully seeded in with juniper and/or piñon trees as a result of changes in climate, disturbance of fire regime, and/or effects of grazing. Similarly, many of the historic savannas have experienced ingrowth of piñon and/or juniper better described as open woodland. The continuous grasses are the key feature for this savanna classification.
2. Shrub woodlands have a successional character that is dominated by shrubs but supports a density of tree cover that fluctuates with climate and disturbance. These areas expand and contract over time. Surface cover is highly variable as typical sites range from deep valley-bottom soils to shallow rocky soils on steep slopes.
3. Persistent woodlands are found on shallow upland soils that favor piñon and juniper over grasses and other non-woody vegetation. Canopy cover varies depending on site. Understory can include grasses, forbs, and/or shrubs, but is not continuous and often displays bare ground. Fire likely was infrequent, though stand replacing. Other environmental factors, such as the Ips beetle epidemic a few years ago, play a significant role in stand dynamics.

The density of piñon-juniper woodlands has increased in much of its range over the past century or more. The range of piñon-juniper woodlands has likely increased as well, with expansion into grasslands. However, large-scale, natural decreases in piñon-juniper have occurred in recent times also. A combination of environmental factors—drought, insects, and high temperatures—killed millions of piñon trees in New Mexico, including portions of the assessment area, in the early 2000s (Romme et al. 2007).

## **Spruce-Fir Ecosystem**

The spruce-fir cover type comprises 6 percent of the assessment area and less than 3 percent of the National Forest land portion. This forest type is predominantly composed of Engelmann spruce and corkbark fir with smaller components of white fir, Douglas-fir, Colorado blue spruce and aspen. Spruce-fir forests are typically dense and uneven-aged, dominated by Engelmann spruce in the overstory and corkbark fir in the understory. Aspen may be a major seral species, but diminishes after a century or more without disturbance. Spruce-fir forests are found at high elevations (often above 10,000 feet) where conditions can be severe. Growing seasons are short, snow loads are high, and average temperatures are low. Stand dynamics rely on disturbance for regeneration, such as fire, insects (spruce beetle), windthrow, avalanche, etc. Fire occurrence is low frequency and high severity, with fire return intervals of 150 years or more (Dahms and Geils 1997). Most of the spruce-fir forest on the National Forest land in the assessment area is on the high peaks north of the Preserve.

On the Preserve, most of the forests including spruce-fir stands were clearcut or selectively logged using jammer-logging techniques, which required construction of over 1,200 miles of roads. At that time, the Preserve was a private ranch, and loggers there were not required to burn the slash or plant new trees. As a result, the present day forests on the Preserve consist largely of second-growth “dog hair” thickets of young ponderosa pine and white fir, averaging over 1600 trees per acre. On the National Forest portion of the assessment area, little or no logging was done before 1950 (US Forest Service 1997), and there are very few spruce-fir stands in these lower elevation areas. Unmanaged spruce-fir stands on the National Forest portion of the assessment area are similar to what existed prior to European settlement in a forest type perpetuated by both high-intensity, low-frequency, large-scale events and frequent patch-scale disturbance.

## **Aspen Ecosystem**

The aspen cover type comprises only 6 percent of the assessment area and 1 percent of the National Forest land in the assessment area. It is found in small stands associated with disturbance as well as a component of many mixed conifer stands. Some of the aspen stands in the assessment area are young, dating to wildfires in the 1970s. However, due to lack of periodic fires that historically regenerated patches of aspen, most of the aspen is mature or over-mature. Conifer trees are taking over the aspen patches due to the lack of natural fire disturbances, resulting in a gradual reduction in the extent of aspen stands throughout the area and conversion from aspen to mixed conifer stands.

Thus, the acreage of aspen in the Southwest Jemez Mountains assessment area is on a downward trend due to the absence of large scale disturbance. This is the case across much of the West. In fact, over the last 30 years, the acreage of aspen in the Southwest is estimated to have declined by almost one-half (US Forest Service 1993a).

Aspen stands are generally even-aged and have conifer trees in both the overstory and the understory. Average diameters run between 8 to 10 inches DBH, although stands originating in the 1970s average 5 to 6 inches DBH. For mature aspen stands in the assessment area, the average basal area ranges from 110 to 240 square feet per acre. Table 17 illustrates average basal area, average diameter, and average number of trees per acre for aspen in the analysis area, based on stand exam collected in the 1980s and 1990s.

**Table 17. Basal area (BA), quadratic mean diameter (QMD), and trees per acre (TPA) for aspen stands on the National Forest land**

Aspen	Minimum Stand Average	Maximum Stand Average	Assessment Area Average
BA 5"+	112	238	175
QMD 5"+	8.4	10.3	9.3
TPA 1"+	408	1162	702
TPA 5"+	237	510	374

Source: RMRIS database, Santa Fe National Forest

### Grassland and Meadow Ecosystems

Southwestern grassland and meadow ecosystems are being invaded by trees because of the absence of fire and past and continued grazing (Allen 1989). Research by Allen shows a decrease in open grassland area of 55 percent since 1935 in the southeast portion of the Jemez Mountains. On Cerro Grande in Bandelier National Monument grasslands have decreased by 85 percent since 1935. Field reconnaissance in the assessment area revealed meadows that were disappearing as trees encroached. Heavy grazing pressure in moist grasslands is favoring the establishment of the exotic Kentucky blue grass (Figure 20) and encouraging the disappearance of the native bunch grasses. Kentucky blue grass is almost impossible to burn, where the native bunch grasses create an excellent fuel bed for surface fire. Maintaining grasslands with fire where Kentucky blue grass is dominant is not an option.



**Figure 20. Remnant native bunch grasses on left, Kentucky blue grass on right**

## Threatened, Endangered and Sensitive Plants

There are no federally listed threatened, endangered, proposed or candidate plant species that have potential to occur in the assessment area.

There are 11 plant species on the Forest Service’s sensitive plant species list (US Forest Service 2008). Of those, only four were determined to have potential to occur in the assessment area based on their physical and biological habitat requirements. The four sensitive plant species with potential to occur in this area are:

- Yellow lady’s slipper                      *Cypripedium parviflorum var. pubescens*
- Robust larkspur                              *Delphinium robustum*
- Wood lily                                        *Lilium philadelphicum*
- Springer’s blazing star                      *Mentzelia springeri*

The wood lily has documented occurrence in several locations. There are no known records of occurrence for the yellow lady’s slipper, robust larkspur, or Springer’s blazing star on the Jemez District. The Forest Service regional botanist has noted that yellow lady’s slipper occur in Bandelier National Monument, so could occur on the Jemez District (personal communication with Charlie McDonald, Sept. 14, 2009).

The Forest Plan designated a botanical special interest area within this Jemez Mountains assessment area. This botanical special interest area was designated in order to protect a unique bunchberry dogwood plant population.

## Invasive Plants

Invasive/exotic plants (also known as noxious weeds), are aggressive species that displace native plant species. Where invasive plant populations occur in the assessment area, they are gradually out-competing native plants for moisture and nutrients, and taking over native plant communities. They are turning diverse native plant communities into monocultures, and disrupting natural ecosystem processes. By reducing native plant populations and altering natural ecosystem functions, they are also reducing the abundance and diversity of native wildlife species and microorganisms in those ecosystems. Table 18 and Figure 21 show the types and amount of known invasive plant populations within the entire assessment area.

**Table 18. Invasive plant acreages on the National Forest and private land**

Plant Name	Acres
Siberian elm	1,678
Russian olive	1,634
Tamarisk	1,634
Bull thistle	1,623
Nodding plumeless thistle	40
Hardheads	16
Poison hemlock	12
Whitetop	10
Canadian thistle	5
Field bindweed	4

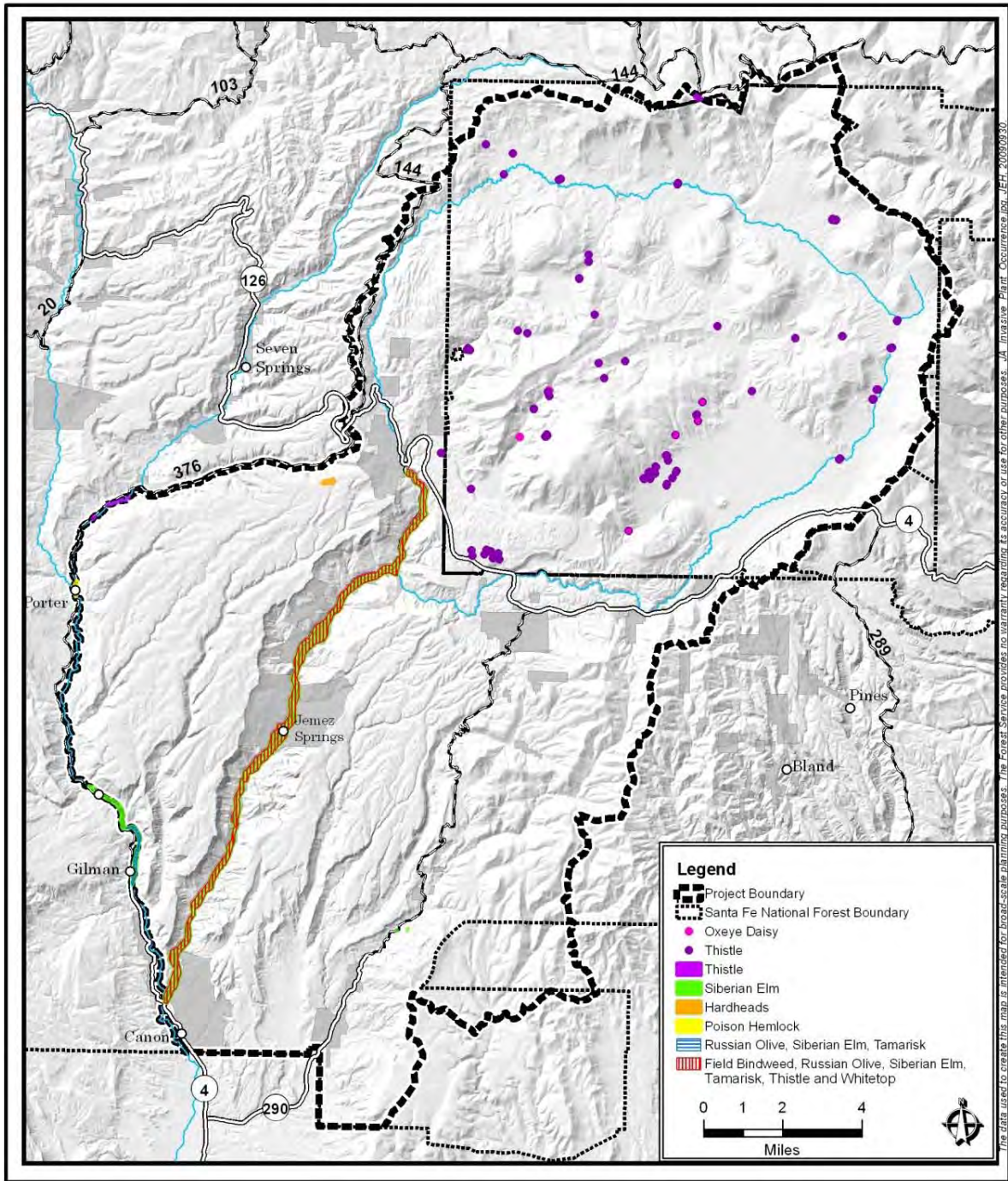


Figure 21. Invasive plant species and distribution

There are approximately 6,700 acres of inventoried invasive plant populations scattered throughout the assessment area, distributed by land ownership as follows:

- National Forest: 3,360 acres
- Private: 3,290 acres
- Preserve: 50 acres

Surveys for invasive plants on the National Forest land have been quite limited, due to funding constraints. It is estimated there are considerably more populations that have not been found. Existing populations are spreading annually.

Concentrations of invasive plants are most noticeable along the riparian areas, as well as along roads where the soil has been disturbed and bare soil exposed.

Species of invasive plants that are the most dominant on the National Forest and private land in the area are tamarisk, Russian olive and Siberian elm, which occur along the Jemez River and other lower elevation streams. On the Preserve, botanical surveys have been extensive and invasive plant control treatments have been occurring annually in recent years. Thus, the extent of invasive plants is significantly lower there. The Preserve has approximately 50 small occurrences, primarily thistles, and some oxeye daisy and bindweed, mostly along roadsides. The National Forest and Jemez Pueblo conducted limited riparian restoration treatments along the lower Jemez River to control tamarisk, Russian olive, and other invasive species, although additional control measures are needed.

A forest-wide Final Environmental Impact Statement that evaluates proposed invasive plant control alternatives was completed and the associated decision appealed. The appeal reviewing officer remanded it back to the Forest, recommending additional analysis. A supplemental (revised) EIS is expected to be completed by December 2010.

## **Insect and Disease Pests**

Insects and diseases are a natural and common occurrence in all forest types in the Jemez Mountains. With a change of species and structural composition due to reasons cited above, an increase of competition between trees for light, moisture and nutrients has resulted in reduced tree growth and vigor. This has lowered the forest's resiliency from outbreaks of insects or diseases. Bark beetles, defoliators, dwarf mistletoes, root diseases, and white pine blister rust have widespread impacts on the forest and within the analysis area.

True mistletoes (*Phoradendron* species) and/or dwarf mistletoes (*Arceuthobium* species) infect every coniferous species in the assessment area. Dwarf mistletoe infection is typically patchy within stands and across the landscape. Infections spread short distances to adjacent trees, so changes in occurrence on a landscape must be measured on a long-term scale, rather than annually (US Forest Service 2008a).

Though not as widespread as juniper infections, dwarf mistletoe infects over one-third of the ponderosa pine acreage and about one-half of mixed conifer acreage in New Mexico and Arizona. The effects of dwarf mistletoe infection on growth and vigor of these commercially important species are significant: an estimated 25 million cubic feet of annual timber production is lost to reduced growth and increased mortality on Forest Service land in New Mexico and Arizona.

Some infection centers are small and manageable, even with uneven-aged silviculture systems. Other infection centers are larger and managing dwarf mistletoe may not be a suitable objective.

Root diseases are another common pathogen, but one which is not readily visible. The most abundant root diseases in this area are likely armillaria (*Armillaria spp.*) and annosus (*Heterobasidion annosum*) root diseases. They are most common in mixed conifer forests, but can infect many species, both coniferous and deciduous. Individuals infected with root disease suffer increased susceptibility to insect attacks as well as higher probability of windthrow, which is often when a root disease is identified. Root diseases spread slowly and survive as decayers on dead woody material. As such, it is a chronic condition that remains on site and can be exacerbated by harvesting.

Unlike mistletoes and root diseases, insect-caused impacts are typically visible in short time frames, making them easier to monitor and evaluate. The Forest Service Southwestern Region forest health staff completes annual insect and disease aerial detection surveys, which are mapped and sampled for accuracy. That source is the most reliable and quantitative source available for displaying the impacts of insects and pathogens in the assessment area. Table 19 shows data for the past 10 years of detection surveys over the entire assessment area (US Forest Service 2007a, 2008a).

**Table 19. Acres of defoliation and mortality in forested cover types**

Primary Host Species	Ponderosa pine	Douglas -fir and white fir	Spruce and corkbark fir	True fir	True fir, Douglas -fir, spruce	Aspen	Aspen	Total Acres
Primary Damage Type	bark beetle mortality	bark beetle mortality	bark beetle mortality	bark beetle mortality	defoliation	defoliation	mortality	
Report Year								
1998	29.6	22.7	151.5	22.7	1,092.5	124.9		5,470
1999	0.0	13.5	0.3	13.5	108.7			122
2000	70.8	23.2	51.3	23.2	1,939.8	2072.2		4,320
2001	141.5	130.7	17.5	57.4	14,365.8	620.6		15,276
2002	840.3	0.2	21.8	0.2	439.7	1904.0		3,206
2003	448.5	479.8	21.4	0.7	10.3	78.4		1,038
2004	134.6	1,802.3	39.0		5,307.3	399.8		7683
2005	18.8	2,030.9		322.9	7,559.6	683.8		10,293
2006	120.2	340.3		34.1	3,949.0	395.8		4,805
2007	628.1	274.9		8.4	19,875.0	819.4	727.4	22,325
2008	239.8	36.7	21.3	21.3	11,826.7	597.3	684.3	13,406
<b>Total Acres Mapped</b>	<b>2,672</b>	<b>5,155</b>	<b>324</b>	<b>484</b>	<b>66,475</b>	<b>7,696</b>	<b>1,412</b>	<b>87,946</b>
<b>Total Ground Area Affected</b>	<b>2,552</b>	<b>4,660</b>	<b>303</b>	<b>246</b>	<b>40,683</b>	<b>6,952</b>	<b>1,393</b>	<b>60,618</b>

Source: R3 Forest Health GIS data 2009

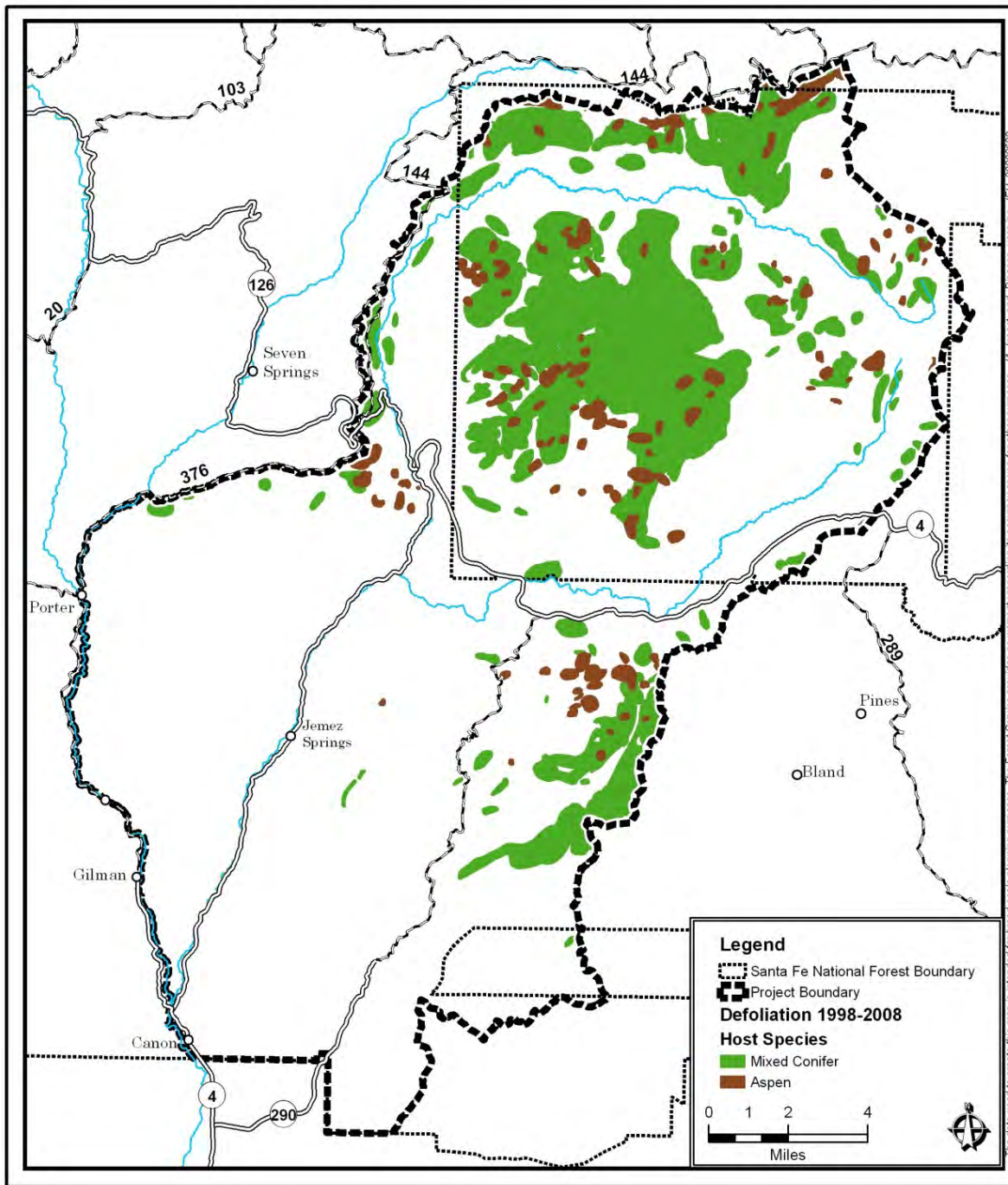


Figure 22. Tree defoliation from insects and disease, 1998-2008

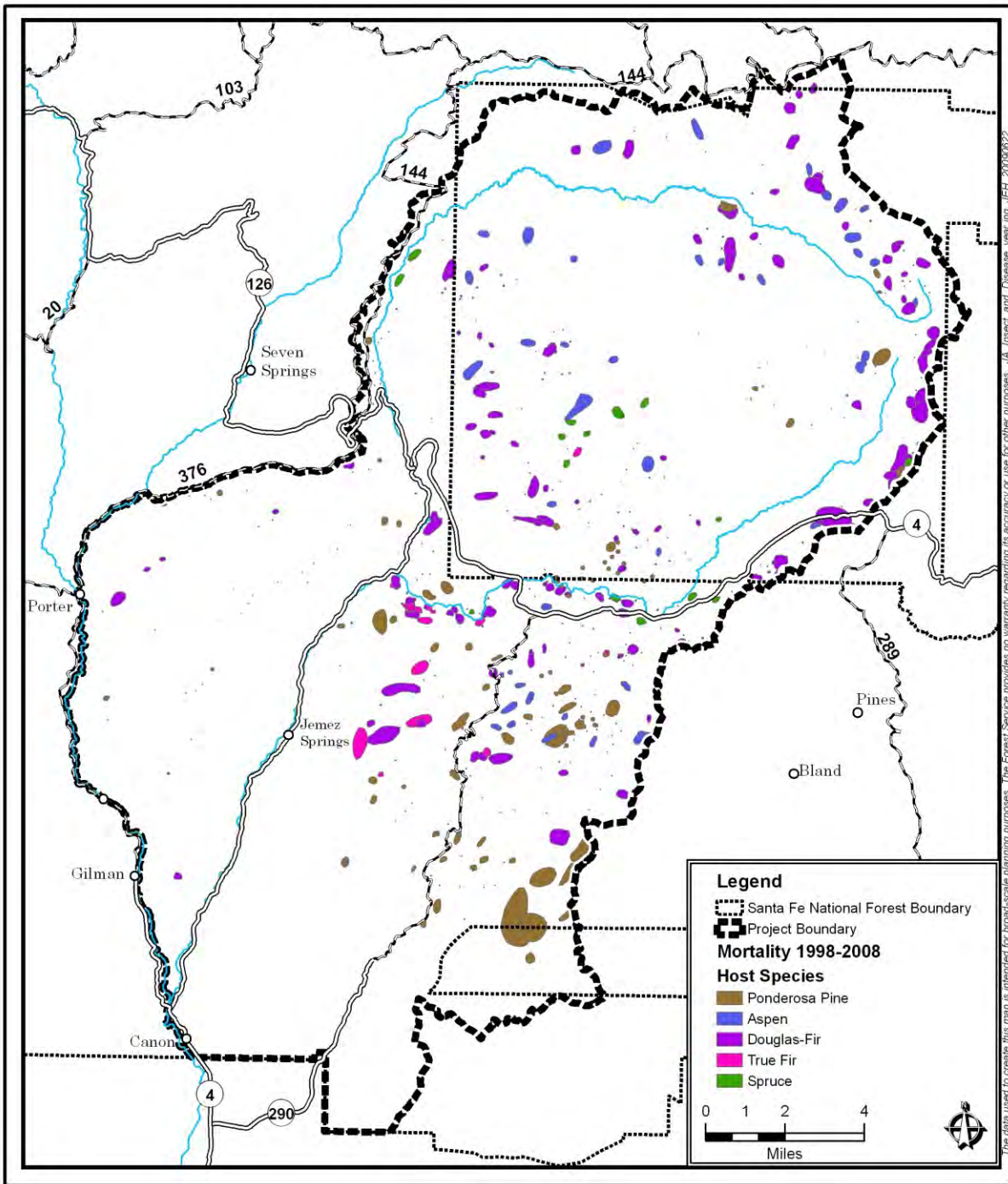


Figure 23. Tree mortality from insects and disease, 1998-2008

In terms of land area affected, **western spruce budworm** (*Choristoneura occidentalis*) has been the most widespread and chronic pest in the assessment area. Spruce budworm defoliates host trees from the top down. Host species include true firs, Douglas-fir and spruce, with white fir seemingly preferred. Multi-storied stands are typical and provide favorable conditions for the larvae to feed upon. Repeated defoliation has occurred in much of the affected area.

Some mortality of larger trees is attributed to repeated defoliation either directly to western spruce budworm or indirectly where bark beetles have attacked weakened individuals. During the survey years 1998 to 2008, approximately 66,500 acres have been mapped with western spruce budworm defoliation, with 2007 and 2008 displaying two of the three largest defoliation years. The affected area on the ground is approximately 40,700 acres. The difference in the two figures indicates repeated defoliation in some areas. Most of the spruce budworm activity has occurred in the Preserve, though much of Paliza Canyon has seen repeated defoliation.

**Piñon ips beetles** (*Ips confusus*) reached epidemic proportions in New Mexico in the early 2000s as a result of ongoing drought and high temperatures. When the epidemic peaked in 2002 to 2004, there was widespread mortality of piñon, especially on lower quality sites. The impact to piñon trees in the assessment area is not well known because the surveys did not consistently include the piñon-juniper types.

**Western pine beetles** (*Dendroctonus brevicomis*) and **Ips engraver beetles** (*Ips* spp) are the primary mortality agents in ponderosa pine trees. Western pine beetles typically attack mature, low-vigor trees, while engraver beetles prefer smaller-diameter slash and damaged trees. During past droughts, however, *Ips* engravers commonly attacked low-vigor smaller tree stems and larger tree crowns, causing mortality in both size classes. Throughout the drought years surveyed, ponderosa pine mortality impacted small pockets and scattered individuals; it never approached epidemic proportions as the piñon did. Mortality increased after 2000, and has fluctuated from almost none to more than 800 acres annually within the assessment area.

**Douglas-fir bark beetle** (*Dendroctonus pseudotsugae*) and **fir engraver beetle** (*Scolytus ventralis*) activity was minimal before 2003 and peaked in 2005, as the effects of drought gradually moved into the higher elevation forests. Mortality was typically confined to small pockets of only a few trees. Douglas-fir mortality was more prevalent in mature and old trees, while white fir mortality occurred in young to mature trees.

**Spruce beetle** (*Dendroctonus rufipennis*) activity has not been reported in the last four years of detection surveys. Prior to that, approximately 300 acres of mortality were mapped. It was relatively evenly divided between high-elevation spruce-fir forest type and blue spruce in or near drainages in mixed conifer stands. Some mortality of corkbark fir from western balsam bark beetle was recorded in 2008 and was also found intermixed in the earlier spruce mortality when ground-checked.

**Western tent caterpillars** (*Malacosoma californicum*) are endemic to the area and feed on several species, but are most visible in aspen. Larvae feed on aspen leaves and large populations can completely defoliate stands of aspen. Repeated defoliation appears to be limited within the assessment area. However, aspen decline (mortality) has been mapped in recent years and may be attributed to western tent caterpillars.

**White pine blister rust** is caused by the fungus *Cronartium ribicola*, introduced from Asia around 1900. As the name implies, it infects white pines, including southwestern white pine and

limber pine (*Pinus flexilis*). Although the Santa Fe National Forest supports the largest population of white pines in the Southwestern Region, there is currently very little blister rust. The first, and currently the only, white pine blister rust infection center known on the forest was discovered in the assessment area in 2007 (Conklin et al 2009). It is expected to spread over time, with intensity and severity dependent on site suitability. No management options currently exist to mitigate the impacts of this disease on host species. Conservation of white pines is the most likely means of ensuring future viability of southwestern white and limber pines.

## Old Growth

Old growth (also called late successional stage or climax) forest is a unique component of all healthy, functioning forest ecosystems. Old growth forest is critical to maintaining the biological diversity and abundance of many species of native plants and animals. There has been a long-term decline in the abundance of old growth forests in this area and throughout the Southwest, which has contributed to the decline of some old growth associated wildlife species. For example, the proportion of open-canopy old growth ponderosa pine forest is only about 3 percent compared to a historic range of 30 to 75 percent (based on fire regime condition class analysis using LANDFIRE).

Monument Canyon Research Natural Area is located in a 160-acre section of the assessment area. It is used to research old growth ponderosa pine ecosystems and its response to various types of restoration treatments. Research on old growth in the RNA is ongoing by scientists from Rocky Mountain Research Station and University of Arizona.

Over the past 10 to 20 years, vegetation management practices included maintaining or enhancing development of old growth forest within the assessment area in accordance with Forest Plan direction, as well as agency requirements in the Healthy Forest Restoration Act (HFRA). Section 102(e)(2) of HFRA provides direction to “fully maintain, or contribute toward the restoration of, the structure and composition of old-growth stands according to the pre-fire suppression old-growth conditions characteristic of the forest type, taking into account the contribution of the stand to landscape fire adaptation and watershed health, and retaining the large trees contributing to old-growth structure.”

Based on Forest Plan direction, old growth on the National Forest is managed using a minimum 40-acre stand size. Within Ecosystem Management Areas, at least 20 percent of each forest type should be allocated to maintaining or improving old growth. Table 20 displays the minimum criteria for defining old growth, common to Forest Plans throughout the Southwestern Region. Stands meeting these criteria are considered old growth, but stands are not required to meet these criteria to be managed for old growth.

Forest Plan direction says to *...develop or retain old growth function on at least 20 percent of the naturally forested area by forest type in any landscape*. Further direction is provided to allocate those percentages at the ecosystem management area (EMA) level. The assessment area includes portions of nine EMAs: Polvadera, Cañones, San Antonio, L.A., Canyon, Cebollita, San Juan, Paliza, and Borrego and has not been fully inventoried for old growth. Areas with the greatest likelihood to currently meet old growth criteria include steep slopes, unlogged drainages, and reserved areas such as Mexican spotted owl protected activity centers and northern goshawk post-fledgling and nest areas. Productive soil types have the best potential for achieving old growth conditions in the future.

**Table 20 Minimum criteria for old growth structural attributes (Forest Plan)**

Forest Cover Type	Piñon-Juniper		Ponderosa Pine		Aspen	Mixed-Conifer		Spruce- Fir	
	Low	High	Low	High	All	Low	High	Low	High
Site Capability									
Live Trees in Main Canopy:									
Trees/Acre	12	30	20	20	20	12	16	20	30
DBH/DRC	9"	12"	14"	18"	14"	18"	20"	10"	14"
Age (Years)	150	200	180	180	100	150	150	140/ 170	140/ 170
Dead Trees Standing									
Trees/Acre	0.5*	1	1	1	ND	2.5	2.5	3	4
Size DBH/DRC	9"	10"	14"	14"	10"	14"	16"	12"	16"
Height (Feet)	8'	10'	15'	25'	ND	20'	25'	20'	30'
Dead Trees Down									
Pieces/Acre	2	2**	2	2	ND	4	4	5	5
Size (Diameter)	9"	10"	12"	12"	ND	12"	12"	12"	12"
Length (Feet)	8'	10'	15'	15'	ND	16'	16'	16'	16'
Number of Tree Canopies	SS/ MS	SS/ MS	SS/ MS	SS/ MS	SS	SS/ MS	SS/ MS	SS/ MS	SS/ MS
Total BA, Square Feet/Acre	6	24	70	90	ND	80	100	120	140
Total Canopy Cover, Percent	20	35	40	50	50	50	60	60	70

Source: Santa Fe National Forest Plan

Where stand exam data exists, 14 stands were classified as VSS 5 or VSS 6 conditions at time of inventory. They range in size from 7 to 140 acres each. These stands may exhibit old growth character. They represent 5 percent of the sampled stands, and only 2 percent of the sampled acres. In evaluating VSS 5 and 6 at the plot or clump level, the VSS 5 and 6 clumps represent 14 percent of the ponderosa pine cover type. This is well below historic reference conditions.

In ponderosa pine, the forest plan requires managing for a wide range of VSS classes, distributed in small clumps with openings in between clumps. In ponderosa pine systems, approximately 20 to 40 percent of the clumps should be in VSS 5 or 6, or in a mature to old growth condition. In ponderosa pine under a natural fire regime, it is unlikely that old growth would exist in 40-acre or larger patches, but would instead be peppered throughout the landscape. In mixed conifer stands with a mixed-severity fire regime, old growth may exist in 40-acre and larger patches due to the typical fire disturbance pattern. In spruce-fir forests, old growth may exist in larger, more contiguous areas, as disturbances tend to occur less frequently but over a larger area. In aspen

patches, old growth is rare as aspen is an early development ecosystem that is over-taken by various fir and spruce trees over time, and is historically regenerated by a fire or insect epidemic.

## **Vegetation Management**

As previously mentioned, past management activities have contributed to changes in forest conditions. Treatment-specific records of activities occurring before the 1990s are quite limited. The level of detail in treatment records has greatly improved over the past decade, and currently, Geographic Information System (GIS) databases enable the National Forest to maintain accurate records of treatment locations.

Most of the vegetation management activities in the area over the past 30 to 40 years have been intermediate treatments—thinning the smaller trees for a variety of resource objectives. Approximately 2,100 acres of commercial thinnings have been carried out on National Forest land in the assessment area, including sanitation and salvage harvests to remove dead or dying trees, as well as thousands of acres of precommercial thinning. Spacing of saplings and poles after precommercial thinning remained close (8 to 10 feet apart) with the anticipation of a future pulpwood harvest which never came to be. Consequently, many of these areas have received additional non-commercial thinning since the 1990s, while others remain densely stocked.

Approximately 900 acres of regeneration harvests have occurred in the assessment area, mostly in the ponderosa pine forest in the late 1980s and early 1990s. Most were shelterwood prescriptions. The shelterwood harvests removed the understory trees and retained an open canopy of large ponderosa pine trees to provide a seed source for regeneration. Although removal of the overstory was planned for a later date, it never occurred for most of the shelterwood units. In a few stands, shelterwood final removals or other overstory removals were used where there was sufficient pine seedling regeneration, to allow for better growth of the seedlings. Group selection harvests or removals of small patches less than 4 acres in size were also used in some forest stands. No clearcut harvests were conducted in the assessment area.

Reforestation (tree planting) occurred on approximately 1100 acres in the assessment area, mostly in larger wildfire burn areas where seed sources were lacking. Stands were typically planted with 300 trees per acre or more, and with the lack of subsequent fire or thinning, many remain uncharacteristically dense.

Table 21 and Figure 24 summarize the forest and fuels management projects with NEPA analysis and decision documents that were completed over the past 20 years. Several of these projects have not yet been fully implemented. The activities are listed by project area name, in chronological order from the most recent to the oldest, per existing records. Treatments in the Preserve are noted, and all others are on the National Forest. Activity type acronyms used in the table are as follows: IH=Intermediate Harvest (thinned); RH= Regeneration Harvest; B=Burn (burned without mechanical thinning).

**Table 21. Vegetation management projects with NEPA decisions completed, 1989-2009**

NEPA Decision Date	NEPA Project Name & <i>Implementation Name</i>	NEPA Doc. Acres or GIS map acres	Activity Types
2007-09-12	<b>Jemez Collaborative Forest Restoration Program</b> <i>Redondo (3 units), East Fork (3 units), and a Mistletoe unit</i>	203, 47, 142	IH, B
2007-09-12	<b>Jemez Collaborative Forest Restoration Program: (on Preserve)t</b>	165	IH, B
2006-02-02	<b>Paliza Burn</b>	2,100	B
2005-09-21	<b>Preserve: Valle Toledo RxFire</b>	1961	B
2005-08-02	<b>San Antonio Ck Riparian Thin</b>	4 miles	IH, B
2005-01-27	<b>Oak-Pony-Hay Meadow Restoration</b>	250	IH, B
2004-11-24	<b>LosConchas Meadow Restoration</b>	70	B
2004-09	<b>Cajete Blowdown</b>	12	RH
2004-08-31	<b>Monument Canyon Research Natural Area Ecological Restoration Project</b>	234	IH, B
2004-04-15	<b>F.Road 10 Thinning (12 mi. road)</b>	45	IH, B
2003-09-30 amended 2007-01-17	<b>Forest Health- Stand Improvement (Thinning) Jemez Ranger District Campgrounds</b> <i>Jemez Falls-150 acres, San Antonio-20 acres, Redondo- 100 acres, Paliza Family-75 acres, Paliza Group-20 acres</i>	365	IH, B
2003-08-08	<b>Preserv: Fuels &amp; Veg Project</b>	607	IH, B
2003-08-06	<b>Lakes Fire Timber Salvage, portion within assessment area</b>	4,887	RH
2003-06-10 2002-DN appealed; 2007 clarifctn	<b>Jemez Wildland Urban Interface Hazard Reduction Project: Sierra Los Pinos and Thompson Ridge (portions within assessment area)</b>	1,948-2,270	IH,B
2001-09-17	<b>Sierra los Piños 2 Fuels Reduction</b>	483-467	IH, B
1999-11-22	<b>Jemez Corridor Fuelbreak; Forest Rds 607, 1610</b>	970	IH, B
1999-09-28	<b>EastFork Thinning Fuelbreak</b>	260	IH, B
1998-01-06	<b>Thompson Ridge Fuelbreak</b>	130-194	IH, B
1997-09	<b>Vallecitos Fuelbreak</b>	500	IH, B
1997-07-09	<b>San Juan Mesa Burn</b>	7150	B
1997-03-27	<b>Monument Cyn Fuelbreak</b>	50	IH, B
1996-05-31	<b>Stable Mesa Burn</b>	6200	B
1995-08-04	<b>Dollar Fuelwood</b>	110	IH, B
1995-	<b>Nicole Fire Salvage</b>	288	IH
1994-	<b>Cat Mesa Burn</b>	1381	B
1994-09 1995-06-05 DN-Suppl.	<b>Paliza Vegetation Mgt.: GrpSel- 354 ac; Thin-1372 ac; ThinPJ- 20 ac; SpCuts-194 ac; Shltrwd-40 ac; Burn only- 4,520 ac.</b>	6500 total: IH/RH,B: 1980 Burn only: 4520	IH/RH, B

**Table 21. Vegetation management projects with NEPA decisions completed, 1989-2009**

NEPA Decision Date	NEPA Project Name & <i>Implementation Name</i>	NEPA Doc. Acres or GIS map acres	Activity Types
1989-	<b>Bonito Diversity Unit:</b> <i>Bonito, Banco and Bench timber sales</i>	7037 ( <i>analysis area acres</i> )	RH, IH, B

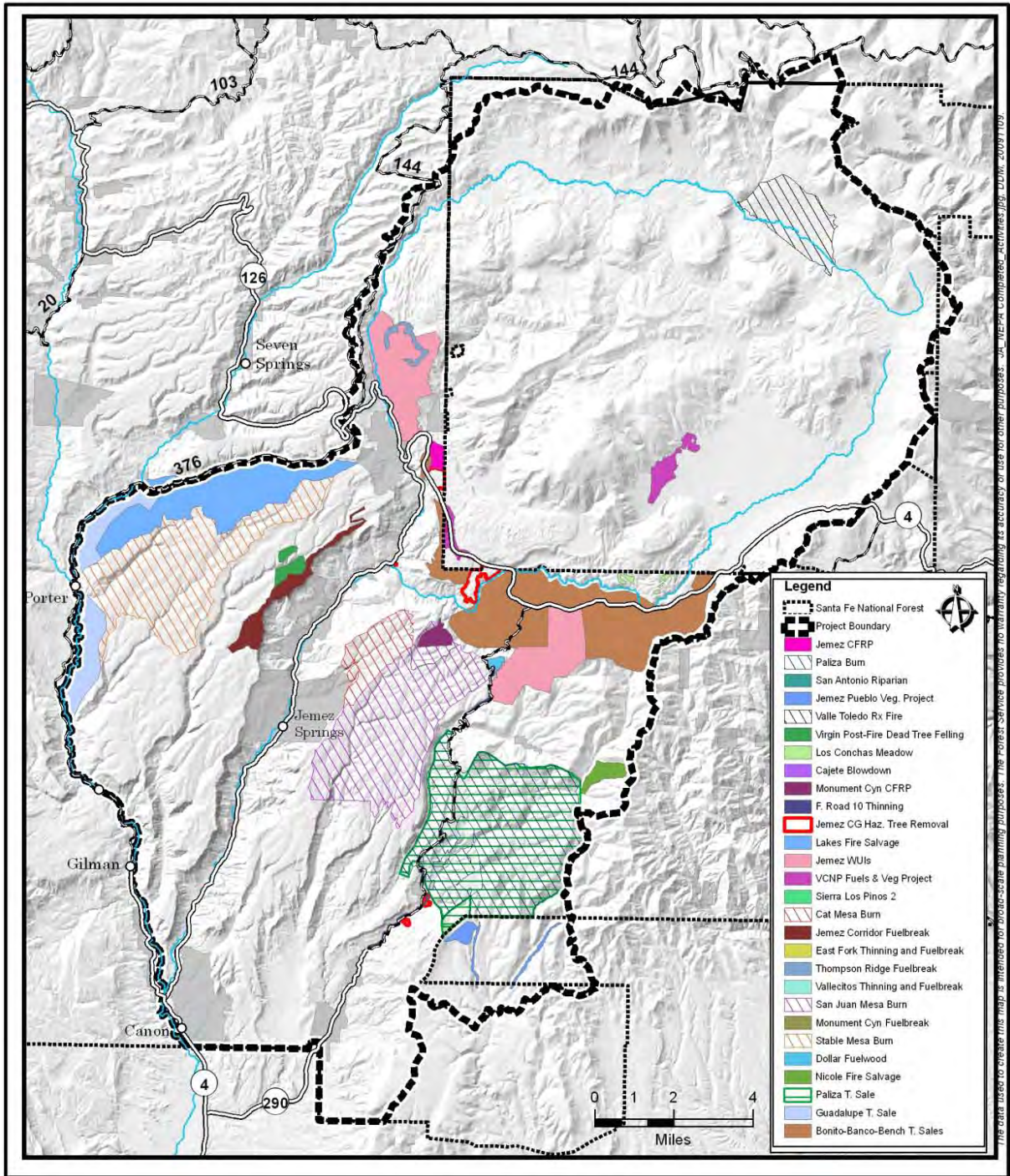


Figure 24. Vegetation management projects with NEPA decisions completed

# Fuels and Fire

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of forest fire and fuels within the assessment area. Reference conditions or management standards come from the 1995 Federal Wildland and Prescribed Fire Policy, the Forest's fire management units (FMUs) and associated objectives. The FMUs identify which wildland fire use strategy is typically preferred based on conditions within a specific geographic area. FMUs also indicate the prescribed fire objectives that apply to a given area (fire management plan section D). Conditions are described in terms of fire regimes (including frequency, extent and intensity of fires), and potential fire behavior, such as the potential for high-intensity crown fire behavior. Definitions of the terminology used in this section can be found in the Glossary.

