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Assessment Report

Revised Land Management Plan for the Manti-La Sal National Forest

Forest Service Intermountain Region October 2018

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Assessment Report

Manti-La Sal National Forest

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1. ASSESSMENT OVERVIEW

1.1 Forest Plan Revision Framework

The Forest Service's 2012 Planning Rule (36 CFR 219) provides the process and structure to create land management plans for National Forest System (NFS) lands across the nation. The rule establishes a three-phase process: assessment, plan development or revision, and monitoring. The intent of the planning framework is to create a responsive land management planning process that informs integrated resource management and allows the Forest Service to adapt to changing conditions. Figure 1 provides additional details regarding the planning process on the Manti-La Sal National Forest (the Forest). The planning framework is structured to use an integrated approach recognizing the interdependence of ecological processes with external social and economic influences and demands. The approach uses the best available scientific information to inform decisions, emphasizes public involvement at every step of the process, and encourages collaboration with state, local, and tribal governments. The Forest will recognize the many ongoing programs, plans, and policies that are being implemented in and around the planning area by other land managers and government agencies as required by the 2012 Planning Rule.

Please note that throughout the Assessment Report values in tables are rounded to the nearest whole number.

The Forest planning process will allow for unprecedented, robust public participation throughout every phase, including populations historically uninvolved with forest planning. The Revised Forest Plan will focus on adaptive management to respond to changing conditions and will provide strategic guidance for multiple uses.

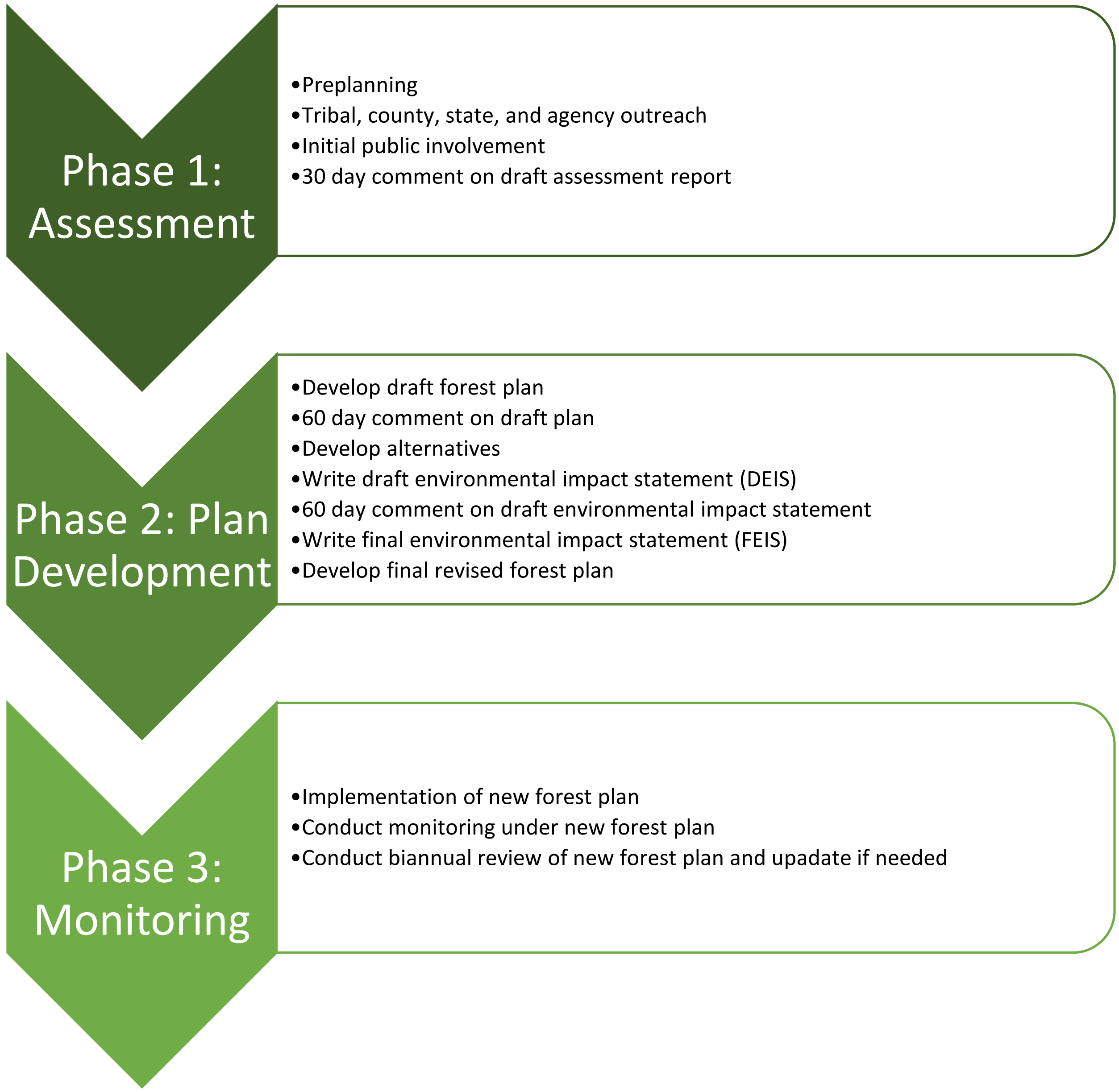


Figure 1. Manti-La Sal National Forest revision process and phases.

Please note that throughout the Assessment Report values in tables are rounded to the nearest whole number.

The Forest planning process will allow for unprecedented, robust public participation throughout every phase, including populations historically uninvolved with forest planning. The Revised Forest Plan will focus on adaptive management to respond to changing conditions and will provide strategic guidance for multiple uses. The Forest is aiming to complete the revision process in a 4-year timeframe that began in 2016.

1.2 Assessment Report Objectives

This report represents the assessment phase of the planning process, which is designed to rapidly evaluate existing information, condition, and trends around the ecological and social aspects of the Forest. The assessment consists of existing information that is currently available in a usable form, without further data collection, modification, or validation. Information was collected from the Forest, the public, state, local, and federal agencies, and tribes during the fall of 2016. The assessment phase also provided the Forest with opportunities to develop and strengthen relationships with interested parties.

The assessment evaluates the 15 topics that were listed in the 2012 Planning Rule (36 CFR 219.6(b)). Table 1 shows these topics as they relate to the various resource areas on the Forest. The Assessment Report provides a base of currently available information that will be used to identify the need for change from the current Forest Plan and to inform development of a Revised Plan (36 CFR 219.19). This report is not a decision document and does not authorize any on-the-ground actions.

During the next phase—plan development—the information from this report will be used along with input from the public and other entities. Public feedback from comments, collaboration, and other consultation will be used to revise the Forest's land management plan.

Table 1. Planning rule topics and the chapters and subchapters where they are discussed in this assessment report.

Topic	Chapter	Subchapters
1. Terrestrial ecosystems, aquatic ecosystems, and watersheds	Ecological Assessment	Terrestrial and Aquatic Ecosystems
2. Air, soil, and water resources and quality	Ecological Assessment	Terrestrial and Aquatic Ecosystems
3. System drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability of terrestrial and aquatic ecosystems on the plan area to adapt to change	Stressors and Drivers	Not applicable
4. Baseline assessment of carbon stocks	Ecological Assessment	Carbon Stocks
5. Threatened, endangered, proposed and candidate species; potential species of conservation concern (SCC); and species of public interest present in the plan area	Ecological Assessment	At-Risk Species
6. Social, cultural, and economic conditions	Social and Economic Assessment	Cultural, Social, and Economic Conditions, Benefits People Obtain from the Forest, and Multiple Uses
7. Benefits people obtain from the Manti-La Sal National Forest plan area (ecosystem services)	Social and Economic Assessment	Cultural, Social, and Economic Conditions, Benefits People Obtain from the Forest, and Multiple Uses
8. Multiple uses and their contributions to local, regional, and national economies	Social and Economic Assessment	Cultural, Social, and Economic Conditions, Benefits People

		Obtain from the Forest, and Multiple Uses
9. Recreation settings, opportunities and access, and scenic character	Social and Economic Assessment	Recreation Settings, Opportunities, Access, and Scenic Character
10. Renewable and nonrenewable energy and mineral resources	Social and Economic Assessment	Mineral Resources, and Renewable and Nonrenewable Energy
11. Infrastructure, such as recreational facilities and transportation and utility corridors	Social and Economic Assessment	Infrastructure-Transportation, Utility Corridors, and Facilities
12. Areas of tribal importance	Social and Economic Assessment	Areas of Tribal Importance
13. Cultural and historical resources and uses	Social and Economic Assessment	Cultural and Historical Resources and Uses
14. Land status and ownership, use, and access patterns	Social and Economic Assessment	Land Ownership, Status, and Use Patterns
15. Existing designated areas located in the plan area including wilderness, wild and scenic rivers, and potential need and opportunity for additional designated areas	Social and Economic Assessment	Wilderness and Other Designated Areas

1.3 Manti-La Sal National Forest

1.3.1 Values

"The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value." -Theodore Roosevelt

Increased public interest in land management issues due to an active political environment surrounding public land issues in Utah and Colorado indicates an appreciation for the social and economic importance of the Forest and a general sentiment toward conserving the Forest for use and enjoyment by current and future generations. Through the assessment process, there has been a high level of local participation, which is an encouraging sign of the commitment from an engaged local population that cares deeply about its public lands. During the assessment public meetings, people recounted childhood stories about the Forest, as well as the socioeconomic benefits from and recreation value of the Forest to local communities. Others value the richness of Native American history in the Monticello District, with its countless cliff dwellings and cultural sites. Many people have a sincere commitment to fully engage in the Plan Revision process on the land that many call home.