Some of the modeling tools used in this analysis included:

- Historic fire weather was analyzed to determine winds and fuel moisture conditions during the fire season using FireFamilyPlus (USDA 2002). Adjustments were made based on weather conditions data from the Jemez RAWS station. Wind speed and direction were inputs into fire behavior calculations, using Wind Wizard (Butler et al. 2006) to model variability of wind speed and direction due to topography across the landscape.
- Research on fire history conducted in the Jemez Mountains and other reliable scientific research publications were used to illustrate the departure from reference conditions for each of the ecosystems in the SWJM landscape area.
- The PROBACRE computer program was used to estimate the probability of a single large fire event (over 4,000 acres) occurring within the next 20 years, or a combination of wildfires occurring that exceeds a certain number of acres (Wiitala 2008).
- The latest version of FlamMap/FBAT was used in conjunction with LANDFIRE vegetation and fuels data, as a spatial (mapping) fire behavior risk model. It uses LANDFIRE data (Stratton 2009; [www.landfire.gov](http://www.landfire.gov)) to model fire behavior at a single point in time. Fuels and forestry specialists from the National Forest, Preserve, Forest Service Fire Sciences Lab and Washington Office critiqued and corrected LANDFIRE data for this specific landscape, using field verified forest and fuels condition data and walk-thru surveys to adjust the LANDFIRE satellite imagery data to better reflect actual conditions.
- The Forest Vegetation Simulation (FVS) model was used to calculate site specific values for trees per acre, crown density and crown-to-base height, based on inputs of field reconnaissance data, that share common vegetation and fuel characteristics due to past disturbances (wildfire), management activities (harvesting, thinning, burning), biological and physical characteristics (soils, aspect). Potential fire behavior was modeled with FVS to compare with the outputs from FlamMap/FBAT.

## Wildfire History

Historic reference condition (pre-1900) fire regimes in ponderosa pine forests of the Jemez Mountains were characterized by high frequency, low intensity low severity fires (Touchan and Swetnam 1995). The Jemez Mountains experience one of the highest levels of lightning activity in the western United States (Reap 1986) resulting in a high frequency of lightning caused fires (Barrows 1978). Figure 25 shows lightning-caused fire ignitions in the area since 1970.

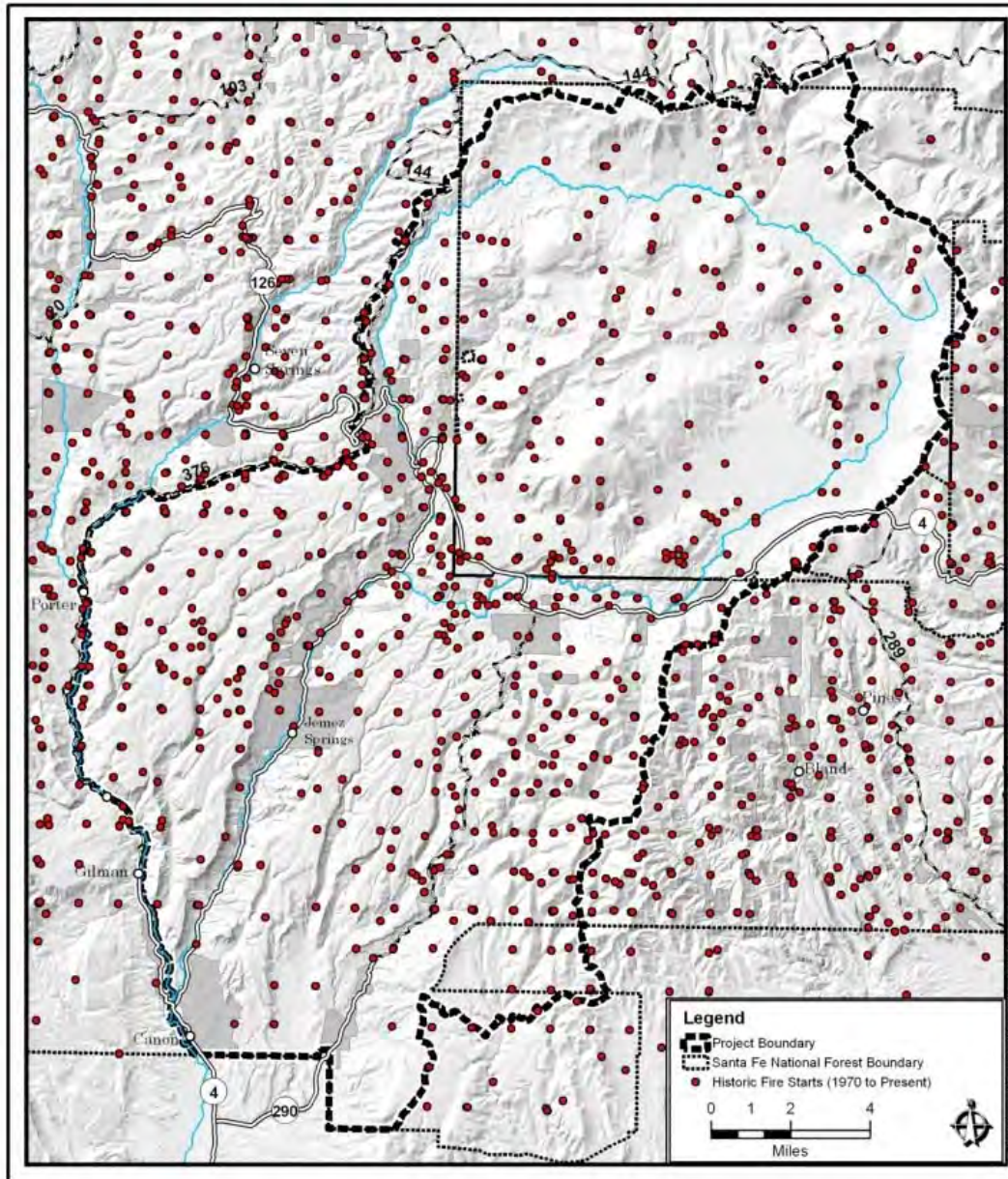


Figure 25. Past fire ignition points, 1970 to 2009

There have been seven large wildfires (over 300 acres) within the assessment boundary in the past 20 years. All of them, with the exception of the Stable, exhibited crown fire behavior, and all of them burned in the direction of the prevailing south-southwest winds that predominate during fire season. The Porter and Cebollita fires burned 8,000 acres in the early to mid 1970s. Just to the east of the assessment area, La Mesa, Dome and Cerro Grande fires burned a combined 80,000 acres, much of them with crown fire. Table 22 and Figure 26 display the recent past wildfires over 200 acres in size that burned in this area.

**Table 22. Large fires in the assessment area, 1989 - 2009**

Fire Name	Size (Acres)	Cause	Fire Date
Virgin	406	Human Caused	June/2003
Henry	800	Lightning	June/1991
Stable	1246	Human Caused	Oct/1999
Lakes	4095	Human Caused	Aug/2002
Hondo	445	Lightning	Aug/2000
Nicole	400	Lightning	June/1996
Labor	200	Human Caused	August/2002

(Source: Forest GIS database 2009)

## Fire Disturbance Regimes

Fire regimes in the mixed conifer forests were characterized by somewhat lower fire frequencies and higher severity than in the ponderosa pine forest (Allen 1984). Prior to 1893, the mean fire return interval (MFI) for the ponderosa pine stands in the Monument Canyon area was 5 years (Swetnam 1995). The MFI for the mixed conifer stands at the Los Griegos Mountain site was 15 years (Swetnam 1995). Patchy crown fires also occurred during some years in the mixed-conifer forests which encouraged the establishment of aspen. Data collected by Swetnam in the Canada Bonito area above Los Alamos indicates a pulse of aspen regeneration in the 1890s, which suggests crown fire occurrence across much of those mixed conifer forest slopes (Allen 1984, Swetnam 1988).

A great deal of variability in past fire regimes existed in the pine and mixed conifer forests of the Southwest. On a local scale, fire behavior and growth are heavily influenced by slope, elevation and aspect as fire patterns tend to follow topographic landforms (Graham 2003, Graham and McGaffrey 2004).

On a regional scale, a change in the climate conditions after 1875 played an important role in the decline of fire occurrence after the late 1800s. Touchan and Swetnam's (1995) climate reconstruction for the Southwest indicates a very wet period occurred from 1875 to 1930. There was a cessation in widespread fire occurrence in the Jemez after 1893 (Allen 1989, Allen 1984), principally because of intensive wide spread grazing. By 1900, intensive livestock grazing had reduced the continuity of the grassy surface fuels and hence the ability of surface fires to spread. Trails created by the herding of animals also disrupted fuel continuity and fire spread patterns. Land use changes have continued to alter the ignition and spread patterns of historical fires (Figure 25). Prior to European settlement fires that ignited in the low elevation grasslands gained

access to adjacent forest lands. Now the continuity of fine fuels across these non-forested lands has been reduced or eliminated because of human land use such as development, road construction, and agriculture.

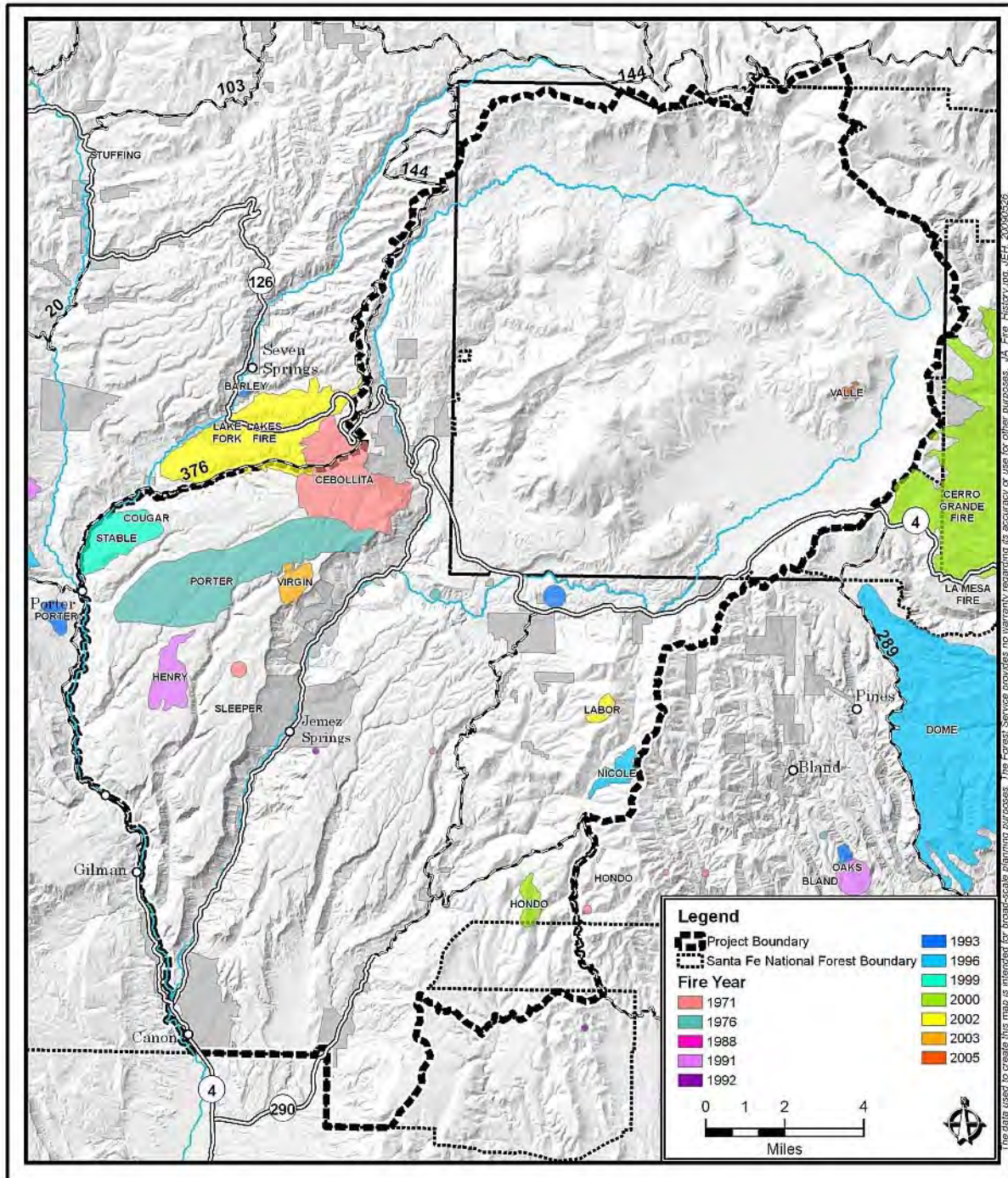
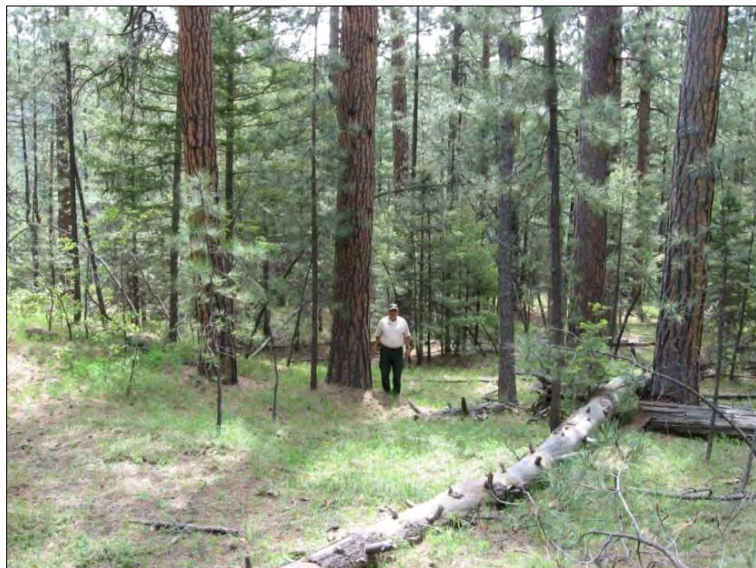


Figure 26. Past wildfires, 1971 to 2009

Fire detection and aggressive suppression programs began in this area in the 1920s, marking the beginning of the era (nearly a century) of fire exclusion. It appears that only a small fraction of the pre-1900 annual average fire acreage is being burned today in the Southwest (Gruell 1985). Gruell estimated that throughout the Rocky Mountain Region, modern fires burn less than one-fourth of the land that burned prior to 1890. Not all ecosystems or plant communities in the Southwest have experienced the impacts of fire exclusion as yet. In some ecosystems such as alpine or desert scrub, fires were important, but their rate of occurrence was low and they have not been as severely altered as the ponderosa pine forests by the relatively short period of fire suppression. Despite these exceptions the Southwestern landscape is not burning at the pre-1900 rate (Covington et al 1994).

Fire suppression (exclusion) has resulted in the most devastating impact on this landscape, in part because the long-term impacts of fire suppression are manifest in nearly every portion of the landscape rather than localized to small areas (Keane 2002). Fire plays a critical role in sustaining forest ecosystems. It recycles nutrients, regulates succession by selecting and regenerating plants, maintains diversity, reduces biomass, controls insect and disease populations, regulates interaction between vegetation and animals, and maintains biological processes (Agee 1993).

Past harvesting and silvicultural practices, such as overstory removal of ponderosa pine, favoring white fir and Douglas fir as the replacement stand, and logging with no follow up slash disposal compounded the effects of fire exclusion. The most documented and studied effect of fire exclusion is the change in stand composition and structure in historic ponderosa pine forest ecosystems. Fire exclusion resulted in dramatic increases in shade-tolerant late seral species such as white fir, and increasing tree densities regardless of site (Figure 27). Increases in tree densities result in increased accumulations of woody surface and canopy fuels. Crown fuels increase because late seral, shade tolerant species tend to have more biomass in the forest canopy due to their leaf areas, and the needles tend to be well distributed over the height of the trees. Shade tolerant species generally have longer needle retention times, and because of their shade-tolerance, they rapidly generate an overabundance of seedlings and saplings in the understory. They also have thinner bark and lower branches than ponderosa pine trees, which makes them more susceptible to mortality in surface fires. Forest composition has gone from shade-intolerant tree species like ponderosa pine to shade intolerant species such as white fir, with stand structure shifts from single-layer canopies to multiple-layer canopies (Keene et al 2002). The combination of greater crown leaf mass distributed along greater parts of the



**Figure 27. Old growth ponderosa pine forest invaded by white fir**

bole and high seedling and sapling densities create ladder fuels that allow flames from surface fires to climb into the canopy and result in crown fires.

Figure 28 shows an old growth stand of ponderosa pine that was invaded by shade-tolerant Douglas fir and white fir trees as a result of fire exclusion. Under a natural fire regime, a low to moderate intensity surface fire would have killed the fir trees when they were seedlings or young saplings, the large pine trees would have survived, and pine seedlings would have grown into the sunlit openings. The photo was taken north of the East Fork of the Jemez River along the Preserve boundary. The ponderosa pine tree in the foreground is over 400 years old, and there are other large pines in the left margin of the photo. The Douglas fir and white fir trees in the background are 80 to 90 years old.



**Figure 28. Typical dense ponderosa pine stand in the area**

Stand exam data collected in dry ponderosa pine forest stands show tree densities of 800 to 1,000 ponderosa pine trees per acre, which is much higher than what occurred under historic fire regimes. A sample ponderosa pine stand in the Monument Canyon Research Natural Area was a dense thicket of over 8,700 trees per acre, consisting of mostly saplings and small pole-size trees and about 40 stems/acre of large mature ponderosa pine, prior to being thinned in 2007.

Because of the dry climate, productivity exceeds decomposition and woody surface fuels tend to increase in the absence of fire (Keene et. al.2002). Long periods between fires means dead fuels have more time to accumulate on the ground. Fire suppression/exclusion has allowed for development of highly unnatural stand structures and dead woody fuel accumulations in the ponderosa pine. Accumulations of pine needles and other organic matter have increased in some places by up to 200 percent (Fulè et al 1997). Grass and non-woody plants have dramatically disappeared from the forest floor as the dense tree canopy shaded them out.

Grazing and fire exclusion have resulted in changes to surface fuels, with corresponding changes in surface fire intensities and rates of spread. Prior to intensive grazing and fire suppression, surface fuels that were responsible for carrying fire were grasses intermixed with dead plant material (Figure 29). Note in Figure 28 above, the absence of grass or any vegetation under the dense canopy of ponderosa pine. Under the same weather conditions, a fire burning in grass will spread at 2300 feet per hour and generate flame heights of six feet where a fire burning through pine needles will spread at 528 feet per hour and generate flame lengths of two and a half feet. A surface fire burning through compact fir needles will spread at 100 feet per hour and generate flame lengths of only one foot. The difference in intensities between fuels beds is because the “fluffier” the fuel the more oxygen there is available for the fire to burn, tightly packed fuels burn slower with less intensities than loosely packed fuels.



**Figure 29. Herbaceous understory recovery after thinning and burning**

Historically surface fires in the forest were probably more intense and faster moving than surface fires are today. However, the accumulations of large diameter woody fuel and litter and duff layers have probably increased the severity of today’s fires. Large logs and heavy duff burn and smolder for extended periods of time known as residence time. Increased residence times promote the formation of water-repellant layers at or near the soil surface, and loss of soil structural stability. The results are increased run-off and soil particle detachment by water and increased transport off-site (erosion). Generally, there is a close correlation between soil properties and the amount of heat experienced by the soil as well as the residence time of the heat in contact with the soil.

## Fire Regime Condition Class

Fire Regime Condition Class (FRCC) measures the degree of departure (gap) between existing conditions and reference conditions<sup>1</sup>. Causes of this departure in this area include fire suppression, livestock grazing, and timber harvesting, as just discussed (Schmidt et al 2002). FRCC represents the current ecological trend in forest structure, composition, and processes. FRCC is commonly reported in three classes:

- FRCC 1: No or low departure
- FRCC 2: Moderate departure
- FRCC 3: High departure

FRCC was measured using the Standard Landscape Mapping Method (Hann et al. 2008), using the FRCC Mapping Tool (FRCCmt) version 2.2.0, was applied to geospatially assess FRCC departure metrics for the project area. The FRCCmt produces consistent, objective, and spatially specific output data for multiple scales. The FRCCmt requires geospatial data on biophysical setting (BpS), succession class (S-Class), and landscape units, plus the tabular dataset of reference conditions.

The BioPhysical Setting (BpS) layer was downloaded from the [LANDFIRE](#) products. Biophysical settings are the primary environmental descriptors used for determining a landscape's natural fire regimes<sup>2</sup>, vegetation characteristics, and resultant FRCC departure metrics. Biophysical settings use dominant vegetation types and their associated fire regimes. Map units are classified using [NatureServe's Ecological Systems classification](#) and represent the natural plant communities that may have been dominant on the landscape during the reference period and are based on both the current biophysical environment and an approximation of the historical disturbance regime.

Each BpS is associated with a vegetation dynamics model, which is used to quantitatively assess information about the rates and pathways of vegetation succession and the frequency and effects of disturbances during the reference condition period. Each model is created through a series of expert workshops and a review process that engages regional experts from around the country and is based on expert knowledge and published literature. Each model includes comprehensive documentation that describes the vegetation, geography, biophysical characteristics, succession stages, and disturbance regimes of the BpS. Figure 30 displays a map of the major (largest, grouped) biophysical settings in the assessment area.

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<sup>1</sup> Reference Condition: “the composition of landscape vegetation and disturbance attributes that, to the best of our collective expert knowledge, can sustain current native ecological systems and reduce future hazard to native diversity” (Hann and others 2008).

<sup>2</sup> A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention but including the possible influence of aboriginal fire use (Agee 1993, Brown 1995).

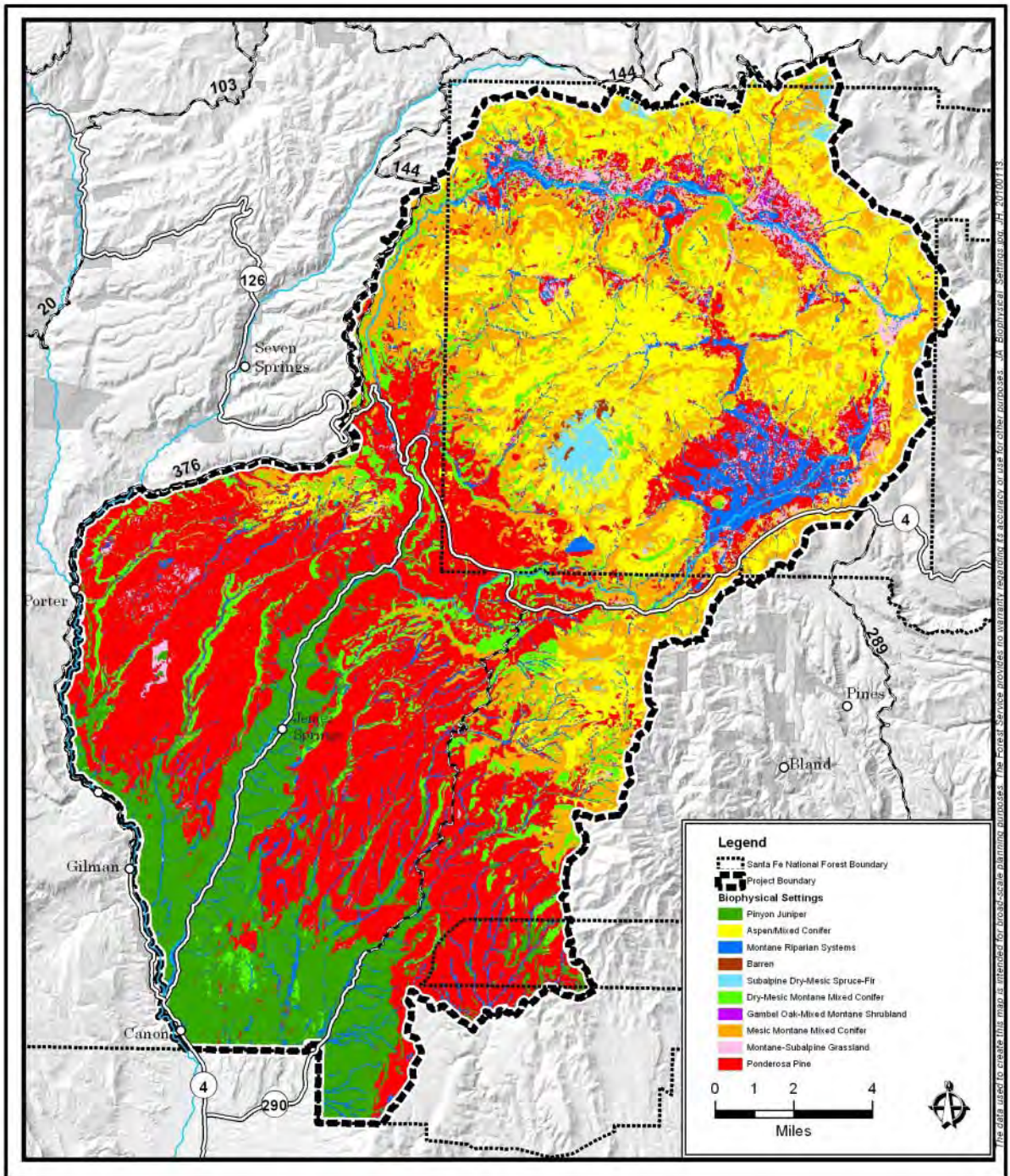
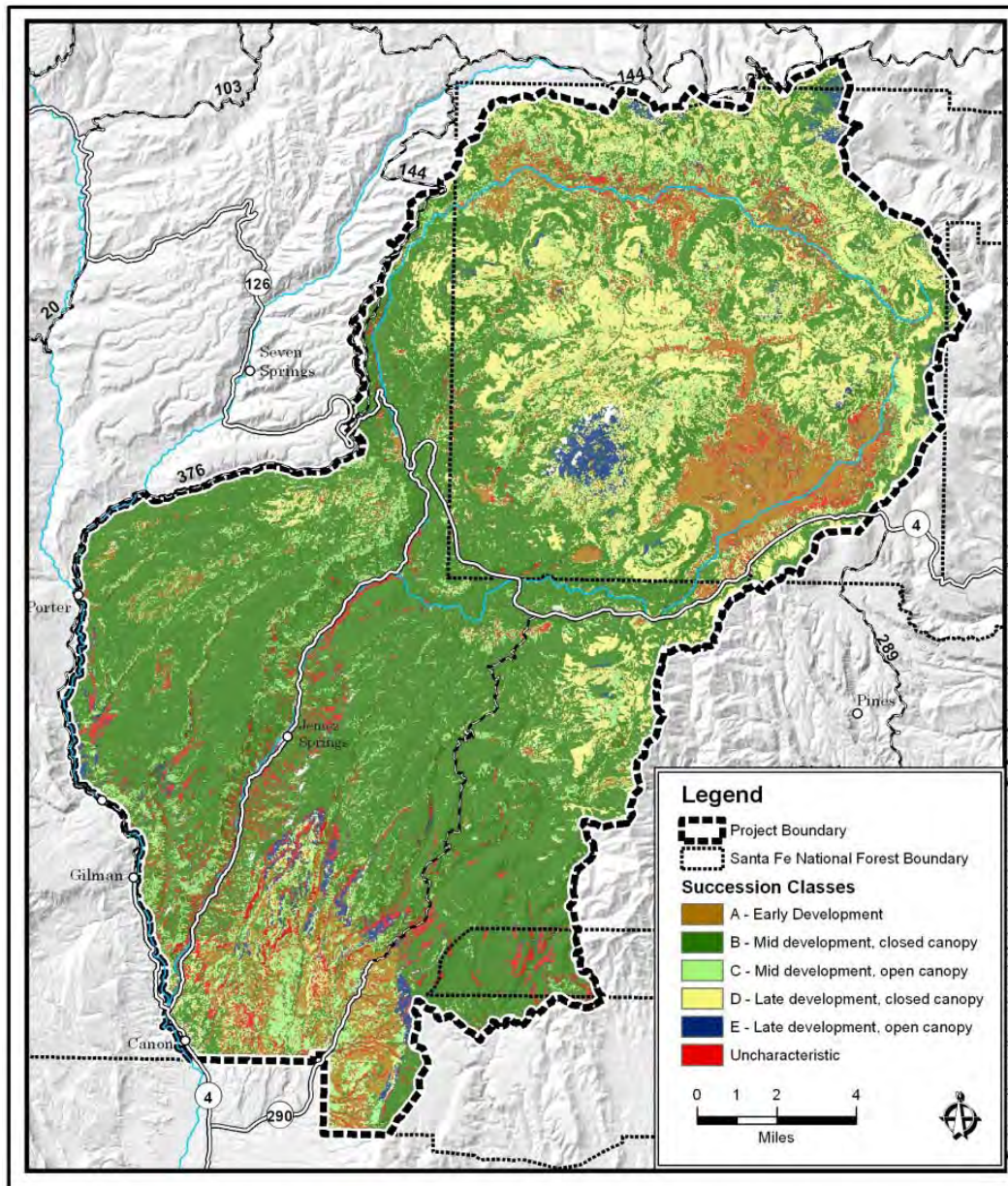


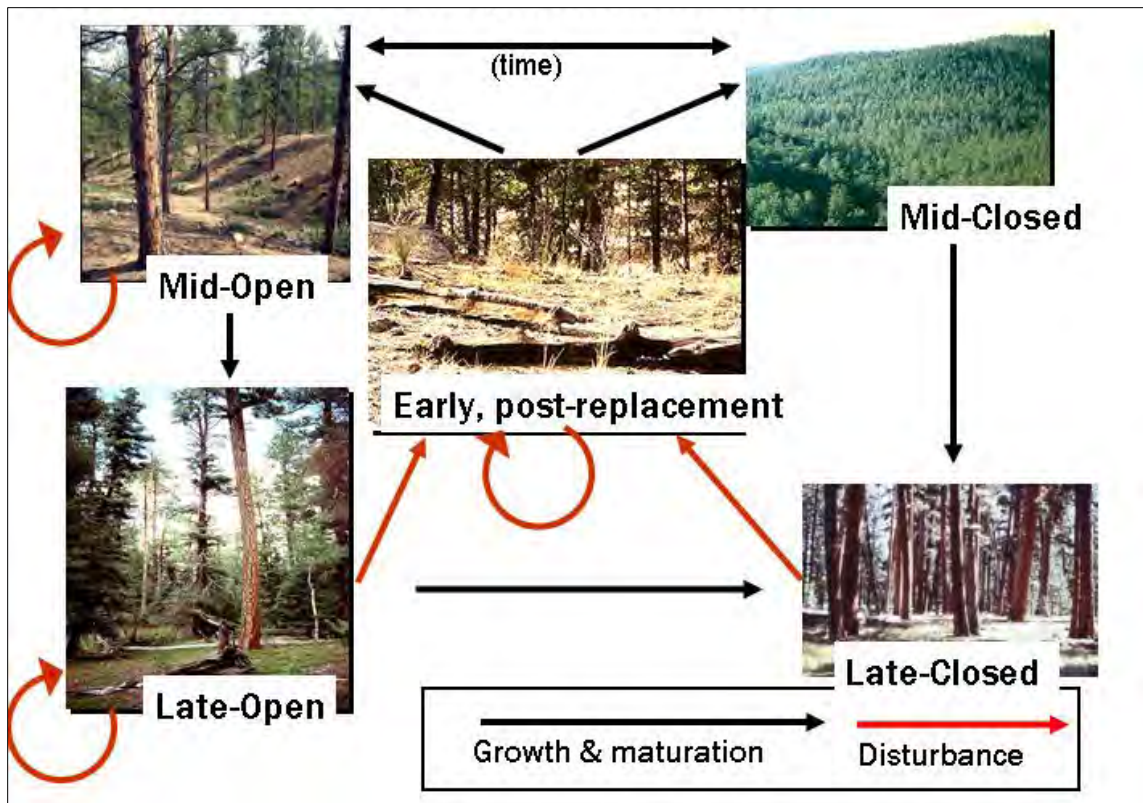
Figure 30. Major biophysical settings (ecosystem types)

Succession classes (S-classes) are characterized by the structural traits for each BpS vegetation type. For any given stand, only one S-Class can occur at a time. However, multiple succession classes can occur in different stands across a given BpS. While there are five standard S-classes in forest ecosystems, grasslands may have only one to three S-classes (Hann et al 2004).

Figure 31 is a map displaying the distribution of S-classes across this landscape area. The area is clearly dominated by mid-stage closed canopy forest, in nearly all forested ecosystems. This differs from the more structurally diverse and more open canopy conditions that historically dominated the ponderosa pine forest, woodlands, and dry mixed conifer forests covering most of this landscape. Figure 32 shows photos and dynamic flows of S-classes for a forest ecosystem (Agee and Skinner 2005).



**Figure 31. Forest succession classes (structural stage and canopy closure)**



**Figure 32. Succession class dynamics, early-open to late-closed forest**

FRCC analysis involves the following data assumptions and limitations:

- The BpS layer represents an ecosystem’s reference condition based on an estimated historic range of variation and disturbance regimes.
- The historical range of variation may portray climatic conditions that are not representative of current and future conditions. The reference conditions used in this analysis represent conditions that are considered to be resilient and capable of supporting future biodiversity at the landscape scale.
- FRCC departure estimates are sensitive to the S-Class layer mapped by LANDFIRE, which is assumed to represent the current distribution of vegetation composition and structure.

Results from the FRCC analysis found that 94 percent of the assessment area is departed from reference conditions, with 53 percent being moderately departed and 41 percent highly departed. Thus most of the ecosystems in the area are in FRCC 2 or 3, which makes them highly susceptible to uncharacteristic wildfires.

Table 23 shows the S-class reference conditions for major biophysical settings within the assessment area; for biophysical settings totaling over 2,500 acres within the entire assessment area. They are listed in order of abundance in the area. Some LANDFIRE map units were corrected based on more accurate data regarding the biophysical settings known to occur in certain geographic locations in the area. For example, LANDFIRE map units originally identified

as madrean encinal, big sagebrush shrubland, and juniper woodland were found to be located within and correlated with the Southern Rocky Mountain piñon-juniper woodland biophysical setting. Other corrections included changing LANDFIRE’s agriculture map unit to grasslands, and a few other minor corrections.

**Table 23. Reference condition successional class distribution among the major biophysical settings**

Biophysical Setting	Percent of Area	Successional Classes				
		Early	Mid Closed	Mid Open	Late Open	Late Closed
Southern Rocky Mountain Ponderosa Pine	35%	10	10	25	40	15
Inter-Mountain Basins Aspen-Mixed Conifer (Rocky Mountain Aspen)	19%	25 (5)	40 (35)	5 (60)	30 (0)	0 (0)
Southern Rocky Mountain Mesic Montane Mixed Conifer	15%	10	40	25	10	15
Colorado Plateau/Southern Rocky Mountain Pinyon-Juniper Woodlands	14%	5	20	30	35	10
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer	7%	15	15	10	50	10
Rocky Mountain Montane Riparian	7%	65	35	0	0	0
Southern Rocky Mountain Montane-Subalpine Grassland	2%	20	30	50	0	0
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir	2%	15	20	15	20	30

The successional class layer from LANDFIRE for current vegetation. FRCCmt compares current successional classes and their historical reference conditions to assess departure of vegetation characteristics within a landscape. The fire regime, size of the landscape, and amount and extent of the BpS should be taken into account when interpreting FRCC analysis results. The size of the landscape used to assess FRCC is based on the dominant fire regime of each BpS. The FRCC guidebook recommends using relatively small watersheds, 6<sup>th</sup> level HUCs- 10,000 to 40,000 acres, where small patchy fires in regime class I or II dominated historically (Hann et al 2004). Where variable-sized, mixed-severity fires dominated, mid-scale 5<sup>th</sup>-level watersheds- 40,000 to 250,000 acres are recommended. In areas dominated by large, replacement-severity fires, subbasins at the 4<sup>th</sup> level HUC- approximately 450,000 acres are recommended.

Three fire regime groups are associated with the biophysical settings within the area. Table 24 shows the natural fire regimes within the assessment area and the scale at which each was assessed.

**Table 24. Natural fire regimes: frequency, severity, and typical watershed size**

Fire Regime	Frequency (years)	Severity	Severity Description	HUC Level
I	0 – 35	Low/mixed	Generally low severity fires replacing less than 25% of the dominant overstory vegetation. Can include mixed severity fires that replace up to 75% of the overstory.	6 <sup>th</sup>
III	35 – 200	Mixed/low	Generally mixed severity, can also include low severity.	5 <sup>th</sup>
IV	35 - 200	Replacement	High severity, replacing more than 75% of the overstory vegetation.	4 <sup>th</sup>

Other FRCC-based metrics useful for evaluating the need for ecosystem restoration include:

- **BpS departure:** overall departure across all succession classes within a particular BpS
- **S-class departure:** succession classes that are departed within a given BpS and landscape
- **S-Class relative amount:** amount of an S-class that is deficient or excessive relative to the reference condition: Trace, Under-represented, Similar, Over-represented, or Abundant.

Table 25 shows the S-class relative amount and FRCC for the two dominant biophysical settings in the assessment area. Other tables comparing reference to current conditions are in the project record.

**Table 25. S-class relative amounts for the two dominant biophysical settings**

BpS Name	S-Class	Reference %	Current %	Acre Difference	S-Class Rel. Amt.
Mesic Montane Mixed Conifer	A-early	10	0.8	-2522	trace
Mesic Montane Mixed Conifer	B-mid closed	40	92.8	14539.9	over rep
Mesic Montane Mixed Conifer	C-mid open	25	4.6	-5631.6	trace
Mesic Montane Mixed Conifer	D-late closed	10	0	-2755.1	
Mesic Montane Mixed Conifer	E-late open	15	0.2	-4089.9	trace
Mesic Montane Mixed Conifer	U- unchar	0	1.7	458.8	abundant
Ponderosa Pine	A	10	10.2	43.8	similar
Ponderosa Pine	B	10	72.1	14757.6	abundant
Ponderosa Pine	C	25	10.5	-3445.2	under rep
Ponderosa Pine	D	40	0.7	-9335.7	trace
Ponderosa Pine	E	15	1.1	-3293.8	trace
Ponderosa Pine	U	0	5.4	1273.2	abundant

The mixed conifer and ponderosa pine biophysical settings that comprise at least 50 percent of the area are significantly departed from reference conditions. The ponderosa pine forest is highly departed from reference in all S-classes. Both biophysical settings show an excess of acres in the mid-development, closed canopy S-class and a deficit in the older structural classes and more open canopy structures. These results suggest a need to thin smaller trees within the dense mid-stage closed canopied stands (mechanically or with prescribed fire). This would still leave a shortage of late-development, open and closed canopy stands that only time and succession can mitigate but may have the additional benefit of reducing crown fire potential by reducing canopy bulk densities and raising canopy base heights.

Approximately 94 percent of the assessment area is in FRCC 2 to 3; moderately to highly departed from ecological reference conditions. Only 6 percent of the assessment area (excluding rock and waterbodies) was estimated with no significant departure (FRCC 1). Those FRCC 1 areas are located primarily in the moist meadows, riparian areas, and ridgetop grasslands (see Figure 33). Nearly all forested ecosystem areas are in FRCC 3, and the remaining are in FRCC 2. Ponderosa pine accounts for 74 percent of the FRCC 3, and the mesic (moist) mixed conifer 17 percent. About 75 percent of the FRCC 2 is from the aspen-mixed conifer (35 percent), mesic (moist) mixed conifer (29 percent), and piñon-juniper (11 percent). The mid-successional closed-canopied acreages are clearly over-represented throughout most of the assessment area. The late-successional open and closed classes are the most under-represented, compared to reference conditions. Figure 33 shows the distribution of FRCC classes in the area.

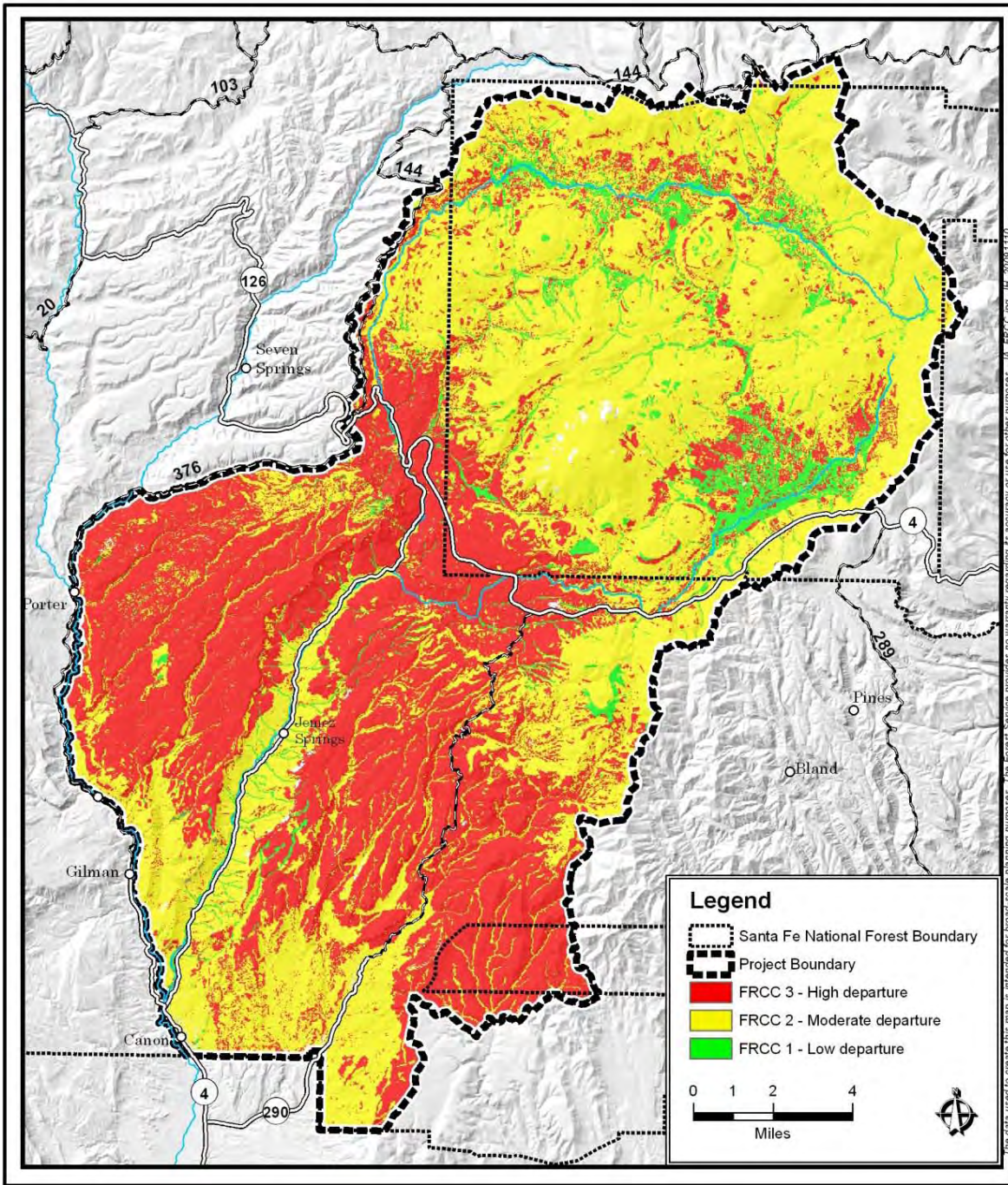


Figure 33. Fire regime condition class distribution across the landscape

**Table 26. FRCC departures for major biophysical settings**

Biophysical Setting	HUC Level	FRCC	Acres	Difference from reference condition
Ponderosa Pine	5 <sup>th</sup>	3	67,438	74% of the FRCC 3 in the project area Surplus of mid-development closed canopy stands Deficit of open canopy and late-development closed
Aspen-Mixed Conifer	6 <sup>th</sup>	2	38,644	Surplus of late-development open and closed canopy stands Deficit of early development and mid-development closed stands
Mesic Montane Mixed Conifer	5 <sup>th</sup>	2	32,209	Over 90% in mid-development closed canopy No late-development open canopy stands were mapped in the area Only trace amounts of the other succession classes
Pinyon-Juniper Woodland	5 <sup>th</sup>	2	15,904	Surplus of mid-development closed canopy stands Deficit of all other succession classes Uncharacteristic vegetation high (>20%)
Dry-Mesic Montane Mixed Conifer	6 <sup>th</sup>	3	14,952	17% of the FRCC 3 in the area Surplus of mid-development closed canopy stands Deficit of early development and late-development open and closed Mid-development open canopy stands highly variable
Montane Riparian Systems	5 <sup>th</sup>	1 & 2	13,942	Upper Jemez River 5 <sup>th</sup> level HUC has similar percentages of early and mid-development succession classes Uncharacteristic vegetation accounts for 16% in Upper Jemez River Other 5 <sup>th</sup> level HUCs have over-representation of mid-development Uncharacteristic vegetation accounts for up to 17%

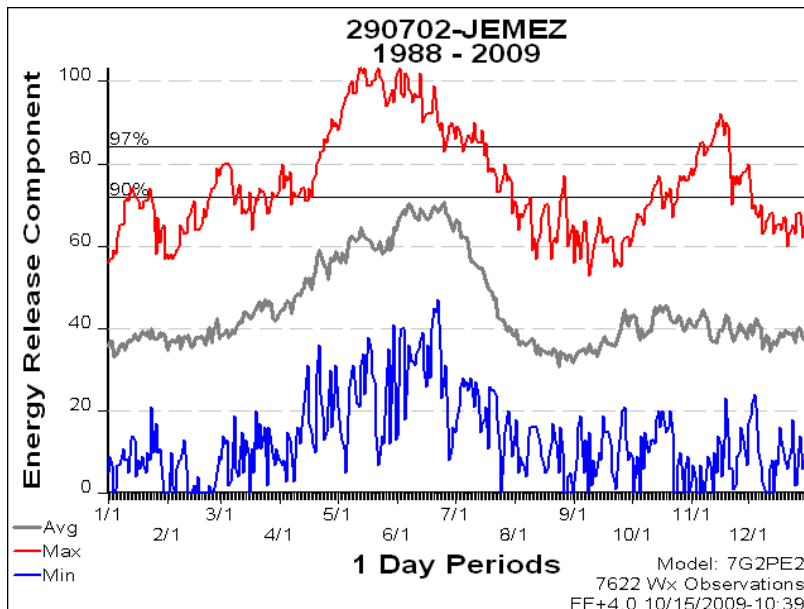
## Fire Behavior

Historical fire weather analysis utilized Remote Automated Weather Stations (RAWS) weather data available through KCFAST (<http://fam.nwcg.gov/fam-web/kcfast/mnmenu.htm>) and the Western Region Climate Center (<http://www.raws.dri.edu/index.html>). Weather for this analysis was initially obtained from two RAWS stations. Table 27 summarizes the length of data and some station information. The Jemez station data was determined to best represent the assessment area while the Tower data was used for landscape calibration using FARSITE.

**Table 27. RAWS station information in the Jemez Mountains**

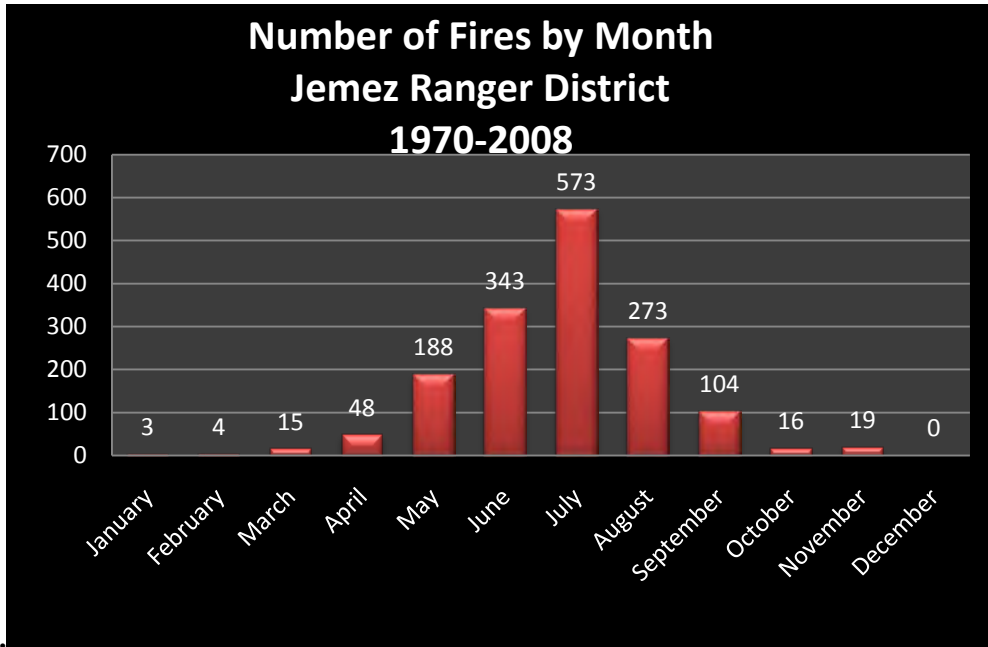
Station Name	Station Number	Record Period	Elevation (ft)
Jemez	290702	1966 - 2009	8,000
Tower	290801	1964 - 2009	6,500

Historic fire weather was analyzed to determine winds and fuel moisture conditions during the fire season using FireFamilyPlus (US Forest Service 2002b). ERC is a commonly used indicator of drought and fire potential that is calculated from fuel moistures and is used to assess the fire season. FlamMap adjusts fuel moisture for each pixel of the landscape to account for aspect, elevation, slope and canopy cover. Adjustments are based on weather conditions data from the Jemez RAWS station. Wind speed and direction are inputs into fire behavior calculations. Wind Wizard (Butler et al. 2006) was used to model variability of wind speed and direction due to topography across the landscape.



**Figure 34. Graph of energy release component from the Jemez RAWS station, for year round data, 1989 – 2009**

Approximately 90 percent of human and lightning ignited fires from 1970 to 2008 occurred when the ERC (G) was above 32, which is at the 28<sup>th</sup> percentile (1988 - 2008). Eighty-five percent of fires greater than 10 acres initiated when the ERC(G) was above 40 (43<sup>rd</sup> percentile).



**Figure 35. Fire occurrence 1970 to 2008 on the Jemez Ranger District, Santa Fe National Forest**

The PROBACRE Model for Computing Aggregate Burned Acreage Probabilities for Wildfire Risk Analyses (Wiitala 2008) was used for assessing the probability of crown fire behavior in the area. Inputs included historical fire size and annual occurrence over the past 20 years, such as: four 400-acre fires with an annual occurrence of 0.20, one 800-acre fire with annual occurrence of 0.05 and one 4,000-acre fire with an annual occurrence of 0.05. All probabilities were computed from information on the annual fire frequency data by size class. Burned acreage probability estimates were made on the assumption that the number of fire events in any period follows a Poisson probability model. PROBACRE assumes that the frequency and distribution of fire sizes will remain constant over any assessment time frame.

PROBACRE determined an annual probability of **not** having a fire of at least 4,000 acres to be 36 percent over the next 20 years. There is equal probability of having one 4,000-acre fire every year over the next 20 years, and an 18 percent chance of having two 4000-acre fires a year over the next 20 years. It estimated a 65 percent probability of wildfires exceeding 4,000 burned acres.

**Table 28. Probability of fire occurrences, per PROBACRE model results**

Size Class (Ac)	Annual Fire Frequency	Probability of Number of Fires Per Period					
		None	1 fire/year	2 fires/year	3 fires/year	4 fires/year	>4 fires/year
400	0.2	0.02	0.07	0.15	0.19	0.19	0.37
800	0.05	0.37	0.37	0.18	0.06	0.01	0.003
4000	0.05	0.36	0.36	0.18	0.06	0.01	0.003

Probability of exceeding 4,000 threshold in 20 years is 0.654; Probability of exceeding 20,000 threshold in 20 years is 0.004 (Wiitala 2008)

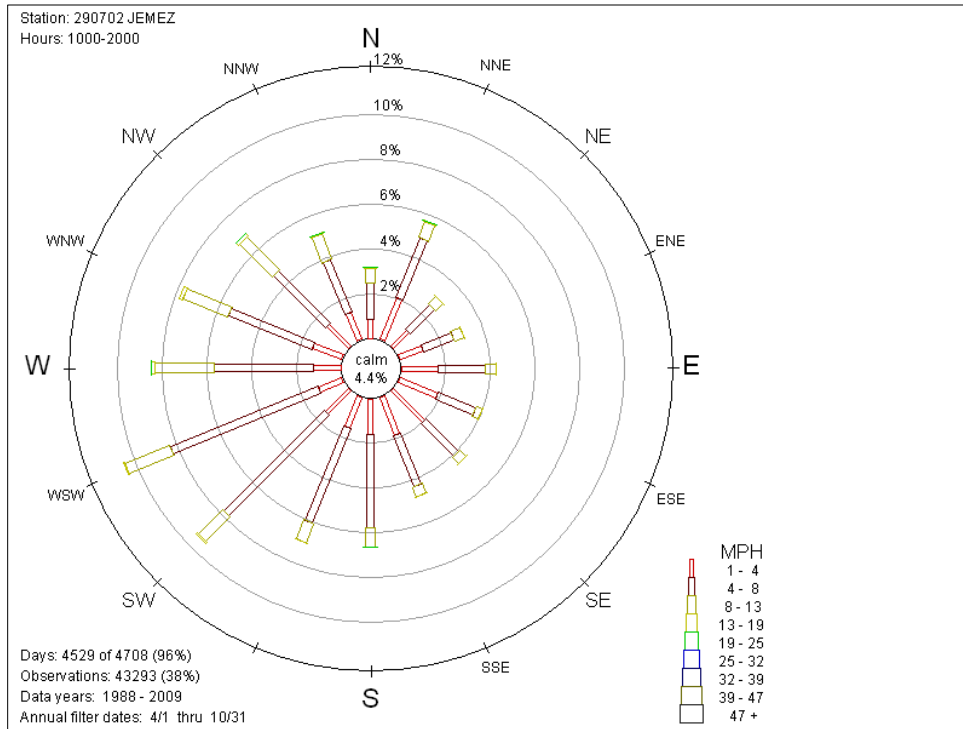
The FlamMap modeling system (Finney 2006) was used to assess distribution of potential fire behavior characteristics in the assessment area. Specific characteristics assessed were fireline intensity expressed as flame length, rate of spread, and type of crown fire activity. FlamMap was used to estimate burn probability, defined as the number of times a pixel burned as a proportion of the total number of fires simulated. Five thousand random ignitions were used in the simulations. Burn probabilities are related to the sizes of fires that occur on a given landscape. Large fires burn a larger portion of the landscape than small fires and therefore a given pixel is likely to be burned by multiple fires resulting in a higher burn probability.

To model fire behavior in FlamMap, fuel moistures and conditioning periods were selected to represent the Dome Fire (1996) and Cerro Grande Fire (2000). Both fires burned in late spring with dry fuel moistures and strong winds. Conditions during the Dome Fire were the maximum recorded from 1966 to 2009, while the conditions during Cerro Grande Fire approximate the 90<sup>th</sup> percentile conditions for 1988 – 2009. These conditions are referred to as maximum and dry (respectively to represent Dome and Cerro Grande fire weather). Fuel moistures were conditioned using weather data from the time periods these fires exhibited very active fire, including crown fire. FlamMap runs were completed with conditioned fuel moistures at 4:00 pm. One hour fuel moistures for the maximum conditions ranged from 1 to 6 percent with a modal value of 2 percent. For dry conditions, one-hour fuel moistures ranged from 2 to 9 percent across the landscape with a modal value of 4 percent.

Live woody fuel moistures vary greatly depending on time of season. Based on live fuel moisture guidelines (Scott and Burgan 2005), live herbaceous and live woody fuels are assumed 2/3 cured (60 percent herbaceous, 90 percent woody) for the maximum conditions and 1/3 cured (90 percent herbaceous, 120 percent woody) for dry conditions in the standard fuel models. For the wet meadows of Preserve, live fuel moistures are assumed at full vigor (120 percent herbaceous, 150 percent woody). Generally fire in fuels with shrubs (grass shrub, shrub, and timber understory models) will have more active fire behavior when live woody fuel moisture is below 100 to 120 percent, depending on species and location. By using the selected live fuel moistures, the modeled fire behavior in this analysis will reflect more active fire behavior in fuel models that incorporate live fuels during maximum conditions.

Winds during the daylight hours (1,000 to 2,000 hours) are somewhat variable, but are predominantly out of the southwest to west. Wind gusts of 30 to 40 miles per hour are fairly common. Winds of 30 mph from the southwest were used for analysis. Figure 36 graphically

shows the 1000 to 2000-hour wind speeds, April through October, from the past 10 years of recordings at the Jemez Springs climate station.



**Figure 36. Wind speeds at Jemez RAWs Station, Apr-Oct. 1988 – 2009**

Fuel models were inputs to the FlamMap model, to help predict surface fire behavior and transition to crown fire. The original fuel models from LANDFIRE data were refined based on field verified data from specific locations in the area. There are approximately 15 different fuel models identified in the area.

About 40 to 52 percent of the assessment area is mapped as fire behavior fuel model timber-understory 5 (TU5) and timber understory 1(TU1). The primary carrier of fire in timber understory is grass, shrub, litter, and small tree understory. About 20 to 33 percent of the area is mapped with a timber litter (TL) fuel model. The primary carrier of fire in the timber litter fuel models is dead and down woody fuel. Live fuel, if present has little effect on fire behavior. The remainder of the area is mapped as grass, grass-shrub or shrub. Fire behavior characteristics are directly related to fuel models, but vary with fuel moisture and wind. Table 29 shows the fuel models in the assessment area and their relative amount, in acres and percent of the entire area.

**Table 29. Fuel models and acreages**

Fuel Model	Fuel Model Descriptor	Forest		Preserve	
		Acres	Percent of Total	Acres	Percent of Total
TU5	Very high load, dry climate timber-shrub	61,733	29	33,924	39
TL8	Long needle litter	51,201	24	5,246	6
TU1	Low load dry climate timber-grass-shrub	20,251	10	10,902	13
TL3	Moderate load conifer litter	17,654	8	12,050	14
SH1	Low load, dry climate shrub	14,524	7	9	<1
GR2	Low load, dry climate grass	13,413	6	10,279	12
Custom	Moderate load, dry climate wetland	6,991	3	6,602	8
GS1	Low load, dry climate grass-shrub	6,026	3	851	1
GS2	Moderate load, dry climate grass-shrub	5,359	3	1,884	2
GR4	Moderate load, dry climate grass	4,043	2	3,321	4
GR1	Short, sparse dry climate grass	3,347	2	261	<1
SH2	Moderate load, dry climate shrub	2,534	1		
SH7	Very high load, dry climate shrub	745	<1	167	<1
TL1	Low load, compact conifer litter	724	<1	251	<1
SH5	High load, dry climate shrub	57	<1		

Fires are likely to exhibit a wide range of flame lengths and rates of spread and are likely to be crown fires in forests where there are sufficient surface fuels in association with low canopy bases to support crown fire. The FlamMap/LANDFIRE analysis resulted in comprehensive data tables of the predicted crown and surface fire behavior, including flame length, fire size, rate of spread, and other attributes, within each fuel model (available in fire and fuels specialist report and project record). While dry conditions have fewer acres of active crown fire and lower flame lengths and rates of spread, the patterns across fuel models are similar. Under maximum and dry conditions, flame lengths range from less than 1 foot to several hundred feet in forests where there are sufficient surface fuels in association with low canopy bases to support crown fire. The dominant TU5 fuel model will have the most potential for crown fires. Rates of spread range from less than one to several hundred chains per hour. Generally fire behavior will be dominated by active surface fire in the grass, shrub, and forest communities with little live surface fuels and crown fire in forests represented by timber understory fuel models.

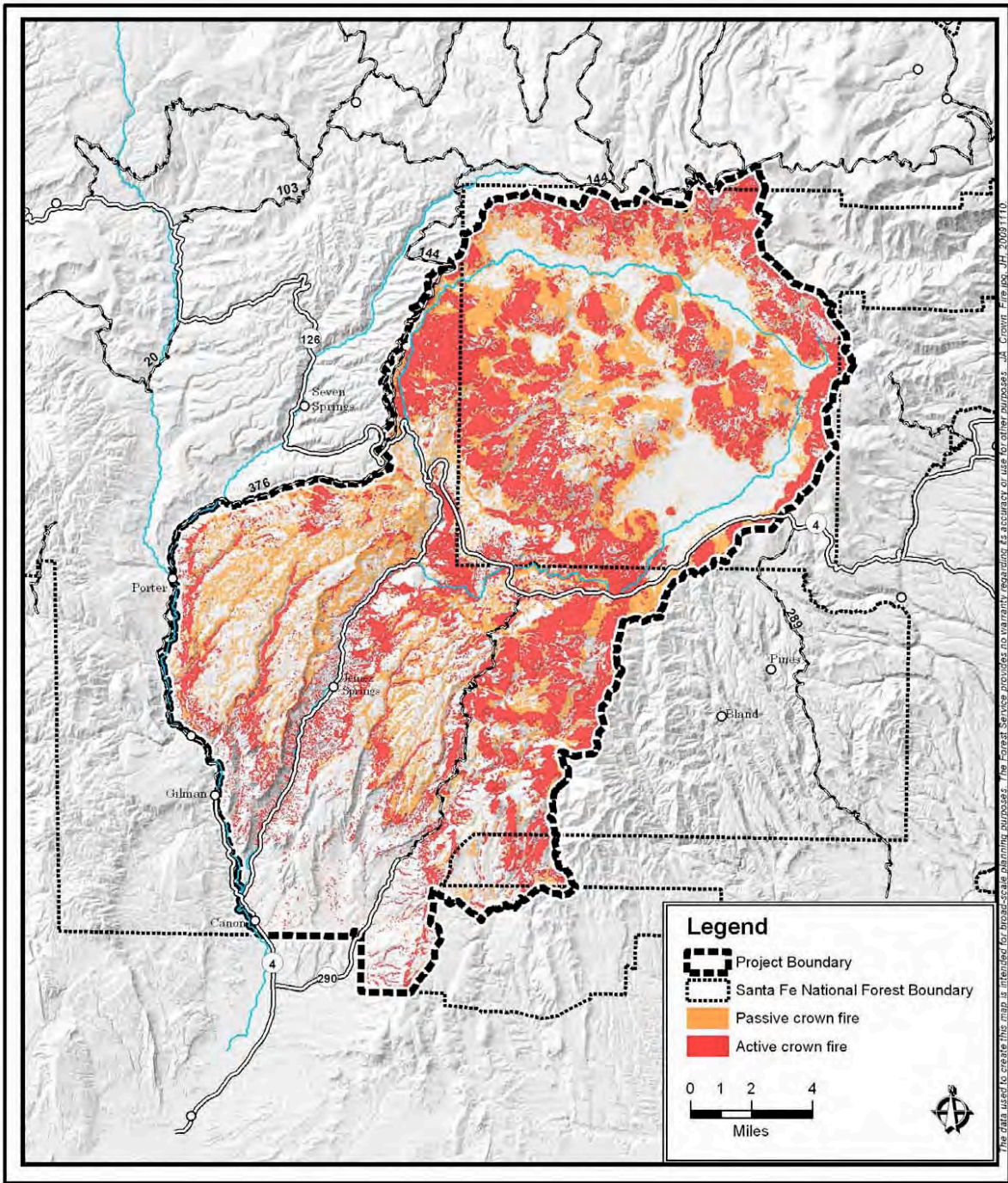
On the Preserve, a higher proportion of the landscape is predicted to experience crown fire due to the higher percentage of the landscape being represented as timber with heavy understory fuels. Wet meadows in the south of the preserve should be resistant to fire spread unless there is drought, which greatly reduces soil moisture and live herbaceous fuel moisture. If this should

occur, the meadows are expected to experience fire behavior similar to the moderate load, dry climate grass (GR4).

The entire assessment area has vegetation and fuel conditions that support fire, and most of the area supports crown fire behavior. The probability of fire burning on the landscape is greatly related to the arrangement of fuels on the landscape, which determines how fires move across a landscape (Figure 37). The forested slopes in the Preserve have the highest probability of burning within the assessment area, and a fire could reasonably be foreseeable to burn into Los Alamos, the National Lab complex, Santa Clara Pueblo and Bandelier National Monument. Under maximum conditions, forests in the southern portion of the assessment area have the highest burn probabilities, along with areas north and east of the assessment area (Figure 37). Flame length includes flame length when crown fire is predicted Figure 43 displays the predicted distribution of crown fire, both active and passive crown fire, likely to occur on this landscape, under extreme fire weather conditions. Extreme fire weather conditions occur at some point nearly every fire season. The remaining areas are more likely to burn as surface fire. In order to treat the assessment area to disrupt the growth of large crown fires, fuel treatments would need to be arranged in an optimal pattern over at least 1 to 2 percent of the landscape each year (Finney et al 2007).

## **Fuels and Fire Hazard by Geographic Area**

Geographic subdivisions of the assessment area were mapped based on areas that share common biological and physical characteristics (soils, aspect), or vegetation and fuel characteristics due to past disturbances (wildfire) and management activities (harvesting, thinning, burning). Each geographic area has a distinguishing set of fuel conditions that influence the need and opportunity for restoring natural fire regimes. Data on fuel quantity and arrangement, crown to base heights, species composition, tree density and arrangement was gathered in each block, along with photo point data, in representative locations. The data is not statistically robust but provides a basis for the characterization of forest conditions. The data was input into the Forest Vegetation Simulation Model (FVS) to calculate site specific values for trees per acre, crown density and crown-to-base height. Potential fire behavior was modeled with FVS for the sample plots to compare with the outputs from FlamMap/FBAT. Figure 38 is a map showing these distinct geographic areas.



**Figure 37. Crown fire risk under extreme fire weather conditions**

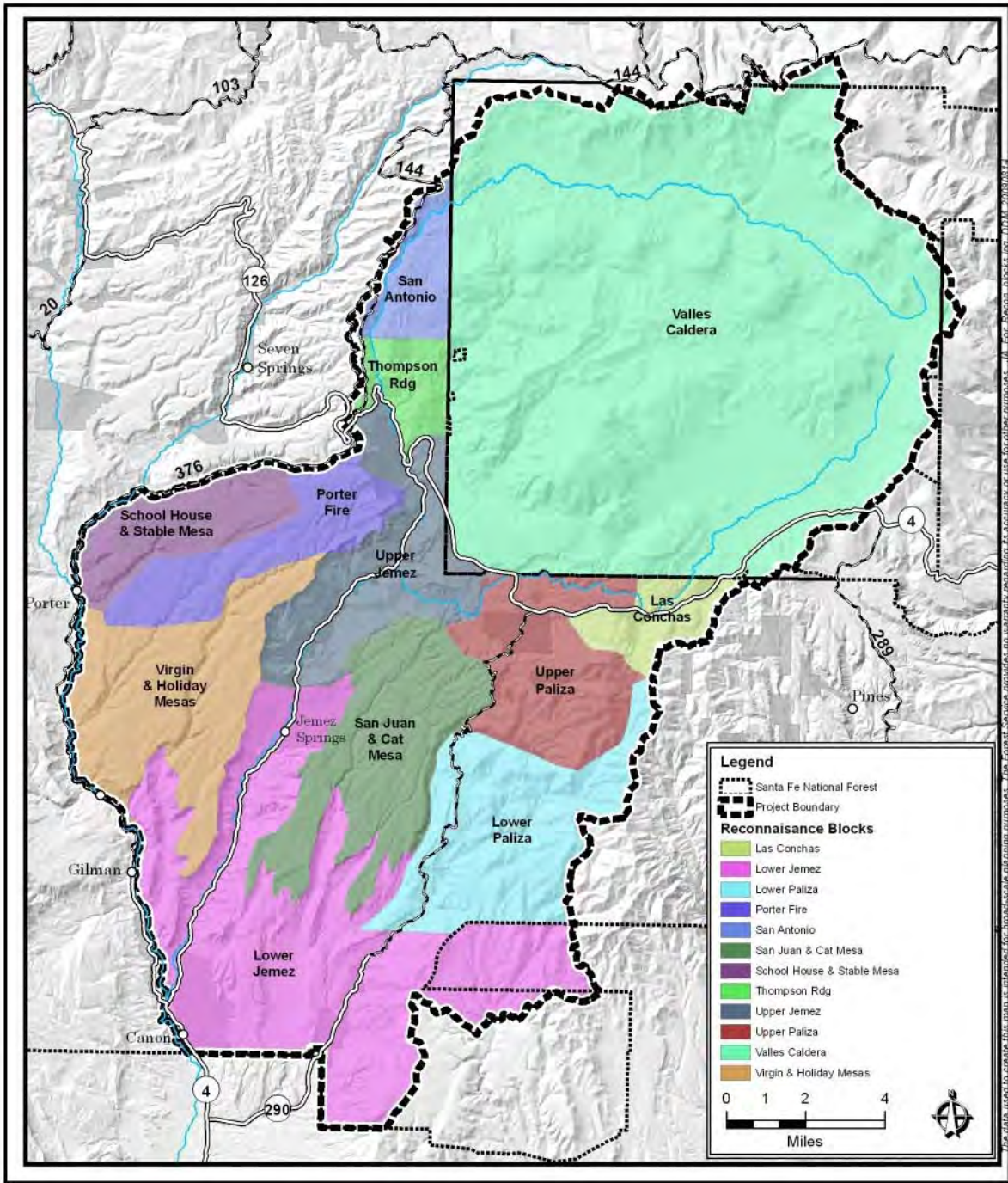


Figure 38. Geographic areas with similar physical characteristics

For each geographic area, the FlamMap model was used to predict crown fire hazard. Crown fire hazard includes six ratings: low, moderate, high, very high, severe, and extreme. They are based on the relationship between torching and crowning indices. These indices indicate the relative susceptibility to crown fire behavior. Torching index (TI) and crowning index (CI) quantify the amount of wind required to initiate crown fire (torching of the tree crown) and spread (Scott and Reinhardt 2001). The lower the index value, the higher the potential for initiating crown fire. In a dense, multi-storied stand, lower wind speeds (low TI and CI) can initiate extreme crown fire behavior. In a more open stand, higher wind speeds (high TI and CI) are needed to initiate and spread a crown fire. Thus, fuel conditions that yield lower torching and crowning indices have higher crown fire hazard ratings. Wind speeds used in the fire modeling assume a 20-foot open wind speed. The following table shows the relationship between TI, CI and crown fire hazard ratings used in this assessment.

**Table 30. Relationship between torching index (TI) and crowning index (CI) and crown fire hazard ratings**

	Low TI 0 -16 mph	Moderate TI 16 -40 mph	High TI 40+ mph
Low CI 0 -16 mph	Extreme	Severe	Very High
Moderate CI 16 -40 mph	Severe	High	Moderate
High CI 40+ mph	High	Moderate	Low

Source: US Forest Service, Paul Langowski and Eric Twombly

The following table shows the potential fire behavior and related characteristics under severe fire weather, for each geographic area. It shows the current average trees per acre and diameter (at breast height), as well as the crown base height (distance from ground to bottom of tree branches or crown), and crown bulk density, although these average attributes vary widely within these large blocks. It also shows the expected surface fire flame length and crown fire hazard rating, predicted by the model.

**Table 31. Potential fire behavior under severe weather, by geographic area**

Geographic Area	Trees per Acre	Average Diameter (in)	Crown Base Height (ft)	Crown Bulk Density (kg/m <sup>3</sup> )	Surface Flame Length (ft)	Crown Fire Hazard Rating*
Thompson Ridge/San Antonio Canyon	798	5.7	13	0.350	3.7	High
Cebollita and Porter	539	5.7	8	0.048	2	Low
School House Mesa Area	799	5.5	6	0.063	3.4	High
South aspect of unnamed canyon in School House Mesa Area	56	18	53	0.30	4.6	Low

**Table 31. Potential fire behavior under severe weather, by geographic area**

Geographic Area	Trees per Acre	Average Diameter (in)	Crown Base Height (ft)	Crown Bulk Density (kg/m <sup>3</sup> )	Surface Flame Length (ft)	Crown Fire Hazard Rating*
Virgin and Holiday Mesas	1,044	5.6	2	0.135	2.3	Severe
San Juan/Cat Mesas, excluding Monument Canyon	232	9.8	24	0.068	3.1	Moderate
Upper Jemez Canyon	944	5.8	9	0.350	2.1	Severe
ponderosa pine in Paliza Canyon area	2,487	3.1	4	0.072	3	High

### Thompson Ridge/ San Antonio

San Antonio Creek runs north south through a canyon that splits the block. The canyon is a cold air drainage, which favors blue spruce along the bottom. The largest spruce trees are 80 to 100 years old, suggesting they became established right after heavy sheep grazing stopped and fire exclusion began. Larger diameter ponderosa pine and Douglas fir are mixed with a dense shade-tolerant conifer understory. The larger ponderosa and Douglas fir are over 300 years old. The combination of extensive ladder and surface fuels (over 20 tons per acre), canyon alignment with south winds, and steep slopes make this area highly susceptible to crown fire under extreme fire weather. On the east side of the canyon below and south of the Thompson Ridge community is a stand of large old growth ponderosa pine with an understory of over 800 saplings per acre.



**Figure 39. Larger ponderosa pine and Douglas fir trees are scattered in the younger white fir understory, above San Antonio Creek**

There is currently a 500-acre contract to thin and pile the sapling understory for burning in the winter. Within the 500 acres is a section of private land and several houses. There have been no Firewise measures taken by these residents. County Rd 106 is the only road access into Thompson Ridge. A contract was completed in 2008 for thinning and masticating the slash for 300 acres along Rd 106, with the intent of securing an evacuation route for the community in the case of wildfire. These 300 acres are scheduled to be prescribed burned in 2009. The area north of Thompson Ridge and east of San Antonio Creek is an extensive mixed conifer stand with a short needle surface fuel bed typical of a mixed severity fire regime (see Table 31).

### Porter and Cebollita Fire

The Porter and Cebollita Fires on Holiday and Stable Mesas burned 8300 acres in the 1970's. At that time, the timber production objective following forest fires drove the cutting of all trees exhibiting any degree of crown scorch (many would have survived). The Porter and Cebollita fire areas were planted with ponderosa pine seedlings according to guidelines that maximized timber production.

Planted areas seeded in with more ponderosa pine and Douglas-fir seedlings. Scattered patches of pole size trees are present but not extensive. Aspen regenerated extensively throughout the burns. It forms a mosaic, interrupting crown fuel continuity and reducing the potential for crown fire initiation and spread. Surface fuels are sparse and compact. The area is heavily grazed and Kentucky blue grass is dominant on moist sites (see Table 31).



**Figure 40. Planted Cebollita Fire area, with suppressed pole-size trees and no herbaceous understory vegetation**



**Figure 41. Young aspen in the Cebollita Fire area**

consumed most of the slash, but had little effect on the residual stand. Surface fuels are light accumulations of pine needles. There are almost no herbaceous plants on the forest floor. The sparse surface fuels, absence of ladder fuels and high crown to base heights make it very difficult to carry a prescribed burn in this area to modify stand structure. Thinning would have to be done mechanically first, in order for fire to remain on the surface.

### School House Mesa

The School House Mesa Area sits between the 2005 Lakes Fire and the Porter Fire. There are no recently cut stumps-only stumps from harvesting in the early 1900s. The majority of the mesa top is covered with ponderosa pine pole and sapling stands, thinned in the 1970s. Tree density is still high, averaging 799 tree per acre. Stand structure is homogeneous (uniform) with few trees over 16 inches in diameter. The largest tree measured in the reconnaissance plots was 13 inches in diameter.

The mesa was burned with a low intensity prescribed fire after the thinning. The fire



**Figure 42. Pine stands in school house Mesa area where thinning occurred**

Several canyons intersect School House Mesa including School House, Stable and several unnamed canyons. The canyons still have scattered large trees to provide some structural diversity. The canyons do not have signs of being burned with prescribed fire. Surface fuel beds have more large logs and a thicker accumulation of pine needles than the mesa top. The deep litter depth may be why grasses and non-woody plants are scarce.

### **Virgin Mesa, Holiday Mesa**

The 1970s Porter Fire burned the northern portion of Holliday Mesa, then the 1991 Henry Fire burned 800 acres in the southern portion of Holiday Mesa. The Henry Fire was a crown fire that burned through dense thickets of young ponderosa pine trees. The burned area was not planted and has grown back in patchy oak and grass. The forest south of the Henry Fire is extremely dense, like stands on Virgin Mesa. Surface fuels are pine needles, logs, and branches.

Virgin Mesa parallels Holiday Mesa on the south side of Virgin Canyon. The 2003 Virgin Fire burned 400 acres as a crown fire at the north end of the mesa. Scattered large pole and small saw timber ponderosa pine survived the fire.

Scattered pine seedlings are present in the burn area. The majority of the burned area has come back into bunch grasses that are being grazed heavily. Approximately 120 acres of ponderosa pine were thinned south of the Virgin Fire, and a narrow strip along the Jemez Canyon rim north of the fire has been thinned. Thinning was done according to uniform tree-spacing guidelines, creating uniform stands similar to those on School House Mesa. The thinning slash remains. South of the Virgin Fire and the recently thinned area, forest conditions become a dense thicket of saplings and poles. Historic logging removed the large, straight ponderosa pine and left poorly formed large



**Figure 43. Dense forest with low branches, on Virgin Mesa**

pine trees scattered throughout the stands.

The southern two thirds of Virgin Mesa and the southern third of Holiday Mesa are the last large contiguous blocks of unthinned forest and hazardous fuels west of the Jemez Canyon rim. The rest of this area has seen the dense fuel continuity broken up by past fires that burned approximately 15,000 acres (Stable, Porter, Cebollita, Henry, Virgin and Lakes) and extensive thinning and prescribed burning, creating a network of areas with lower crown fire hazards.

A fire starting on the south end of Virgin or Holiday Mesas during the fire season would be in alignment with burning uphill on a south slope pushed by the prevailing SW winds. Given the forest and fuel conditions and a “severe” crown fire rating, there is a high degree of certainty that an ignition in this area during fire season will initiate a crown fire. Virgin Canyon with its southwest orientation would compound the situation as prevailing winds would funnel rapidly up the canyon. The danger of a fire in this area is from the transport of embers by the wind and fire column that would start more fires downwind. Downwind includes the Village of Jemez Springs and the dense forests and residential properties in upper Jemez Canyon.

### **Lower Jemez Canyon**

The dominate forest type in the Lower Jemez Canyon Area is piñon-juniper woodland. Surface fuels are sparse and tree crown continuity discontinuous. Wildfire spread in this woodlands type and rocky terrain would be limited by both fuels and topography. Prescribed fire is not an option because of the lack of surface fuels. No additional reconnaissance plot data was collected.

### **San Juan/Cat Mesa**

The San Juan and Cat Mesas lie to the south and in alignment with the community of Vallecitos. Monument Canyon Research Natural Area (RNA) is at the north end of Cat Mesa. The RNA is selected to represent a remnant old growth ponderosa pine stand. Portions of the area (323 acres) were thinned in 2006, removing the majority of the sapling and pole understory. The remaining northern third of San Juan Mesa was thinned within the past 20 years to a uniform tree spacing. The mesa, with the exception of the RNA, was prescribed burned twice since 2000. Surface fuels are pine needles. Non-woody vegetation on the forest floor is sparse. The past prescribed burns were low intensity and did little to alter the ponderosa pine overstory. In many cases the past burns did not even kill or thin out dense thickets of small seedlings that were established in openings. Crown to base heights however were raised from the fire scorch. The sparse surface fuels, absence of ladder fuels and high crown to base heights make it very difficult to use prescribed fire to thin and modify stand structure. As the Mesa slopes gently to the south, density of ponderosa pine stands



**Figure 44. Thinned stand on San Juan Mesa has high branches, uniform spacing, and lack of ground vegetation**

decrease and the site becomes rocky and surface fuels discontinuous. At the southern end of the mesa, the vegetation transitions to piñon-juniper, and surface fuels are sparse and discontinuous, interspersed with bare soil.

The northern third of this block has seen a ponderosa pine regeneration event within the past 3 years. Openings in the tree canopy filled in with dense ponderosa pine seedlings, averaging 10,000 seedlings per acre in the RNA (Figure 45).



**Figure 45. Ponderosa pine seedlings that regenerated in the larger canopy openings**

### **Upper Jemez Canyon**

The Upper Jemez Canyon block begins just north of Jemez Springs where the piñon-juniper transitions into mixed conifer on the north aspect and into ponderosa pine on the south aspect. The canyon is in alignment with the southwest winds. The canyon sides are steep and interspersed with rocky cliffs, so access is difficult. Crown fuels are continuous vertically and horizontally. The north aspects have a buildup of heavy fuels, including large recently beetle-killed trees that are falling down.