1.3.2 Benefits, Uses, and Opportunities

There are many ways the Forest benefits local communities and the nation. Providing ecosystem services, such as clean air and water, forage for livestock, energy resources, giving families and children a relationship with nature, and preserving cultural and natural treasures for future generations are all benefits from, uses of, and opportunities on the Forest.

Many people, particularly in local communities, identify with how management of the Forest affects their ability to work and earn income. The Forest contributes to economic activity in the areas surrounding it by providing recreational and hunting opportunities as well as timber, energy and minerals, and livestock grazing. Payments to states and counties from Forest Service revenues and royalties support schools, road maintenance, stewardship projects and county government operations. Additionally, Forest Service investments in infrastructure, ecosystem restoration, forest health, and salaries further support jobs and income in the local economy.

The uses of the Manti-La Sal National Forest, and visions of its future, are as diverse as the Forest's geographic landscapes and user demographics. Such diversity of thought presents an enormous opportunity for the Forest and its users to create a dynamic Forest Plan that provides for multiple uses and meets the needs of all users. Indeed, while not all users' visions for the future of the Forest coincide, virtually all users agree that the Forest must be managed in such a way as to ensure its persistence in perpetuity for the benefit of present and future generations.

1.3.3 Where Is the Manti-La Sal National Forest?

The 1.4 million acres of the Manti-La Sal National Forest, located in central and southeast Utah and the extreme western part of Colorado, provides for multiple uses, such as recreation opportunities, wildlife viewing and hunting, livestock grazing, and mineral exploration and extraction. The Forest is divided into five districts: Sanpete, Price, Ferron, Moab, and Monticello. These five districts are often lumped into a North Zone and a South Zone with the Sanpete, Price, and Ferron Districts composing the North Zone and the Moab and Monticello Districts the South Zone. The North Zone is primarily composed of the remnant Wasatch Plateau with elevations ranging from 5,000 to 10,000 feet and exhibiting high elevation lakes, diverse vegetation, near vertical escarpments, as well as areas of scenic and geologic interest. The two Districts making up the South Zone are two separate sky island mountain ranges rising from the surrounding lower elevation desert environments. The Moab District is composed of high mountain peaks reaching elevations of 13,000 feet, canyons, and forest that add climatic and scenic contrast to the red-rock landscape of Arches and Canyonlands National Parks. The Monticello District includes the peaks of the Abajo mountain range as well as the high flat-topped mesa known as Elk Ridge. Deep sandstone canyons dramatically dissect the landscape on either side of Elk Ridge.

The Forest crosses two physiographic zones, each with distinct landscapes, landforms, rock types, and history. The North Zone is in central Utah in Carbon, Emery, Juab, Sanpete, Sevier, and Utah counties, has two prominent geographic features, the San Pitch Mountains, and the Wasatch Plateau. The South Zone is in southeastern Utah in Grand and San Juan counties and in southwest Colorado in Mesa and Montrose Counties, and has three prominent physiographic features, the La Sal Mountains, Abajo Mountains and Elk Ridge. The Sanpitch Mountains and the Wasatch Plateau are closest to the urban areas of the Wasatch Front, including Salt Lake City. See Figure 2 for the relationship of the Forest within the map of Utah and Colorado. See Appendix 1 for several maps related to the Forest.

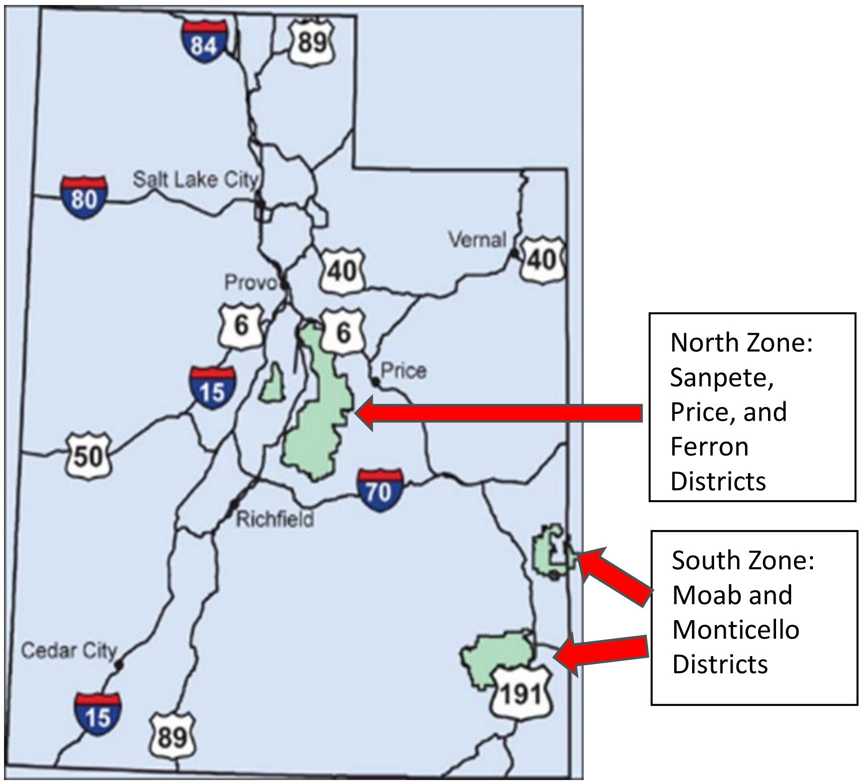


Figure 2. Location of the Manti-La Sal National Forest in relation to major population areas.

1.3.4 Public Participation

The 2012 Planning Rule underscores the importance of public involvement through every step of the planning process and specifies working with state, local, and tribal governments. The Rule places a strong emphasis on providing opportunities for meaningful participation early and throughout the planning process and directs outreach to, “Tribes and Alaska Native Corporations, other federal agencies, state and local governments, individuals, and public and private organizations or entities” (36 CFR 219(4)(a)(1)). The importance of fostering greater recognition and discussion of issues that have cross-boundary effects, looking for common objectives and solutions, and finding opportunities to integrate management across landscapes is essential. The Forest is committed to using a broad spectrum of traditional and non-traditional outreach and communication methods to connect with all user groups throughout every phase of the planning process. Input received during public involvement activities is one source that helps inform the content and direction in the Forest Plan. Public involvement activities are designed not to require a significant time investment from the public, but rather to inform the public of the plan revision process and to generate dialogue and feedback. Input received during public involvement activities may also provide useful information to help support and sustain collaboration. Appendix 2 contains a summary of the specific outreach efforts conducted by the Forest during the Assessment Phase.

The intent of public participation during the assessment phase is to identify as much relevant information as possible to inform the Forest Plan Revision process; specifically, to gain information about the 15 assessment topics shown in Table 1 above. Contributors were encouraged to share their knowledge, concerns, and perceptions of risk to social, economic, and ecological systems in or connected to the planning area. Information about current conditions and trends in the natural resources, social values, and goods and services produced by lands within the Forest was requested. The information received covered a wide spectrum of information, thoughts, opinions, ideas, and concerns.

The Forest has and will continue to come together through meetings and workshops with the public, tribes, state and federal agencies, counties, and associations and will receive written information by email and traditional mail. In addition, the Forest invited tribal, local, state, and federal agencies to participate as Cooperating Agencies in the Plan Revision process. Other ways that stakeholders and the Forest will continue to communicate and inform is through social media, websites, newsletters and other print media, fieldtrips, newspapers, radio, and contact lists. Cooperating Agencies, as well as the public, will continue to have opportunities to participate in Cooperating Agency meetings. Forest specialists will work with their Cooperating Agency counterparts during Forest Plan development.

To gain a better understanding of the needs of the public and the benefits that the Forest provides, the Forest engaged with the following diverse set of stakeholders. These groups and individuals are an essential and important part of all phases of the planning effort on the Forest, and they will continue to have opportunities to contribute to the assessment.

- Tribes–Federally Recognized Native American tribes with a current or historical connection to the Forest’s lands.
- Cooperating Agencies–Local, state, and federal agencies with legal authority and expertise in land management, resource areas, wildlife, or other areas critical to the Forest Plan Revision (Appendix 3).
- User Groups–Forest users organized into groups, usually based upon their uses of the Forest, such as recreation, industry, all-terrain vehicle (ATV), and hunting groups.
- Non-Governmental Organizations–Any non-profit, voluntary citizens' group, which is organized on a local, national, or international level.
- U.S. Forest Service Employees–Permanent, non-permanent, full-time, and temporary employees, as well as volunteers and partners.
- State Government–Utah and Colorado State legislative representatives, Governor’s Offices, and state agencies with expertise in forest land management, wildlife, and/or other resource areas.
- Congressional–State and federal staff.
- Interdisciplinary Team–Designated national forest members.
- Local Government–County government officials, including commissioners and county land management entities, and city government officials.
- Permittees and Lessees–Any entity who possesses a permit or lease on the Forest such as livestock grazing, communications sites, residential, recreation/tourism, timber, mining, and oil/gas.
- Youth and Young Adult–K-12 students at schools throughout the Forest’s area, as well as college students.
- Rural Populations–Population, housing, and territory not included within Urbanized Areas (UAs) of 50,000 or more people or Urban Clusters of at least 2,500 and less than 50,000.
- Low-Income Populations–Those who fall below the Federal Poverty Level (FPL) established by the U.S. Department of Health and Human Services. FPL is dictated by the minimum amount of yearly gross income an individual or family needs for shelter, transportation, clothing, food, or other necessities.