**Figure 46. North-facing slopes of Upper Jemez Canyon show ladder fuels**

Potential ignition sources are along State Highway 4, with subdivisions on both sides of the highway, a summer music camp, several dispersed recreation areas and Battleship Rock Campground. Wildfire in this block would also endanger the communities of La Cueva, Vallecitos de los Indios and Thompson Ridge, which are in alignment with a fire burning up canyon. Redondo and Jemez Falls Campgrounds would be in the fires path. A severe fire in the canyon would devastate the economy of the nearby Jemez communities. Flooding in the aftermath of a severe fire would endanger property and agricultural fields in the Jemez River floodplain along with State Highway 4.

There has been past thinning along the north rim of the canyon in the Banco Bonito area. Adjacent to Banco Bonito, over 200 acres were thinned and masticated in the southwest corner of the Preserve. Thinning is being done in the Jemez Falls Campground, but too few trees are being cut and the area is too small for the treatment to have any effect on wildfire behavior.

## Upper and Lower Paliza Canyon

The Paliza Canyon area is dominated by a series of canyons, including Paliza and San Juan Canyons, which are in alignment with the southwest winds. The community of Vallecitos de los Indios sits to the north, in the path of any wildfire burning up the canyons. Topography, slope and aspect are varied and broken with corresponding variability in vegetation and fuels. Cerro del Pino, Cerro Pelado, and Los Griegos are peaks in the area and are above 9,000 feet. The southern portion of the Paliza area includes National Forest land and a portion of the Jemez Pueblo tribal land. Jemez Pueblo has thinned the ponderosa pine stands on their land, although they did not burn the thinning-generated slash. Prescribed

burning on adjacent National Forest lands is therefore difficult because of this surface fuel hazard. Vegetation and fuel is continuous vertically and horizontally across the area. The only openings are a scattering of pumice mines and the scars of three crown fires that burned in the last 15 years. Surface fuels are long and short needle cast. Aspen is not a major component.



**Figure 47. 1996 Hondo Fire area showing lack of forest recovery**



**Figure 48. Dense ponderosa pine saplings in the Paliza area**

Large trees were selectively harvested from ponderosa pine stands, but some large trees remain. Dense sapling and pole-sized stands with scattered large pine trees dominate dry sites. Moist sites contain mostly white fir seedlings under a pine and mixed conifer tree overstory. The area has been logged extensively, with the most recent Paliza timber sale in the late 1990s. That harvest randomly removed individual trees and did not accomplish any ecological objective. Pre commercial thinning scheduled to follow was not done. In the Conejos area, thinned stands were open to fuelwood gathering. The planned prescribed burning was not completed, so the thinning-slash remains. The 6000 acres planned to be burned was never

conducted. Paliza Campground on the banks of Vallecitos Creek was marked to thin, but no one bid on the contract. The area around Paliza Campground is a popular dispersed camping and party area and potential ignition source. The main danger to the campground is from the flooding of Vallecitos Creek in the aftermath of a severe wildfire in Paliza Canyon. A wildfire would rapidly funnel up the canyon, driven by prevailing winds. It would be followed by severe mass wasting

and flooding that would endanger the community of Ponderosa and the community's reservoir at the mouth of Paliza Canyon.

Three crown fires over 300 acres each in size, occurred in this area in the past 15 years (Nicole, Labor and Hondo fires). Two were lightning caused and one human-caused. They burned as crown fires for only one day then dropped to the ground due to sudden rains and wet weather. All three fires burned toward the northeast (per prevailing southwest winds). The burned areas filled with grass and oak brush, although some scattered ponderosa pine seedlings are present in the Hondo and Nicole fire areas. Some of those wildfire burn areas still show a lack of recovery to forest vegetation (Figure 47).

Thinning is ongoing in the Los Griegos area at the north end of the block, and has been completed along the perimeter of the Vallecitos de los Indios community. The thinned timber stands that sit to the south and west of Vallecitos de los Indios exhibit classic historical ponderosa pine stand structure; park like stands with large diameter trees and regeneration in a clumpy arrangement. The thinned area was open for fuel wood gathering but never prescribe burned.

### **Las Conchas**

The Las Conchas area is in the area along State Road 4 between the National Forest and Preserve boundary. It is a relatively steep, higher elevation area than the rest of the National Forest land in this assessment area, and is composed of moist mixed conifer, spruce and aspen. The majority of the area is on north-facing slopes, and not in alignment with the prevailing southwesterly winds. Surface fuels are predominately short needle cast typical of a mixed severity fire regime. No additional reconnaissance plot data was collected here.

## **Fire Management and Community Protection**

The interagency fire teams define wildland urban interfaces (WUIs) as areas where human habitation and development meet or intermix with wildland fuels (USDI and USDA, 2001). The Federal Register lists WUI communities in the vicinity of federal lands that are at high risk from wildfire (Federal Register 66(3) 751-777). Forest Service direction for managing WUIs is provided by the National Fire Plan, including the 10 Year Comprehensive Strategy- a Collaborative Approach for Reducing Wildland Risks to Communities and the Environment, 2001. The goals for managing WUIs are to: improve fire prevention and suppression; reduce hazardous fuels; restore fire adapted ecosystems; and promote community assistance.

The Forest Plan (pages 19 and 22) includes goals to protect life and property from wildfire; protect forest resources from wildfire at a level commensurate with the value of the resource; and utilize prescribed fire as a tool where it can effectively accomplish resource management objectives. The objectives the National Forest hopes to accomplish by 2020 are to (a) identify and treat areas of the forest in which hazardous fuel loadings are a risk to communities within the WUI, and (b) conduct hazardous fuels treatments to change behavior and result in moving fire from the crowns of trees to surface fires around at-risk communities.

In 2002, the Greater Jemez Mountains WUI Working Group of the national USA Firewise program prepared a fuel and fire risk assessment in the area. It includes recommendations on reducing fuels within 100 to 200 feet of ignitable structures. This group obtained grants to

continue their efforts to reduce hazardous fuels on private lands in the area, and over 50 private properties in the assessment area were treated, based on State Forestry data.

In 2008, the Sandoval County's Community Wildfire Protection Plan (CWPP) was collaboratively completed (Sandoval County 2008). Recommendations in the CWPP were to increase defensible space, create and continue fuel breaks and fuel mitigation measures around communities, establish evacuation and egress routes and develop pre-fire plans. It defined WUIs within the assessment area and ranked the at-risk communities as to their relative fuel and wildfire hazard. Figure 49 shows the WUIs that cover a majority of the National Forest land in the assessment area.

The wildfire hazard ratings for WUI communities in the assessment area are as follows:

- Upper Jemez Springs: Extreme
- Lower Jemez Spring: High
- Cerro de Los Pinos: High
- Thompson Ridge: Moderate
- La Cueva: Moderate
- Ponderosa: Moderate

WUI community disasters almost always occur under extreme fire weather conditions such as high wind speeds and low humidity. Once a fire ignites under the worst weather conditions, it can spread rapidly at high intensities. Fire is often carried through live vegetation such as trees, grass or shrubs. The grassfires in Oklahoma in 2008 killed two people and destroyed over 100 homes. Preventing the ignition of flammable materials around the home is the best and most effective way to keep home from burning (Cohen 1999). When numerous homes become involved under extreme fire weather conditions, fire fighters, equipment and water supplies become depleted and overwhelmed. The Los Alamos Fire Department during the Cerro Grande Fire had enough water pressure in the municipal water system to fight one structural fire at a time (conversation with Steve Coburn, prevention chief). There were over 300 structures burning almost simultaneously during Cerro Grande, overwhelming the fire department's capacity.

Flame length is not the main cause for a WUI fire disaster. The primary factors affecting homes burning in the WUI are the ignitability of the home and its immediate surroundings (approximately 100 to 200 feet) known as the "Home Ignition Zone" (Cohen 1999). Manipulation of vegetation outside this zone has little or no effect on the chances of a structure surviving a wildfire. Thus, the most effective approach to reducing losses are improved home construction and reduced ignition hazards in the Home Ignition Zone. Touring the communities and discussions with State officials reveal that an estimated 20 percent of what was recommended in the CWPP have been completed (Conversation with Karen Lightfoot, NM State Forestry 2009).

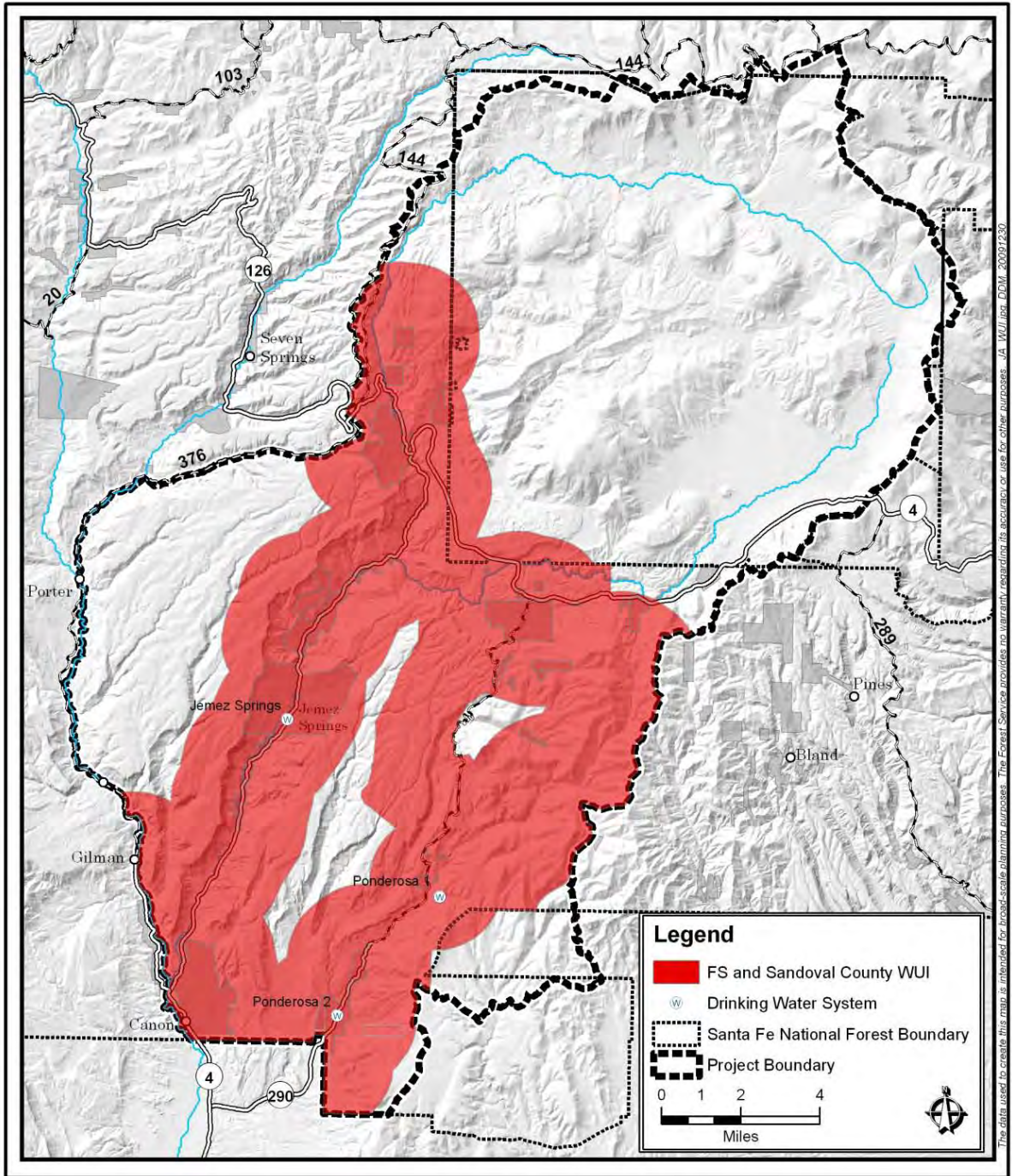


Figure 49. Wildland-urban interface (WUI) areas

## Management of Natural Ignitions

Management of naturally ignited (lightning-caused) fires to accomplish specific resource management objectives is referred to as Wildland Fire Use. Areas where this may occur is defined in the Forest Plan and Fire Management Plan. These naturally ignited wildfires can be managed as prescribed fires to accomplish objectives within those pre-defined areas. Otherwise, if unwanted or unplanned fires result from natural or human-caused ignitions they are managed and defined as wildfires.

The 1995 Federal Wildland and Prescribed Fire Policy and Program review states: (1) the role of fire as an essential ecological process and natural change agent will be incorporated into the planning process; and (2) fire management plans, programs, and activities support land and resource management plans and their importance. Managing natural ignitions and planned ignitions as prescribed fires are complimentary ways to meet management objectives.

Managing natural ignitions may only be done under safe, carefully planned conditions to benefit natural resources, reduce future fire suppression costs, help restore natural fire regimes, and achieve Forest management goals and objectives. Thus, it is an essential tool for restoring and maintaining fire-adapted ecosystems.

However, in this assessment area, most stands need to be mechanically thinned before natural fire ignitions can be safely managed as prescribed fires. In part this is due to forest and fuel conditions, and in part due to the scattered communities and human developments (high value infrastructure) throughout the area, as indicated by the WUI map.

The fire management units (FMUs) identified in this area in collaboration with multiple resource specialists, agencies, and adjacent land owners, provide guidelines for managing wildfire ignitions. They indicate the most appropriate management strategy to apply to various areas on this landscape, although decisions must be made site-specifically on a case-by-case basis. The Forest Plan section D) describes the Forest's prescribed fire program fuels treatment objectives with respect to each FMU. Use of prescribed fire in any FMU should enhance fire-fighting capability, lower or maintain fuel profiles to reduce the severity of fire, and provide a buffer around communities. In WUIs and high fuel hazard areas, mechanical treatments are typically needed before prescribed fire, including use of natural ignitions as prescribed fire.

The following map shows the FMUs and associated fire use strategy.



**Figure 50. Unthinned forest on private land (left) adjacent to thinned area on National Forest Land (right)**

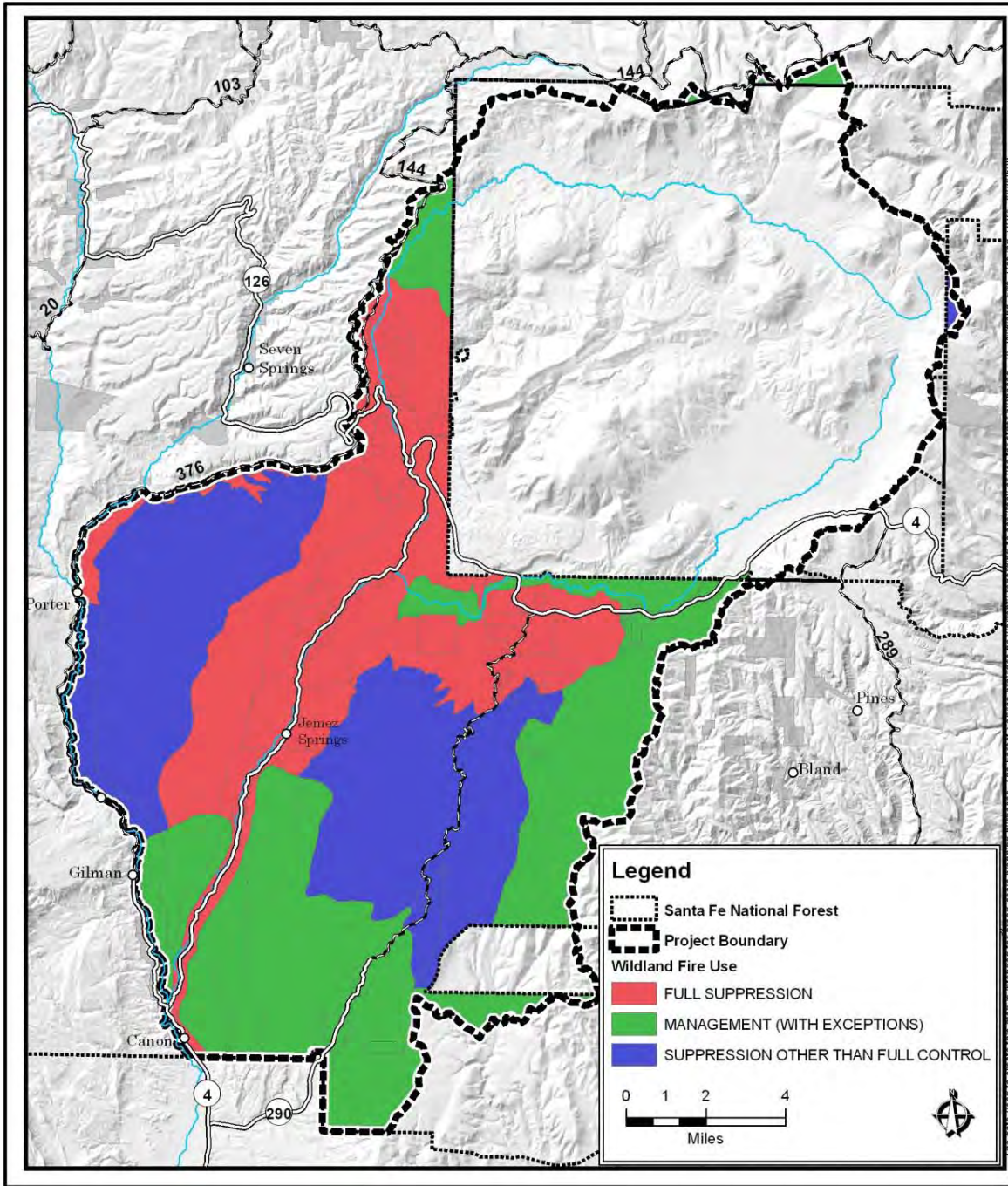


Figure 51. Fire management units – general levels of management control

# Wildlife Habitat and Species

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of wildlife habitat and species within the assessment area. This comparison forms the basis for identifying restoration needs and opportunities. This section focuses on the National Forest lands within the assessment area, as a complement to the wildlife habitat and species description in the Preserve's existing conditions report. For National Forest lands in the area, this section describes:

- Proposed, endangered, threatened, and sensitive species (PETS)
- Management indicator species
- General wildlife

In addition, it will evaluate known occurrence and potential suitable habitat for the above-noted species. The area evaluated for existing conditions and referenced conditions will include only Forest System land.

Because of the confidential nature of locations of PETS species, maps of these locations are not included, but are kept in confidential files for analysis purposes rather than public distribution.

Forest Plan goals for managing wildlife habitat (page 19) are being routinely followed in managing resources in this assessment area, and include:

- Manage habitat to maintain viable populations of wildlife and fish species and improved habitat for selected species. Coordinate habitat management with other resource activities.
- Cooperate with the New Mexico Department of Game and Fish to contribute toward management goals and objectives specified in the State Comprehensive Plan.
- Identify, protect and enhance habitat that contains threatened, endangered, and sensitive species of plants and animals to contribute toward the goal of species recovery.

## Forest Habitat

The forest ecosystem and topographic conditions previously described in this report describe some of the wildlife habitat concerns for native species in this assessment area, from species associated with narrow habitat niches to the habitat generalists. The primary habitat concerns related to forest ecosystem conditions previously described are as follows:

- The uniform, homogenous forest composition and structure across much of this assessment area, translates to degraded native habitat conditions and reduced wildlife species diversity. Virtually the entire forested area is composed of mid-aged, closed-canopy forest; substantially more than the historic condition in these ecosystems.
- The over-abundance of small diameter trees and lack of large old growth trees, as well as large logs and snags, further compromise the abundance and diversity of native wildlife species, especially species associated with mature and old growth forest characteristics. However, the tree mortality from past fires and insect/disease outbreaks has resulted in adding snags and downed logs for wildlife habitat, and they appear to be adequate across

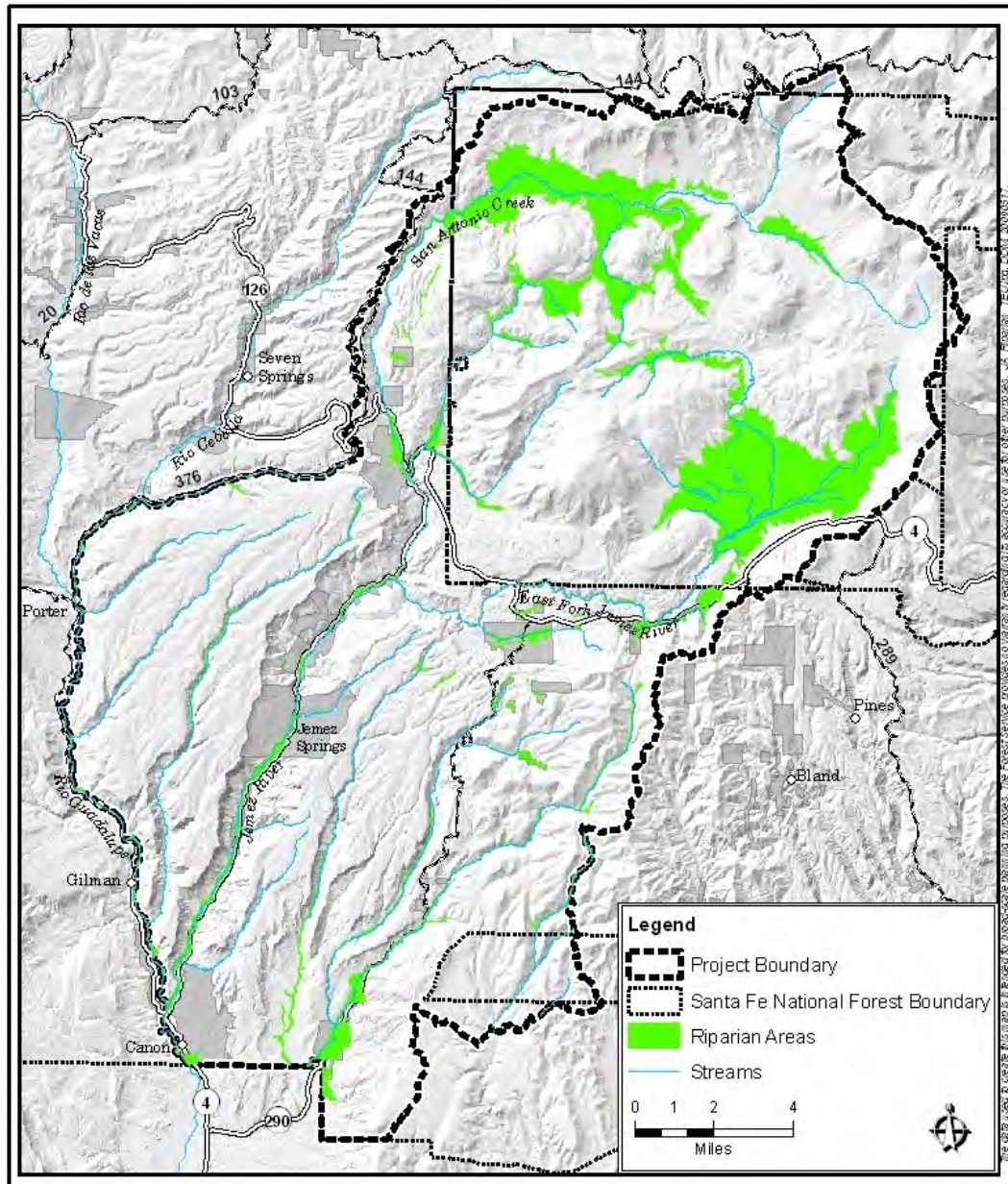
most of the assessment area (Forest Plan, Appendix D, page 9). Snags are lacking near the most accessible roads as they are removed by the public for firewood.

- Understory plants have declined in abundance and diversity as well, creating a significant lack of cover and forage for large and small mammals, birds, and other wildlife.
- Stand densities and fuel conditions present an increased risk for uncharacteristic high severity wildfire, which can result in a loss of both habitat and species.
- Open grassy meadow habitat has been decreasing because of conifers encroaching into the meadows, due in part by grazing along with the lack of fire (Keane et al. 2002).
- Mast production (such as oak acorns and piñon nuts) is patchily distributed, and may be reduced in some areas from year to year.
- Aspen patches have declined as well due to encroachment by conifers and lack of regeneration by fire.
- Human activity and noise disturbance are prevalent over much of this area, as it is close to the largest population centers in the State and receives heavy use by locals and tourists alike.
- Vehicles using the high density of roads and trails disturb wildlife species and reduce habitat quality. There are many unauthorized routes created by off-road vehicles, including routes through breeding habitat for PETS species.
- Water tanks constructed in the area did not include ramps to allow small mammals, reptiles, or amphibians to escape. The Forest Plan notes that water tanks should be monitored, and in cooperation with livestock grazing permittees, escape ramps should be placed where needed.

## Riparian Habitat

Water, an essential component for high quality wildlife habitat, is not abundant or widespread in this project area. Water is available year-round in perennial streams located in Virgin Canyon, San Antonio Creek, Rio Cebolla, Rio Guadalupe, East Fork Jemez River and Jemez River. On the mesa tops, water is available only seasonally, during snow melt and storm runoff, or in some springs, seeps or water developments (see the Water Resources section). Many springs and seeps that previously provided water for wildlife are now dry or have sharply declined in the amount of water available. Snow captured in the closed canopy forests is increasing lost to the atmosphere through sublimation (evaporation), which results in loss of surface and ground water supplies (see Water Resources).

Riparian corridors are being impacted by elk and livestock grazing, and by recreation use—anglers, camping, and vehicles. Vegetation is not reaching its potential in height, density, and species diversity, and there are areas of bare soil that add sediment to the streams. These activities are impacting the abundance and diversity of native riparian vegetation along streams and in wet meadows for several sensitive species, such as for NM meadow jumping mouse and other small mammals, native fish such as Rio Grande cutthroat trout, Rio Grande sucker, Rio Grande chub, and longnose dace, and amphibians like northern leopard frog. Additionally, some riparian corridors do not have sufficient aspen, willow, or other vegetation growth to sustain existing beaver populations, which are considered keystone indicator species for riparian health (Maehr 1999).



**Figure 52. Riparian areas**

The Forest Plan calls for regenerating aspen, especially in the higher elevation riparian areas, to improve beaver habitat; and then reintroducing beaver in riparian sites where sufficient aspen and willow exists to support and sustain population.

Invasive, non-native woody plants such as Siberian elm, Russian olive and tamarisk (salt cedar) are adversely impacting riparian habitat in the lower Jemez River, Rio Guadalupe, Rio Cebolla, and other streams in the area (see Invasive Plant section). These plants are causing the decline in native species like cottonwood, willow, sedges, and other native riparian plants, which impacts riparian-dependent wildlife species. Riparian restoration including invasive plant control

treatments have been initiated along lower Jemez River, East Fork Jemez River, Rio Cebolla, and others, although there is still much more to be done to restore native species composition, structure and function (reach properly functioning riparian conditions).

## Threatened and Endangered Species

Lists of threatened and endangered (T&E), along with federally proposed, and candidate species that may occur on the National Forest were reviewed to determine the likelihood of occurrence for these species or their potential habitat within the assessment area (US Forest Service 2004d). Of the T&E, proposed and candidate species reviewed, this area does not have habitat for Rio Grande silvery minnow or Holy Ghost ipomopsis (plant). It does have potential for Mexican spotted owl and Southwestern willow flycatcher (T&E), as well as western yellow billed cuckoo, Gunnison’s prairie dog, Rio Grande cutthroat trout, and NM meadow jumping mouse (candidate species). More detailed information on each species can be found in the draft TES reference list for the National Forest (US Forest Service 2008).

**Table 32. Endangered, threatened, proposed, and candidate species with potential habitat in the area**

Common Name	Scientific Name	FWS Status	Potential for Occurrence in JLA Area
Southwestern willow flycatcher (and critical habitat)	<i>Empidonax trillii extimus</i>	Endangered	Some riparian areas are progressing toward suitable habitat, although no SWWF have been found on the Jemez District
Mexican spotted owl (and critical habitat)	<i>Strix occidentalis lucida</i>	Threatened	Several PACs; suitable mixed conifer habitat, and 23,000 acres of critical habitat
Western yellow-billed cuckoo	<i>Coccyzus americanus occidentalis</i>	Candidate	Potential in some lower elevation riparian canyons
Gunnison’s prairie dog	<i>Cynomys gunnisoni</i>	Candidate	One small colony near Rio Cebolla has been found
Rio Grande cutthroat trout	<i>Oncorhynchus clarki virginalis</i>	Candidate	No occupied habitat: some streams designated for potential reintroduction
New Mexico meadow jumping mouse	<i>Zapus hudsonius luteus</i>	Candidate	Occupied and potential habitat located in assessment area

### Mexican Spotted Owl - Threatened

There are four Protected Activity Centers (PACs) or breeding areas entirely within the assessment area and one PAC partially within the area. The PACs are named Hummingbird, San Juan, Virgin Canyon, West Mesa and Lake Fork, and altogether comprise about 2,465 acres. The assessment area contains about 17,000 acres (15 percent of area) identified as potential spotted owl habitat, within the mixed conifer forest ecosystem.

The amended Forest Plan and Fish and Wildlife Service’s Recovery Plan provide specific requirements for managing Mexican spotted owl habitat (US Fish and Wildlife Service 1995, US

Forest Service 1996). They call for managing mixed conifer forests toward irregular tree spacing and various patch sizes; horizontal structural variation with natural canopy gaps; species diversity with all species of native trees represented including early seral species; at least 3 snags, 5 downed logs, and 10 to 15 tons of woody debris per acre. Management direction calls for identifying *protected* and *restricted* habitat. Protected habitat consists of all the PACs as well as mixed conifer and pine-oak types with slope greater than 40 percent where timber harvest has not occurred in the past 20 years. *Restricted habitat* consists of all mixed conifer, pine-oak and riparian forests outside of protected areas. The Recovery Plan (pp. 85-87) includes additional specific guidelines in protected habitat for establishing and monitoring PACs, avoiding road and trail construction, avoiding activities during breeding season, avoiding harvest of trees over 22.4 cm. in diameter (at breast height), implementing appropriate fire risk abatement treatments, minimizing impacts during fuelwood harvesting, and others. The Recovery Plan (pp. 93-97) includes additional guidelines for restricted areas including providing for replacement of nest habitat over time, incorporating natural forest structure variations and disturbance patterns, extending rotation ages, retaining trees over 24 inches in diameter, and other guidelines previously mentioned.

The assessment area contains 23,700 acres of designated critical habitat for the Mexican spotted owl, in Unit SRM-NM-1 (US Fish and Wildlife Service 2004). Each unit contains at least one primary constituent element: *those physical and biological features that support nesting, roosting and foraging*. Forest vegetation management treatments that occurred in this area over the past 10 years have been designed to maintain or increase the primary constituent elements for critical habitat for the Mexican spotted owl. The primary constituent elements are specific (a) forest structures such as large trees, snags, canopy cover, down logs and woody debris, (b) elements for tree and plant species diversity and levels of plan understory plant cover to help maintain prey species, and (c) elements related to canyon habitat in terms of water presence, clumps of specific vegetation types, canyon wall features, and ground litter and woody debris (US Fish and Wildlife Service 2004). Current conditions are not meeting these “reference” conditions—guidelines identified in the Recovery Plan, primarily due to the lack of structural and vegetation species diversity, large trees, and understory plants (as previously discussed under forested ecosystems habitat).

### **Gunnison’s Prairie Dog-Candidate**

There is one known colony of Gunnison’s prairie dog in the assessment area. It is a very accessible area along FR 376, and highly visible to the public. If other (unrecorded) colonies are present within the assessment area, they are probably small populations.

### **Western Yellow-billed Cuckoo-Candidate**

There are no known locations of this cuckoo on the Jemez District. There are no records of observations of this species within this assessment area. Suitable habitat could occur in deciduous riparian vegetation, especially cottonwood, along the Jemez River and Rio Guadalupe.

### **Rio Grande Cutthroat Trout -Candidate**

This native fish species no longer occurs in any streams within the assessment area, primarily due to the prevalence of non-native brown and rainbow trout. The closest occupied stream is at least one mile to the west of the assessment boundary. Streams in the assessment area designated for reintroduction include: the Rio Guadalupe, Lower Rio Cebolla, San Antonio Creek, East Fork Jemez, and upper Jemez River down to tributary just north of Redondo Road on Highway 4 – Section 13. See the Fisheries and Aquatic Habitat section for further information.

### **New Mexico Meadow Jumping Mouse-Candidate**

There are several sites of known jumping mouse occurrence within the assessment boundary. Suitable habitat is known to occur along the Rio Cebolla and San Antonio Creek where vegetation is of sufficient height and density immediately adjacent to stream. Other sites of potential suitable habitat may occur in other riparian corridors.

The distribution of this mouse and its habitat declined since the late 1980s (Frey and Malaney 2009). In a survey of current habitat, it was not found at 73 percent of historical localities surveyed in the Jemez Mountains. Sites within the landscape assessment area where jumping mice had been found in the past but where existing habitat was not deemed suitable include Virgin Canyon and San Antonio Canyon. Frey observed areas with potentially suitable habitat – La Cueva Picnic Area, Sulphur/Redondo Creek, Calaveras Canyon, Seven Springs Recreation Area, Rio Cebolla below Seven Springs, Rio Cebolla below Fenton Lake State Park, lower Rio Cebolla above Porter Landing (Frey 2007).

### **Sensitive Species**

The Forest Service list of sensitive species for the Southwestern Region (Region-3) was reviewed to determine the species that occur or have potential habitat within the National Forest lands of this assessment area (US Forest Service 2007b). Wildlife on the Preserve is discussed in their Existing Conditions Report. Additional details about these species on the Jemez Ranger District (District) are available in District files. The following table shows the sensitive species that occur or have potential habitat in the area. It excludes those already discussed as candidates for the list of threatened and endangered species, and those without potential habitat on National Forest lands in the assessment area.

**Table 33. Forest Service Region 3 sensitive species and potential habitat**

Common Name	Scientific Name	Occurrence or Habitat Within the Area
<b>Amphibians</b>		
Jemez Mountains salamander	<i>Plethodon neomexicanus</i>	Occupied habitat; suitable habitat where surveys are needed to determine occupancy
Northern leopard frog	<i>Rana pipiens</i>	Known past occurrence; potential habitat near rivers, in springs, seeps, beaver ponds, and man-made water developments
<b>BIRDS</b>		
Bald eagle	<i>Haliaeetus leucocephalus</i>	Potential roosting/migration habitat present; no breeding habitat present.
Northern goshawk	<i>Accipiter gentilis</i>	Known nest areas present; suitable habitat is present throughout
American peregrine falcon	<i>Falco peregrinus anatum</i>	Several designated breeding zones located within assessment area
Boreal owl	<i>Aegolius funereus</i>	Potential in high elevation spruce-fir
Gray vireo	<i>Vireo vicinior</i>	Potential in low elevation piñon-juniper
<b>FISH</b>		
Rio Grande chub	<i>Gila pandora</i>	Potential habitat
Rio Grande sucker	<i>Catostomus plebeius</i>	Potential habitat
<b>Mammals</b>		
Cinereus (masked) shrew	<i>Sorex cinereus cinereus</i>	Potential in higher elevations
Dwarf shrew	<i>Sorex nanus</i>	Potential in higher elevations
Water shrew	<i>Sorex palustris navigator</i>	Potential in riparian areas
Preble's shrew	<i>Sorex preblei</i>	Potential
Spotted bat	<i>Euderma maculatum</i>	Potential
Pale Townsend's big-eared bat	<i>Corynorhinus townsendii pallescens</i>	Potential
Southern red-backed vole	<i>Clethrionomys gapperi</i>	Potential in high elevation mixed conifer
Long-tailed vole	<i>Microtus longicaudus</i>	Potential
American marten	<i>Martes americana origenes</i>	Potential in high elevation mixed conifer; spruce/fir
Ermine	<i>Mustela erminea muricus</i>	Known occurrence along the Rio Cebolla within assessment area
<b>Plants</b>		
Yellow lady's slipper	<i>Cypripedium parviflorum var. pubescens</i>	Potential
Robust larkspur	<i>Delphinium robustum</i>	Potential
Wood lily	<i>Lilium philadelphicum</i>	Potential
Springer's blazing star	<i>Mentzelia springeri</i>	Potential

## **Jemez Mountains Salamander**

This species is a lungless salamander with a narrow habitat range, primarily in moist mixed conifer forests where it primarily lives beneath logs, rocks and other organic matter on the soil. This area contains occupied habitat for this species, as well as potential habitat defined as Essential zones and Regular Survey zones, in accordance with the Cooperative Management Plan for the Jemez Mountains Salamander (NM Endemic Salamander Team 2000). Additional surveys were planned to occur in the essential habitat zone in 2009, although few were conducted due to insufficient rainfall. Surveys are planned again for the rainy season in 2010. The acres of Jemez Mountains salamander habitat in the assessment area is as follows:

- Occupied: 1,400 acres
- Essential Zone: 2,800 acres
- Regular Survey Zone: 14,400 acres

In the 1980s the greatest threat to these salamander populations and their habitat was forest logging and road construction. Today, with changes in Forest management objectives, the primary threat to this species is related to climate change and stand-replacing fires. Drought and long-term drying trends can cause habitat to dry out, and this species requires moist conditions to survive. Drought can increase forest fire severity, frequency, and duration, to the detriment of this species. The Jemez Mountains salamander has existed in fire-adapted ecosystems, although infrequent, high intensity crown fires are not natural in this area. High-intensity fire cannot only kill individual salamanders and its prey species, it can cause long-term degradation and destruction of the microhabitat it depends on.

The reference condition that provides for sustainable, well-connected salamander populations is described in the management plan previously listed. Current conditions differ from reference conditions. The reference condition habitat should experience natural fire regimes of low and moderate intensity fires that do not consume all the logs and tree cover, such that moisture regimes are retained, along with biological diversity. There should be a mosaic of seral stages, including more mature and older forests, more large-diameter logs and higher snag densities. These conditions do not currently exist in this area. To maintain the Jemez Mountains salamander across its already limited geographic distribution, it is prudent to conserve all extant salamander populations to allow the greatest potential for connectivity between populations of these relatively immobile organisms (New Mexico Endemic Salamander 2000, pp.13-14).

The management plan for this species has restrictions on types of projects that can occur in essential habitat, and requires consultation with the NM Endemic Salamander Team during project analysis. In August 2009, U.S. Fish and Wildlife Service announced a 90-day finding on a petition to list this species as Threatened or Endangered (US Fish and Wildlife Service 2009a). Consultation with the Salamander Team is on-going within this assessment area. The Salamander Team, Forest Service and others have been meeting to share information about salamander life history and habitat requirements; current forest conditions and likely impacts of climate change; what management practices and mitigations could help the salamander adapt to climate change, and other information.

## **Northern Leopard Frog**

Suitable habitat for this frog occurs along rivers, streams, ponds and springs within this assessment area. The Forest wildlife database shows five records of past observations of northern

leopard frogs in four areas within the assessment boundaries. In July 2009, U.S. Fish and Wildlife Service announced a 90-day finding on a petition to list the northern leopard frog as threatened or endangered (US Fish and Wildlife Service 2009b).

### **Bald Eagle**

There is no breeding or foraging habitat for this species in the area, such as large bodies of fish-bearing water. Past records note that bald eagle occurrence is uncommon on the Jemez Ranger District; however, some have been observed in the winter months, including locations along Forest Road 376, Fenton Lake, the Preserve, and Jemez River. Wintering bald eagles near the Jemez Mountains use Cochiti Lake and upper Chama River. Migrating/wintering eagles could pass through and roost, on a transient basis. None of the assessment area watershed drains into bald eagle nesting habitat.

### **Northern Goshawk**

The assessment area contains nine known post-fledging family areas (PFAs) completely within the assessment boundary, and one partly within the boundary. Surveys for new goshawk locations began during the 2009 field season within this area. Past surveys were completed in Lower Paliza Canyon, and portions of Schoolhouse, Stable, Virgin and Holiday Mesas. One new nest location was found, and a PFA drawn based on that nest site. A goshawk was seen in the Lower Paliza, but no nest found. This site will be re-surveyed during 2010, along with surveys within the other areas of the assessment area.

The Forest Plan (Appendix D) contains standards and guidelines to follow in designing and implementing projects in goshawk habitat, and an implementation guide (US Forest Service 2007c) provides additional guidance. Potential goshawk habitat covers a broad range of forest cover types, including all forest and woodland ecosystems outside of Mexican spotted owl protected and restricted areas.

The general vegetation management guidelines in the Forest Plan specify distribution for vegetation structural stages (VSS) for ponderosa pine, mixed conifer and spruce-fir forests. Because the goshawk guidelines were developed based on habitat needs for prey base for goshawk, thinning according to goshawk guidelines would be the desired condition over much of the ponderosa pine stands on the forest. Current conditions are highly departed from the reference conditions in the Forest Plan, as previously described in this document, primarily due to the lack of structural diversity, mature/old growth components, and ground vegetation. This species and its prey require maintaining an uneven-aged forest structure, down woody debris, old growth structures, and a mosaic of age classes and species across the landscape. The area is deficit in those conditions. Healthy riparian vegetation needed for goshawk prey species is also degraded. More grass/forb/shrub growth on the forest floor would not only enhance forage, cover and/or nesting habitat for goshawk, it would greatly benefit owls and other raptors, bats, small rodents, migratory birds, turkey, elk, mule deer, and many other wildlife species. Compared to reference conditions for goshawk, the current conditions have extremely low proportions of large trees, canopy openings, and structural diversity. Forest conditions do not currently support low intensity surface fires and instead create a risk of large-scale high intensity wildfire that would destroy potential goshawk habitat for long periods of time.