- Distance Urban Populations–Users generally from counties outside of the Forest boundary with large urban populations, such as the Wasatch Front, who generally have a recreational or residential stake in the Forest.

We recognize and thank those who shared information and invested time and effort to share information in response to the Federal Register notice published on July 29, 2016, which initiated the assessment phase of the Forest Plan Revision. We are committed to transparency and robust engagement in the Forest Plan Revision process; we are listening, and public input will impact the planning process. This Assessment Report and subsequent planning processes are strengthened by the contributions of local partners as well as that from local land managers, and their knowledge, expertise, and experience. The large landscape and the associated diverse group of stakeholders affected provides an opportunity to take advantage of each other's knowledge and, using a variety of strengths, work in partnership, to successfully meet the multiple use needs on the Forest.

1.4 Best Available Scientific Information

The 2012 Planning Rule (219.3) describes best available scientific information as scientific information that is, "…the most accurate, reliable and relevant to the issues being considered." In recent years, the concept of best available science has been used as a touchstone in federal planning efforts. The Planning Rule does not require that additional scientific information be developed, but that the assessment should be based on scientific information that is already available.

Accurate data is that which is collected using an appropriate study design and well-developed scientific methods that are clearly described. Reliable scientific information considers whether scientific methods have been applied using scientific principles and if the resulting information demonstrates consistency. Relevant scientific information pertains to the issues under consideration at spatial and temporal scales appropriate to the plan area and to a land management plan. To be considered accurate, the scientific information must estimate, identify, or describe the true condition of its subject matter.

Best available science can vary based on what research has been conducted and whose findings are available, which can include peer-reviewed journals, data collected using scientific methodology and standards. When relevant best available science information is unavailable, studies on topics related to, or studies conducted in locations similar to those on the Forest may be cautiously used to inform a decision.

The Forest coordinated with outside land management agencies and provided opportunities for the public to participate and provide comments, information and data during the assessment. This information and feedback was used to inform the assessment of the conditions and trends of the ecological or socioeconomic systems of the assessment topics analyzed. Public and stakeholder feedback will help ensure the continued accuracy, reliability, and relevance of scientific information as we move forward with Forest Plan Revision.

1.5 Spatial Scales

The assessment area of analysis is intended to capture broad-scale trends and the natural range of variation (NRV) in disturbance intensity, frequency, and aerial extent. Each assessment topic is reported at one or more scales.

1.5.1 Forest Boundary

Most Assessment topics as described in Table 1, are addressed at the Forest-wide scale. Some topics used the Ranger District boundaries to further refine the resource areas.

1.5.2 Land-type Associations

Land type associations (LTAs) are landscape-scale terrestrial ecosystems used in NFS land management planning as a framework for analysis. LTAs are used as a framework during project planning. The Forest has been sub-divided into 45 LTA categories based on the Terrestrial Ecological Unit Inventory Technical Guide (Winthers et al. 2005) and the National Hierarchical Framework of Ecological Units. The categories are described in detail in (Kilbourne 2016; USDA 2016d). The ecological assessment topics are based on the LTA scale. For many resource areas, the vegetation types mapped across the Forest were also used for spatial reference.

1.5.3 Watershed Boundary

A watershed is a geographic area of land, water, and the animal and plant life within the confines of a drainage divide or line. The boundary between two watersheds is the topographic dividing line from which water flows in two different directions. The following topics are assessed at the 5th code watershed scale (HUC5):

- Cultural and Historical Resources and Uses
- Watersheds and Water

1.5.4 Topic Specific

For some topics, topic-specific scales are used as they provide the best, and sometimes, the only data and information needed to appropriately complete the assessment. For instance, political and administrative designations (for example, county or forest boundaries) do not necessarily correspond with economically-meaningful units. Therefore, the appropriate scale for addressing the social and economic environment is different from the scales used to address other topics in the assessment. Scales by topic are:

- Air – state air sheds
- Forest Contributions to Cultural, Social, and Economic Conditions and Benefits People Obtain from the Forest – counties
- Land Status, Ownership, and Use Patterns – land ownership and special use authorizations
- Recreation Settings, Opportunities, Access, and Scenic Character – recreation zones
- Riparian – four geographically distinct areas
- Tribal Areas of Importance – areas of tribal importance

- Wilderness and Other Designated Areas – boundaries of inventoried roadless areas and existing boundaries of Research Natural Areas and Special Interest Areas (such as Pinhook Battleground and the Great Basin Experimental Range).

2. STRESSORS AND DRIVERS

2.1 Introduction

The planning rule requires in topic 3 that the assessment include an appraisal of “system drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability of terrestrial and aquatic ecosystems in the plan area to adapt to change” 36 CFR 219.6 (b)(3). The intent of documenting the stressors and drivers in the assessment is to establish a baseline that will serve in subsequent steps in the planning process. A consistent set of stressors and drivers, with a clear description of each and a reflection of each as they pertain to the Forest, provides for a common understanding.

Drivers, as used in this report, are processes that act on key ecosystem characteristics (KECs) of terrestrial, aquatic, and riparian ecosystems, and watersheds. Drivers include natural disturbances, major climate regimes (precipitation, temperature, growing season, or drought), broad-scale regimes (wildfire, wind, flooding, or insects and disease), and natural vegetation succession.

Stressors, as used in this report, are factors that may directly or indirectly degrade or impair ecosystem composition, structure, or ecological process in a way that impairs its ecological integrity.

Table 2. Stressors and drivers detailed in this chapter.

Topic	Driver	Stressor
Climate	Climate	Climate change – ecological stressor
Wildfire	Wildfire	Wildfire – ecological stressor
Vegetation succession	Natural succession	Encroachment – ecological stressor
Landslides and geologic hazards	Landslides and geologic hazards	High precipitation, high snow pack, saturated soils and rapid spring snowmelt run-off – ecological stressors
Insects and Diseases	Insects and diseases	Drought severity and frequency, wildfire, vegetation structure and composition -ecological stressors
Invasive Species	Invasive species	Disturbance events - ecological stressors
Recreation	Demand for recreation	Increased human populations and tourism - social and multiple use stressors
Access/infrastructure	Human use	Increased human populations and tourism - social and multiple use stressors
Cultural Resources	Wildfire, landslides and geologic hazards and climate change	Insects and disease, tree encroachment, invasive species, human populations and multiple use impacts - ecological and social and multiple use stressors
Wildlife	Wildlife populations	Increased human populations and forest use - social and multiple use stressors
Ground Water Withdrawals	Human use	Increased human populations and associated water demand, mining, water diversions, - social and multiple use stressors

Air emissions	Human use	Increased human populations, air pollution - social and multiple use stressors
Mineral exploration and development	Human use	Increased human population and associated economic demand - social and multiple use stressors

When the best available scientific information was available, the following points were addressed for each stressor and driver:

- What are the indicators and the scale used to measure the conditions of each stressor and driver?
- What are the existing conditions and trends, both past and future?
- What are the resource areas impacted by these stressors and drivers?
- Are stressors reversible by taking management actions? Are stressors under control of Forest management?
- Identify stressors resulting from other stressors, overlapping stressors, and accumulating stressors.

2.2 Climate

2.2.1 Stressor or Driver Description

Climate is defined as the average value of weather over a time period, including range and variability, at a defined spatial scale (NOAA 2016, Luce et al. 2012, Furniss et al. 2010). The variables that makeup weather and climate include temperature, precipitation. These make up climate regimes that influence extreme weather-related disturbance events all of which influence ecosystem composition, health, and productivity (Peterson et al. 2011, Voss et al. 2012). Climate change is the change in the long-term statistics of weather (NOAA 2007). These changing conditions, such as changes in precipitation and temperature, are stressors that affect long-term ecological conditions.

In an effort to provide the best available scientific information, the Forest Service Intermountain Regional Office, the Rocky Mountain Research Station and other partners are working collaboratively to review historical and projected climate data. This effort, the Intermountain Adaptation Partnership (IAP), is in progress and will result in a series of reports by resource-focus areas that will be compiled into a general technical report (GTR). The Forest will use draft reports as they became available during the planning process.

The Earth's climate began to warm rapidly during the 20th century and warming is expected to intensify in the future (Furniss et al. 2010). Increases in greenhouse gases including: carbon dioxide, methane, nitrous oxide, and fluorinated gases, are resulting in a rapid increase in atmospheric temperature and amplifying natural climate variation (EPA 2016, Luce et al. 2012, Peterson et al.. 2011, Halofsky et al.. 2011). The complex changes in the heat balance of the Earth alter, atmospheric flow patterns, and redistribute wind streams that result in changes in precipitation (Halofsky et al. 2011). Changes to the timing, amount, and type of precipitation can negatively impact forest ecosystem health by allowing for the introduction and establishment of invasive species, inciting insect infestations, carbon storage, and by decreasing species health, resistance, and resilience (USDA 2016f, Peterson et al. 2011).

2.2.2 Indicators

Indicators used on the Forest to measure the impacts of a changing climate on ecosystem resources include changes in temperature extremes, the amount, timing and type of precipitation, stream temperatures and base-flow, projected community water needs based on future population estimates, groundwater recharge rates and volume, vegetation community composition (meaning a landscape under natural disturbance regimes and the abundance of native plant species), and greenhouse gas levels.

2.2.3 Scale

The Intermountain Adaptation Partnership (IAP) breaks the Forest Service's Region 4 into six sub regions based on common geological and ecological features and history. The Forest falls primarily within the Plateaus Subregion, which was used as the analysis scale, combined with the Forest boundary. Figure 3 shows the location of the forest within the subregions.

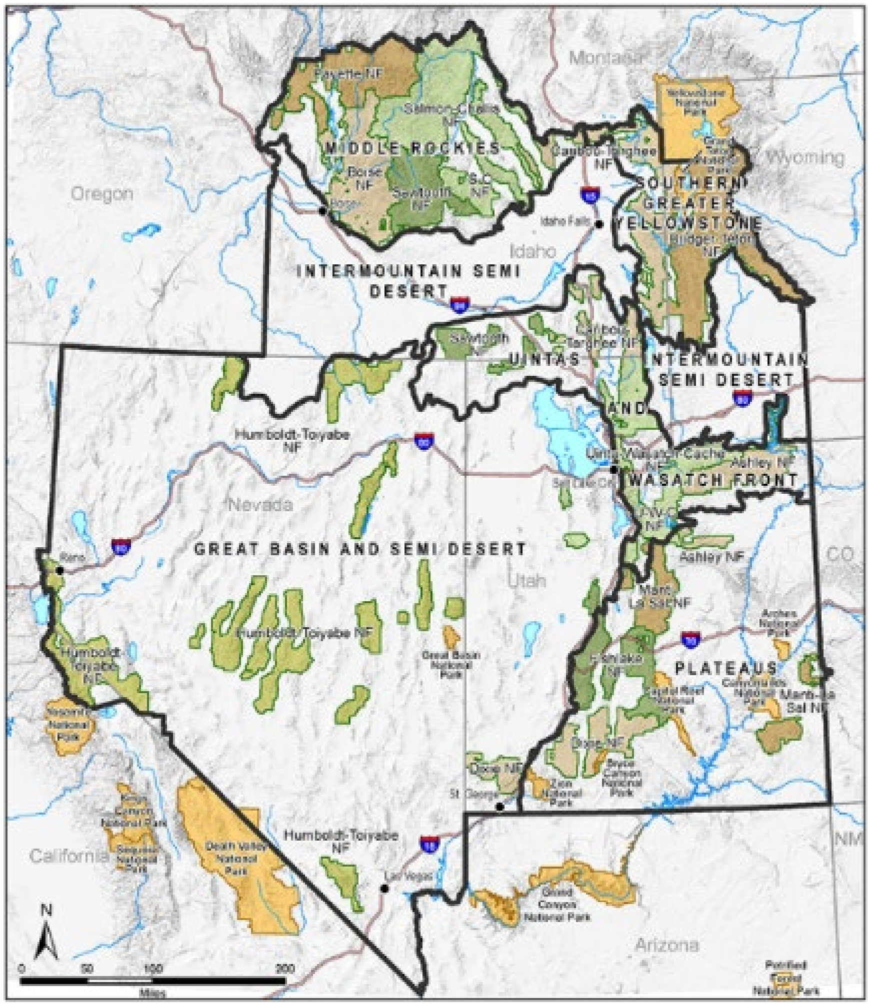


Figure 3. Map of Intermountain Region adaptation partnership subregions (USDA 2016).

2.2.4 Existing Condition of the Indicators

For the Plateaus Region, mean, minimum, and maximum temperatures have been increasing over the last 30 to 50 years (USDA 2016f), while changes in precipitation patterns of precipitation have not shown consistent patterns of deviation from norms as shown in Figure 4. Within the Plateaus subregion, both mean and maximum temperatures have risen around 0.027°F in the last 50 years. Within the last 30 years, maximum temperature has increased 0.081°F per year on average while minimum temperature has only risen 0.034°F on average per year (Figure 4, USDA 2016f). Precipitation (inches/year) is variable with no obvious trend.

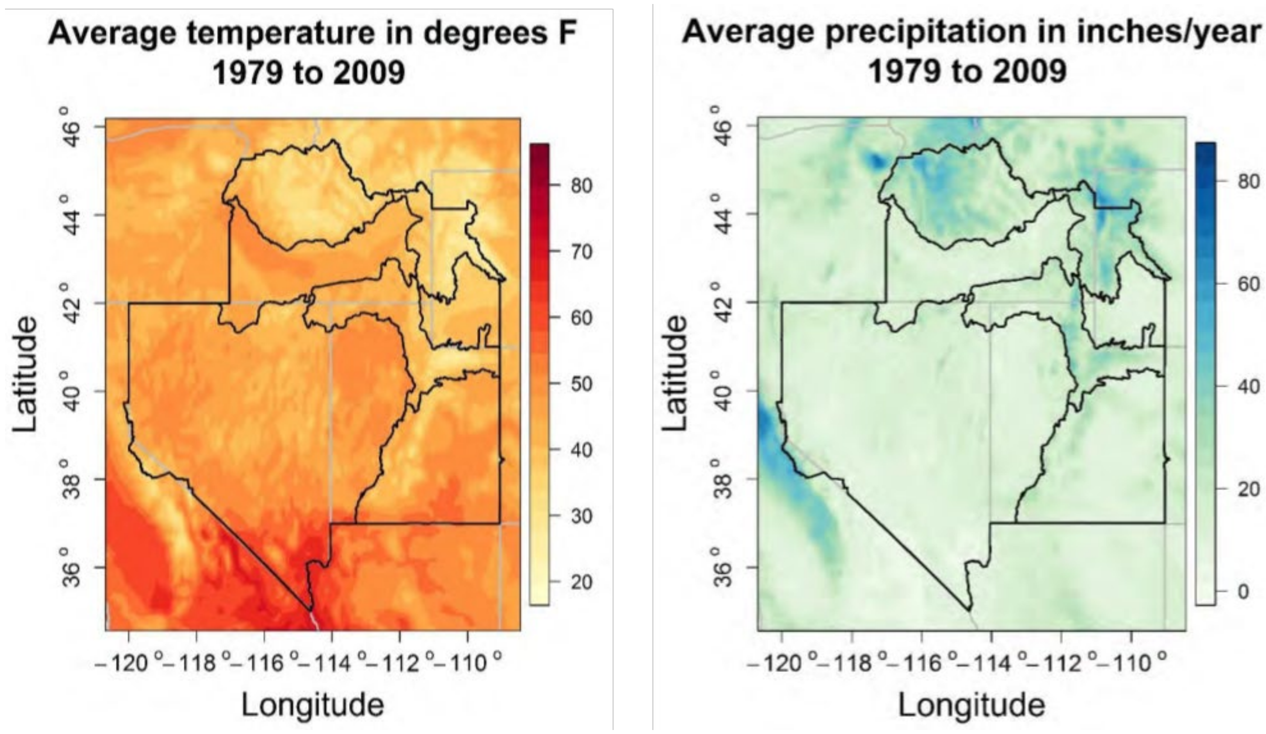


Figure 4. Historical (1979-2009) mean annual monthly temperatures in Fahrenheit, and total annual precipitation in inches across Region 4 (USDA, 2016).

2.2.5 Trends

Ecological systems and communities are not static over time but may fluctuate within certain parameters before shifting into a different system or community type; often called the natural range of variation (NRV) for a system. Climate and climate related variables can directly and indirectly impact an ecosystems ability to remain within its NRV.

In the region, annual minimum and maximum temperatures are projected to rise between 5° and 10° F by 2100 (RCP 4.5 and 8.5 respectively). Projections for precipitation are variable. As Table 3 shows greenhouse gases, temperatures, and community water needs have been increasing and are projected to continue an upward trajectory (USDA 2016f). While the projections for precipitation are variable, there are expected changes in the frequency, intensity, timing, and type. These changes impact snowpack, stream temperature, vegetation community, groundwater recharge, and stream flow and temperatures. Higher temperatures will accelerate evapotranspiration resulting in soils drying faster.

Table 3. Summary of historical and expected future trends in climate variables in the Intermountain Adaptation Partnership Plateaus Subregion (USDA 2016f).

	Historic Conditions	**Future Conditions**		
Climate Variables	**Baseline**	**Expected Direction of Change**	**Expected Changes by Season**	**Confidence**
Temperature	Both mean and minimum temperatures have risen 0.027 ^{0}F over the last 50-years. In	By mid-21st century, under Representative Concentration Pathway (RCP) 4.5, maximum	Maximum temperatures rise in all seasons in all scenarios (RCP 4.5 & 8.5) with the greatest change	Although there are variations in climate change models, these

Table 3. Summary of historical and expected future trends in climate variables in the Intermountain Adaptation Partnership Plateaus Subregion (USDA 2016f).