The table below shows the existing and reference vegetation structural stage (VSS) condition for ponderosa pine stands within the assessment area based on goshawk management direction in the Forest Plan. In general, VSS 1, 2, 5, and 6 are lacking within the assessment area. It is easy to restore VSS 1-2 because seedlings and saplings quickly fill in where openings are created in the forest canopy. It takes over 100 years to restore pre-suppression old growth forest conditions that are currently lacking throughout this landscape.

**Table 34. Vegetative structural stage (VSS) distribution in ponderosa pine goshawk foraging areas**

VSS Class	Reference Condition	Existing Condition	Foraging Area Desired Canopy Cover	Foraging Area Existing Canopy Cover
VSS 1 (.1-.9")	10%	6%		
VSS 2 (1-4.9")	10%	8%		
VSS 3 (5-11.9")	20%	51%		
VSS 4 (12-17.9")	20%	21%	40%	48%
VSS 5 (18-23.9")	20%	11%	40%	46%
VSS 6 (>= 24")	20%	3%	40%	45%

### American Peregrine Falcon

Designated suitable breeding habitat zones for this falcon species are established across the National Forest, as zones A, B, C, and D, with management guidelines associated with each zone. There are ten designated suitable breeding habitat zones completely within the boundaries of the assessment area, and two with just portions of the zones within the boundaries: R26, R27, R28, R33-34, R35, R39, R41, R44, and R58; R20 (small portion of D zone), R37 (C and D zones). Forage for the small prey species consumed by peregrine falcon is threatened by the same conditions (ecologically departed from reference conditions) as described for the spotted owl and northern goshawk, such as lack of structural diversity, canopy openings, and ground vegetation.

### Boreal Owl

No boreal owls have been recorded on the Jemez Ranger District, although suitable habitat exists in the higher elevation spruce-fir forests, especially in the Preserve. A survey using taped calls was done in 2009 surrounding Cerro Pelado, but no boreal owls were seen or heard.

### Gray Vireo

No gray vireo observations have been recorded on the Jemez Ranger District; however, they were found adjacent on adjacent Jemez Pueblo land during a federal highway development project. Surveys will be done in suitable piñon-juniper in 2010.

### Rio Grande Chub and Rio Grande Sucker

These native fish species occur in the area. See the Fisheries and Aquatic Habitat section.

### **Cinereus Masked Shrew**

Potential suitable habitat is limited in this area to the small acreage (3,000 acres) of spruce-fir forest above 9,500 feet (other than on the Preserve).

### **Dwarf Shrew**

There are no records of this species in the assessment area, although potential habitat occurs in approximately 16,900 acres of white fir and Douglas fir forest stands in this area.

### **Water Shrew**

The water shrew is widespread in the Jemez Mountains, although not common (Frey 2007). This shrew is known to occur within the assessment area along the Rio Cebolla and San Antonio Creek. Suitable habitat occurs along most rivers and streams.

### **Preble's Shrew**

There is known occurrence of this shrew in the assessment area, where it was collected in an open, park-like stand of ponderosa pine with Gambel oak, grass and forb understory. Potential habitat occurs in all ponderosa pine forest in the area.

### **Spotted Bat**

This bat is known to occur within the assessment area along the East Fork of the Jemez River. Potential foraging habitat occurs throughout the entire assessment area.

### **Pale Townsend's Big-eared Bat**

This species was seen near Jemez Springs, and potential foraging habitat occurs in all vegetation types in this assessment area.

### **American Pika**

This species has been observed just outside of this assessment area near Ruiz Peak and on the Preserve. Suitable habitat within the assessment area is limited by lack of talus slopes at high elevations. In May 2009, the U.S. Fish and Wildlife Service announced a 90-day finding on a petition to list the American pika as threatened or endangered (US Fish and Wildlife Service 2009c).

### **Southern Red-backed Vole**

There are four records of past occurrence of this species in the area and several just outside of the assessment area. Other suitable habitat occurs in spruce-fir forest (approximately 3,000 acres).

### **Long-tailed Vole**

There are 15 records of past observations of this species in the area and several observations just outside the assessment area. Suitable habitat occurs in mixed conifer and spruce-fir forest.

## American Marten

There are no records of past observations within the assessment area, although there have been sightings on the Jemez District in the past. Long noted that many seemingly good sightings were reported, but only a small portion of potential habitat was surveyed (pers. comm. 2006). Suitable habitat occurs in the Los Griegos area of this assessment area. Some surveys of this area may be done in 2010.

## Ermine

Ermine have been documented on the Jemez Ranger District. One recent capture was along the Rio Cebolla within this assessment area (Frey 2007).

## Sensitive Plants

Of the sensitive plants that could occur in this area, the wood lily is the only one with documented occurrence in the area, in several locations. There are no known records of occurrence for the robust larkspur, Springer's blazing star, or yellow lady's slipper on the Jemez District. The Region 3 botanist noted that yellow lady's slipper occur in Bandelier National Monument, so it could occur on the Jemez District as well (personal communication with McDonald, 2009).

## Management Indicator Species

Management Indicator Species (MIS) for the National Forest, listed in the 1987 EIS for the Forest Plan, were originally selected to represent plant communities and seral habitats that management activities in the 1980s could affect. The 1970s MIS list for the Forest Plan is outdated but has not yet been revised or amended. The following table lists the MIS species that have habitat in the area and occur in the assessment area, such that population and habitat trends can be monitored. The National Forest's annual MIS monitoring report (on Forest website) provides additional details. (US Forest Service 1987b).

**Table 35. Management indicator species and associated habitat**

Species	MIS Associated Habitat	Occurrence in Assessment Area
Merriam's turkey <i>Meleagris gallopavo</i>	Mature ponderosa forest	Widespread throughout area
Hairy woodpecker <i>Picoides villosus</i>	Mature forest and woodland	Widespread throughout area
Rocky Mountain elk <i>Cervis elaphus nelsoni</i>	Mid elevation grasslands, meadows and forest	Widespread throughout area
Mourning dove <i>Zenaida macroura</i>	Mid and low elevation grasslands, woodlands and ponderosa pine	Widespread throughout area
Pinyon jay <i>Gymnorhinus cyanocephalus</i>	Piñon-juniper habitat	In piñon-juniper woodlands (approx. 31,000 acres suitable)
Mexican spotted owl	Late seral stage mixed conifer	In mixed conifer forest (approx.

Species	MIS Associated Habitat	Occurrence in Assessment Area
<i>Strix occidentalis lucida</i>		17,000 acres suitable)

Elk habitat is widespread across the District. Elk numbers were estimated in 2007 and 2008 (pre-season) to be 5,500 to 8,000 in Game Units A, B (Preserve), and C (National Forest), with about 3,500 of those on the Preserve (personal communication with Stewart Liley at NM Dept. of Game and Fish, Sept. 2009). Because of the large population of elk in the Preserve, a fair number have summer and calving areas on the National Forest, and move down to lower elevations during the winter. In coordination with NM Department of Game and Fish, the most important habitat for summer habitat/calving and winter habitat on the Jemez Ranger District is delineated and mapped in the Forest GIS database.

## Other Wildlife

Mule deer are common, but populations are more patchily distributed on the district, according to locations of shrub/forage availability. The NM Department of Game and Fish, provided estimates for mule deer populations in Game Units 6A and 6C on the Jemez District based on studies conducted in December 2004/January 1005; thus, they are based on low numbers of observances. Without using models to estimate deer populations, the population is approximately 639, and using models the population is estimated at 1,186; however, there is a high degree of potential variability in these estimates (personal communication with Barry Hale at NM Dept. of Game and Fish, Sept. 2009)..

Beaver ponds are present on the Jemez River, East Fork Jemez, Rio Cebolla, San Antonio Creek, and Rio Guadalupe. A limiting factor for beaver occurrence is the availability of food sources, such as aspen and willow, to sustain long-term populations.

A wide variety of other wildlife is also found in this assessment area including many species of birds, mountain lion, gray fox, black bear, coyote, raccoon, amphibians, rattlesnake, lizards, other reptiles, small rodents, butterflies and other insects.

Current conditions compared to reference conditions for nearly all species that use this area are significantly lacking in the abundance and diversity of grass/forb/shrub on the forest floor, interspersed among the trees. It is also lacking in the proportion of mature, old growth stands and overall structural diversity across the landscape. Moving toward reference conditions with more of those elements would improve forage and cover habitat for turkey, bats, small rodents, small birds, deer, and elk, among others. It would increase prey base for falcon, goshawk, other raptors, owls, coyote, fox, and others. It would increase the mast crops that provide food for black bear, turkey, and many bird species.

Water tanks in the area are lacking escape ramps for small mammals and where possible, they should be included as a design feature in all water tanks being repaired or replaced.

# Fisheries and Aquatic Habitat

## Introduction and Methodology

This section describes and compares existing and reference conditions for fisheries resources, including stream and riparian habitat conditions. The assessment includes information relative to stream habitat and fish populations within the five perennial stream systems that occur in the assessment area outside the Preserve.

Figure 11 in the earlier Water Resources section of this report, is a map showing streams and waterbodies in the assessment area. In this section, Figure 53 shows which streams contain native fish species as well as the potential stream habitat for Rio Grande cutthroat trout, which currently do not reside in streams on the National Forest land in the assessment area.

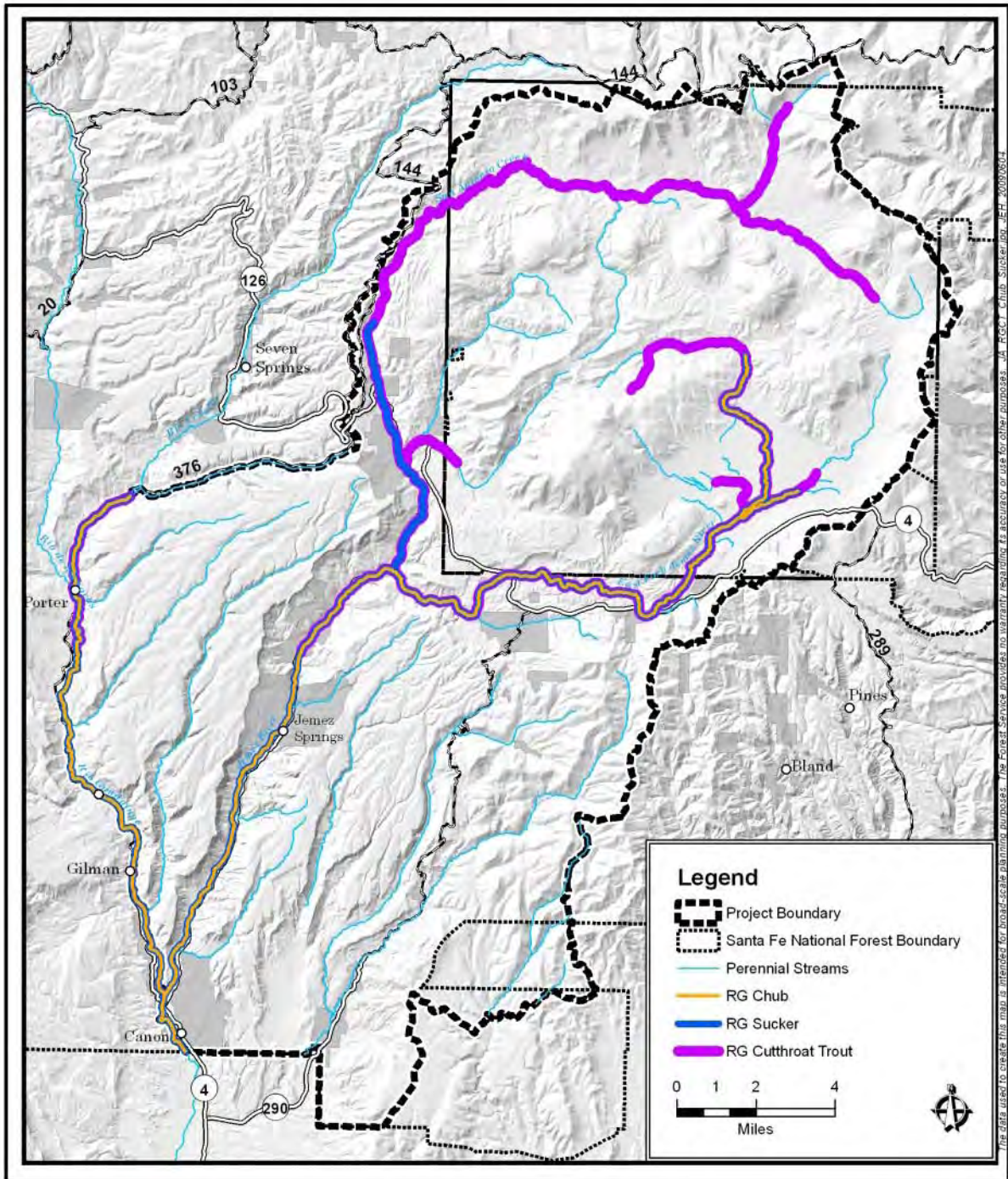
Reference conditions used in this section come primarily from the Forest Service Region-3 Level I and II Stream Inventory Ratings of properly functioning conditions (US Forest Service 2005a), along with management direction from the Forest Plan (including plan amendments from management plans for the Jemez National Recreation Area and East Fork Jemez River Wild and Scenic River). Additional reference conditions come from conservation plans for Rio Grande cutthroat trout (RGCT Conservation Team 2009 and New Mexico Department of Game & Fish 2002).

## Fish Species

An assemblage of native fish as well as introduced rainbow trout (*oncorhynchus mykiss*) and brown trout (*salmo trutta*) occur in the perennial (year-round) streams within the assessment area. The three native fish species present in the area include:

- Rio Grande chub (*Gila pandora*)
- Longnose dace (*Rhinichthys cataractae*)
- Rio Grande sucker (*Catostomus plebeius*)

The previous map shows the distribution of these species in the assessment area, along with streams where Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*) historically occurred in the assessment area. Rio Grande cutthroat trout (RGCT) is one of 14 subspecies of cutthroat trout native to the western United States (Behnke 2002). They are found primarily in clear, cold mountain lakes and streams in Colorado and New Mexico within the Rio Grande Basin (Sublette et al. 1990). On the National Forest, RGCT exist in mountain streams in the Sangre de Cristo and Jemez Mountain ranges in tributaries to the Pecos, Chama, and Jemez rivers, although there are no occupied streams within the assessment area.



**Figure 53. Rio Grande chub and sucker locations and potential Rio Grande cutthroat trout habitat**

Studies indicate that RGCT historically occupied approximately 965 miles of the 1,072 miles of perennial streams on National Forest land, prior to stocking of non-native trout [first stocking record noted in New Mexico was in 1896 (Sublette et al. 1990)]. As of May 2007, New Mexico Department of Game and Fish (NMDGF) and National Forest have identified 39 streams as occupied with RGCT, totaling 138.3 miles. Of these occupied stream miles, 47.0 miles are currently considered secure (no invasion of non-native fish). In 2008, the U.S. Fish and Wildlife Service completed a status review for the Rio Grande cutthroat trout (RGCT) under the Endangered Species Act and found that listing the species was warranted but precluded by higher priority actions. As a result of that review, Rio Grande cutthroat trout was included on the candidate species list “with a listing priority of 9, because the threats affecting it have a moderate magnitude and are imminent” (Federal Register May 14, 2008).

The decline in RGCT in New Mexico is attributed to many factors including the dewatering of streams by irrigation and altering stream habitat. Introduction of non-native trout is the major culprit, as non-native trout prey upon or hybridize with RGCT. Brown trout introduced in the early 1900’s occupy most perennial streams on the National Forest and limit RGCT productivity, although stocking streams with brown trout no longer occurs. Rainbow trout have continued to be stocked in cold-water streams and lakes throughout New Mexico since 1896 (Sublette et al. 1990). Rainbow trout compete for food and hybridize with RGCT, thereby limiting the genetic survival and productivity of RGCT.

Native RGCT are afforded protections as a State Sensitive Species and Species of Greatest Conservation Need (New Mexico Department of Game and Fish 2006), a US Forest Service Regional Forester’s Sensitive Species (US Forest Service 2008), a Forest Plan management indicator species (US Forest Service 1987b), and a candidate species under ESA. In response to its population decline and current risk of being formally listed under the ESA, agencies in Colorado and New Mexico signed range-wide and state-wide conservation agreements for this species. The statewide conservation agreement states that the signatories shall *protect, maintain, and improve existing and potential RGCT habitat and manage these watersheds and stream-riparian habitats to ensure long-term conservation and persistence of the subspecies* (US Forest Service 2002c). In order to achieve this, the Forest shall *prevent or alleviate management related impacts that could degrade occupied or potential RGCT habitat and/or impair current populations* (RGCT Conservation Team 2009). This is to be accomplished by identifying all core and conservation populations and occupied habitat; securing, enhancing, and restoring conservation populations and watershed conditions; and conducting public outreach, data sharing, and interagency coordination.

Reference conditions related to native fish species in this assessment area include the following goals from the Forest Plan (as amended) and RGCT conservation plans:

- A native fish assemblage is fully represented on the landscape, including RGCT, Rio Grande sucker, Rio Grande chub, and longnose dace.
- Habitat for threatened, endangered, and sensitive aquatic species is identified, protected, and enhanced to contribute toward the goal of species recovery.
- Long-term viability of RGCT throughout their historic range is assured through maintenance of areas that currently support RGCT and management of other areas for increased abundance. New populations are established where ecologically and economically feasible in conjunction with NMDGF, including the East Fork Jemez River,

San Antonio Creek, and Rio Cebolla. Threats to wild RGCT are either eliminated or reduced to the greatest extent possible.

The Rio Grande silvery minnow (*hybognathus amarus*) is listed as *endangered* under the ESA. Although it has no current or historic distribution within the analysis area, the Jemez River watershed drains into designated critical habitat in the middle Rio Grande. Thus, significant impacts to water quality in the Jemez River watershed, which could occur following a severe wildfire, may impact silvery minnow habitat in the Rio Grande. Rio Grande silvery minnow was historically one of the most widespread and abundant fishes in New Mexico. Its current habitat is limited to about 7 percent of its former range and is fragmented by dams. The species appears to be limited to a 163-mile reach of the Rio Grande from Cochiti Dam to Elephant Butte Reservoir, and a 2.8 mile stretch of the Lower Jemez River, between the Jemez Canyon Dam and its confluence with the Rio Grande (U.S. Fish and Wildlife Service 2007, Platania and Dudley 2003).

## Aquatic Habitat

Stream habitat conditions were assessed for the five major perennial stream systems that occur on the National Forest land in the assessment area. A separate report covers aquatic habitat and fisheries on the Preserve portion of the assessment area. Three partly perennial streams in the assessment area are not addressed because they have not yet been inventoried: Redondo Creek (6 miles in area), La Jara Creek (5.3 miles in area), and Vallecitos Creek (12.2 miles in area). Table 36 shows the perennial stream name, miles within the assessment area, and the 6th Hydrologic Unit Code (HUC) number and name in which the stream occurs.

**Table 36. Perennial streams with completed habitat and fishery inventories**

Stream Name	Miles in the Assessment Area	HUC 6 Number	HUC 6 Name
Rio Cebolla	3.41	130202020104	Outlet Rio Cebolla
San Antonio Creek	31.51	130202020204	Outlet San Antonio Creek
East Fork Jemez River	21.14	130202020203	East Fork Jemez River
Jemez River	16.86	130202020205	Church Canyon-Jemez River
Rio Guadalupe	13.21	130202020107	Rio Guadalupe

This assessment of fishery habitat conditions was derived from inventories of stream habitat conditions and fish populations. The stream habitat inventories were conducted using the Forest Service Region-3 Level I and II stream inventory protocol, modified from the Region -6 protocol (US Forest Service 2005a; Hankin and Reeves 1988). The inventory is designed on a hierarchical scale to provide the user the opportunity to choose an inventory protocol that meets the data needs for individual situations. Level I is the basic office procedure, which identifies standard attributes of the watershed and stream to be analyzed based on knowledge of the stream system. Level II is an extensive field inventory of stream channels, riparian vegetation, and aquatic habitat conditions on a watershed-wide scale. This level is to be used to determine the condition of a system during low flow periods. In the Level II inventory, stream habitats are broken up into

riffles, pools, side channels, dry channels, culverts, and waterfalls and given a Natural Sequence Order number (NSO). In addition, tributaries, such as streams, seeps and springs are inventoried and given a NSO. Riffles, pools, culverts, and waterfalls are then tabulated to calculate stream length. The other NSO units are used to calculate available stream habitat, but not stream length. Inventories repeated over time are useful in measuring changes or trends in stream and habitat conditions, providing indicators for management and as a monitoring tool.

The Level II stream inventory catalogues aquatic habitat conditions using a matrix of quantitative and qualitative factors and indicators developed for various target species across the West. In the case of Region 3, a literature and peer review was conducted to develop a matrix for RGCT streams. This matrix is used to compare existing conditions to reference conditions for each aquatic (stream) system, as shown in Table 37. This Level II stream inventory, shown in Table 37, categorizes current conditions as *properly functioning*, *at risk*, or *not properly functioning* in comparison with the reference condition, which reflects the range of natural variability for occupied and historic RGCT streams. Thus, this table is used throughout this document as a guide to the comparisons of current conditions to reference conditions. An element *at risk* or *not properly functioning* indicates the element that has been altered or is departed from reference.

Additional reference conditions related to stream and riparian habitat in this area include:

- Streamside riparian zones along the Lower Jemez River and Rio Guadalupe are no longer at risk to non-native invasive plants.
- Non-system user created roads in riparian area along the Rio Guadalupe corridor are obliterated in order to protect soil and water resources. Areas where people can park and drive are designated.
- Recreation has minimal impact on stream and riparian resources, due in part to implementation of activities proposed under Respect the Rio and Leave No Trace Outdoor Ethics, including: development of educational brochures and installation of information kiosks along the Guadalupe corridor in order to inform the public about the value of riparian areas, techniques for river-friendly camping, designated parking areas, construction of restroom facilities, designation of appropriate dispersed recreation sites and removal/ rehabilitation of sites creating resource impacts near the river, and designation and management of pedestrian trails linking the dispersed sites to parking areas and the river.

**Table 37. Factors and indicators of stream health for historic and occupied Rio Grande cutthroat trout streams as related to R3 stream habitat inventory**

Factors	Indicators	Properly Functioning	At Risk	Not Properly Functioning
Water Quality	<i>Temperature – State of New Mexico Standards</i>	<20°C (68°F) (3 day avg. max)	≥20°C (68°F) <23°C (73.4°F) (3 day avg. max)	≥23°C (73.4°F) (3 day avg. max)
	<i>Temperature – Salmonid Development</i>	≤17.8°C (64°F) (7 day avg. max)	>17.8° (64°F) < 21.1° (70°F) (7 day avg. max)	≥21.1°C (70°F) (7 day avg. max)
Habitat Characteristics	Sediment	<20% fines (sand, silt, clay) in riffle habitat. Fine sediment within range of expected natural streambed conditions		≥20% fines (sand, silt, clay) in riffle habitat. Fine sediment outside of expected natural streambed conditions.
	Large Woody Debris <sup>1</sup>	>30 pieces per mile, >12" diameter, >35 feet in length	20-30 pieces per mile, >12" diameter, >35 feet in length	<20 pieces per mile, >12" diameter, >35 feet in length
	Pool Development <sup>2</sup>	≥30% pool habitat by area		<30% pool habitat by area
	Pool Quality	Average residual pool depth ≥1 foot		Average residual pool depth <1 foot
Channel Condition and Dynamics	<i>Width Depth Ratios by Channel Type</i>	Width/depth ratios and channel types within natural ranges and site potential		Width/depth ratios and channel types are well outside of historic ranges and/or site potential
	<i>(utilize Rosgen type and range given if applicable)</i>	Expected range of bankfull width/depth ratios and channel type	<i>Rosgen Type</i> A, E, G B, C, F D	<i>W/D Ratio</i> <12 12-30 >40
	Streambank Condition <sup>3</sup>	<10% unstable banks (lineal streambank distance)	10-20% unstable banks (lineal streambank distance)	>20% unstable banks (lineal streambank distance)

1 Large Woody Debris numeric are not applicable in meadow reaches

2 Pool Development numeric are applicable to 3rd order or larger streams

3 Streambank Condition numeric are not applicable in reaches with > 4 percent gradient

## Rio Cebolla – Aquatic and Riparian Habitat Conditions

Reach 1 of the Rio Cebolla begins at the mouth, which is the confluence with Rio de las Vacas, near Porter Landing (T 18N, R2E, Sec. 1). This is the only reach of the Rio Cebolla within the assessment area. The survey of this reach started on July 4, and ended on July 17, 2001. The reach starts at 7,190 feet above sea level and continues upstream for 3.0 miles, where Rio Cebolla enters a big meadow at 7,440 feet (T19N, R2E, Sec. 30). This reach has moderate gradient of 1.6 percent. A sand/silt substrate type dominates this reach. The Rosgen channel type for this reach is an E5 type channel (Rosgen 1994).

This stream reach includes Porter Landing, the site of a historic logging camp and the junction of a spur rail line that came up the Rio Guadalupe through Gilman Tunnels. Forest Service (FS) Road 376 parallels Rio Cebolla throughout Reach 1, allowing easy public access to dispersed recreation sites. Campsites are the main concern for water quality in this reach. During the survey, a portable toilet was found in the stream with human waste entering the water. Other campsites in the area included latrine sites and unburied human waste within 1 to 3 feet of the stream. Large amounts of litter were evident as well as numerous dispersed foot and ATV trails fording the stream, contributing to bank destabilization. Some minor beaver activity was observed, but most pools (both natural and man-made) had filled in or were filling in with fine sediment. Numerous small rock and woody debris dams were present in this reach. Most of these man-made structures were constructed to provide swimming holes for recreationalists.

Riparian vegetation consists mostly of woody species such as alder with some willow. Most of the ground was covered with various grass species, which are the dominant riparian vegetation. Reach 1 is a meadow reach, with a wide-open valley floor, with some pockets of forested overstory. The majority of the overstory throughout this reach consisted of ponderosa pine, with some Douglas-fir and juniper.

When compared to the indicators of stream health for historic and occupied RGCT streams, Reach 1 is **not properly functioning** for all habitat characteristics and channel conditions except pool quality. Streambank condition is **at risk**. Large Woody Debris (LWD) is excluded from analysis in this reach as it is a meadow reach. For example, riffles are **not properly functioning** for average sediment amounts, with 54 percent sand (sand, silt, clay, and fines), which is above the less than 20 percent criterion. Reach 1 is a low gradient reach, conducive for the settlement of fine substrates, although the high amount of fine sediments in riffles in Reach 1 is well above natural levels. This reach was **properly functioning** for pool quality, with an average residual pool depth over the minimum indicator of 1 foot. Reach 1 was **not properly functioning** for pool quantity, with only 7.5 percent of the reach in pools, which is below the 30 percent minimum criterion. Pool depth was also poor, with no pools deeper than three feet, and many filling in with sand (fine sediment). Although there are only 2 pools evaluated to base this analysis on, sand was the dominant substrate composition (75 percent) in those pools.

Reach 1 is defined as a meadow reach, so the lack of LWD may be natural. However, in the middle part of this century it was common for land managers to remove LWD from streams, as logjams were seen as barriers to fish passage. However, LWD does not hinder fish movements and is an essential part of pool formation, critical to providing thermal protection to overwintering fisheries. Recreationists have physically removed LWD for use in campfires, and fire suppression practices that reduce tree mortality also contributes to reduced quantities of LWD in streams.

The bankfull width-to-depth ratio for Reach 1 was 9:1, which meets criteria for a typical “E” channel and a properly functioning condition. There is evidence of entrenchment that should be further investigated (Figure 54). Road 376 and the old railroad bed adjacent to the stream are prohibiting natural meandering, affecting the width-to-depth ratio, and forcing the stream to one side of the floodplain.



**Figure 54. Entrenched channel with bank erosion on Rio Cebolla Reach 1, with willows growing at top of the slope**

Streambank condition of Reach 1 is at risk, with 10 percent bank instability, which exceeds the properly functioning criterion of less than 10 percent. This bank instability is due to the heavy recreational use along the floodplain and is compounded by heavy grazing pressure. The photo in Figure 55 shows an example of where dispersed recreation activity has resulted in loss of ground vegetation and increased soil compaction and streambank instability. Both sides of the river are riddled with dispersed trails and recreation sites causing bank instability. With some rehabilitation, such as planting willows and other native grasses, the bank stability could be increased dramatically.



**Figure 55. Dispersed campsite causing bank erosion on Rio Cebolla Reach 1, with wood being used to create a stream crossing**

Pool development was the other criterion that was not properly functioning, but this can be easily remedied through increases in LWD. Adding LWD to improve pool formation would greatly improve fish habitat, bankfull width-to-depth ratios, and return the stream channel to its properly functioning condition. Sections of the rail line that are confining the stream channel and should be removed to allow natural meandering and floodplain functioning. This reach of the Rio Cebolla does not have a recorded fishery survey (NMDGF personal communication, January 14, 2010), so no fish data is available.

### **East Fork Jemez River - Stream and Riparian Conditions**

The National Forest's fisheries crew conducted a stream survey on 21.43 miles of the East Fork Jemez River during the summer of 2001, from the mouth (Township 19N Range 3E Section 32 at 6,755 feet elevation) to the headwaters (8,523 feet elevation) where the East Fork Jemez River starts at a group of springs. The East Fork Jemez is a 4th order tributary to the Jemez River. The East Fork Jemez River and San Antonio Creek come together at Battleship Rock to form the Jemez River.

The East Fork Jemez River originates in the northwest corner of the Preserve. It drains Valle Grande, where it picks up several major tributaries, including Jaramillo Creek and La Jara Creek. It flows 21.43 miles to its confluence with San Antonio Creek, forming the Jemez River. The upper 9 miles are on the Preserve. The National Forest section of the East Fork Jemez River is a designated Wild and Scenic River and is part of the Jemez National Recreation Area. Management direction for the East Fork Jemez Wild and Scenic River require maintaining the natural water flow and water qualities for which it was designated (US Forest Service 1999).

East Fork Jemez River was evaluated based on eight different reaches, distinguished by stream and valley morphology and dramatic changes in stream flow (Table 38). The survey began at the

mouth of the river and worked its way upstream. The stream reaches were numbered in an upstream progressive order.

**Table 38. Description and length of stream reaches on the East Fork Jemez River**

Reach	River Miles	Landmark at Beginning and End	Land Jurisdiction
1	0-1.95	Mouth to McCauley Warm Springs.	National Forest
2	1.95-3.15	McCauley Warm Springs to Jemez Falls	National Forest
3	3.15-5.0	Jemez Falls to NM Highway 4 Crossing	National Forest
4	5.0-6.01	NM Highway 4 Crossing to "The Box"	National Forest and Preserve
5	6.01-7.99	The Entrance of "The Box" to the Exit of "The Box"	National Forest
6	7.99-12.81	"The Box" to Entrance to Valle Grande	National Forest, Preserve, and Private
7	12.81-16.51	Entrance to Valle Grande to Confluence with Jaramillo Creek	Preserve
8	16.51-21.43	Jaramillo Creek to Terminus of Headwaters	Preserve

Overall, the gradient on the East Fork Jemez River is extremely variable, ranging from 0 percent in the headwaters to over 7 percent in Reach 2 downstream from Jemez Falls. This is atypical; since high mountain streams typically have the highest gradient reaches in the headwaters. However, the headwaters of the East Fork arise on the edge of Valle Grande in the Preserve, a vast low gradient meadow system. Valle Grande lies in the middle of a large volcanic crater. Valles Caldera originated approximately 1.2 million years ago, following the second of two cataclysmic volcanic eruptions that occurred 300,000 years apart from each other. Following the eruptions the center of the volcano collapsed inward, forming the caldera, which filled with water. Eventually, erosion caused by the East Fork Jemez River breached the southwestern rim of the caldera, draining the lake. In 1975, Valles Caldera was designated as a National Natural Landmark (Report on the Study of Baca Location No. 1).

From Reach 8 down through Reach 7, the East Fork meanders through a meadow system, which is broken up by tributaries such as Jaramillo Creek and La Jara Creek. This meadow system is located where the historic lake once occurred. In Reach 6 the river flows through a mixed canyon meadow system, where it then enters Reach 5, also known as "The Box". This section of the river is extremely confined by a steep canyon mostly comprised of bedrock, which is characterized by numerous bedrock falls and chutes. This is the edge of the ancient caldera. The stream then enters a meadow area surrounded by bedrock walls that continues downstream to the last road crossing at NM Highway 4. From here to Jemez Falls, Reach 3 passes through another confined canyon with some falls and chutes. Below Jemez Falls, Reaches 1 and 2 pass through a canyon and then join with San Antonio Creek at Battleship Rock.

The stream is a flashy system where stream flows increase dramatically after typical summer monsoon rain events. It is also a flashy system due to the porous volcanic parent material and loss of wetlands. No irrigation withdrawals or active ditches were found during the survey. The East Fork has excessive fine sediment loads and high turbidity. A 1997 study found that the East Fork was not in compliance with the high quality coldwater fisheries standards for dissolved oxygen,

pH, dissolved aluminum, and total phosphorous (Everett and Hodgins 1991). Water quality analysis conducted in 2001 by New Mexico Environmental Department Surface Water Department determined that the East Fork exceeded the following water quality standards for a quality cold water fishery: water temperatures below La Jara Creek; pH levels below La Jara Creek; dissolved oxygen (DO) concentrations above Jaramillo Creek; fecal coliform counts in East Fork Jemez and Jaramillo Creek; and turbidity levels below La Jara Creek.

During the habitat survey, the river was broken up into 562 total NSOs (habitat units), which measured a total of 113,160 feet in length. Of these 562 NSOs, there were 201 pools, 231 riffles, 4 culverts, 19 tributaries, 40 falls, and 67 side channels. There were no stream length measurements for tributaries, as they did not contribute to the habitat in the main stem of the river. Based on the indicators, the East Fork Jemez River is not properly functioning for all habitat characteristics and channel condition and dynamics, except pool quality and streambank condition. The East Fork Jemez River is comprised almost entirely of riffle habitat, with a pool to riffle ratio, 1:1.2. There is almost 8 times more riffle than pool habitat. For a stream to be properly functioning it must have at least 30 percent pool habitat. The lack of pool habitat is mostly in upper Reaches 6 to 8, and attributed to stream widening, decrease in sinuosity, and sediment input. Sediment is filling in pools from the banks and erosion in the uplands of the Preserve. During the survey, one person recounted that he had not been to the East Fork for approximately ten years. During that time, it appeared to him that the pools were becoming shallower. One pool that he used to swim in was too shallow, becoming a riffle.

In the lower reaches, a few stretches of stream also had a lack of pool habitat, mostly attributed to the lack of LWD and sediment filling in pools. The high gradient of the lower reaches have increased the numbers of pools, but decreased the length of pools. Because the gradient is so high in these areas, a step pool system is created.

Although there are no guidelines for side channel habitat, having only 3 percent side channel habitat is very low. A little less than half of the river was meadow habitat, approximately 9 miles. The area of stream in the low gradient, high sinuosity meadow systems should have higher amounts of side channel habitat. During the survey, side channels were observed that were no longer active, these channels are also noted on USGS quad maps (Revised in 1993). Due to past grazing practices, these side channels have been converted to dry sites. In the non-meadow reaches, another contributor to the lack of side channel habitat is lack of LWD.

The amount of LWD per mile for the entire river was 8.31 pieces per mile, which is well below the 30+ pieces per mile that indicates a proper functioning condition. The lack of LWD is due in part to geomorphology of the stream channel, as a high gradient, flashy system transports LWD downstream. Other factors include fire suppression and public collection of firewood. The average length of riffles among reaches varies greatly. The lower reaches have numerous short riffles, while the upper reaches have a smaller number of riffles, and the average length increases dramatically. Several riffles in the Valle Grande Reaches (7 and 8) are close to a mile long (three times longer than the average riffle in the entire river), indicating a lack of quality pool habitat. The Valle Grande is mostly one long riffle for 8 to 9 miles. An under-sized bridge created the most prominent pool (albeit unnatural) feature in Valle Grande. If this bridge was repaired, it is very likely that this pool would fill in with fine sediment. Meadow systems like Valle Grande are typically comprised of a meandering riffle system dominated by gravels, along with long deep pools. However, in Valle Grande, the system has been altered by past grazing practices. The undercut banks have begun to slough off, and the stream has become wider and shallower, adding

fine sediments to the stream. The fine sediments have filled in pools and helped create the very long riffles.

Average sediment levels in riffles throughout the entire river far exceed allowable levels for a properly functioning habitat. The amount of fines (sand, silt, and clay) in the riffles is 27 percent, compared to the properly functioning level of less than 20 percent. Riffles are typically dominated by a gravel/cobble substrate. The amount of fines is largely due to inputs from the Valles Caldera. The lower river is very turbid from sediment carried downstream, and the turbidity begins to diminish in Reach 8, above Jaramillo Creek.

Pool habitat quality is properly functioning, for the indicator of average residual pool depth, which is of 2.7 feet. However, the number of pools is far below the acceptable pool: riffle ratio of at least 1:1. Unfortunately, there are more riffles than pools in the entire river. The river has only 10.7 percent pool habitat, lower than the 30 percent indicated for a properly functioning fisheries stream. The amount of pools declines below The Box. There are only 36 pools in the last 13.4 miles of stream (2.7 pools/mile), and 27 of these are in Reach 6. Unstable banks comprise 8.7 percent of the entire river, excluding Reaches 1 and 2. Reaches 1 and 2 have average gradients greater than 4 percent, and streambank condition does not apply to such high gradient reaches. The river as a whole has a properly functioning streambank condition, with less than 10 percent defined as unstable. However, the upper reaches had exceptionally high percentages of unstable banks.

Thus, the degree of bank erosion varies by reach, with the highest amount in Reaches 7 and 8 in the Preserve, and low bank erosion in Reaches 2 to 5. Reach 1 had a higher amount of bank erosion due to heavy recreational use along an unconfined high gradient section. The riparian areas in the lower reaches are well developed and, in some cases, limit bank erosion. The amount of unstable banks in the upper reaches is due to historic grazing, and heavy recreational use in Reach 6. Due to past grazing, Reaches 7 to 8 have been converted from Rosgen E type channels to C type channels. Undercut banks are sloughing into the channel, sediment is filling pools, and there is a lack of sinuosity and side channels. Reaches 2 to 5 have the most LWD, which seems natural as these are forested reaches with a confined floodplain. However, most of the LWD is old and there is little new LWD entering the channel. In Reach 4, the double culvert has one pipe that does not allow transport of LWD or floodwater, which creates a drastic change in gradient and substrate downstream from the culvert. It is also causing fine sediment to accumulate above the culvert. Two other culverts in this river system are having similar negative impacts on stream morphology and water quality. An open bridge construction would be a beneficial alternative to those culverts and allow the stream to recover.

### **East Fork Jemez River Fishery**

On July 6, 2009, staff from New Mexico Department of Game and Fish and the National Forest conducted a survey on the East Fork of the Jemez River to gather information about the fish. Two sites were surveyed using a three-pass electro-shock depletion protocol, including an upper site at the Las Conchas Fishing Access, and a lower site near the Jemez Falls turnout. The survey areas were 80 and meters long, respectively. All captured fish were weighed and measured after each pass (in grams and mm). The exception was the rainbow trout, as they were obviously stocked fish. The first 10 rainbow trout were measured, and all others were just counted.

Table 39 displays the fish species and percent caught of each, at the upper and lower survey sites sampled. Survey results showed that the most abundant species at both the upper and lower survey sites is brown trout, comprising 51 and 42 percent of the catch respectively. There are approximately 962 brown trout per 1,000 meters, weighing 136 kg/ha. Least abundant are the Rio Grande chub and sucker, which are native fish species.

**Table 39. Fish species distribution, East Fork Jemez River**

Species Name	Common name	% of Catch at Upper Site	% of Catch at Lower Site
Salmo trutta	Brown trout	51	42
Oncorhynchus mykiss	Rainbow trout	16	25
Rhinichthys cataractae	Longnose dace	23	8
Gila pandora	Rio Grande chub	1	17
Catostomas plebius	Rio Grande sucker	9	8

### San Antonio Creek – Stream and Riparian Conditions

San Antonio Creek is a 5th order stream originating from springs in Valle Toledo within the Preserve, and ending at the confluence with the East Fork Jemez River near Battleship Rock forming the Jemez River (see Streams and Waterbodies map, Figure 11). It flows 30.5 miles from the mouth (6,755 feet elevation) to the headwaters (8,760 feet elevation). The San Antonio Creek drains the area between East Fork of the Jemez River and Rio Cebolla. Upper reaches, upstream from the town of La Cueva, are on the Preserve, and lower reaches are mostly on the National Forest, with portions flowing through private lands in and around La Cueva.