	Historic Conditions	**Future Conditions**		
Climate Variables	**Baseline**	**Expected Direction of Change**	**Expected Changes by Season**	**Confidence**
	the last 30-years, the maximum temperature has on average increased 0.081^{0}F per year and the minimum temperature has risen 0.034 ^{0}F per year.	temperature is projected to rise by nearly 5 ^{0}F and minimum temperature is projected to rise similarly.	occurring during the summer months. Minimum winter temperatures rise remain below freezing by 2100, however, minimum spring and fall temperatures may rise above 40^{0}F by the end of the 21st century.	results are very likely.
Precipitation	Most precipitation occurs in early winter and late spring.	Precipitation projections are highly variable.	Precipitation projections are variable but the greatest change in winter precipitation is expected in the northern districts on the Forest.	While there is a high likelihood of change on amount, timing and type of precipitation, the predicted extent of these changes is currently highly variable.
Snowpack	April-1 Snow-water equivalent has been declining in this area since the late 1940s.	Higher elevations may not see substantial changes in April-1 SWE, center of melting time, or snow residence. Intermittent snow packs on mid-to-low elevations will likely see snow more rarely and have a reduced snowpack.	Where snowpack still occurs, snowmelt timing will likely occur earlier in the year.	Although precipitation projections are highly variable, temperature-related changes are relatively robust.
Stream Flow	Annual water yield and summer low flows have been decreasing since the 1940s.	Total yields may decrease.	Earlier stream flow center timing is expected and summer low flows are expected to be lower.	Since groundwater systems are closely tied to precipitation and snow pack, there is some uncertainty to extent of impact on these systems.
Stream Temperature	Data Gap	Data Gap	Data Gap	Data Gap

Table 3. Summary of historical and expected future trends in climate variables in the Intermountain Adaptation Partnership Plateaus Subregion (USDA 2016f).

	Historic Conditions	**Future Conditions**		
Climate Variables	**Baseline**	**Expected Direction of Change**	**Expected Changes by Season**	**Confidence**
Groundwater Recharge Rate	Snowmelt likely contributes to the majority of recharge in most mountain regions.	Potential changes remains uncertain throughout the region	Potential changes remains uncertain throughout the region. Groundwater systems will be less impacted by increasing temperatures then surface waters.	Difficult to predict due to poorly understood factors.
Projected Community Water Needs	Data Gap	Data Gap	Data Gap	Data Gap
Vegetation Community Health & Composition	Changes in temperature, snow packs and precipitation have already resulted in increased fire frequency and intensity as well as more frequent and intense pest outbreaks.	The degree of climate change impact will vary by vegetation community. But increased temperatures and fires and changes in water resources will stress communities making them more vulnerable to additional stressors. These changes will result in shift in habitat types by area and elevation.	The warmer seasons will likely see the greatest impact by catastrophic events (drought, fire, etc.) and infestations.	Although the intensity and frequency of events may vary by community type, these changes are very likely.
Greenhouse Gas Levels	Over the last century, greenhouse gases have been increasing with the rate of increase growing in more recent decades.	Rates of increase have been slowing, but still increasing.	Data Gap	Data Gap

Across the Plateaus Subregion, under the more conservative RCP 4.5 model, the maximum and minimum temperatures are projected to increase by at least 5°F by 2100. The maximum temperature is expected to increase for all seasons, with the greatest departure from historical occurring in the summer season. Average summer maximum temperatures are predicted to rise above 95°F by 2100, with autumn average maximum temperatures rising to 75°F. Winter minimum temperatures will remain below freezing through 2100, under both the RCP 4.5 and 8.5 models (USDA 2016f).

With the exception of the Monticello District, a 9 to 10°F change in average winter temperature predicted to occur throughout the Forest by 2080 under RCP 8.5, with regions of higher elevations showing the greatest increase (predictive maps developed using methodology from Abatzoglou and Brown 2012). There is a greater predicted change in cumulative winter precipitation, between 16 and 22 percent change, for the northern districts, while the southern districts are projected to experience a less dramatic change (predictive maps developed using methodology from Abatzoglou and Brown 2012). However, areas within the southern districts that are projected to experience the greatest change are areas of higher elevation in the Moab District.

Winter snowpacks are tied to winter temperatures and precipitation type and timing. As such, areas of greatest projected change are similar to those identified for temperature and precipitation. The snowpack has been declining on the Forest and is projected to continue to decline in the future (Luce et al. 2016). Snow residence time is declining and snowmelt is occurring earlier in the year then historical norms (Luce et al. 2016, USDA 2016). Stream flow volumes in this region are tied to snowmelt volume and timing, a change in peak stream flow timing and intensity results in lower summer stream flows. These accumulated impacts, along with changes in temperature, precipitation and fire regime, will directly impact vegetation communities. Dryer soils and changes in water availability will strongly impact riparian, alpine and sub-alpine, dry big sagebrush, grasslands, and mountain mahogany habitats, while oak-maple woodlands and mountain shrublands are likely to be less impacted than most habitat types (USDA 2016f).

2.2.6 Resources Affected

Due to variability in natural systems, the predictive models that are designed to show future conditions inherently include a number of uncertainties (Daniels et al. 2012). For forest planning, while it is important to understand the sources of the variability in modeling outputs, it is not necessary to identify a “correct” model. It is important to be aware of the range of possibilities, the primary factors influencing outcomes, and how these factors impact resources to best build resiliency into a system or resource (Table 4). Examples of possible impacts include:

- Changes in precipitation due to a changing climate have significant implications on aquatic habitats and the species that depend on them (Isaak et al. 2016). Resulting changes will impact habitat quality, quantity and location and may result in shifts in species distribution and abundance.
- Changes in climatic conditions may alter the supply and demand on outdoor recreation activities and access within the Forest (Hand et al. 2016). The Forest’s capability to meet these changes in demand may directly impact the local economy for communities around the Forest. Impacts may vary by season.
- Changes in climate that result in increased rainfall and flooding will pose substantial risk to infrastructure as disturbance events escalate beyond the capability of existing infrastructure (i.e., culverts) to handle (Furniss et al. 2016).

Resource-specific information regarding impacts of a changing climate on Forest specific resources can be found under other resource topics in this report.

Table 2. Resources impacted by climate change on national forests in the Intermountain Adaptation Plateaus Subregion (USDA 2016, Reeves and Bagne 2016, Vose et al. 2016).

Resources Affected	Indicator for Monitoring	Most Vulnerable[1]
Vegetation	Ground cover percentages, resource value rating (RVR), invasive species – presence, riparian ecosystem condition, vegetation species composition, groundwater dependent vegetation, timing and volume of base flows, soil bank stability, vegetation species richness and diversity	Riparian ecosystems, soil bank stability, species richness and diversity, vegetation species composition
Range	Ground cover percentages, resource value rating (RVR), vegetation species composition, vegetation species richness and diversity	Ground cover percentages, vegetation species composition
Soils	Soil integrity, erosion and sedimentation, productivity and organic matter, vegetation suitability	Soil integrity, erosion and sedimentation

Wildlife	Habitat quality (resilience and integrity), species richness and diversity, species composition, vegetation structure, ecosystem function, habitat fragmentation and connectivity, wildlife populations	Species richness and diversity, habitat quality (resilience and integrity), vegetation structure, ecosystem function
Aquatics	Habitat fragmentation and connectivity, water temperature, surface water quality, surface water quantity, soil bank stability, sedimentation, timing of peak water flows, watershed function and condition, species richness and diversity	Habitat fragmentation and connectivity, surface water quality, water temperature, watershed function and condition
Minerals	Landslides and geologic hazards, contribution to economic sustainability	Landslides and geologic hazards, contribution to economic sustainability
Hydrology and Groundwater	Surface water quality, surface water quantity, watershed function condition, number of recharge and discharge points, aquifer water quality	Watershed function and condition, surface water quality, surface water quantity
Timber and Silviculture	Vegetation species composition, vegetation structure, ecosystem function, habitat fragmentation and connectivity, habitat quality (resilience and integrity)	Vegetation species composition, habitat quality (resilience and integrity), vegetation structure
Fuels	Fire regime condition class (FRCC), fuel loads, fire intensity	Fuel loads, fire regime condition class (FRCC)
Wilderness and Special Designations	Wilderness stewardship performance elements, consistency with research natural area (RNA) management goals	Wilderness stewardship performance elements, consistency with research natural area (RNA) management goals
Recreation	Consistency with the recreation opportunity spectrum (ROS) classes	Consistency with the recreation opportunity spectrum (ROS) classes
Scenery	Consistency with the visual management system (VMS) or scenery management system (SMS)	Consistency with the scenery management system (SMS)
Lands	Proposals for land exchange, land special use permits	Land special use permits
Engineering	Inventory, maintenance, condition, expected needs	Maintenance, condition, expected needs
Cultural and Heritage	Number of sites, condition of sites, number of eligible sites, condition of eligible sites	Condition of sites and condition of eligible sites
Social and Economic	Demographics, economic characteristics, forest contributions to social and economic sustainability, services provided by the forest, forest influence on community	Forest contributions to social and economic sustainability, services provided by the forest,
Air	Air quality, wilderness air quality	Air quality
Carbon Stocks	Carbon sequestration, carbon storage, benefits obtained by ecosystems	Carbon sequestration and carbon storage

[1] Most Vulnerable: those resources a most risk, with the most urgent need for management actions and/or monitoring. This is not a comprehensive list.

2.2.7 Management Tools

Incorporating the potential impacts of climate change into land management planning and decision-making requires the inclusion of scientific information as well as social, economic, and cultural considerations (Peterson et al. 2011, Moss et al. 2014, Joyce et al. 2014). Successful management tools often involve educating and working with the public and outside organizations. Tools that support these efforts include joint fact-finding, structured decision-making, adaptive management, as well as computer/statistical modeling. The overall objective of managing for climate change impacts is managing risk. For land management agencies, that translates to managing for resiliency in an ecosystem or resource, while reducing vulnerability (Peterson et al. 2011, Swanston and Janowiak 2012, Swanston et al. 2016). The first step in the process includes completing assessments of all resources to identify the current state and current and futures risks.