The entire stream was surveyed in 2002 using the USFS Region 3 Stream Survey Protocol from the modified Region-6 protocol (Hankin and Reeves 1988, US Forest Service 2005a). Streams were surveyed from the mouth moving upstream, and separated into riffle, pool, side channel, dry channel, culvert, and falls habitat types by specific attributes. Tributaries were also surveyed and classified as a seep, spring, or stream. Habitat types were assigned a Natural Sequence Order number (NSO) and grouped into a sequence of reaches.

Fish populations are present from the mouth (T19N, R3E, Sec. 32) at 6,755 feet to the headwaters at 8,760 feet.

San Antonio Creek is divided into 11 reaches, each with similar habitat characteristics and stream morphology. The average gradient of is 1.3 percent, and ranges from 0.1 to 4.9 percent. It flows across volcanic parent material that is highly erosive. It has excessive fine sediment loads and high turbidity, exacerbated by historic and current grazing practices, historic logging on the Preserve, and recreational and road-related impacts. Stream flow fluctuates between high flow events during spring runoff and summer monsoon rains, to low flows the rest of the year. The driest year in the past 20 years occurred in 2002, which is when the stream survey was conducted. Water diversions include one irrigation ditch and one pond. The ditch near San Antonio Campground diverts approximately half of the stream flow to the left bank. The constructed pond is constantly fed by a negligible quantity of water from San Antonio Creek in Reach 4 (La Cueva). (US Forest Service 2005b and 2003a).

Water quality monitoring by the State in 1998 and 1999 (at two sites) found water quality to generally meet the standards. However, turbidity exceeded standards twice during spring runoff and once in the fall. Total organic carbon (TOC) exceeded standards once in the fall at each site and could be attributed to decomposing deciduous vegetation (NMED 2001).

The pool:riffle ratio by number of habitats is 1:1.5, the same ratio by length of habitat is 1:13.0. The pool to riffle volume ratio is 1:1.7. A higher volume to length ratio in pools is due to pool shape. The riffle habitat is much greater than pool habitat.

San Antonio Creek contains a mix of not properly functioning and properly functioning characteristics. The parameters that are not properly functioning include: water temperature, sediment content in riffles, density of large woody debris (LWD), pool development, and width-to-depth ratio. Properly functioning characteristics include stream bank condition.

Water temperature is a crucial parameter for fish health and development. Water temperature data from five sample sites was compared to both National Forest and NMED standards. The National Forest standard classified San Antonio Creek as not properly functioning for salmonid development at all sites except station 5, near the headwaters. The NMED standard classified two of the five sites as not properly functioning for water quality. Future management actions should mitigate human-caused elevation of stream temperatures on San Antonio Creek. .

Riffle substrate content is important to the spawning and reproductive success of fish. The relative quantity of fine sediment in San Antonio Creek is not properly functioning by matrix standards, as riffle sediment content was about 30 percent.

Pool habitat is important over wintering, resting, and feeding habitat for fish. The relative pool habitat volume (depth) is not properly functioning, well below the greater than 30 percent standard. In addition, the quantity of pool habitat is of concern in all reaches except Reach 2 (34 percent). The relative quantity of pool habitat ranges from about 0.4 percent (Reach 10) to 14 percent (Reach 7).

The amount of LWD is related to habitat complexity and the health of fish populations in stream habitats (Fausch and Northcote 1992). In all reaches except those classified as a meadow, LWD density is not properly functioning. In non-meadow reaches, LWD density ranges from 0.0 pieces per mile in Reach 2 to 17.0 in Reach 5. All non-meadow reaches are far below the greater than 30 pieces per mile standard. Thus, there is a need to increase LWD, which would also improve other degraded conditions including lack of pools and excess sediment in riffles.

As defined by Rosgen stream classifications, each stream class has an expected natural bankfull width-to-depth ratio, which is related to how the stream should react to its valley formation (Rosgen and Silvey 1998). Reaches 1, 6, 8 and 11 are not properly functioning for the expected width:depth ratio for their respective Rosgen stream classifications. These reaches should be further analyzed to determine if this is surveyor error or management related. The other reaches are properly functioning excluding Reach 3, which was not surveyed or classified. The width:depth is not properly functioning in Reach 6 and at risk in Reach 1. Also, two of the 10 surveyed reaches are at risk for length of unstable banks: Reach 6 is at 11 percent and Reach 10 is at 10 percent. . The remaining reaches are properly functioning for streambank stability.



**Figure 56. Long riffle habitat and bank instability San Antonio Reach 6, 2002**

The following table shows the relative density of fish species based on a July 2009 survey conducted at two sites in San Antonio Creek. The upper site was within a special trout water area and the lower site was above the Highway 126 crossing. The special trout water designation requires that anglers use artificial fly or lure with a single barbless hook--catch and release only. The survey found brown trout density at about 362 to 375 fish per 1000 meters, weighing 52 to 57 kg/ha. Longnose dace (a native fish) was found to be the most abundant, followed by brown trout (a non-native). Rainbow trout is the least abundant.

**Table 40. Fish species density in San Antonio Creek**

Species Name	Common name	% of Catch at Lower Site	% of Catch at Upper Site
<i>Salmo trutta</i>	Brown trout	41	20
<i>Oncorhynchus mykiss</i>	Rainbow trout	0	1
<i>Rhinichthys cataractae</i>	Longnose dace	59	79

### **Jemez River – Stream and Riparian Conditions**

The Jemez River is a 5th order tributary to the Rio Grande. It starts from the confluence of San Antonio Creek and East Fork Jemez River at Battleship Rock, and flows all the way into the Rio Grande. The Upper Jemez flows through the National Forest land and some private land within the assessment area about 12.7 miles to its confluence with Rio Guadalupe. It begins below the Preserve. It has five reaches and the gradient ranges from 1.0 to 2.2 percent.

The upper Jemez River was surveyed in the summer of 2006, using the USFS Region 3 stream survey protocol previously described (a modification of the Region 6 protocol (US Forest Service 2005a).

The Jemez River has some reaches with not properly functioning conditions for: sediment, density of LWD, and pool development. Properly functioning characteristics include pool quality, stream bank condition, and width-to-depth ratio. The riffle habitat comprises 89 percent of the stream habitat throughout this River, reflecting a lack of adequate pool habitat. Sediment content

in riffle habitat is 27 percent, which indicates it is not properly functioning. The dominant substrate type is cobble followed by sand. Pool quality is properly functioning in the Jemez River with 90 percent of the pool habitats with at least a 1-foot residual depth. Residual pool depth is poor, at almost twice the properly functioning indicator. The length of pool habitat is also of concern in every reach. Pool quantity in reaches that are not properly functioning range from 4.0 percent in Reach 4 and to 12 percent in Reach 3, with the average quantity at only 10 percent.

The density of LWD is not properly functioning in all reaches of the Jemez River. The average LWD density is only 2.6 pieces per mile. The LWD density ranges from 1.45 pieces per mile in Reach 5 to 4.65 pieces per mile in Reach 4. Increasing the low densities of LWD should be a focus in the management of the Jemez River. Size of the LWD is also generally below the minimum standard of 12 inches in diameter at the large end and 35 feet long. Increasing the LWD density should be a focus in the management of the Jemez River, to improve several stream and fisheries habitat conditions.

Bank stability is highly variable, averaging 4.2 percent instability, which is properly functioning. Reach 1 is not properly functioning for bank stability, with 13 percent instability, due to activity at the developed recreation and fishing access areas.

In July 2009, a fish survey was conducted at two sites along the Jemez River within the assessment area: the upper site at the gauging station and the lower site just below the Ranger Station. Longnose dace, a native species, is the dominant species at the lower site (31 percent of the catch). Brown trout, a non-native species, is the most dominant species at the upper site (42 percent of the catch). Rainbow trout are least abundant. Table 67 shows the relative abundance of each fish species in this 2009 Jemez River survey.

In 2003, the number of brown trout was significantly higher at the lower site near the Ranger Station. The reasons for the differences are not understood because habitat characteristics between the 2003 and 2009 surveys were similar. The surveys may have coincided with a “boom and bust” incidence where a rise and fall in population numbers occurs as a result of forage abundance, annual recruitment, predation, angler take, and other factors. It may be that the brown trout are at carrying capacity for the stream, given the demand for food by the other resident fish species, or that the 2003 result was an anomaly and no longer relevant.

Stream temperatures in the Jemez River are too high to support a Rio Grande Cutthroat Trout (RGCT) population. At the Jemez River site below the Ranger Station, water temperature on the day of the survey was measured at 19 °C. At the upper survey site water temperature was 21 °C.

**Table 41. Fish species density on the Jemez River**

Species Name	Common name	% of Catch at Upper Site	% of Catch at Lower Site
<i>Salmo trutta</i>	Brown trout	42	15
<i>Oncorhynchus mykiss</i>	Rainbow trout	7	6
<i>Rhinichthys cataractae</i>	Longnose dace	35	31
<i>Gila pandora</i>	Rio Grande chub	0	20
<i>Catostomas plebius</i>	Rio Grande sucker	15	27

## Comparison of Existing and Reference Conditions

The following table summarizes the comparison of existing and reference conditions based on key aquatic stream and riparian habitat indicators for fisheries resources. Each of the major perennial stream systems evaluated in this report are included, along with the Jaramillo Creek and Rito de los Indios Creeks where additional stream surveys were conducted. The Ecosystem Elements column lists key ecosystem structure, composition, or functional indicators or attributes used to compare current to reference conditions. The last two columns describe the departures or gaps between current and reference conditions and the causes for those departures from the natural range of variability.

However, stream and riparian habitat conditions have substantially improved over the past 10 years. Since 2001, the National Forest's Respect the Rio program has resulted in improving stream and

riparian conditions within the assessment area. Respect the Rio includes environmental education, on-the-ground projects to improve water quality and watershed conditions, and public involvement to empower local communities and forest users to participate in watershed restoration. This program has helped to decrease stream temperatures and sediment delivery in these stream systems, in partnership with other agencies and organizations. The program integrates multiple disciplines in the treatment of dense forest stands, maintenance of riparian meadows, improvement of stream health, management of range (grazing), roads, trails, and dispersed recreation, and enforcement of federal regulations that emphasize water quality. Public education is one of the largest components of Respect the Rio, to reduce recreation-related impacts and build public support for the restoration activities.

**Table 42. Comparison of existing and reference conditions – stream and fish habitat**

Ecosystem Elements (Key Structure, Composition or Function Attributes as Indicators)	Current Conditions (Quantified if Possible)	Reference Conditions or Mgt. Standards	Departures: Gap Between Current And Reference Conditions (Quantified; or Surplus or Deficit)	Causes (For Departure)
Aquatic & Riparian Ecosystem: <b>East Fork Jemez River</b> (21.1 miles)				
Aquatic Habitat Condition <b>Riffle sediment:</b> <b>Large woody debris:</b> <b>Pool development:</b> <b>Pool Quality:</b> <b>Stream bank condition:</b>	Not properly functioning Not properly functioning Not properly functioning Properly functioning Properly functioning	Properly functioning	Excess fine sediment in riffles, lack of large woody debris, too few pools	Probable Cause of Impairment: Streambank destabilization, loss of large woody debris & riparian habitat, grazing, roads, recreation,

**Table 42. Comparison of existing and reference conditions – stream and fish habitat**

<b>Ecosystem Elements (Key Structure, Composition or Function Attributes as Indicators)</b>	<b>Current Conditions (Quantified if Possible)</b>	<b>Reference Conditions or Mgt. Standards</b>	<b>Departures: Gap Between Current And Reference Conditions (Quantified; or Surplus or Deficit)</b>	<b>Causes (For Departure)</b>
Native fish species occurrence <b>Rio Grande cutthroat trout,</b> <b>RG chub,</b> <b>RG sucker,</b> <b>Longnose dace</b>	Not present; brown & rainbow trout present Present, all reaches Present, all reaches Present, all reaches	Present Present Present Present	Loss of native trout species	Probable Cause of Impairment: introduction of non-native species, degradation of stream & riparian habitat
<b>Aquatic &amp; Riparian Ecosystem: Jaramillo Creek (12.1 miles)</b>				
Aquatic Habitat Condition <b>Riffle sediment:</b> <b>Large woody debris:</b> <b>Pool development:</b> <b>Pool Quality:</b> <b>Stream bank condition:</b>	Not properly functioning N/A – meadow reach Not properly functioning Properly functioning At risk	Properly functioning	Excess fine sediment in riffles, too few pools, streambanks in degraded condition	Probable Cause of Impairment: Streambank destabilization & degradation of riparian habitat as a result of grazing, roads, recreation,
Native fish species occurrence <b>RGCT</b> <b>RG chub,</b> <b>RG sucker,</b> <b>Longnose dace</b>	Not present; brown & rainbow trout present Present Present Present	Present Present Present Present	Loss of native trout species	Probable Cause of Impairment: introduction of non-native species, degradation of stream & riparian habitat
<b>Aquatic &amp; Riparian Ecosystem: Jemez River (16.9 miles)</b>				
Aquatic Habitat Condition <b>Riffle sediment:</b> <b>Large woody debris:</b> <b>Pool development:</b> <b>Pool Quality:</b> <b>Stream bank condition:</b>	Not properly functioning Not properly functioning Not properly functioning Properly functioning Properly functioning	Properly functioning	Excess fine sediment in riffles, lack of large woody debris, too few pools	Probable Cause of Impairment: Streambank destabilization, loss of large woody debris & riparian habitat, grazing, roads, recreation,
Native fish species occurrence <b>Rio Grande cutthroat trout,</b> <b>RG chub,</b> <b>RG sucker,</b> <b>Longnose dace</b>	Not present; brown & rainbow trout present Present Present Present	Present Present Present Present	Loss of native trout species	Probable Cause of Impairment: introduction of non-native species, degradation of stream & riparian habitat

**Table 42. Comparison of existing and reference conditions – stream and fish habitat**

Ecosystem Elements (Key Structure, Composition or Function Attributes as Indicators)	Current Conditions (Quantified if Possible)	Reference Conditions or Mgt. Standards	Departures: Gap Between Current And Reference Conditions (Quantified; or Surplus or Deficit)	Causes (For Departure)
Aquatic & Riparian Ecosystem: <b>Rio Cebolla</b> (3.41miles)				
Aquatic Habitat / Channel Condition  <b>Riffle sediment:</b> <b>Large woody debris:</b> <b>Pool development:</b> <b>Pool Quality:</b> <b>Stream bank condition:</b>	Not properly functioning Not properly functioning Not properly functioning Properly functioning At risk	Properly functioning	Excess fine sediment in riffles, lack of large woody debris, too few pools, high level of streambank instability (borderline not properly functioning)	Probable Cause of Impairment: Streambank destabilization, loss of large woody debris & riparian habitat due to grazing, roads, recreation
Native fish species occurrence <b>RGCT</b> <b>RG chub,</b> <b>RG sucker,</b> <b>Longnose dace</b>	Not Present due to browns & rainbows Uncertain Uncertain Uncertain	Native fish community present in sufficient numbers	Loss of native trout species	Probable Cause of Impairment: introduction of non-native species, degradation of stream & riparian habitat
Aquatic & Riparian Ecosystem: <b>Rio Guadalupe</b> (12.7 miles)				
Aquatic Habitat / Channel Condition  <b>Riffle sediment:</b> <b>Large woody debris:</b> <b>Pool development:</b> <b>Pool Quality:</b> <b>Stream bank condition:</b>	properly functioning not properly functioning not properly functioning properly functioning properly functioning	Properly functioning	Lack of in-stream large woody debris, too few pools	Probable Cause of Impairment: localized streambank destabilization & degradation of riparian habitat due to grazing, roads, recreation
Native fish species occurrence <b>Rio Grande cutthroat                      trout,</b> <b>RG chub,</b> <b>RG sucker,</b> <b>Longnose dace</b>	Not Present; brown & rainbow trout present Present Present Present	Native fish community present in sufficient numbers	Loss of native trout species	Probable Cause of Impairment: introduction of non-native species, degradation of stream & riparian habitat

**Table 42. Comparison of existing and reference conditions – stream and fish habitat**

Ecosystem Elements (Key Structure, Composition or Function Attributes as Indicators)	Current Conditions (Quantified if Possible)	Reference Conditions or Mgt. Standards	Departures: Gap Between Current And Reference Conditions (Quantified; or Surplus or Deficit)	Causes (For Departure)
<b>Aquatic &amp; Riparian Ecosystem: Rito de los Indios (4.5 miles)</b>				
Aquatic Habitat / Channel Condition  <b>Riffle sediment:</b> <b>Large woody debris:</b> <b>Pool development:</b> <b>Pool Quality:</b> <b>Stream bank condition:</b>	not properly functioning N/A; meadow stream not properly functioning not properly functioning at risk	Properly functioning	Excess fine sediment in riffles, too few pools which are too shallow, high level of streambank instability (borderline not properly functioning)	Probable Cause of Impairment: Streambank destabilization, loss of large woody debris & riparian habitat, grazing, roads, recreation,
Native fish species occurrence  <b>Rio Grande cutthroat                      trout,</b> <b>RG chub,</b> <b>RG sucker,</b> <b>Longnose dace</b>	Not present; brown trout Present; very low density Not present Not present	Present Present Present Present	Loss of native trout species, RG suckers, & longnose dace	Probable Cause of Impairment: introduction of non-native species, degradation of stream & riparian habitat
<b>Aquatic &amp; Riparian Ecosystem: San Antonio Creek (31.5 miles)</b>				
Aquatic Habitat Condition  <b>Riffle sediment:</b> <b>Large woody debris:</b> <b>Pool development:</b> <b>Width/depth ratio:</b> <b>Stream bank condition:</b>	not properly functioning not properly functioning not properly functioning not properly functioning properly functioning	Properly functioning	Excess fine sediment in riffles, lack of large woody debris, too few pools which are too shallow	Probable Cause of Impairment: localized streambank destabilization, loss of large woody debris & riparian habitat due to grazing, roads, recreation
Native fish species occurrence  <b>RGCT</b> <b>RG chub,</b> <b>RG sucker,</b> <b>Longnose dace</b>	Not present due to browns & rainbows Present, lower reaches Present, lower reaches Present	Present Present Present Present	Loss of native trout species & loss of RG chubs & suckers from upper reaches	Probable Cause of Impairment: introduction of non-native species, degradation of stream & riparian habitat

# Heritage Resources

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of heritage resources within the assessment area. The term “heritage resources” is used to encompass archeological sites, in-use historic buildings (and other structures and features), and traditional cultural properties (TCPs).

To complete this analysis, several types of information were used to gather heritage resource data, including heritage resource types and the distribution of those resources on the landscape; in order to understand how this project could affect them. Heritage resource tables built from GIS layers describe each site in order to assign sensitivity when exposed to the elements. A literature search identified site types and the effects on those sites by other similar projects completed in the past, and also helped to describe the distribution of heritage resources based on altitude, slope and aspect; procured resources, and proximity to water; as well as current fuel loads. Maps were used as a visual tool to identify heritage resource distribution based on location and topography. The maps also predicted site density in areas where there is no survey data or invalid survey data, thus protecting resources not identified in other sources of information. This also identifies the need to use another tool; predictive models, to pinpoint high density areas.

## Surveys and Consultation

The record of heritage resource sites has been defined by heritage resource survey and reconnaissance activities conducted within the assessment area. A total of 442 survey and reconnaissance activities have been conducted, covering approximately 56 percent of the National Forest portion of the assessment area (Figure 57). Of these, 193 of these activities are considered to be valid, having been conducted to current Forest Service heritage resources survey standards. The valid activities cover approximately 40 percent of the area. By contrast, only about 25 percent of the National Forest as a whole has been examined by survey and reconnaissance activities; 13 percent of the National Forest has been examined by valid activities.

Survey and reconnaissance activities have recorded 2,916 heritage resource sites (Figure 58). These sites constitute approximately 32 percent of all 9,216 sites recorded on the National Forest, and approximately two percent of all recorded sites in the state of New Mexico, based on current site registration numbers in the New Mexico Cultural Resource Information System database. The Forest Service initiated consultation with the Jemez Pueblo to notify them of this landscape assessment and upcoming forest restoration strategy, and to gather information on TCPs in the project area. The locations and sensitivity of TCPs is information held only by the Pueblo, and cannot be identified or protected without collaboration with them. As provided for in the American Religious Freedom Act, in areas of Native American religious use, the Forest Service will determine, with the appropriate traditional religious leaders, actions to preserve the religious practices and to protect Native American religious sites and shrines from ground disturbing activities.

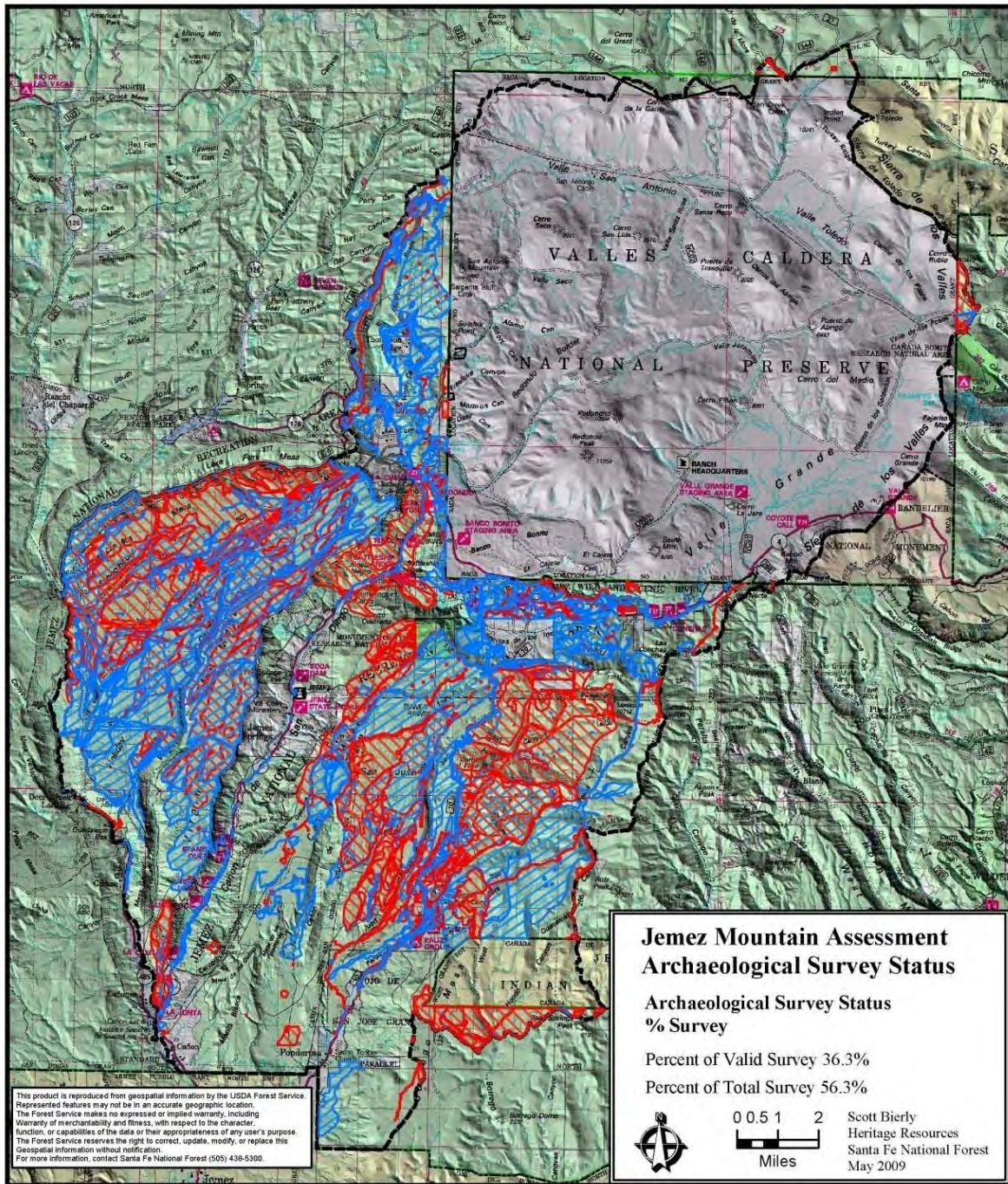


Figure 57. Archaeological survey status on National Forest Land

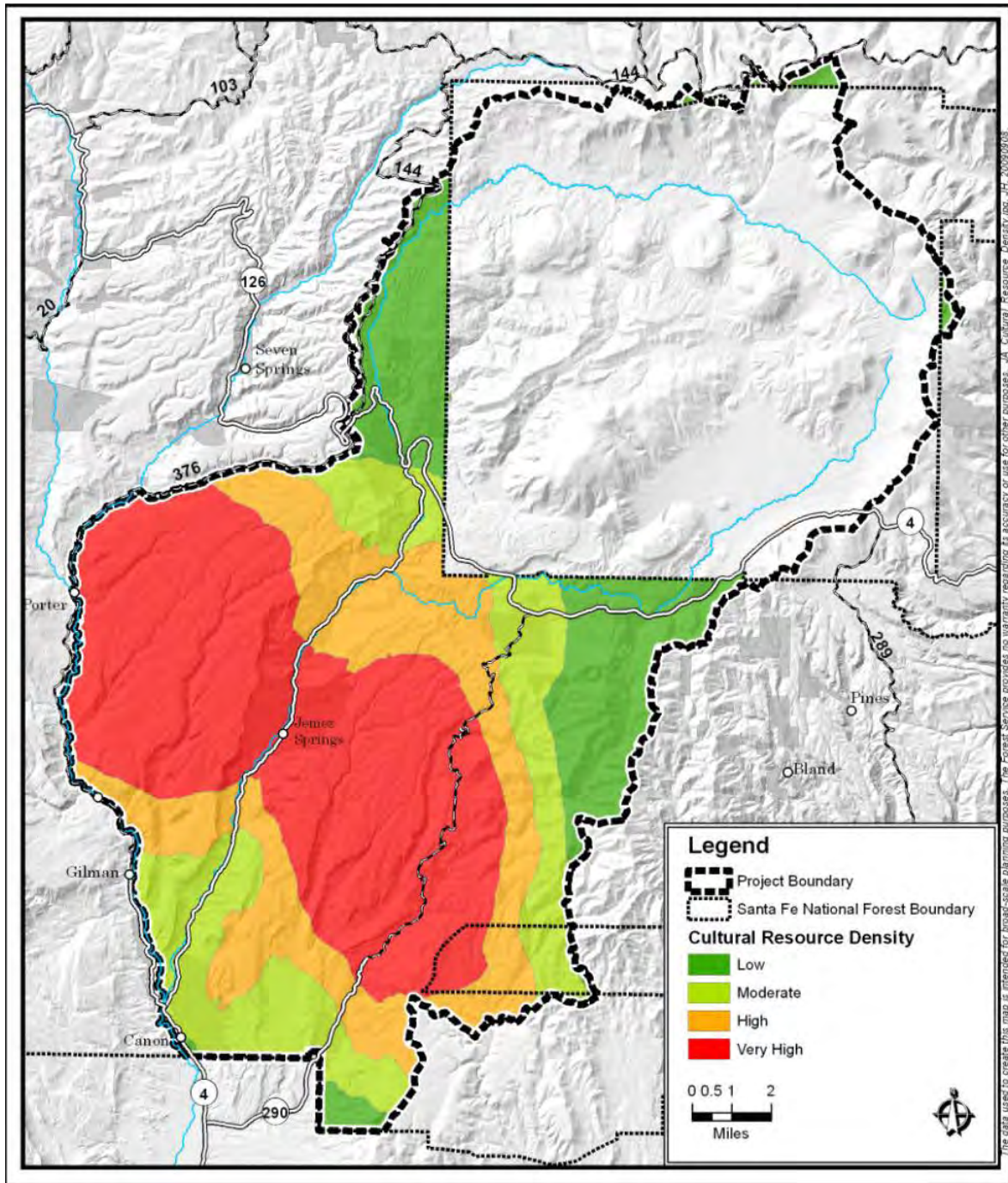


Figure 58. Heritage resource site density on National Forest land in the area

There are also numerous guidelines requiring coordination of Native American heritage resource needs with other resource management activities. This consultation and coordination is typically done in coordination with project planning, and information is shared to allow the Pueblo and tribal leaders to evaluate potential impacts to cultural and religious sites and identify possible mitigation measures. Heritage resource management is conducted in accordance with National Historic Preservation Act and implementing regulations at 36 CFR 800.

## **Heritage Resource Sites**

The National Forest land within the assessment area is within a historic cultural area known as the Jemez plateau or Jemez province. This area contains archeological and in-use historic remains from Native American, Hispanic and Anglo/Euro-American residence and use in the area. There are archaeological sites that date from paleo times as early as 10,000 years ago or earlier right through the archaic middle Holocene from 7,500 to 1,000 years before present; however the majority of heritage resources within the assessment area are archeological sites that date to the Native American (Pueblo Indian) use and occupation of the Jemez Plateau between approximately A.D. 1150 and 1700. Toward the end of that era, the Spanish colonized New Mexico and brought about many changes to the local native culture (Elliott 2002).

The Native American occupation of the plateau is considered by archeologists to be one of the largest and densest during this time period not only in the Southwest but in the entire North American continent (Snead et al. 2004). The Pueblo Indian occupants of these archeological sites were the ancestors to people within the contemporary Native American community of Jemez Pueblo, a sovereign Indian tribe (Sando 1982). Thus, pre-historic and proto-historic site density in this area is considered the highest in the United States.

The scientific, historic and cultural significance of archeological sites in this area is also considered to be exceptional. The Forest Plan recognizes the significance of archaeological sites in the area, with over 60 percent of the assessment area allocated to management areas that emphasize heritage resource management and protection (shown in Table 2 and Figure 3). The exceptional historic/pre-historic significance of the area is also indicated by the proportion of sites listed on the National Register of Historic Places. There are 42 sites listed on the Register within the assessment area; approximately 65 percent of all the register sites located on the National Forest.

The highest heritage resource site density occurs at elevations below 8000 feet. Some sites do exist above 8000 feet but most of those were used for hunting. Thus the potential for sites at high elevations is considered low. Mesa tops and canyons below 8000 feet, especially those with close proximity for water and not located on steep slopes, were the most desirable areas for pre-historic peoples (Skinner 2003). Historic sites however, are spread more evenly across the landscape and occur at just about every elevation and landscape. Historic sites, most dating to the late 19th and early 20th century, are related to uses such as logging, associated railroad construction and sheep and cattle grazing. The main types of sites found in the area include: pueblos; field houses; cavates, rock shelters and cliff dwellings, game traps and hunting blinds; agricultural features, artifact scatters and a variety of historic sites.

## **Pueblos**

There are 84 native pueblos (living structures) that date to the pre-historic and proto-historic periods within this area. The rooms in the pueblos are generally set in a rectangular configuration and may be one- to three-story room blocks around a central plaza. Round ceremonial structures called kivas are also located in and around the pueblo. Most of the pueblos in the project area are reduced to rubble mounds; however a few still have some standing features such as walls, and some also contain perishable materials such as wooden vigas (support beams). Large pueblos are considered to be fire sensitive sites that should be protected by the removal of fuels from the site, black lining or other methods of fire avoidance.

## **Field Houses**

There are approximately 2,025 recorded field houses in the assessment area. A field house is a small structure of one to four rooms generally considered puebloan (pre-historic to proto-historic), and associated with agricultural areas or fields. Most of these structures have been reduced to rubble mounds, however a few may have standing walls and perishable features. While burning over these sites usually does not affect the integrity, high intensity fires could overheat cultural deposits changing geomagnetic dating potential as well as damage to the cultural material buried in the field house. Also these houses are often built using soft and porous tuff rock which can change color, spall and shatter during such high intensity fires. As a result, these sites are considered fire sensitive and should be protected from intense fire.

## **Cavates, Rock Shelters and Cliff Dwellings**

The area contains approximately 20 cavates, 83 rock shelters, and no known cliff dwellings. Cavates, rock shelters and cliff dwellings are three types of puebloan living or storage sites associated with cliff faces. Cavates are holes or caves hollowed out in cliff faces that have tuff soft enough to dig in. Rock shelters are natural recesses in the base of cliffs that have not been made with human hands, but rather through wind or wave action in the past. The roofs of both these structures may be smoke blackened, and they may contain rooms. Cliff dwellings are medium to large pueblo type structures built into the cliff faces in large overhangs and recesses. Fire has a minimal potential to impact these types of sites, unless they contain petroglyph rock art or outside structures. There are several examples of such rock art at some of these sites.

## **Game Traps and Hunting Blinds**

Three game trap and hunting blinds have been found from the frequent pre-historic hunting activity that occurred. Game traps, such as raptor traps, are often identified as pit features near mesa tops. Hunting blinds were used to hide the hunter from the prey. These particular sites within the assessment area would not be affected by fire.

## **Agricultural Features**

Agricultural features, represented by several different kinds of ground alterations, indicate the production of native plants for food, such as corn, squash, beans and peppers. Sites include check dams for diverting water to the gardens, and rock alignments delineating garden areas, used from pre-historic through the historic era. Fields commonly are described as terraces that have small stone alignments in the front of the terrace landings (Fliedner 1975). While there may be thousands of agricultural features in this area, only 27 have been recorded to date, because they so

readily blend into the landscape. Many are recorded as simple features or Isolated Occurrences (IO) and not sites, and occur commonly near field house and pueblo sites. While these sites can be harmed by ground disturbing activities, fire generally has little to no effect on them.

### **Artifact Scatters**

There are about 203 artifact scatters recorded in the assessment area. These are sites with no obvious structural features. Artifact scatters can include pre-historic stone and pottery to historic artifacts like cans and bottles. Some of the scatters date from the late archaic to the paleo times 10,000 years ago. These sites can be somewhat susceptible to fire, especially high intensity fire, and ground disturbing activities.

### **Historic Sites**

There are approximately 128 historic sites recorded in this area, ranging from whole camps like those used for logging to single features such as sheep pens or hunting blinds. They may include sites historic trails and roads. Many trails and roads follow routes that have been used since pre-historic times. Historic sites typically have artifacts such as glass, nails and cans associated with them. These sites are especially sensitive to fire because many include wood material. Thus, both fire and ground disturbing activities can still greatly affect the integrity of these sites.

### **Traditional Cultural Properties**

There are two TCPs in the area along with a number of potential TCPs, which are being evaluated for eligibility to be listed in the National Register of Historic Places. A TCP is considered eligible the National Register of Historic Places if it is associated with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (Parker and King 1990). The nature of TCPs is strictly confidential; however, the two identified TCPs in this area would both be affected by ground disturbing activities including fire. Thus, the decision to use prescribed fire on or around these TCPs must be evaluated on a case-by-case basis, in consultation with the Pueblos.

### **Other Sites**

There are about 130 other types of sites dating from pre-historic to historic that do not categorize easily because of their obscurity or numbers. They include burials, cache pits, and hearths, as well as jacal structures (burnt adobe), kivas, pithouses, pre-historic features, rock features, and shrines. These sites are important, and are either somewhat sensitive or highly sensitive to fire.

### **Forest Plan Direction**

The Forest Plan contains forest-wide and specific management area direction relevant to management and protection of heritage resources. Thus, these Forest Plan standards and guidelines provide “reference conditions” that are useful in developing the landscape restoration strategy and site-specific proposed actions. This management direction is summarized and paraphrased to reduce bulk and redundancy. Management areas are described and shown on a map in Table 2 and Figure 3, at the beginning of this report. The following lists the most relevant forest-wide standards and guidelines followed by management area standards and guidelines for the management areas in this assessment area. Refer to the Forest Plan for additional detail.

## **Forest-wide Standards and Guidelines**

- Heritage (or cultural) resources management includes an active program of inventory, nomination, protection, and restoration, as well as interpretation and research.
- Complete coordination and cooperative planning with the State Historic Preservation Office, other State and Federal government agencies, and Native American tribes.
- Survey areas scheduled for “undertakings” (ground disturbing activities), in consultation with the State Historic Preservation Officer (SHPO) and, as appropriate, the Advisory Council on Historic Preservation (ACHP). Complete 100 percent survey of all project areas specified in the lawsuit settlement agreement (Save the Jemez/State of New Mexico v. Forest Service).
- Complete inventory and site marking (and avoidance) at a sufficient level to protect sites from management activities.
- Identify, prioritize and survey areas not scheduled for surface disturbing projects, such as areas that lack site density information, have a high site density, or have a high potential for vandalism.
- Assess the potential effects of proposed actions upon cultural resources, and evaluate all sites to determine if they are potentially eligible for the National Register of Historic Places (NRHP).
- Manage and protect all sites listed in, eligible for, nominated to, or potentially eligible for the NRHP to achieve a “no effect” finding. Where resource conflicts preclude this, manage sites to achieve a “no adverse effect” finding. Where there is evidence of vandalism, artifact collecting, or illicit excavation, implement appropriate protective measures, such as signing, fencing, administrative closure, remote sensing, increased patrolling, or public education. For evidence of natural deterioration, implement appropriate stabilization measures. Enforce laws firmly and with appropriate uniformity, and emphasize personal contacts to reduce pot hunting of cultural resources.
- In planning and conducting fire and fuel management activities: (a) consult with the Forest or District Archeologist prior to activities such as construction of firelines or prescribed burning to avoid impacts to cultural resources; (b) consider potential impacts to cultural resources when determining strategies for managing wildfires, including “escape” fires; and (c) avoid the use of bulldozers on slopes greater than 40 percent.

## **Management Area I - Standards and Guidelines**

These areas contain high value cultural resources representing the major cultures which once lived on the National Forest, and the majority of the Forest’s National Register sites occur within this management area. Because of the sensitivity of the location of these areas and the potential for disruption of the sites due to disclosure of their locations, this management area does not appear on public maps and locations remain confidential, in accordance with 36 CFR 296.18.

- Exclude major land disturbing activities and focus these areas on cultural resource site nomination, interpretation, and research.
- Continue to evaluate additional areas for possible inclusion to management area “I”, based on site density, unique size or quality, and characteristics of a particular time period or cultural adaptation not sufficient represented in current management areas.
- Evaluate roads through important sites for the possibility of closure or realignment.

- Evaluate all NRHP sites for mineral withdrawal and closure to off-road vehicle use.
- Monitor NRHP and other high priority sites every other year, and take appropriate action to protect those sites.
- Locate range structures to avoid the concentration of livestock on cultural resources.
- Allow tree removal to reduce damage to cultural resources, and personal use firewood harvesting, if removal does not conflict with the cultural resource objectives for the area. Identify, mark if appropriate, and direct use away from cultural resource sites.
- Do not construct roads except where necessary for permitted special uses, mineral activities, private land access, to access adjacent management areas where other reasonable access is not available or to support cultural resource management. Close all unnecessary roads where they currently exist.
- Manage wildfires with sensitivity to the cultural resources being protected. Identify fireline locations in consultation with the archaeologist. Use natural barriers, roads, or other non ground disturbing methods where possible to suppress wildfires.
- Allow prescribed fire or other fuel treatments only if the activity will maintain or enhance cultural resource values.

### **Management Areas P, R and S - Standards and Guidelines**

These management areas contain a rich resource of historic and pre-historic sites, and management emphasis is on heritage resource inventory, nomination, and protection

- Evaluate and nominate, as appropriate, sites in this area that are not currently listed in the NRHP. Allow interpretation and development of NRHP sites, in consultation with Native American tribes, federal and state agencies and citizen groups.
- Protect important cultural resource sites by emphasizing law enforcement and site monitoring.
- Evaluate roads through important sites for the possibility of closure or realignment.
- Evaluate all NRHP sites for mineral withdrawal and closure to off-road vehicle use.
- Monitor NRHP and other high priority sites every other year, and take appropriate action to protect those sites.
- Stabilize or repair damaged cultural resource sites, based on severity of damage and the relative importance of the site.
- Design timber sales and stand improvement projects to avoid or properly mitigate disturbance to archeological or Indian religious sites.
- Allow prescribed fire and fuel treatment activities, commensurate with protection of the cultural resources.
- Use non-ground disturbing methods for firelines where possible (fire retardant, natural barriers, etc), and consult with the archaeologist prior to constructing firelines.

### **Management Area X- Jemez National Recreation Area**

- Ensure protection of religious and cultural sites and provide access to those sites by Indian peoples for traditional cultural and customary uses

- When marking or identifying archaeological sites to be protected during project implementation, consider options other than paint.
- Strive to maintain the character of the Civilian Conservation Corps (CCC) facilities through the use of similar materials and design elements.

### **Management Area F- East Fork Jemez Wild and Scenic River**

- Use education and interpretation as the primary means to protect heritage resources, by increasing appreciation and respect for historic and pre-historic sites.

### **Programmatic Agreement**

The *Programmatic Agreement Regarding Historic Property Protection and Responsibilities* outlines Forest Service responsibilities for management of historic properties, public participation, and tribal consultation. It describes fire sensitive sites and how these sites will be identified in consultation with the State Historic Preservation Office and fire management personnel. Fire-sensitive sites determined to be ineligible for the National Register of Historic Places do not require protection under Section 106.

# Recreation & Scenic Quality

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of recreation and scenery resources within the assessment area, based on a variety of sources including: the Forest Plan, the Jemez National Recreation Area Assessment Report and Management Plan, the Jemez Wild and Scenic River Corridor Plan, Forest's Recreation Facility Master Plan and National Visitor Use Monitoring Report (2005), the 2005 Jemez Watershed Assessment, Forest Service Manual 2370 and Forest Service Trails Handbook 2309.11k, and the Forest Service's Recreation Opportunity Spectrum handbook (US Forest Service 1986).

## Recreation Opportunities and Settings

Outdoor recreation is a dominant activity within the assessment area, which lies in close proximity to the most populated cities in New Mexico. The area contains many developed campgrounds, picnic areas, fishing access areas, trails, and trailheads. The Wallotowa Visitor Center, jointly managed by the Forest Service and Pueblo of Jemez, provides interpretive displays and visitor information. In addition, numerous opportunities exist for dispersed (undeveloped) recreation, based on a well-developed system of access roads (shown in Figure 59). While most roads in the area are dirt or gravel roads, four state highways provide access in the assessment area, highways 4, 126, 485, and 290. There are also four specially designated areas within the assessment area: Jemez National Recreation Area (JNRA), East Fork of the Jemez Wild and Scenic River (WSR), Monument Canyon Research Natural Area (RNA), and an unnamed Inventoried Roadless Area (IRA).

The Recreation Opportunity Spectrum (ROS) classification system is used to describe the variety of recreational settings provided on national forest system lands. There are four (or six) ROS settings that occur in the assessment area: Rural, Routed Natural, Semi-Primitive Motorized, and Semi-Primitive Non-Motorized, as shown on the map in Figure 60. The relative percentage of each ROS in the assessment area is as follows:

- Routed Natural (RN): 45 percent
- Semi-Primitive Motorized (SPM): 44.4 percent
- Semi-Primitive Non-Motorized (SPNM): 10.4 percent
- Rural (R): <0.2 percent

Seven descriptors for each ROS setting provide additional management tools, and describe the relative degree of: access (roads, trails); remoteness from human activities; naturalness of the physical environment; social encounters (expected frequency of encountering other people); visitor impacts; visitor management (regulation, control); and facilities (services, development). The ROS setting does not apply to private lands, although private inholdings are considered in managing for ROS settings on surrounding National Forest land (Figure 60). (US Forest Service 1986).

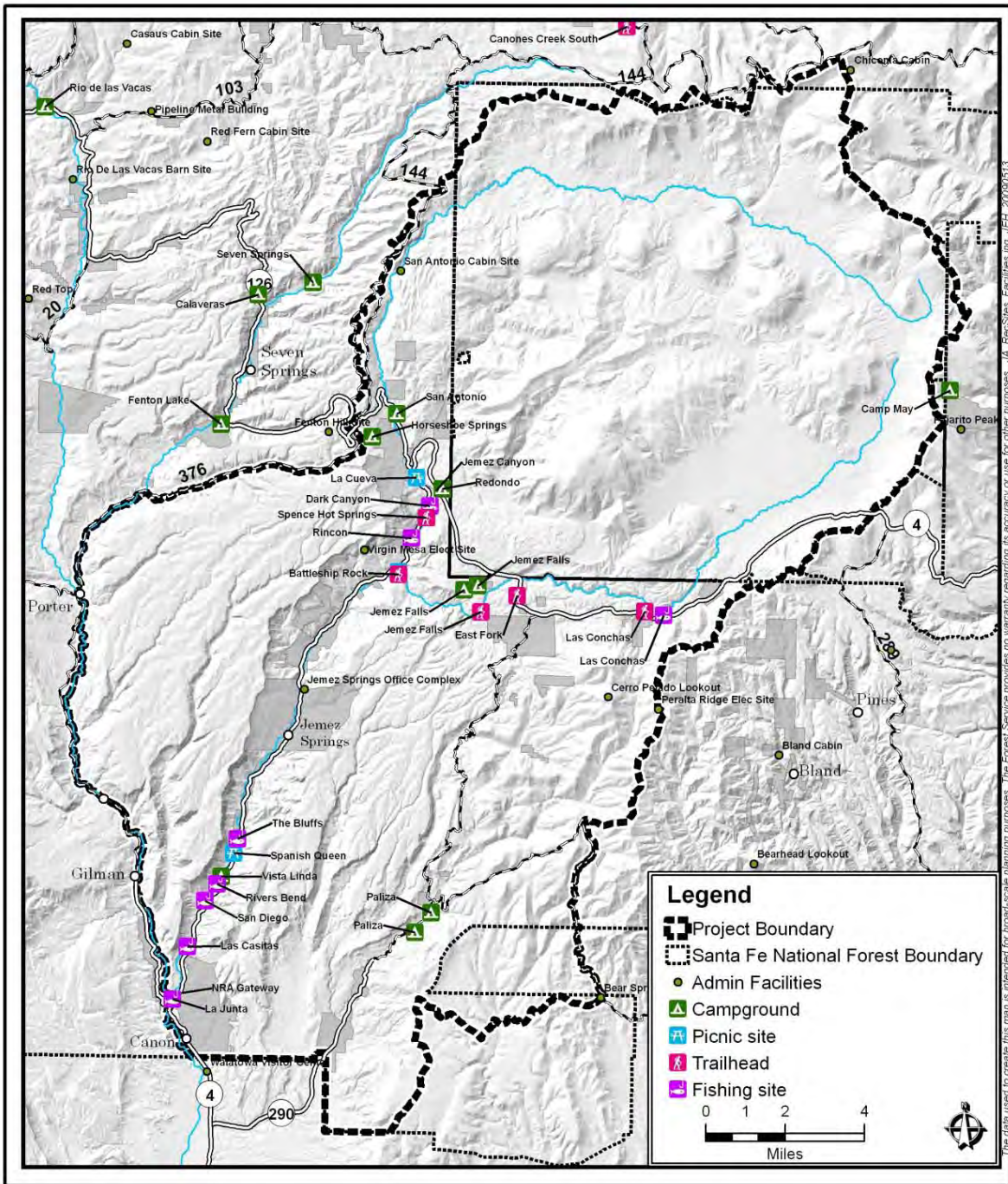


Figure 59. Developed recreation facilities

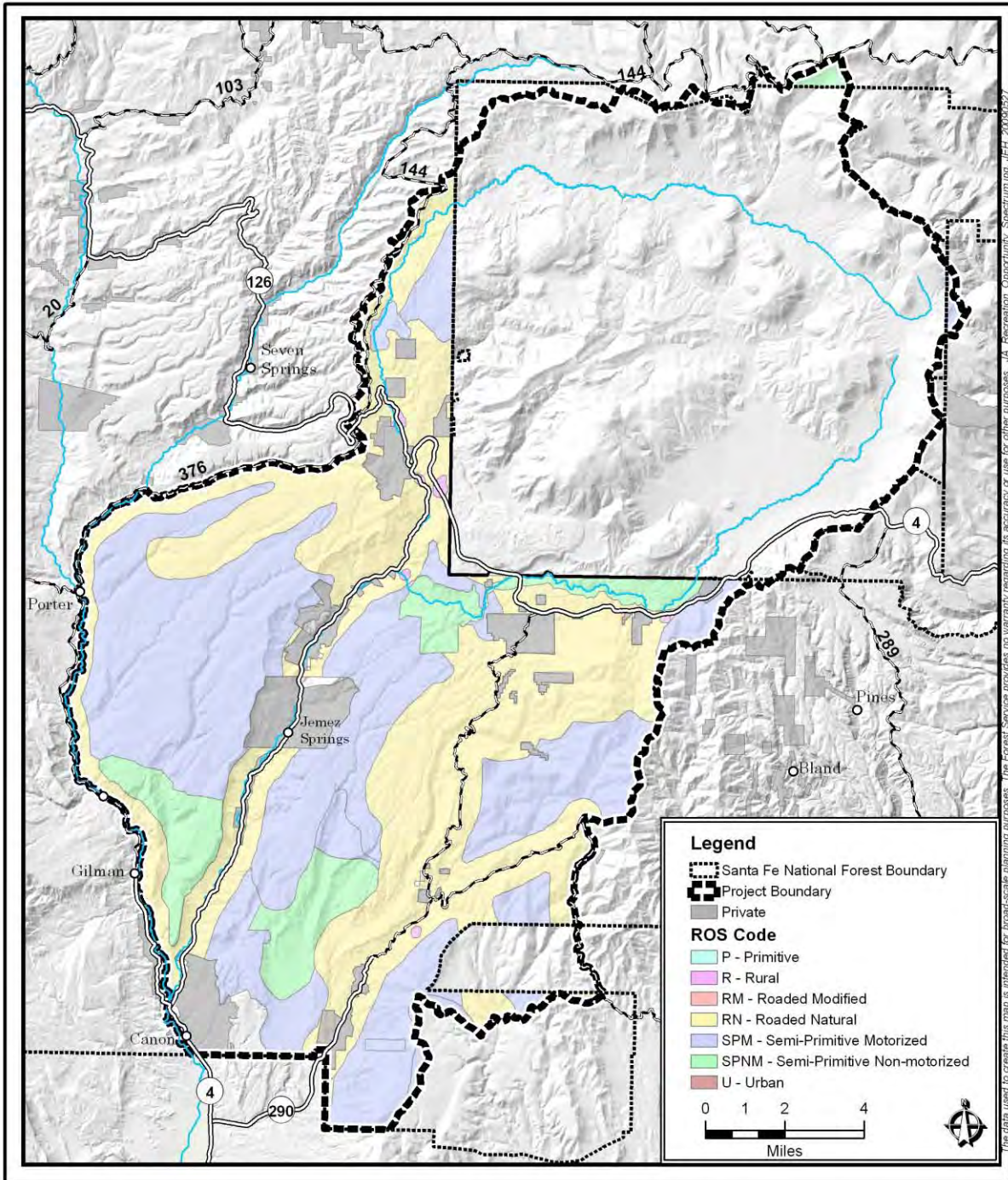


Figure 60. Recreation opportunity spectrum settings

## Developed Recreation

The Forest Plan directs managers to provide recreational facilities within the JNRA that minimize impacts on scenic beauty, natural character, and archaeological and religious sites (PL 103-104, Sec. 2[j]). In providing for recreational facilities, emphasis shall be placed on the preservation, stabilization, and protection of cultural resources and conservation of wildlife.

There are seven developed Forest Service campgrounds within the assessment area, of which five are in the JNRA. They are all heavily used, especially between Memorial Day and Labor Day. A list of campgrounds and units available at each is presented in Table 43. Fees are charged under the Recreation Enhancement Act (REA) at all of these campgrounds. Sites at Paliza and Redondo can be reserved through the National Reservation System. These campgrounds are generally full to capacity every weekend from Memorial Day to Labor Day.

**Table 43. Forest Service campgrounds and number of units at each site**

Campground	Area	Number of Units
San Antonio	JNRA	47
Redondo	JNRA	59
Jemez Falls	JNRA	52
Vista Linda	JNRA	13
Paliza	Outside JNRA –Vallecito Ck	30
Paliza Group 1 & 2	Outside JNRA – Vallecito Ck	16 & 8

Source: (JNRA 1997; Forest website)

There are six Forest Service picnic areas within the assessment area, all of which fall within the JNRA. Fees are charged at three of these sites. Jemez Falls Group site can be reserved for use through the National Reservation System. Table 44 shows the list of picnic areas and number of units available at each. These day-use sites are popular and on weekends they fill to capacity. Over-crowding has caused parking and access problems within several of the sites (Battleship, La Cueva and Jemez Falls Family).

**Table 44. Forest Service picnic areas and number of units at each site**

Picnic Area	Number of Units
Battleship	33
Jemez Falls Group Area	1 (up to 100 people)
La Cueva	12
Las Conchas	0 (fishing access site)
Spanish Queen	12

Source: (Forest website)

The need for change in developed recreation within the assessment area includes the following:

- Increase availability of developed recreation sites, while staying within RN ROS. Include addition/expansion of both campgrounds and picnic areas.
- Decrease resource impacts from large groups of picnickers at fishing access points by converting some of these areas to picnic sites or by increasing the number of developed picnic areas.
- Reduce human-created resource impacts within developed recreation sites caused by overcrowding of campgrounds and picnic areas by increasing the number of sites available through the National Recreation Reservation System.

## **Dispersed Recreation**

Hunting is a major recreation activity in the assessment area. Hunting is allowed in accordance with state and federal regulations. The assessment area includes Big Game Hunting Unit 6A, 6B, and 6C. Big Game Unit 6A includes the Jemez watershed, Unit 6B includes the Valles Caldera, and Unit 6C includes a small portion near Las Conchas. The hunting unit boundary division for Unit 6C follows Peralta Canyon. The New Mexico Department of Game and Fish (NM Game and Fish) is responsible for issuance of hunting tags for the various big game species within the hunting units. Small game units are also issued by NM Game and Fish; however, these small game tags or stamps are typically issued for statewide use on public or permissible private lands.

Fishing is a very popular activity and available on every major stream in the assessment area. The Jemez River, East Fork Jemez, Vallecito Creek, and San Antonio Creek fisheries are composed of naturally reproducing brown trout, rainbow trout, and a host of other native and non-native species. Developed fishing access points include: La Junta, Las Casitas, San Diego, River's Bend, The Bluffs, Las Conchas, Rincon, and Dark Canyon. The Lower Jemez River sites are increasingly used for picnicking, making access by anglers more difficult, due to limited parking. However, anglers can access fishing locations all along the river, outside developed sites.

There are no opportunities for motorized boating because the waterbodies in the assessment area are too small or have large amounts of coarse woody debris blocking the channels. Small boaters may be able to negotiate portions of some streams, although it is fairly dangerous and limited.

Other dispersed recreation activities in the assessment area are soaking in the hot springs, hiking, biking, primitive camping, picnicking, photography, rock-hounding, horseback riding, and wildlife viewing. The hot springs are extremely popular, with parking areas being full most days of the week during the peak recreation season. This is particularly true of Spence Hot Springs; however, due to poor grade and pumice soils, erosion of the parking area and trail are extensive, causing safety concerns for visitors to the area, though closing the area to use is virtually impossible to enforce. Camping in the Forest Road 376 corridor is extremely popular, with most campsites being utilized each weekend. Though the area is designated as a dispersed camping corridor by the Forest Plan, the amount of use is increasing and impacts from trash, human waste, and loss of vegetation in riparian areas is a major issue. Dispersed camping also takes place in the Forest Road 10 corridor, though not to as great an extent as on Road 376 and does not appear to be affecting the visual quality objectives of the area.

The Forest Plan directs managers, when rehabilitating recreation facilities, to consider the dispersed area that the facility serves and resource capacities associated with the dispersed area. It also directs managers to eliminate illegal dumpsites and other garbage and debris.

The need-for-change in dispersed recreation management includes the following:

- Increase cooperation with the State Department of Transportation and law enforcement agencies to reduce parking issues within the Highway 4 corridor and eliminate pedestrians along the highway, particularly at Las Conchas trailhead, Soda Dam, and El Puente Blanca.
- Restore natural conditions at the hot and warm springs by reducing use of these areas.
- Reduce resource degradation in the FR 376 corridor that is occurring from vehicles parking on roadside vegetation by increasing the amount of constructed parking areas.
- Reduce resource impacts from overcrowding and overuse of dispersed camping sites within the Rio Guadalupe and Rio Cebolla river corridors. Establish system of designated campsites within these areas.
- Increase riparian vegetation and scenic values in heavily used areas within the JNRA, particularly the WSR, by closing and rehabilitating denuded sites.
- Reduce resource impacts from overcrowding and overuse of dispersed camping sites within the WSR corridor by providing designated dispersed campsites or camping zones away from the stream and riparian areas. Limit camping in the WSR corridor.
- Increase recreation opportunities within the WSR corridor, outside of riparian zones.
- Reduce recreational use in reaches 1 and 6 of the WSR corridor that result in bank erosion and instability.
- Reduce human waste and trash within riparian areas along river corridors.
- Increase presence and monitoring within the assessment area to improve compliance with closure orders, particularly within the JNRA and WSR corridor.
- Reduce erosion and sedimentation at Spence Hot Springs area. Improve parking to reduce resource impacts and degradation to the springs caused by over use of the area.

## **Recreation Special Uses**

A number of recreation special use permits are issued within the assessment area each year including those for recreation events like the Adventure Race and NM Motorcycle Trials Event; non-commercial group uses like family reunions; commercial uses like outfitting and guiding (hunting, rock climbing, sight-seeing, birding...), and filming. Several major motion pictures and television series have been filmed in the assessment area.

Special use permit authorizations may be issued on the National Forest when the proposed use: fulfills a demonstrated special need without unduly infringing the general public; meets approved management plans and will not adversely impact natural resources; and serve a function that cannot be provided off National Forest land.

## Special Area Designations

### Jemez National Recreation Area

The congressionally designated Jemez National Recreational Area (management area X) was established in 1993, and an assessment report, EA and management plan for this area were completed as an amendment to the Forest Plan (US Forest Service 1998, 2002). The Jemez National Recreation Area receives about 1.6 million visitors each year. It is accessed by State Highway 4, a State Scenic and Historic Byway, and State Highway 126. Within the NRA is the 3,520-acre congressionally designated East Fork of the Jemez Wild and Scenic River corridor, management area F in the amended Forest Plan (US Forest Service 2002d).

The JNRA is managed for the following goals, and standards and guidelines, some of which are required by the 1993 JNRA Act (shown in italics). Some are paraphrased here to make this document more concise. These JNRA goals, standards and guidelines are adequately addressed by past, current, or planned management activities. (US Forest Service 2002f).

- *Permit scientific investigations in the area if they are in the public interest and compatible with the purposes of the JNRA Act (PL 103-104, Sec. 2[m]).*
- *Establish a visitor center and interpretive facilities in or near the recreation area for the purpose of providing for education relating to the interpretation of cultural and natural resources of the recreation area (PL 103-104, Sec. 2[k]).*
- Do not use marketing or other methods to increase visitation to the area.
- Encourage volunteer programs and partnerships with other agencies, tribes, local communities, and user groups in planning, implementing, and monitoring activities.
- Provide opportunities for tribes, local rural communities, and user groups to present information on their culture and traditions to visitors.
- Maintain the option of charging user fees to help offset the costs of managing the JNRA.
- Work with local cooperative emergency services to increase or improve emergency services so that local residents are assured of prompt emergency care.
- Provide facilities, services, and opportunities that reflect the interests and values of local residents, in addition to considering the desires of non-resident visitors.
- Work with the State Highway Department and local communities to minimize the impacts from the increasing traffic through the area.
- Manage for the level of recreational development consistent with the Recreational Opportunity Spectrum (ROS) classifications for this area.
- When rehabilitating recreation facilities, consider the dispersed area that the recreation facility serves and consider resource capacities associated with the dispersal area.
- Manage the four landscape units (Lake Fork, Guadalupe, East Fork, and Lower Jemez) to emphasize each unit's unique recreation opportunities and character and to reduce negative impacts of overuse.
  - Manage the Lake Fork and Guadalupe for dispersed recreation.
  - Manage the East Fork for both developed and dispersed recreation as further defined in the management direction for the East Fork WSR.
  - Manage the Lower Jemez for developed recreation.

### **Rio Guadalupe and Rio Cebolla Corridors**

The majority of dispersed recreation activities in the assessment area occur within the JNRA, particularly in the Rio Guadalupe corridor. On most weekends during peak recreation season (Memorial Day to Labor Day), numerous campsites are used throughout this corridor, as well as areas posted as closed. Forest Plan direction calls for this corridor to be managed for dispersed recreation.

Stream inventories conducted in 2003 on the Rio Guadalupe and Rio Cebolla and reported in 2004 Stream Inventory reports, found that in the summer the Guadalupe corridor receives a considerable influx of people recreating along its stream banks (US Forest Service 2003b, 2004a-c). Dispersed campsite inventory completed in 2003 (Respect the Rio 2003) found that the Guadalupe corridor has 22 complexes and 127 individual campsites (see Table 45). These campsites are characterized by large areas of exposed soil, which during rain events can lead to heavy sediment loading in the streams. There is approximately 123 acres of disturbed ground along Rio Guadalupe associated with dispersed camping (US Forest Service 2003, 2004b-c). Fence and sign maintenance is needed in this corridor. While Table 45 quantifies impacts along these two streams, stream side recreation impacts occur throughout the assessment area, adversely affecting water quality, fisheries, wildlife habitat and proper ecological functions, as described in other sections of this report.

**Table 45. Dispersed campsite conditions along Rio Guadalupe and Rio Cebolla**

<b>Inventory Component</b>	<b>Rio Guadalupe</b>	<b>Rio Cebolla</b>	<b>Total</b>
Complexes (number)	22	29	<b>51</b>
Individual Sites (number)	127	130	<b>257</b>
Fire Rings (number)	265	226	<b>491</b>
Disturbed Soil (acres)	123	132	<b>255</b>
Vegetation Loss (acres)	43	45	<b>88</b>
Damaged Trees (number)	435	710	<b>1,145</b>
Unstable Banks (feet)	420	822	<b>1,242</b>
Toilet Proximity to Stream (feet)	130	9	

The 2003 campsite inventory also identified human impacts throughout the Guadalupe corridor, including user-created roads and trails, dams, angler trails, and trash (see Figure 61 and Figure 62). Areas denuded by dispersed camping are prevalent along the left bank. Orea at the end of the reach (Gilman Peak) is commonly used as an illegal dumping site. Garbage and toilet paper occur in many areas of the corridor. The Forest Plan directs managers to eliminate illegal dumpsites and other garbage and debris, and manage recreation uses in a manner that protects resources.

Human impacts in the Guadalupe Box area are represented by graffiti on the rocks, jeep trails, and angler trails. Fishing line, tires and other trash was found in the stream. Pools near the top of Reach 3 are used as swimming holes, and the Gilman tunnels are a popular stopping point for forest visitors. Yet much of the stream and bank are degraded by human impacts.



**Figure 61. Campsite litter along the banks of the Rio Guadalupe, 2004**



**Figure 62. Dispersed campsite next to Rio Guadalupe, 2004**

The Forest Plan directs that when rehabilitating recreation facilities, consider the dispersed area that it serves and the natural resource capacity associated with the dispersal area. In 2003-2004, the Contact Ranger Program documented intensity of use, where visitors resided, changes witnessed by repeat visitors, and suggestions for improving the experience. Also, visitors were asked if they would pay a fee to visit the area. Survey results found there are many different types

of users in different corridors, a progressive growth in visitation, many new dispersed sites, a willingness to pay a minimal fee, and that most visitors reside in the Albuquerque area.

As a result of this program, the Guadalupe corridor underwent changes during the summer of 2004 under the Respect the Rio program. These changes included modifying dispersed campsites that encroach on the stream banks; closing Forest Road 376 (road to the river) to all vehicles; prohibiting overnight use at Deer Creek Landing, a popular swimming hole and camping area; planting native vegetation in degraded riparian areas; and adding educational signs throughout the watershed to inform visitors about low impact camping, native ecosystems, and the purpose of the restoration activity.

After one season, there appeared to be a large reduction in trash, vegetation was starting to re-establish, and people seemed to be reading and understanding the Respect the Rio messages. However, information gathered after 2005 indicated that users have become less respectful of the resource. Trash and human waste are again a major issue, riparian resources are being disregarded, and the number of streamside campsites is growing. Signs are often vandalized and fences pulled down by people trying to access closed areas along the river.

Similarly, in the Rio Cebolla drainage, there are many dispersed trails and campsites, including 130 individual sites and 822 feet of unstable banks. The heavy recreational use of these areas has degraded riparian vegetation, stream banks, and water quality. The numerous dispersed trails and campsites near the river have resulted in loss of vegetation, increased soil compaction, erosion and sediment input to the stream. Many of the dispersed campsites are also within the floodplain—an unsafe situation for overnight visitors. Also, visitors have been seen removing large woody debris from the stream and floodplain for firewood, which further degrades the stream.

Along San Antonio Creek, similar impacts from heavy recreational uses occur. In 2002, Forest staff took measures to reduce the amount of dispersed recreation in the area. They constructed buck and pole fences along Lake Fork Canyon to reduce areas where dispersed camping occurred next to streams. Unnecessary roads and trails were closed to prevent further degradation to soils and vegetation, which improved stream and riparian habitat along 3 miles of stream. However, the fences used to limit access are currently in a state of disrepair and need to be replaced in order to continue to keep these areas closed.

### **East Fork of the Jemez Wild and Scenic River**

A congressionally designated Wild and Scenic River (WSR) occurs on the East Fork of the Jemez, designated in the Forest Plan as Management Area F. The WSR corridor lies approximately 5 miles northeast of Jemez Springs, within the JNRA. The WSR is bounded by the Preserve to the north and National Forest lands on the east, south, and west. It has been in the national WSR system since 1990. It is 11 miles long, flows in a westerly direction, and has a corridor averaging no more than 320 acres per mile, comprising approximately 3,518 acres (US Forest Service 2002a).

The first two-mile segment of the WSR from the Preserve boundary to the second highway crossing of New Mexico State Hwy 4 is the designated recreation segment, or Conchas Reach. The next 4 miles extending from the second water crossing to the third highway crossing is the designated wild segment. The wild segment must remain free of impoundments and generally

inaccessible (except by trail), with shorelines essentially primitive and waters unpolluted. This segment contains the Middle Reach and Box Reach. The last 5 miles ending at the confluence with San Antonio Creek is the designated scenic segment. This scenic segment must similarly remain free of impoundments and with shorelines largely primitive and undeveloped, but can be accessible in places by roads. This segment contains the Battleship Reach and Falls Reach.

During a 2009 Need for Change analysis, many concerns were identified for this WSR corridor, such as loss of streamside vegetation, erosion of heavily used areas, and trash and human waste left at campsites (US Forest Service 2009d). A great deal of dispersed recreation takes place within the WSR corridor. Public access to the river is an issue, in part due to the limited parking space available along Highway 4 at the Las Conchas trailhead, and along the highway at El Puente Blanca. This poses a serious safety risk to visitors and drivers along the highway due to traffic speed (55 mph). On a given weekend there may be as many as 30 vehicles parked along the highway in this area, with visitors walking down the highway to access the river.

Management emphasis in the WSR is to preserve and protect the outstandingly remarkable values for which the river was designated. Forest-wide management direction for WSRs is to maintain the river's free-flowing character while providing quality water based recreation opportunities, wildlife habitat improvement, and other resource management consistent with the intent of the WSR Act. The WSR Act specifies that designated rivers and the outstandingly remarkable values they possess will be "protected for the benefit and enjoyment of present and future generations". The outstandingly remarkable values for this WSR are: scenery, recreation, geology, ecology, fisheries and wildlife.

The following abbreviated Forest Plan standards and guidelines apply to recreation and access management in this WSR corridor:

- Manage the corridor as a SPNM setting, except along the highway and in recreation sites
- Reduce over-capacity parking, by encouraging parking in low use areas...
- Emphasize resource protection and scenic values... rehabilitate denuded sites....
- In the Wild segment, develop water crossings to the minimum level and only where necessary for protecting resources and providing for public safety.
- Manage the Las Conchas Picnic Area/Fishing Access area at the standard service level.
- Provide information and education to warn people about safety hazards...cliff jumping...
- Provide wildlife viewing opportunities where possible.
- Where fences are necessary, design fences to allow for public passage-ways....
- Discourage camping in riparian areas.....
- Prohibit camping adjacent to Las Conchas trailhead, before the first stream crossing.
- Enforce closures to ensure that resource impacts remain within acceptable limits.
- Provide designated dispersed campsites or camping zones away from the stream banks.
- Do not construct new campgrounds, picnic grounds or trailheads in the corridor...
- Prohibit rock climbing in the petroglyph area at Battleship Rock....
- Provide frequent monitoring and official presence at heavily used recreation areas.
- Inform the public and enforce rules about Leave No Trace practices...
- ...Manage pedestrian traffic along Highway 4 to discourage walking in travel lanes...

- ...Prohibit discharging of firearms...
- Prohibit new road construction and motorized use, except along highways and ....
- Prohibit use of motorized rafting or boating.
- Permit the use of mechanical conveyances, such as mountain bicycles.
- Relocate, rehabilitate or eliminate user-created trails...
- Maintain system trails to agency standards for a SPNM classification...
- Provide trail segments and bridges over streams to disperse use and reduce impacts...
- Repair or replace bridges to protect river resources and free-flowing conditions....
- Create public partnerships for trail maintenance, river clean-up and rehabilitation....
- Have snow plowed from parking areas used for winter recreation activities....

### **Monument Canyon Research Natural Area (RNA)**

The Monument Canyon Research Natural Area (RNA), Management Area M, was created in 1932 *...to preserve in a natural state a typical area of western yellow pine as found in northern New Mexico*. This area is managed to provide opportunities for research and education, and to represent an undisturbed ponderosa pine forest ecosystem.

Most of the RNA has a SPNM ROS classification. While this ROS classification prohibits motorized vehicle use, illegal motorized use has resulted in many user-created roads and trails. The proliferation of two-track roads and ATV trails in the RNA and throughout the assessment area is being addressed by travel management planning, in accordance with the 2006 Travel Management Rule. The RNA is currently undergoing scientific research studies and treatments to restore natural ecological structures and functions for this ponderosa pine forest ecosystem.

### **Inventoried Roadless Area (IRA)**

There is one inventoried roadless area (IRA) within the assessment area, located at the southern end of Virgin Canyon and Virgin Mesa. The IRA overlaps Forest Plan Management Area N, a Threatened, Endangered and Sensitive Species Habitat management area (see management area map, Figure 3, at beginning of this report). This IRA has a SPNM ROS classification where motorized vehicle use is prohibited. This area has seen proliferation of user-created roads, which should be addressed in the travel management planning process under the 2006 Travel Management Rule.

Management in the IRA must conform to the 2001 Roadless Rule, although this rule has been the subject of conflicting judicial opinions in Wyoming and California District Courts. Due to the uncertain outcome of on-going litigation on the 2001 Roadless Rule, current interim Forest Service direction requires proposed new roads or tree-cutting activities in IRAs to be approved by the Regional Forester or Forest Service Chief, depending on the proposed action.

### **Other Management Areas**

Several Forest Plan management areas within the assessment area focus on recreation, either as a primary or secondary emphasis. Management Area C emphasizes developed recreation facilities as well as dispersed use. Management area E also emphasizes recreation and is generally open to motorized uses.

Management area L is designated for roadless recreation, similar to management of the Inventoried Roadless Area within the assessment area. Management area L, management area N (the IRA), and much of the WSR corridor constitute three distinct portions in the assessment area that are managed for Semi-Primitive Non-Motorized recreation. The SPNM ROS areas are closed to all motorized vehicle travel except for access to parking areas at trailheads, and motorized use authorized by special permits. Mountain biking is permitted in these SPNM areas. Human interaction is limited in these SPNM areas, and should be no more than 6-15 human encounters per day on the trails.

Management Areas P, R, S and I emphasize management of cultural resources, and dominate much of the assessment area. Recreation direction in these management areas focuses on enhancing recreational enjoyment of important historic sites, and allows for cultural resource interpretive sites to be developed where they simultaneously protect cultural resources.

## **Roads and Trails**

### **Roads**

There is a well-established road system throughout the assessment area. Figure 63 shows the National Forest system roads and trails in the current roads database (April 2009). There are sufficient roads to accommodate public recreation access needs along with forest and rangeland management activities in the area. There does not appear to be a need for additional permanent roads in the area for the foreseeable future.

Road density is excessive in parts of the area where system roads alone average 3 to 6 miles per square mile. User-created roads add to that density. The Forest Plan calls for roads to average a maximum of 2 to 3 miles per square mile, depending on the specific management area. There are over 400 miles of low-maintenance, high-clearance vehicle (maintenance level 2) roads on the National Forest lands in the assessment area that are in excess of the minimum road needs identified in the Travel Management proposed action. Thus, these roads are identified in travel management planning database for closing or decommissioning, although there is a need for additional field verification prior to actually closing or decommissioning them. Many are user-created roads in very poor condition, crossing drainages without adequate stream protection, and causing adverse stream and riparian impacts. During the travel management planning process in 2009, Jemez Ranger District employees and the public identified several road-related concerns in the assessment area, including: safety hazards, conflicts with other uses, and environmental damage (wildlife, water, soil, etc).

Under the Travel Management (TM) Rule and proposed action, public motorized vehicle travel off designated routes will no longer be allowed. However, there may be a few fixed distance corridors along road-sides designated for motorized dispersed camping or big game retrieval. In management areas F, I, L, M, N, and X that occur in assessment area, no open motorized travel routes will occur and public motorized use will be limited to big game retrieval during the hunting season. Additionally, some management area boundaries will be adjusted to correct errors on original Forest Plan maps. The JNRA Management Plan (amended to the Forest Plan) called for closing 14 miles of open roads (allowing administrative or permittee use only on those roads), along with decommissioning approximately 84 miles of roads. However, those actions have not yet been implemented.

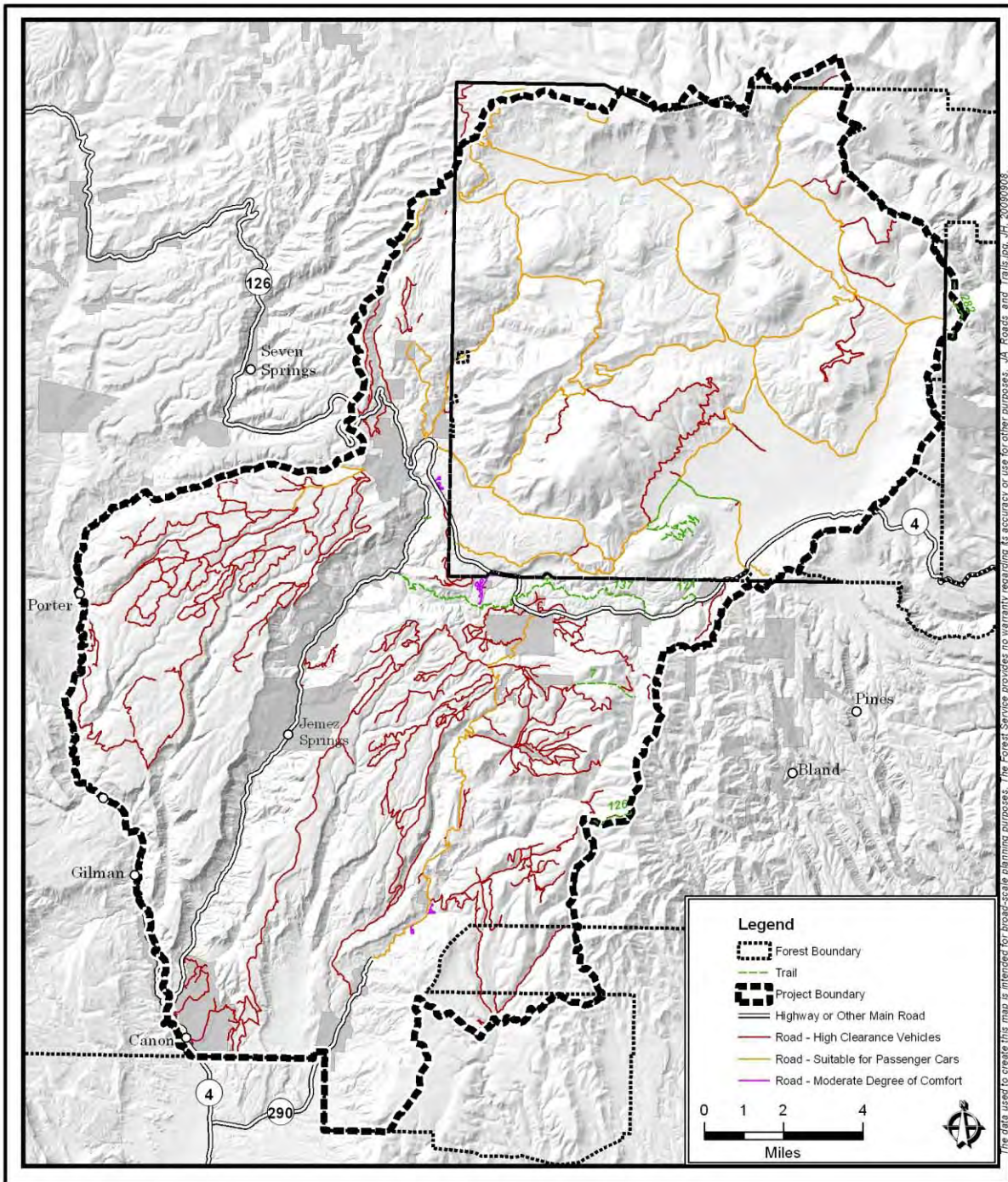


Figure 63. Designated roads and trails, April 2009

## Trails

There are approximately 13 miles of designated trails on Forest land in the assessment area. Most are associated with developed recreation facilities and points of interest in the JNRA. Developed trailheads include Battleship, East Fork, Las Conchas and Jemez Falls, which access the East Fork trail 137. The Peralta Canyon trail has parking at both ends but is relatively undeveloped. Trail degradation by OHV and ATV use has resulted in a proliferation of user-created trails and roads crossing the historic trail or road system, or overlapping entire sections of historic trails.

Designated trails within the assessment area include:

- Trail 126 Peralta Ridge 1.11 miles long
- Trail 130 Spence Hot Springs 0.33 miles long
- Trail 134 East Fork Box Trail 0.35 miles long
- Trail 135 Spur Trail East 0.28 miles long
- Trail 137 East Fork Trail 9.44 miles long
- Trail 7 Cerro Palado 1.66 miles long

Some of the needs identified for trails include the following:

- Increase coordination with the State to contribute to goals of the State Comprehensive Outdoor Recreation Plan (SCORP).
- Increase trails for all use types, including motorized, non-motorized and winter-use trails.
- Increase trails designated for specific uses, to reduce user conflicts and disperse uses. Separate motorized and non-motorized trails within the Guadalupe corridor.
- When increasing designated trails, consider inclusion of user-created trails, if they can be brought up to Forest Service trail standards within a reasonable amount of cost. Continue to work with volunteer trail and OHV organizations to maintain trail systems.
- Increase parking for winter sports including Nordic skiing in the East Fork, and parking for snowmobiling and Nordic skiing around the junction of FR 126 and FR 376.
- Increase parking at trailheads, particularly at Las Conchas trailhead, along the Rio Cebolla, and along San Antonio creek.
- Reduce stream bank degradation along Rio Guadalupe, Rio Cebolla, and EF WSR by providing for water crossings where appropriate.
- Stop the proliferation of user created motorized trails in SPM and SPNM ROS settings, and close or obliterate non-system trails causing unacceptable resource damage.
- Increase maintenance of closure fences and signs, particularly in the Guadalupe corridor.

Specific trail management needs in subunits of the JNRA are as follows:

- *In Lake Fork Subunit:* Designate motorized/non-motorized use areas; provide trailhead parking along San Antonio Creek; provide parking and pedestrian trails along Rio Cebolla for fishing access; convert some two-track roads to non-motorized trails along San Antonio Creek; and continue to work with the State Highway Department to add more parking along Highway 126 near FR 376 junctions for winter sports.
- *In Guadalupe Subunit:* Designate motorized/non-motorized use areas; separate motorized and non-motorized use trails; designate dispersed recreation sites and small parking areas

- along FR 376 to access the river; provide pedestrian trails from dispersed sites and parking areas to the river.
- *In Lower Jemez Subunit:* Allow only pedestrian-use trails; design new trails to be consistent with existing trails; limit new trails to hardened, designated access to and along the river.
  - *In East Fork Subunit:* permit only non-motorized use on Trail 137; add some non-system trails to the system; link Trail 137 to other non-system trails; add more trailhead parking; and continue working with New Mexico Ski Club to identify more cross-country skiing trails.

## Scenic Quality

The Visual Management System (VMS) used by the Forest Service describes scenic characteristics and sensitivity levels, along with visual quality objectives, for all National Forest lands. The VMS is used to plan, manage and monitor activities on the National Forest. Visual quality objectives incorporate the variability of scenic quality, visual sensitivity, and the ability of various forest landscapes to undergo alteration. The VMS considers effects of both human and natural processes on the esthetics of the landscape. (US Forest Service 1974).

The primary visual resource management needs are to ensure that the VQOs assigned to each landscape are met, when planning and implementing activities in the area. The most important need-for-change related to scenic quality in the assessment area is to close or obliterate unnecessary roads and trails, especially those in SPNM areas and Retention VQO areas.

In the JNRA, the scenery is to be managed toward a Retention VQO. The current landscape character in the JNRA ranges from Naturally Evolving and Naturally Appearing Forest to Heavily Altered. Thus, there are landscapes where human activities have occurred but do not dominate the landscape, landscapes where natural processes dominate the esthetics, and areas more heavily altered by human activities. In the Guadalupe corridor, the natural beauty and scenic integrity of the area remain virtually intact. However, over-use of dispersed camping sites, vandalism (graffiti) and user created trails detract from the scenic integrity in the immediate foreground zone. And uncontrolled roads and trails have impacted the riparian area, making it appear heavily altered. Visual features include dramatic, steep, rocky and narrow canyons, and broad lush meadows. Some of the middle- and fore-ground areas around Gilman and Butterfly Springs have less scenic diversity or distinction.

The lower Jemez River corridor has a slightly altered appearance due to human activities and developments. However, the visual and spatial diversity in this river corridor is high, so human modification remains subordinate to the overall character of the area. Thus, the scenic quality in this entire sub-unit is classified as distinctive. In the East Fork corridor, the vegetation and landforms are highly scenic, even though the highway detracts from the natural forest setting. Some areas along the East Fork are classified as distinctive, although the majority of this subunit is classified as common. The Lake Fork subunit is the least modified by human activity. The foreground in this landscape is distinctive along FR 376, in Lake Fork Canyon, and along some sections along Highway 126. There are a few scattered sections of this subunit along Highway 126 and FR 376 classified as common or minimal (less scenic diversity or distinctive features). The VQOs along FR 10 vary from Retention (R) in the Paliza Campground Area, to Partial Retention and Modification in the Cerro del Pino area.