Management tools to support resiliency begin with decision support tools and methods. It is becoming more important to identify various alternatives and to consider the long-term effects as well as other resources that are tied to the resources being acted on directly. This includes looking at comparative trade-offs and possibly, integrating appropriate science-based modeling (Peterson et al. 2011, Moss et al. 2014). It is also important to review possible future 'big-picture' conditions and threshold events and consider possible scenarios and discuss how current actions can best impact, prevent and/or prepare for those events.

U.S. Forests absorb and store more than 227.6 million tons of carbon per year making them an important carbon sink (Joyce et al. 2014). Increasing forest health and acreage, while being mindful of any increase in water demands, will increase carbon sink capacity (Garfin et al. 2013, Joyce et al. 2014). However, carbon storage is expected to decline due to accelerated mortality of forested vegetation from disturbance. One important factor for managing greenhouse gases is to manage carbon sequestration (i.e., a forest's ability to absorb carbon). Practices to do so include increasing forest growth and continued treatment of disease, invasive species, and pests. Additionally, harvesting forested vegetation influences carbon storage. Removing fuel (e.g., thinning) can reduce the risk of catastrophic fires (Peterson et al. 2011) and reduce the amount of carbon released from fires.

Water resource management, current and future, will play an important role in supporting resiliency in many ecosystems as well as for public use (Georgakakos et al. 2014). Potential management tools include changing water use practices to more efficient methods and updating and improving infrastructure planning to incorporate water efficient options. Education and communication within and across sectors will also play an important role. Land management options include maintaining and restoring hydrology and riparian areas (Swanston and Janowiak 2012).

Challenges for adapting certain management tools include the lack of fine-scale information, limited financial resources and personnel, pre-existing laws and policies that do not incorporate climate change impacts, national and regional policies and processes, affinity for traditional management approaches, 'checkerboard' pattern of land management across the larger-landscape, expansion of residential development and recreational activities, regulatory standards that impact the quantity and timing of management actions, and appeals and litigation of proposed projects(Peterson et al. 2011, Moss et al. 2014).

2.3 Wildfire

2.3.1 Stressors or Driver Description

According to *The National Strategy: The Final Phase in Development of the National Cohesive Wildland Fire Management Strategy* there are five national challenges or stressors that should be addressed in managing wildland fire. They include weather and changing climate, vegetation and fuels, homes, communities and values at risk, human-caused ignitions, and effective and efficient wildfire response. Each stressor and indicator are identified in Table 3.

Table 3. Manti-La Sal National Forest wildfire related stressors and associated indicators.

Stressor	Indicator
Weather and changing climate	Climate change, change in mean temperature, change in energy release component
Vegetation and fuels	LANDFIRE, fire regime groups, vegetation condition class, surface fuels
Homes, communities and values at risk	Frequency and extent of wildfires, distribution and density of homes within the wildland urban interface
Human-caused ignitions	Acres burned from human-caused ignitions
Effective and efficient wildfire response	Fires of concern where they pose a threat and are not management of wildlife habitat

2.3.2 Scale

Three separate scales are used; strategic fire management zones, forested/non-forested vegetation groups, and land type associations (LTAs). Even though wildland fire is not restricted to any ownership boundaries or vegetation types, these three scales are used to help guide management decisions when managing the potential impacts of wildland fire.

2.3.3 Existing Condition of the Indicators

Weather

The North Pacific high pressure system dominates summertime weather causing hot temperatures, moderately low humidity, and low fuel moistures (2 to 5 percent). Several times throughout the fire season, the Pacific high is intruded upon by tropical moisture from the Gulf of Mexico or the Pacific that brings thunderstorms to Utah. Thunderstorms that start fires have occurred as early as May but are more likely to occur between June and September. The Pacific high is at its greatest expanse and strength in August and begins to weaken in September as an Aleutian low pressure system reappears in the Gulf of Alaska and pushes south.

Vegetation and Fuels

Management strategies including but not limited to fire suppression and the lack of treating fuels, have contributed to Forest conditions that encourage high-severity fires. The previous policy of excluding all fires, eliminated fires of low to moderate severity resulting in a higher probability of high-severity, stand-replacing fires. This has resulted in a landscape with an increase in flammable vegetation and the potential for crown fires. Crown fires are considered the main threat to ecological and human values, and they are one of the biggest challenges of fire management. The existing condition of vegetation condition classes and fire regimes on the Forest is described in Table 4.

Table 4. Summary of existing fire regimes and acres within each vegetation condition class.

Fire Regime[1]	Class[2] 1a	Class[2] 1b	Class[2] 2a	Class[2] 2b	Class[2] 3a	Class[2] 3b	Total
I	16	8,647	165,638	354,662	128,592	250	657,805
II	1	1	72	96	27	9,407	9,604
III	1	333,047	54,235	50,987	1,331	14	439,615
IV	2	1,226	118,691	1,826	636	13	122,394
V	295	6,216	91,715	1,626	175	13	100,040
Total	315	349,137	430,351	409,197	130,761	9,697	1,413,144[3]

[1]Fire regimes are classified into categories by frequency and severity. I: 0-35 years frequency, low severity; II: 0-35 years frequency, stand replacement severity; III: 35-100 plus year frequency, mixed severity; IV: 35-100 plus year frequency, stand replacement severity; and V: 200 plus years, stand replacement severity.

[2]Vegetation condition classes represent a categorization of the vegetation departure of the current vegetation from the estimated historical vegetation reference conditions. 1a: very low departure; 1b: low departure; 2a: moderate to low departure; 2b: moderate to high departure; 3a: high departure; 3b: very high departure.
[3]This total acres includes 83,686 non-burnable acres that are not within the five fire regimes. These acres are classified as barren, agricultural, or urban acres in terms of vegetation type.

The rate of accumulation of fuels, along with tree mortality from insects and disease, exceeds the rate of decomposition, resulting in an increasing fuel load. The end result is a landscape that is increasingly susceptible to high-intensity stand replacing fire. Overall, roughly 84 percent of the Forest would experience low-to-moderate intensity fires, with various fire-return intervals under normal fire conditions. The remaining 16 percent of the Forest could expect to see high intensity stand replacing fires, with long fire return intervals under normal fire conditions.

All of the vegetation groups have changed over time on the Forest. The majority, about 84 percent fall within low to moderate departure from historical conditions. These departures are a result of multiple impacts but not limited to change in climate, tree encroachment, fire suppression, and grazing. Aspen and mixed conifer vegetation group has experienced greatest departure from historical conditions, with shade-tolerant species encroaching into aspen stands due to lack of fire.

To quantify the effects of a wildfire, fuel models are selected. A fuel model is chosen by the primary carrier of the fire, and its fuel characteristics. Fuel models are derived from the vegetation layer and can describe fire behavior based on weather and topography. Due to the multiple aspects, soil types, and elevations, surface fuels form a non-continuous mosaic consisting of pinyon-juniper and woodlands on lower elevations and transitioning into timber, open grasslands, and alpine meadows at higher elevations. The existing acres within each fuel model code on the Forest is described in Table 5.

Table 5. Summary of existing fuel models.

Fuel Model Code	Fuel Model Description	Total Acres
GR1	Short, Sparse Dry Climate Grass	48,863
GR2	Low Load, Dry Climate Grass	27,924
GS1	Low Load, Dry Climate Grass-Shrub	128,769
GS2	Moderate Load, Dry Climate Grass-Shrub	234,720
NB1	Urban/Developed	5,921
NB3	Agricultural	23
NB8	Open Water	2,672
NB9	Bare Ground	55,304
SH1	Low Load Dry Climate Shrub	29,630
SH2	Moderate Load Dry Climate Shrub	2,153
SH5	High Load, Dry Climate Shrub	169,756
SH7	Very High Load, Dry Climate Shrub	122,215
TL1	Low Load Compact Conifer Litter	194
TL3	Moderate Load Conifer Litter	187,234
TL6	Moderate Load Broadleaf Litter	816
TL8	Long-Needle Litter	60,857
TU1	Low Load Dry Climate Timber-Grass-Shrub	189,030
TU5	Very High Load, Dry Climate Timber-Shrub	147,076

Homes, Communities and Values

When fire enters the wildland urban interface (WUI), where homes are built near the forest, there exists the potential for loss of life, property, and other values. Social issues also exist where many homeowners find it undesirable to live in a burned-over forest, even if their home has survived (The National Strategy 2014). Recent policy direction (Cohesive Strategy 2000, Healthy Forest Initiative of 2003, and Healthy Forest Restoration Act of 2003) has directed the Forest Service to prioritize hazardous fuels reduction projects in the WUI that are in condition class 2 or 3.

Frequency and Extent of Wildfires

The communities surrounding the Forest consider municipal and agricultural watersheds as critical in sustaining life; therefore, the watersheds are included as WUI areas within their Community Wildfire Protection Plans. Thus, almost 70 percent of all fires burned are considered within the WUI, even though they may not be close to any structures. Table 6 shows all fire ignitions and acres burned within Forest boundaries.

Table 6. All ignitions and acres burned within the wildland urban interface and non-wildland urban interface between 1970 and 2015.

Land Type	Natural Ignitions	Human Ignitions	Total Ignitions	Total Acres
WUI	905	218	1123	80,342
Non-WUI	1193	104	1297	38,022
Total Fires	2098	322	2420	118,364

Distribution and Density of Homes within WUI

Within 5 miles of Forest boundaries there are 67 communities at risk from wildfire. Even though most of the communities at risk are off the Forest, many of their municipal and agricultural watersheds are on the Forest resulting in major implications if a wildfire were to occur. Communities at risk that exist within Forest boundary as private in-holdings are typically cabins or second homes. These homes are of great concern due to their isolated locations on the Forest and distances from any fire response resources.