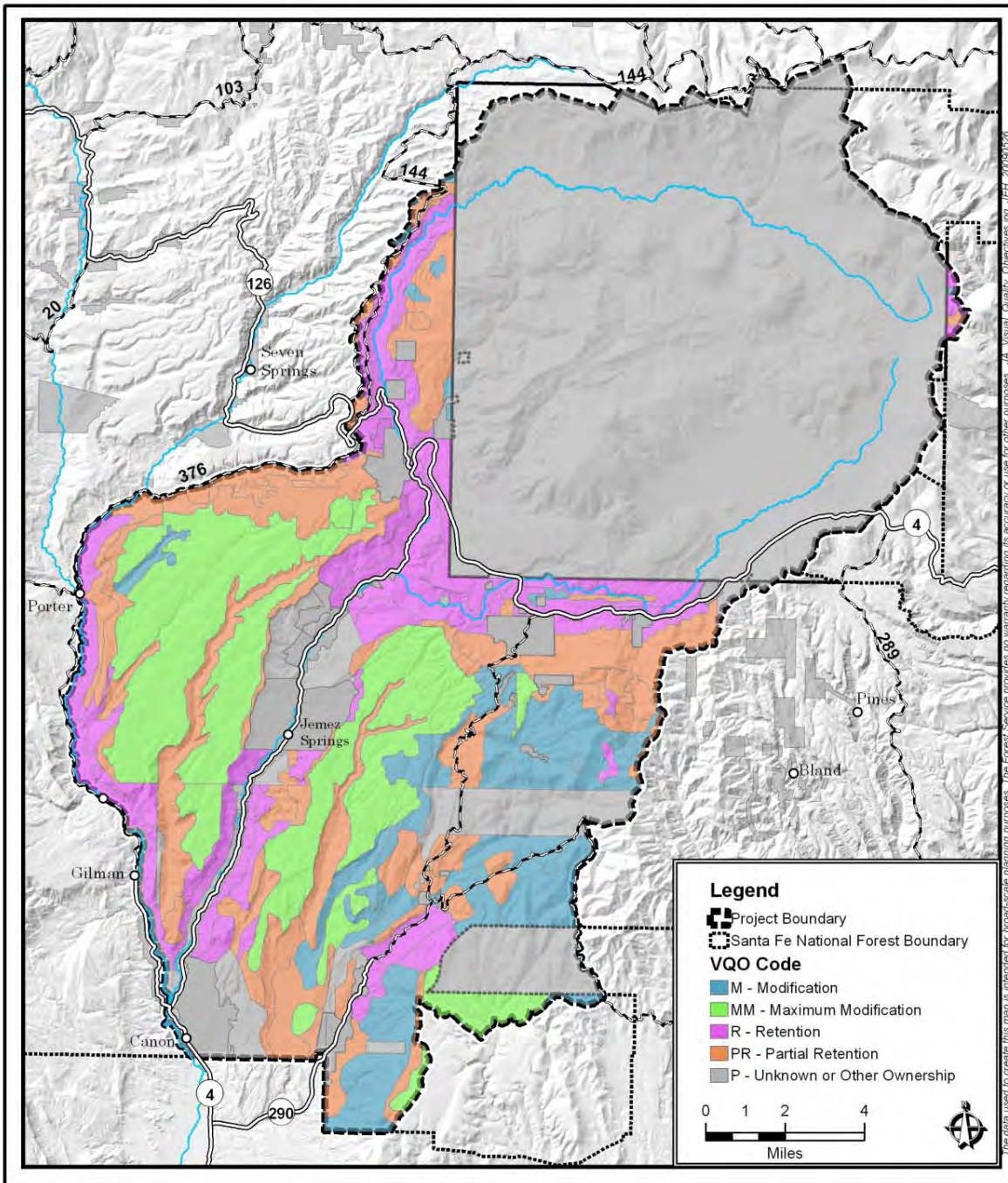


Figure 64. Visual quality objectives

# Rangelands and Livestock Grazing

## Introduction and Methodology

This section briefly describes and compares the existing and referenced conditions of rangeland resources in the assessment area, including livestock grazing management in the area. Information was obtained from the current (April 2009) Geographical Information System (GIS) database, along with the Range Infrastructures Database (INFRA) and others. Additional information was obtained from the most recent Environmental Assessment (EA) or Environmental Impact Statement (EIS) for the grazing allotment within this assessment area.

## Grazing Management

There are seven livestock grazing allotments in the assessment area (over 200 acres in size), as shown in Figure 65. The following table shows those allotments, their total acreage in the area, capacity acres, number of permitted livestock, season of use, and grazing system.

**Table 46. Grazing management on each major range allotment in the area**

Allotment Name	Nat. For. Acres in Area	Full & Potential Capacity Acres	Permitted Livestock	Permitted Season	Grazing System
San Diego	54,758		264	Yearlong	Short-duration in riparian pastures; Deferred rotation in summer pastures; and Continuous grazing in winter pastures
V-Double Slash	22,488		181	Yearlong	2 pastures Continuous System
Vallecitos	15,917	22,395	107	5/1 – 11/7	5 pastures Deferred Rotation System
Cebolla San Antonio	7,161	9,915	347	6/1 – 10/31	
Ponderosa	2,561	1,265	28	11/1 – 4/30	1 pasture Continuous System
Las Conchas	1,365		27	6/1 – 9/30	
Peralta	1,236	2,835	53	6/1 – 10/31	2 pasture –Deferred Rotation

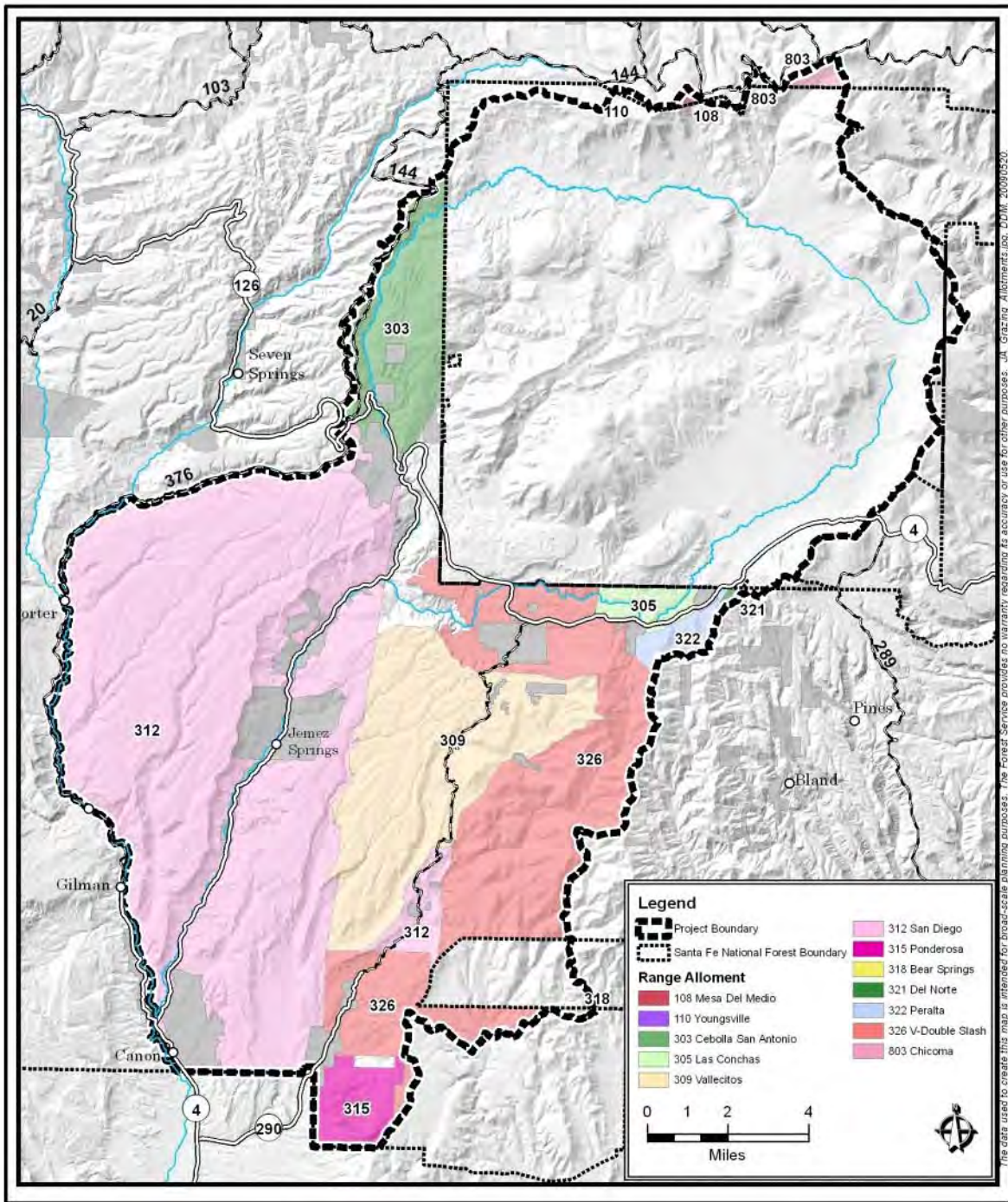


Figure 65. Livestock grazing range allotments

The Forest Plan defines allowable forage utilization standards for varying range conditions and grazing systems. In general, the utilization guidelines prescribe light to moderate grazing intensity (30 to 40 percent for affected allotments). Moderate grazing utilization typically allows the palatable forage species to maintain themselves, though not to their maximum producing ability. Light grazing utilization typically allows palatable forage species to maximize their herbage producing ability. Research convincingly shows that 40 to 50 percent use is moderate on most rangelands and 30 to 35 percent use is needed for improvement in rangeland vegetation (Holechek et al. 1999). Allowable utilization guidelines continue to be applied in the assessment area to allocate forage to grazing ungulates (livestock and elk primarily) while setting stocking rates during the site-specific NEPA analysis for allotment management plans. Proper stocking rate continues to be a key factor in maintaining favorable ecological conditions of rangelands.

Current livestock grazing is managed to avoid grazing in high recreation use areas between Memorial Day and Labor Day, and to severely limit grazing duration in riparian areas (e.g., Guadalupe, Cebolla, Lake Fork, and East Fork Jemez corridors). Over the past 20 years, grazing management strategies including installation of new riparian fences and water tanks have resulted in improved ecological conditions within areas that were previously degraded by livestock.

Some of the reference conditions (standards and guidelines) and continuing management needs identified for the rangeland resources include the following:

- Full capacity rangeland should be within the range of natural capability, exhibit the biodiversity necessary for a sustainable ecosystem, and be in fully functioning range condition.
- Maintain or move herbaceous species composition and surface components, such as litter and basal vegetative percentages toward site potential.
- Forage species composition should exhibit a suite of species that are appropriate for the site based on the potential natural capacity description.
- Move toward satisfactory range conditions with a mid to high similarity to potential natural capacity.
- Improve livestock distribution and follow rotation schedules to minimize overuse in certain areas. Do not exceed 40 percent utilization of forage species.
- Control or eliminate non-native and invasive plant populations within the allotment. This topic is addressed in detail in the Vegetation section of this report. The recently completed Final EIS for Invasive Plant Control on the Santa Fe and Carson National Forests describe proposed actions to reduce or eliminate invasive, non-native plant species, and the associated environmental consequences. (A revised EIS and Record of Decision are expected to be finalized by December 2010).

# Minerals and Mining

## Introduction and Methodologies

This section evaluates and compares the existing and reference conditions of the mineral resources within the assessment area. The Forest Service mineral resources management program is composed of three parts—locatable minerals, salable minerals, and leasable minerals. All three types of minerals exist within the assessment area. There is also an Abandoned Mine Lands Rehabilitation Program that is being implemented in the assessment area.

The Documented Mine Sites Table (Table 47) lists and the Mining Sites Map (Figure 66) illustrates the location of the documented mine sites. The sites are referenced on the map and in the text by the identification (ID) numbers in the table. The site list and map were compiled from the Mineral Resources Data System (US Geological Survey 2005), the Forest Abandoned Mine layer (Forest Service 1997), and the New Mexico Mineral Industry Location System (EDAC 1994).

## Locatable Minerals

The Forest Plan requires managers to *...support environmentally sound energy and minerals development and reclamation, and to foster and encourage mineral development...* within the overall context of the principles of ecosystem management.

Table 47 shows all of the documented mine sites of all types, as well as geothermal sites, and their status, within the assessment area.

The locatable minerals available to be mined in the assessment area include copper (with associated gold and silver), uranium, sulfur, perlite, and pumice used in the stonewash laundry industry. Most pumice is classified as a common (saleable) mineral material, although some pumice in this area is currently classified as locatable, primarily due to its market value.

Locatable minerals are those minerals for which mining claims can be located. Currently, there are no active mining operations within the assessment area (June 2009).

- There are two small red-bed copper prospects in the study area (sites 11, 12), but no appreciable copper or the associated gold and silver has been produced since the 1940s. The commodity for site 15 is unknown, but it is presumed to be precious metals as it is a placer claim.
- There are two uranium prospects (sites 13, 14) which were never put into production.
- There is one site (site 10) where small amounts of sulfur were produced from private land.
- There is one site (site 16) where exploration for perlite was done, but no production was recorded.
- There are three stonewash-laundry pumice sites (sites 17, 18, 19). Site 17 has been reclaimed, site 18 is in the process of being reclaimed, and site 19 has been proposed but not authorized.

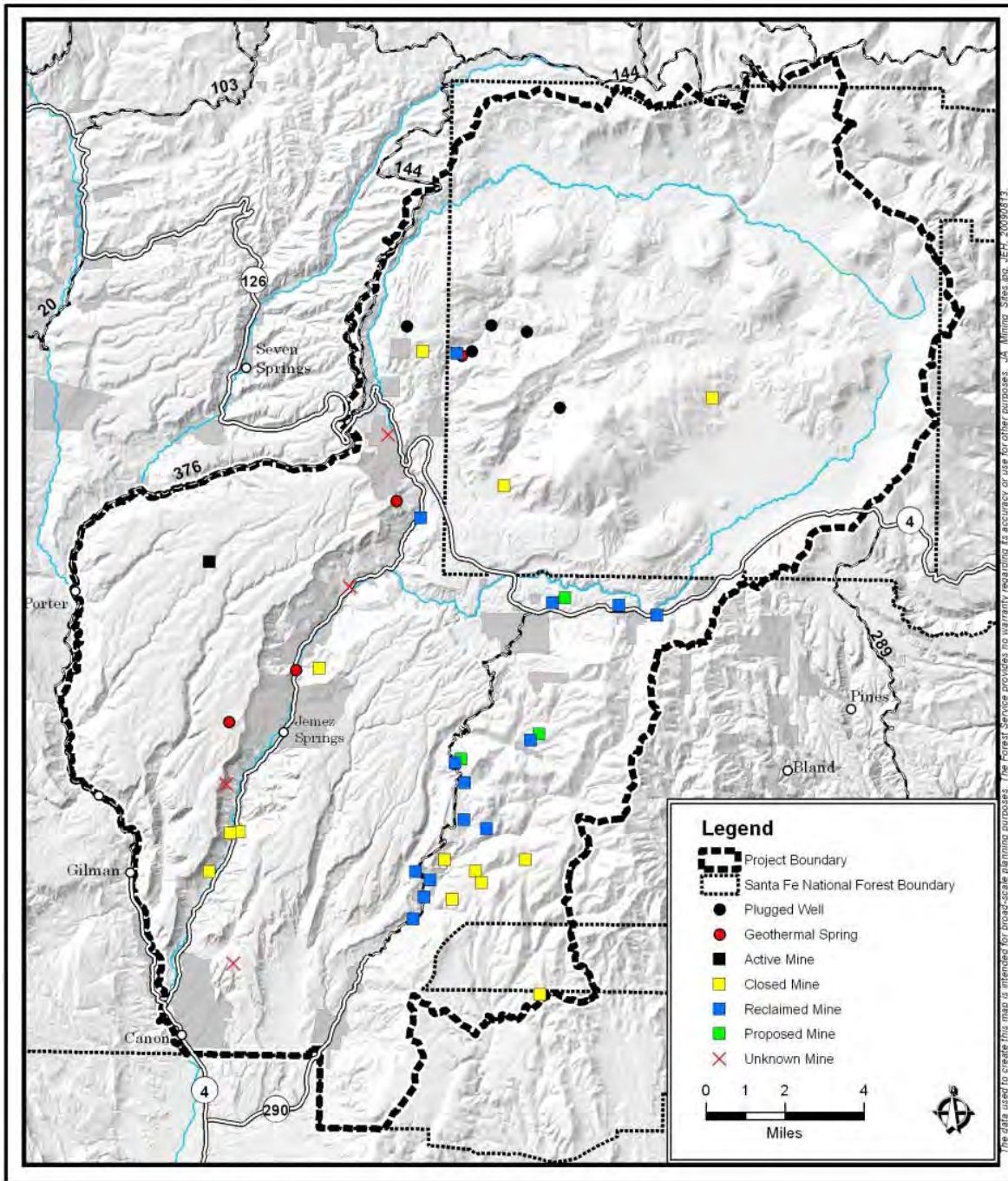


Figure 66. Mines (active, proposed and closed) and geothermal sites

**Table 47. Status of locatable and saleable mines and geothermal sites**

<b>ID No.</b>	<b>Name</b>	<b>Type</b>	<b>Commodity</b>	<b>Surface Owner</b>	<b>Status</b>
1	Steam Well 1 - Western Pet. # 1 Bond	Geothermal Well	Geothermal	Preserve	Plugged
2	Steam Well 2 - Baca Land & Cattle #2	Geothermal Well	Geothermal	Preserve	Plugged
3	Steam Well 3 - Baca Land & Cattle #1 & #3	Geothermal Well	geothermal	Preserve	Plugged
4	Steam Well 4 - Baca Land & Cattle #4, Union Oil	Geothermal Well	Geothermal	Preserve	Plugged
5	Steam Well 5 - unknown	Geothermal Well	Geothermal	Forest	Plugged
6	Sulfur Springs	Hot Spring	Geothermal	Preserve	Active - no commercial use
7	Jemez Hot Springs	Hot Spring	Geothermal	Private	Active - commercial use
8	Soda Dam Springs	Hot Spring	Geothermal	Private	Active - no commercial use
9	San Antonio (Murray) Spring	Hot Spring	Geothermal	Forest	Active - no commercial use
10	Sulfur Bank Group	Locatable Mine	Sulfur	Private	Unknown
11	Spanish Queen Mine	Locatable Mine	Copper, Silver, Gold	Private	Closed - partial reclaimed
12	Pyramid Pumice Mine, Spanish Queen Mine	Locatable Mine	Gold, Copper	Forest	Abandoned
13	N.E. Soda Dam Prospect	Locatable Mine	Uranium	Forest	Closed - no work done
14	Tex-N Prospect	Locatable Mine	Uranium	Forest	Reclaimed
15	La Plata Placer	Locatable Mine	Unknown	Forest	Reclaimed
16	unknown	Locatable Mine	Perlite	Forest	Closed - unknown
17	Las Conchas	Locatable Mine	Pumice	Forest	Reclaimed
18	El Cajete	Locatable Mine	Pumice	Forest	In reclamation
19	El Cajete No. 2	Locatable Mine	Pumice	Forest	Proposed
20	Gravel Pit 1	Salable Mine	Sand/Gravel	Preserve	Closed - reclaimed
21	Gravel Pit 2	Salable Mine	Sand/Gravel	Forest	Closed - reclaimed

**Table 47. Status of locatable and saleable mines and geothermal sites**

<b>ID No.</b>	<b>Name</b>	<b>Type</b>	<b>Commodity</b>	<b>Surface Owner</b>	<b>Status</b>
22	Gravel Pit 3	Salable Mine	Sand/Gravel	Private	Unknown
23	Gravel Pit 4	Salable Mine	Sand/Gravel	Preserve	Closed - reclaimed
24	Pit Number 60-42-S	Salable Mine	Sand/Gravel	Forest	Closed - reclaimed
25	Pit Number 64-56-S	Salable Mine	Sand/Gravel	Private	Unknown
26	Walsh Pit	Salable Mine	Sand/Gravel	Forest	Closed
27	Pit Number 74-4-S	Salable Mine	Crushed Rock	Forest	Abandoned - natural reclaim
28	Cebollito Rock Pit	Salable Mine	Crushed Rock	Forest	Active
29	Pumice Mine 1	Salable Mine	Pumice	Forest	Closed - reclaimed
30	Pumice Mine 2	Salable Mine	Pumice	Forest	Closed - reclaimed
31	Pumice Mine 3	Salable Mine	Pumice	Forest	Closed - reclaimed
32	Pumice Mine 4	Salable Mine	Pumice	Private	Abandoned
33	Pumice Mine 5	Salable Mine	Pumice	Forest	Closed - reclaimed
34	Pumice Mine 6	Salable Mine	Pumice	Private	Closed - reclaimed
35	Pumice Mine 7	Salable Mine	Pumice	Forest	Closed - reclaimed
36	Pumice Mine 9	Salable Mine	Pumice	Forest	Closed - reclaimed
37	Pumice Mine 8	Salable Mine	Pumice	Forest	Closed - reclaimed
38	Pumice Mine 10	Salable Mine	Pumice	Forest	Closed - reclaimed
39	Old Utility Block	Salable Mine	Pumice	Forest	Closed - reclaimed
40	South Pit	Salable Mine	Pumice	Forest	In reclamation
41	Utility Block	Salable Mine	Pumice	Forest	In reclamation
42	Cerro del Pino	Salable Mine	Pumice	Forest	in reclamation
43	Boone Duran	Salable Mine	Pumice	Forest	Proposed
44	South Pit Expansion	Salable Mine	Pumice	Forest	Proposed

There are 66 unpatented mining claims within the area (Bureau of Land Management 2009). All of these unpatented claims are located for pumice. The locatability of pumice on four of these claims is being contested by the Forest Service through the Bureau of Land Management and USDI Interior Board of Land Appeals, with a determination expected in 2010. If the pumice on those four claims is determined to be common variety and not subject to location, the validity of the remainder of the unpatented claims may be contested.

## **Salable Minerals**

Salable minerals are common materials that are sold directly to the public by the Forest Service. These include common stone, fill materials, clay, gravel, and pumice. At the current time, there is

one active site, three sites undergoing reclamation, 19 sites which have been closed or abandoned, and two proposed sites.

- Sites 20 through 26 are sand and gravel pits. All of the pits on National Forest lands have been closed and reclaimed, but there are two sites (sites 22 and 25) on private land where the status is unknown.
- Sites 27 and 28 are crushed rock pits on National Forest lands. Site 27 is closed and has naturally reclaimed. Site 28 is an active site, although there are no current contracts.
- Common pumice has been mined extensively in the study area since at least the early 1940s. Sites 29 through 44 are salable pumice mines. Sites 29 through 39 have been closed and reclaimed or abandoned. Sites 40 through 42 are closed and undergoing reclamation. Sites 43 and 44 have been proposed, but have not been authorized.

## **Leasable Minerals**

Leasable minerals are materials for which the Bureau of Land Management must issue a lease. These include oil, natural gas, and geothermal resources.

There are no records of oil or natural gas production or leasing within the assessment area.

Geothermal resources are present, as demonstrated by the test drilling projects in the 1970s and the numerous hot springs in the assessment area. The project area is within a prospective geothermal area (US Forest Service 1977). Drilling inside and adjacent to the southwestern corner of the Valle Caldera demonstrated there was some potential for geothermal steam production for electrical generation, and the Hot Dry Rock project conducted by the Dept. of Energy/Los Alamos National Labs at Fenton Hill (just west of the area) demonstrated the potential for an enhanced geothermal project; however, no commercial electrical generation has occurred.

Direct use of geothermal energy, such as hot spring spas, occurs within the assessment area, and provides a sizeable economic impact to the community of Jemez Springs.

- Five geothermal wells (sites 1 – 5) have been documented, although numerous other wells are referenced in the literature (Summers 1976; Waring et al. 1983). All of the geothermal wells are plugged.
- Four hot springs (sites 6 – 9) have been documented. All of these are still flowing, but only site 7 (on private land) is being utilized commercially.

## **Abandoned Mines**

Forest managers are responsible for identifying and conducting remedial activities to mine sites that have been abandoned without proper reclamation and present hazards to the forest resources or the public. Two sites on National Forest lands (site 12 and 27) and one site (site 32) on private land have been identified within the assessment area. None of these sites present environmental hazards (acid mine drainage or hazardous material) but they present public safety hazards.

State and Federal agencies are continuing to inventory for these hazards, so additional sites may be identified in the future.

# Social and Economics

## Introduction and Methodologies

This section describes socioeconomic conditions through a series of demographic, social, and economic variables. It also addresses the potential for a sustainable supply of woody products over time. Woody materials are harvested from trees as a by-product of ecosystem restoration efforts, providing social and economic benefits. Having a marketplace for wood products is a crucial component of developing a collaborative restoration strategy in which stakeholders on all sides would benefit. This section assesses the existing marketplace (demand) for small diameter wood products as well as the potential for the development of new markets. This section also addresses the need to monitor social and economic changes to determine the progress toward meeting social-economic objectives that accompany the ecosystem restoration objectives.

The discussion of sustainable supply of wood products includes consideration of probable restoration activities on both the National Forest and Preserve. Woody material removed from both land jurisdictions is expected to provide a long-term (minimum 10-year) flow of products to local markets.

Two different study areas are used in describing the locally affected area. The “local area” is defined as Sandoval County and serves as the base area for statistical analysis in the existing conditions. The entire assessment area is within this County and comprises a large portion of the County. The “production area” adds Rio Arriba, Santa Fe and Los Alamos Counties, which abut the assessment area. These areas are within a reasonable transportation distance for wood product removal and utilization from the assessment area. People from these counties also frequently recreate in and use resources within the assessment area (Sandoval County 2009).

Analytical methods used for this section range from qualitative analysis of social values to quantitative modeling of economic impacts. The best available scientific methods were used, considering the purpose of this assessment. These methods allow one to determine how a restoration strategy may contribute toward the economic and social sustainability objectives outlined in Title IV of the 2009 Omnibus Public Lands Management Act (Collaborative Forest Landscape Restoration). Contributions to this analysis came from a collaborative forest restoration working group that formed in February 2010, consisting of representatives from the wood products industry, interest groups and public land managers. This group helped to collect information regarding the potential wood supply and demand for small diameter products (US Forest Service 2009c)

Forest restoration activities that contribute to the economy primarily involve cutting down and removing trees, transporting logs and biomass to processing facilities, processing logs and wood biomass into saleable products, and distributing products. There are also support activities such as machine maintenance and fuel procurement, indirect activities such as supplying spare parts and fuel, and induced economic activities such as changes in public spending as a result of increased income derived from the economic activities previously mentioned. All of these activities require human labor and capital. IMPLAN provides a computer model that helps describe the production processes and outputs associated with forest restoration treatments.

Economic benefits were estimated by applying regional economic science to the local study area. The volume of jobs and income per unit of measurement of woody products are developed from an economic impact analysis on Sandoval County. Economic modeling was done with IMPLAN version 2.0 and 2007 data. Additionally, another Forest Service analysis tool called Forest Economic Analysis Spreadsheet Tool (FEAST) was used to import data specific to the National Forests and generate outputs by resource area. FEAST was used in conjunction with IMPLAN to estimate economic impacts to the local area (Sandoval County). Economic sectors listed in this section use the 2-digit North American Industry Classification System (NAICS) codes that group industries based on the primary activity with which they are engaged.

## Demographics

Located in north-central New Mexico, Sandoval County is economically and culturally diverse. Sandoval County was created in the New Mexico territory in 1852 (as part of Santa Anna County), established as its own entity in 1903. Los Alamos County was separated out of Sandoval County in 1949 ([www.sandovalcounty.com](http://www.sandovalcounty.com)). County residents rely heavily on ranching operations for income and as a historical cultural tradition. Natural resource-based recreation is becoming an increasingly popular source of economic stimulus. Visitors are drawn to the unique landscape and climate of northern New Mexico to participate in a variety of outdoor recreation activities. The recreational and agricultural opportunities supported by the assessment area generate significant levels of economic stimulus. Sandoval County currently encompasses 3,716 square miles and includes a total of 6 incorporated communities: Bernalillo, Cuba, Corrales, Jemez Springs, Rio Rancho and San Ysidro ([www.sandovalcounty.com](http://www.sandovalcounty.com)).

Sandoval County has experienced substantial population growth in recent years. Between 2000 and 2008, the population grew by 36 percent; this is much faster than New Mexico and the United States which grew by 9 percent and 8 percent respectively (Table 48). Much of this population growth is result from industrial change. Manufacturing enterprises such as Intel have opened production facilities and drawn workers to the area. This has contributed to making Sandoval County the second highest in weekly wages in the state ([www.mrcog-nm.gov/content/view/37/94/](http://www.mrcog-nm.gov/content/view/37/94/)). The local area is also rich in natural amenities, which make it highly desirable location for many residents. While manufacturing in the larger towns has stimulated population growth in the County, agriculture jobs have declined, slowing the growth of rural communities.

**Table 48. Population and growth rate**

Area	2000	2008	Percent Change
Sandoval County	89,908	122,298	36
New Mexico	1,819,046	1,984,356	9
United States	281,421,906	304,059,724	8

Source: [factfinder.census.gov](http://factfinder.census.gov)

Age distribution across Sandoval County is dominantly middle aged. Most individuals lie within the 25 to 54 year old age group, with most in their 30s. This suggests that the majority of residents are of working age and likely dependent on their employment status to support themselves. Areas with an older population typically have a higher percentage of retirees, and are thus less dependent on local employment. There are no significant differences in the age

distribution between the county and state; the largest difference is that Sandoval County has a slightly higher percentage of individuals in the 35- to 44-year-old age (US Census Bureau 2000c).

Ethnic distribution across Sandoval County is predominantly Caucasian, however, a large percentage is American Indian and Latino. Less than 4 percent of the County is reportedly comprised of other ethnicities (African American, Asian, Pacific Islander) (US Census Bureau 2000a). Inherent weaknesses in the Census data include the fact that individuals can report more than one race, and race and ethnicity definitions are complex and confusing to many residents. It is clear, however, that American Indians and Latinos have a strong history in Sandoval County, and many are still actively engaged in employment tied to natural resources and/or livestock grazing. Thus, the Forest and Preserve provide resources needed to sustain many minority residents.

## Employment and Income

Minnesota IMPLAN Group (MIG) reports annual economic data for all counties in the United States (IMPLAN 2007). Employment reported includes full-time, part-time, seasonal and self employment. IMPLAN reports jobs rather than full-time equivalents, so a person with multiple jobs will show up more than once in the data. This prohibits a comparison with population data.

Employment in Sandoval County is approximately 36,109 jobs (IMPLAN 2007 data). Table 49 reports total employment by industry sectors. Manufacturing is the largest employing sector, accounting for 45 percent of total jobs. Professional scientific and technical services jobs are the second most abundant. Relative abundance of jobs is largely influenced by high-tech companies like Intel. Agriculture (including ranching) and forestry account for less than one percent of employment. Historically, livestock based agriculture and forestry services were dominant sectors. A total of 82 of these kinds of jobs remain in the County (0.2 percent of total jobs). Yet agriculture and forestry jobs help maintain the traditions and cultures that are important to locals, especially to the American Indian and Latino residents. (US Census Bureau 2000b)

**Table 49. Employment by sector in Sandoval County**

Sector	Number of Jobs	Percent of Total
Manufacturing (except wood products)	16,329	45.2%
Professional Scientific & Technical Services	6,687	18.5%
Information	3,513	9.7%
Construction	3,128	8.7%
Transportation & Warehousing	2,421	6.7%
Retail trade	1,140	3.2%
Wholesale Trade	1,106	3.1%
Finance & Insurance	947	2.6%
Real Estate & Rental	317	0.9%
Agriculture, Fishing & Hunting	265	0.7%
Mining	87	0.2%
Wood Products Manufacturing	82	0.2%

Sector	Number of Jobs	Percent of Total
Utilities	45	0.1%
Forestry & Logging	42	0.1%
<b>Total</b>	<b>36,109</b>	<b>100%</b>

Source: IMPLAN 2007

Unemployment rates for the County and New Mexico are shown in Table 50. In the past three years, unemployment in both the County and State have been rising. The larger increase in the County's unemployment rate is likely a result of job cuts in high-tech companies. When forest restoration activities begin, it is likely that the new jobs would be filled by the local labor supply and not by in-migration, based on the high level of unemployed workers in the area (US Bureau of Labor Statistics 2009).

**Table 50. Unemployment rate for Sandoval County and New Mexico, 2005 - 2009**

Point in Time	Sandoval County	New Mexico
September 2005	5.0%	4.8%
September 2006	3.9%	3.8%
September 2007	4.1%	3.2%
September 2008	5.1%	4.2%
September 2009	9.0%	7.4%

Source: [www.bls.gov/lau/](http://www.bls.gov/lau/), US Bureau of Labor Statistics

The median household income for Sandoval County is approximately \$54,705, slightly higher than the median for the State and U.S., at \$41,509 and \$50,740 respectively (US Census Bureau 2007). Although household income in the County is higher than the State, 11 percent of the County population and 13.7 percent of minors live the below the poverty standard ([www.census.gov/cgi-bin/saige/saige.cgi](http://www.census.gov/cgi-bin/saige/saige.cgi); US Census Bureau 2000b). Most of the income comes from manufacturing jobs, which are higher paying relative to other job sectors. Manufacturing accounts for 45 percent of total employment and 60 percent of total income (IMPLAN 2007). Agriculture and forestry currently make up only 0.4 percent of total income, but this proportion could greatly increase with creation of forest restoration-related jobs and income, envisioned for the 10 to 20 years.

## Wood Product Supply and Demand

Demand for small diameter wood products was evaluated at a broader scale than Sandoval County alone, and considered the existing and potential infrastructure to support wood product enterprises. This broader production area consists of Sandoval, Rio Arriba, Santa Fe and Los Alamos Counties, which are in relatively close proximity to the assessment area (approximate 50 mile radius). Several proprietor-owned wood products businesses exist in the production area.

Demand for wood products includes both manufacturer demand for raw material and consumer demand for finished products. The price for finished products must at least cover the production costs, including harvest and transportation costs. For New Mexico forest industries, the high cost of transporting wood from stump to mills is often the most limiting factor. If a large quantity of

wood can be sustainably supplied from a centralized area such as the Jemez Mountain range, it can help attract an increase in demand for thinning operators, truck drivers, wood product manufacturers, and distributors. New wood product businesses may emerge in or near the Jemez Mountains based on the projected wood supply from this area over the next several decades.

The assessment of forest conditions in this area indicates that there is an abundance of small diameter trees that should be removed in order to meet ecological restoration objectives. A steady long-term supply of woody material could encourage new wood utilization operations and products in New Mexico.

Thus, managers from the Forest and Preserve assessed the potential supply of woody material from the assessment area, using a combination of stand exam and GIS data. Additional wood products from restoration activities are anticipated to come from surrounding forest land, including the rest of the Jemez, Cuba, Coyote, and Espanola Districts on the west side of the National Forest, along with neighboring portions of the Carson and Cibola National Forest, as well as the adjacent Jemez and Santa Clara Pueblos. Harvestable acreage is typically considered to be on the slopes with less than 40% grade, and these gently sloping forest areas are readily accessible by a well-developed road system. This supply of wood products is further facilitated by the close proximity of the Jemez Mountains to Interstate Highways I-25 and I-40, and the State's largest population centers (Albuquerque, Rio Rancho, Santa Fe, Espanola, and other cities). It is roughly estimated that over 100,000 acres of forestland could be thinned within and adjacent to the assessment area over the next 10 years, if there is a sufficient demand for wood products to help offset the thinning and transportation costs. It is estimated that these thinned acres could yield an average of 8.5 ccf/acre from trees that would mostly range from 5 to 16-inches in diameter.

Treatment costs for contracted thinning, wood removal, and slash preparation services would likely average about \$620 per acre, excluding slash burning that would probably be done by the Forest Service. These costs would be offset by the price contractors will pay for the value of the harvested material, which is uncertain at this time and varies widely among different wood processors. Higher value products and greater offsets would be realized if new businesses decide to locate in the area to take advantage of this significantly increased wood supply.

Processing and distributing the material is one part of industry's role, along with the initial harvest and transport of raw material to processing facilities. The New Mexico Forest Workers Safety Certification (FWSC) Training Program indicates that there are over 400 workers in the state that are certified to conduct the harvest activities, with 113 of those within the production area. Existing harvesters/haulers in the local area include Velasquez, Conley, Cordova, Barela, Restoration Solutions, Western Wood Products, Chimayo Conservation Corps, Rocky Mountain Conservation Corps, Jemez Pueblo, Santa Clara Pueblo, HR Vigil, Mt. Taylor Pellets, and many others. This provides an indication of existing capacity to conduct harvest activities ([http://www.forestguild.org/workers\\_comp.html](http://www.forestguild.org/workers_comp.html)). However, industry may respond to the increase in wood supply in central New Mexico by hiring and training additional employees.

Past experience demonstrates that material from the Jemez Mountains can be efficiently transported to cities within about a 120 mile radius, including Albuquerque, Española, Raton, Grants, Taos, Las Vegas and others. Mt. Taylor Millwork for example is currently getting material from as far away as El Paso and Reserve (with the BCAP program). As biomass markets continue to expand over the next decade, distances could remain viable in the absence of BCAP

funds. A thinning contractor recently hauled low value wood from the Jemez Mountains to Taos and Las Vegas.

While there are no large-capacity lumber mills in the area, there are several smaller plants and a potential to attract additional processing plants in the area. The Jemez Pueblo operates a forest restoration thinning crew and wood processing facility within this landscape ([Walotowa Woodlands Initiative](#)) and the Santa Clara Pueblo also has a restoration thinning crew.

Several existing proprietor-owned businesses in and immediately around the area produce a variety of wood products, including specialty building materials (latillas, vigas and beams), specialty carvings for homes, wood chips, wood stove pellets, small furniture, and firewood. Approximately 23 percent of custom homes built in New Mexico include vigas (structurally or ornamentally), with each unit using an average of 255 lineal feet of vigas at a cost of \$6.20 per lineal foot (Milakovsky and Irland 2009). Also, firewood is an important use of woody material in the region. It provides a cost savings in the form of reduced heating expenses, and an economic opportunity for entrepreneurs. Over 36 percent of houses in the Jemez Pueblo area are heated from wood (US Census Bureau 2000), and the Santa Fe National Forest sells thousands of personal-use firewood permits annually. Wood utilization businesses that recently communicated with Forest and Preserve managers indicated that wood supply is not keeping pace with the demand for their products; thus, they are seeking additional sources of raw material.

Wood utilization companies in the New Mexico/Arizona region who may be interested in expanding their operations into the SW Jemez Mountains area include existing companies who produce: firewood pellets, wooden pallets (for shipping and transportation industries), posts and poles for residential and commercial use; vigas and latillas for home and commercial buildings; log homes; firewood; and lumber-composite building materials. There is also a potential for creation of wood biomass-fueled energy plants that could supply power to schools, hospitals, or research laboratory facilities in the local area. Other companies that conduct thinning operations may also be interested in the potential contracts that could come from this assessment area. Restoration-related labor employment opportunities could include decommissioning or closing roads, treating invasive weeds, planting willows and other native vegetation along streams, and other ecological restoration work envisioned for this area.

Table 51 displays the wood utilization and products that can reasonably be expected to be produced from this area, based on information from local industry representatives. Products not on this list are not likely to be economically viable due to the cost of establishing new plants in the area, such as for products like particleboard, fiberboard, veneer, plywood, and paper.

**Table 51. Wood products currently processed in New Mexico or Arizona**

Firewood, commercial use
Firewood, personal use
Biomass for energy: electricity and heat; wood stove pellets
Milled and preserved lumber, bolts, posts, poles, treated lumber, latillas, vigas
Wood containers and pallets, including wood boxes, flats, baskets, casks, crates
Engineered wood members, trusses, composite lumber materials
Prefabricated wood building materials

Mulch and bark for landscaping, animal bedding, erosion control, etc.

Although wood products businesses declined in the past 20 years, this trend could change if there is a steady and centralized wood supply, along with the new technologies for utilizing small diameter trees. Retail demand for lumber in the U.S. is expected to increase in 2010 and 2011 (Western Wood Products Association 2010). The Forest Service's use of stewardship contracting is a tool that could facilitate thinning, wood removal and transportation contracts. When awarding forestry contracts, the Forest Service also has the authority to give consideration to local contractors in economically disadvantaged rural communities, and to award contracts to local non-profit entities.

If a large amount of woody material could be supplied from this assessment area, it is clear that thinning treatment costs could be reduced (offset by product value), while supporting a wide variety of businesses, providing new jobs, and stimulating local rural economies. Non-market benefits could also be realized. Non-market benefits include social values stemming from improved ecosystem health and wildlife habitat, recreational values, scenic values, and reduced wildfire damage to the environment and private property. Improving the health of forests and watersheds in the Jemez Mountains would also contribute to maintaining and enhancing cultural and spiritual values that are tied to the natural environment in this area.

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