Human-caused Ignitions

Wildland fire can be broadly divided into two principle regimes, natural and human-driven. Unlike natural fires, human-caused ignitions are unpredictable and can occur at any time in the year at any location. The most difficult fires for fire managers to address are on the hottest days and within the WUI where most human activity occurs. Additionally, fires starting at the base of the mountain ranges where most of the homes and communities exist have the greatest potential to cause a threat to firefighter and public safety.

Human-caused ignitions have remained at a constant level since the 1970s. About 20 percent of all acres burned within the WUI are human-caused ignitions, and about 28 percent of all acres burned outside of WUI are human-caused ignitions.

Wildfire Response

Because large wildfires are significant challenges, it is important to know where large, long-duration wildfires are likely to occur and plan accordingly. For analysis purposes, the National Cohesive Strategy defines the indicator as fires of concern as those greater than 1 square mile in extent and at least 2 weeks in duration from report to containment. According to the analysis, the Forest had 13 fires since 1985 that meet this criteria (seven fires on the North Zone and six fires on the South Zone), which is considered a moderate amount of fires of concern.

2.3.4 Trends

Since the mid-1980s, there has been a trend toward increased large fire frequency, longer wildfire durations, and longer wildfire seasons due to both climate change and previous land-use effects (Westerling et al. 2006). In the absence of vegetation management, there is an increased potential for further loss of biological diversity in the event of future high severity large fires that damage or eliminate components of the ecosystem (Martin and Sapsis 1991).

2.3.5 Management Tools

There are many management tools available to address wildfire stressors and drivers. Selection of the appropriate tool is dictated by the national goals and challenges being addressed for wildfire on national forests. The following three national wildfire goals provide insight into the appropriate management tools to address and achieve the goals as well as the challenges associated with achieving the goals.

Restore and Maintain Landscapes

The challenges to restoring and maintaining landscapes are associated with vegetation and fuels.

The management options to address restoring and maintaining landscapes include:

- Expand or maintain prescribed fire use in areas of current use
- Expand use of prescribed fire into areas of limited current use
- Use prescribed fire on a limited basis
- In forested systems manage wildfires for resource objectives
- In non-forested systems manage wildfires for resource objectives
- In areas where increased awareness of community risk is necessary manage wildfires for resource objectives
- Support by forest products industry for non-fire fuels treatments
- In non-forest areas use non-fire fuels treatments
- In areas with limited economic markets use non-fire fuels treatments
- Use mechanical, herbicide or grazing as non-fire fuels treatments
- Use fuels treatments as a precursor to prescribed fire or managed wildfire

Fire Adapted Communities

The challenges to establishing fire adapted communities are associated with vegetation and fuels.

The management options to address establishing fire adapted communities include:

- Expand or maintain prescribed fire use in areas of current use
- Expand use of prescribed fire into areas of limited current use
- Use prescribed fire on a limited basis
- In forested systems manage wildfires for resource objectives
- In non-forested systems manage wildfires for resource objectives
- In areas where increased awareness of community risk is necessary manage wildfires for resource objectives
- Support by forest products industry for non-fire fuels treatments
- In non-forest areas use non-fire fuels treatments
- In areas with limited economic markets use non-fire fuels treatments
- Use mechanical, herbicide or grazing as non-fire fuels treatments
- Use fuels treatments as a precursor to prescribed fire or managed wildfire

Respond to Wildfires

The challenges to respond to wildfires are associated with values at risk including homes and communities, human-caused ignitions, and effective and efficient wildfire response.

The management options to address restoring and maintaining landscapes to address values at risk include:

- Focus on home defensive actions
- Focus on a combination of home and community actions
- Adjust building and construction codes in municipal areas
- Adjust building and construction codes in non-municipal areas

The management options to address restoring and maintaining landscapes to address human-caused ignitions include:

- Reduce accidental human-caused ignitions
- Reduce human-caused incendiary ignitions such as arson

The management options to address restoring and maintaining landscapes to address effective and efficient wildfire response include:

- Prepare for large, long-duration wildfires
- Protect structures and target landscape fuels
- Protect structures and target prevention of ignitions

Stressor Accumulation

Increased insect infestations, disease, fire suppression, human activity, ungulate grazing and changes in the climate compound the potential impacts of wildfire across the landscape.

2.4 Vegetation Succession

Please see 3.2 Terrestrial and Aquatic Ecosystems for a discussion about the stressors or drivers for vegetation succession.

2.5 Landslides and Geologic Hazards

2.5.1 Stressors or Drivers Description

Landslides on the Wasatch Plateau typically occur under conditions of high precipitation rates, including high snow pack, saturated soils, and rapid spring snowmelt run-off. When these factors occur simultaneously, the potential for large landslides increases as do hazards to people, roads, and other facilities on the Forest. The North Zone has the highest concentration of landslides on the Forest, primarily when soils are saturated. The geologic units of the North Zone, include the Tertiary Flagstaff limestone, Tertiary-Cretaceous North Horn shale, and the Cretaceous Price River sandstone and shale. Other contributing factors to increased risk of landslides include slope steepness, earthquakes, loss or removal of vegetative cover, and aspect.

During 1983 and 1984, major landslides occurred on the Wasatch Plateau due to record high snow pack. The largest slide was the Twelve Mile (South Fork) landslide. These conditions repeated in 1998 when another record high snow pack triggered the Cooley Creek landslide. In both cases, catastrophic failure released landslides on low angle slopes due to saturation of soils and rapid spring run-off. Catastrophic slides occur more frequently on the west side of the Wasatch Plateau due to higher precipitation rates and the westerly oriented monocline geologic structure dip-slope angle. Landslides in the Twelve Mile drainage tend to occur on south-west facing aspects, with slopes averaging 15.6 degrees and at approximately 8,400 feet in elevation (UGS power point 2011).

The Meadow Gulch slide in the Muddy Creek drainage is also located on the North Zone of the Forest. This area occurs within the North Horn Formation and is prone to slides and slumping on an annual basis. Unlike the Cooley and Twelve Mile slides, the Meadow Gulch slide area is more prone to rotational failure rather than catastrophic failure, possibly due to more localized soil saturation. However, seasonal spring run-off may infiltrate along cracks causing clay minerals within the formation to swell resulting in continued slumping. Clay layers at the base of the slump are lubricated by water facilitating slide rotation. This may be a self-perpetuated process, which may present a local hazard to roads and structures both above and below the slide area.

2.5.2 Indicators

The key indicator to landslides is the timing of spring run-off (Highland 2004). This input may exceed soil drainage capacity resulting in supersaturation of the soil. Soil saturation due to high precipitation rates in the fall may also contribute to increased landslide probability in the spring. Other indicators may be the presence of older preexisting landslides, slumps, the presence of surface cracks and other more nuanced indicators such as leaning fence posts, telephone poles, or trees indicating creep.

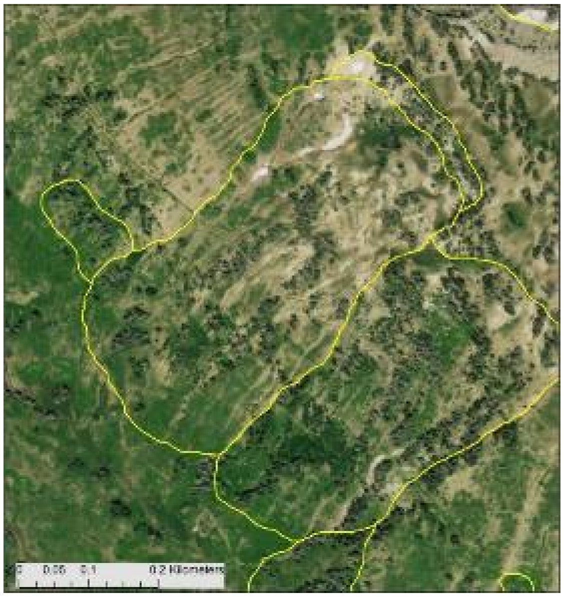
Wildfire results in a loss of vegetation, vegetation canopy, soil surface cover, and the creation of water repellant soils in some ecosystem types (Cannon, 2010; Freidel, 2011). These conditions can cause a significant increase in runoff resulting in rapid erosion, soil movement, and potential landslides.

Road design may not take into account such factors as slope, geology, soil overburden, location of faults, springs, and seeps. Undercutting a steep slope greatly adds to instability by removing the slope's base support. Locating a road in an area of a preexisting water source adds to local instability. Not having properly sized culverts or not keeping culverts clear of debris causes the water to overflow the road and spread out along the slope rather than being confined to the appropriate drainage, which contributes to slope instability.

Over grazing causes loss of vegetation and destruction of roots that bind the soil leading to a loss of natural soil cohesion. Over grazing was so severe in the late 1800s that it was one of the main factors driving the creation of the Manti and La Sal National Forests. Evidence of this past damage is reflected in artificial terraces around some hillsides that were created in an effort to reduce the severe erosion caused by historic over grazing. These terraces are still present today and visible in parts of the Forest. Due to proper range management, the risk of landslides due to grazing has been greatly reduced. The local grazing community has worked closely with the Forest to contribute to these improvements to range management by reducing livestock numbers, constructing and maintaining structural range improvements, helping to implement non-structural improvements (plowing, chaining, re-seeding, etc.) and participating in monitoring activities.

2.5.3 Existing Condition of the Indicators

The Utah Geological Survey (UGS) uses Light Detection and Ranging (LiDAR) techniques to identify and refine landslide boundaries on the North Zone of the Forest. An aerial image of landslide area and a LiDAR image of the same area are shown in Figure 5.



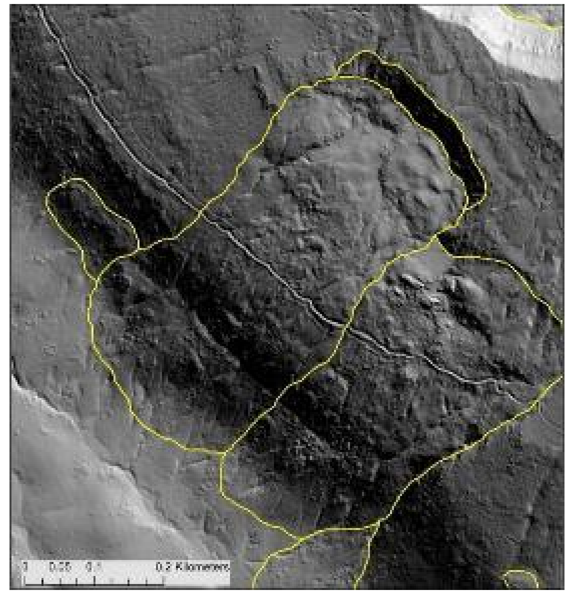


Figure 5. Two images of the same area mapped for landslides, image on the right is using LiDAR.

The Forest has acquired the most recent landslide data from the UGS to update the Forest landslide hazard risk map. This data will be used to understand the condition of the existing indicators, which is the most recent landslides that have occurred on the Forest.

In the South Zone, much of the Forest is within igneous rock (La Sal Mountains and Abajo Mountains, diorite porphyry). This area is more prone to rock slides and falls in the central igneous zone. The geological formations flanking the laccolithic intrusions of the La Sal and Abajo Mountains are also prone to landslides. The upper shale members of the Triassic Moenkopi Formation are often associated with landslides. Forest road 0088, near the Notch-Elk Ridge area of the Monticello District is often in need of repair due to the continuous landslides associated with this formation.

2.5.4 Management Tools

The landslide risk map is a useful tool in project planning where landslide risk is a concern, for example, planning vegetation management and road and facility location and design (UGS 2011). However, the landslide risk map is only as good as the data put into it, therefore, it must be updated routinely for it to be effective.

2.5.5 Stressor Accumulation

Stressors can act together to create a greater likelihood of landslides, for example, fire scarred landscape in addition to heavy winter snow and quick spring warm-up accompanied by rain in a susceptible geologic formation would produce greater risk.

2.6 Insects and Diseases

2.6.1 Stressor or Driver Description

Endemic levels of insect and disease species are natural drivers of vegetative patterns and dynamics. All diseases currently active on the Forest are native pathogens and could be considered endemic. To a different extent, both endemic and epidemic populations of native forest insects can affect important ecosystem processes, such as the allocation of water and nutrients within a stand or a watershed, as well as forest structure and composition (Collins et al. 2011, Mikkelson et al. 2013). Insect and disease epidemics can result in extensive tree stress and mortality. Suitable stand structures and sufficient amounts of preferred host vegetation must be available in a forested ecosystem to accommodate epidemics.

Depending on the magnitude, frequency, and intensity, insects and diseases can stress both host and non-host vegetation and reduce the capability of forests to provide ecologic and resource benefits. Although large scale host mortality caused by insect and disease epidemics are natural events, the cumulative effects of those events in addition to their interactions with other disturbance factors can lead to undesirable impacts. These impacts are expressed in terms of both short and long term effects.

Increased drought severity and frequency increases a tree's vulnerability to both direct (reduced growth and mortality) and indirect (insect outbreaks, pathogens and wildfire) impacts (Schlesinger et al. 2016, Dale et al. 2001, Weed et al. 2013). For example, bark beetle-caused tree mortality combined with decades of fire suppression can result in fires that are both geographically larger than normal and more intense. Changes in disturbance patterns could increase forest canopy gaps and promote desired and undesired (invasive or non-native) species colonization.

2.6.2 Scale

LTA and vegetation communities are the spatial scales used for analysis of forest insects and disease. The temporal scale refers to the mean number of disturbance events per time period within a specified area. For this assessment the temporal scale is from 1991 to 2016 or 25 years.

2.6.3 Existing Conditions of the Indicators

Douglas-fir Beetle

- Douglas-fir beetle: Douglas-fir dry mixed conifer vegetation type = 106,133 acres; aspen and mixed conifer type = 342,739 acres

Douglas-fir beetle is the most destructive bark beetle affecting this tree species in western North American forests. At endemic levels, this bark beetle infests scattered trees of low vigor and poor health. In drought conditions, Douglas-fir beetle outbreaks may be prolonged for several years. Catastrophic events, such as fire, wind throw, and avalanche, may have led to exponentially expanded populations (Kegley, 2011).

Mountain Pine Beetle

- Mountain pine beetle: limber and ponderosa pine; dry mixed conifer vegetation type = 106,133 acres; aspen and mixed conifer type = 342,739 acres

Mountain pine beetle (MPB) is the most destructive bark beetle affecting pines in Western North America. MPB has recently expanded its range, due to changes in climate (Bentz et al. 2010). On the Forest, most of the recent MPB-caused mortality has occurred in limber pine. The loss of mature limber pine would impact many values associated with high elevation, five-needled pine forest and the return to mature forest conditions following outbreaks may take up to 1,000 years. The loss of mature limber pine has and will continue to modify stand and age-class structure and species composition. While large diameter limber pine is still represented across the Forest, current size class distributions indicate a trend toward preferred host size/diameter classes for MPB (Malesky 2016). In addition, forest resource inventory data indicates that much of the ponderosa pine type can be rated at moderate to high hazard levels for mountain pine beetle (O'Brien and Woudenberg 1998).

Pinyon Ips

- Pinyon Ips: pinyon pine in the dry mixed conifer vegetation type = 106,133 acres; woodland vegetation type = 264,737 acres

Pinyon Ips populations persist in pinyon-juniper woodlands by attacking damaged or stressed host trees. Endemic or low populations of this insect are associated with top-kill, branch mortality or kill widely scattered single trees or small groups of trees numbering less than ten. Often these trees have been previously damaged by wind, snow, fire or lightning. In a drought triggered outbreak, landscape scale mortality can occur in stands affected by drought and other stress factors (Shaw et al. 2005).

Aspen Decline

- Aspen decline: aspen and mixed conifer type = 342,739 acres

Aspen dieback and decline have been noted since the 1970s, but recent widespread mortality has led to increasing interest in the status of aspen forests. Increasing dieback and decline was reported across the western United States following a drought from 2001 to 2004. Mortality rates peaked in 2007 and 2008 and have since returned to pre-drought levels. The agents involved in dieback and decline vary depending on location but tend to be a complex of wood boring beetles and canker diseases in Utah (Guyon and Hoffman 2009). The increases in damage are occurring alongside changes in aspen ecosystems due to intense wildlife, domestic grazing pressure and climatic change. The approach to aspen ecology has recently experienced a paradigm shift (Rogers et al. 2014). The commonly held view that fire suppression caused most of the changes affecting aspen health has come into question. Aspen ecology and disturbance patterns are complex, and the functional type should drive decisions about aspen status and management. For example, stable (nearly pure) aspen is much less conducive to wildfire or prescribed burning; regeneration in these forests is dependent on gaps created by continuous, low-level tree mortality.

Spruce Beetle

- Spruce beetle: Engelmann spruce, (rarely, recent regional occurrences); spruce/fir vegetation type = 54,754 acres

Several stand and environmental conditions clearly contribute to outbreaks. First, stand conditions must be conducive; that is, basal area greater than 150 square feet per acre and average stand diameter greater than 16 inches with greater than 65 percent spruce in the canopy (Munson 2001). Additionally, disturbance history and climatic conditions, such as increasing summer temperatures and reduced precipitation, also play a role in the expression of epidemics (Bentz et al. 2010).

Western Spruce Budworm

- Western spruce budworm: Douglas-fir, white fir in the dry mixed conifer vegetation type = 106,133 acres; blue spruce, subalpine fir, and Engelmann spruce in the spruce/fir vegetation type = 54,754 acres

Western spruce budworm (WSBW) is considered one of the most widespread and destructive defoliators in western coniferous forests, particularly where Douglas-fir and true firs are the primary tree species in a stand. The life history requirements for WSBW are highly interdependent upon forest-stand structure and conditions. Multi-age, multi-level forest canopies in stands dominated by host trees, on the Forest these are Douglas-fir; they provide optimal WSBW habitat. The timing and duration of WSBW outbreaks is highly variable and depends on environmental and biological conditions. The periodicity and duration of outbreaks can range from

2 to more than 35 years. Some of the most important impacts of WSWB defoliation are tree mortality, rotation delays, and increased susceptibility to secondary insects and disease (Giunta et al. 2016).

2.6.4 Trends

Douglas-fir Beetle

Tree mortality increased 150 percent in 2014. Numerous pockets of mortality were detected throughout the type on the western slopes of the La Sal and Abajo Mountains. In the North Zone, Sanpete, Ferron, and Price Ranger Districts, a 76 percent increase in Douglas fir beetle-caused tree mortality occurred from 2013 to 2014 (ADS, 2014). This mortality is recorded as numerous small (less than 10 trees) to large-sized pockets (>50 trees) across the western Wasatch Plateau. There is a cyclical trend in mortality, possibly related to episodes of drought stress as shown in Figure 6.

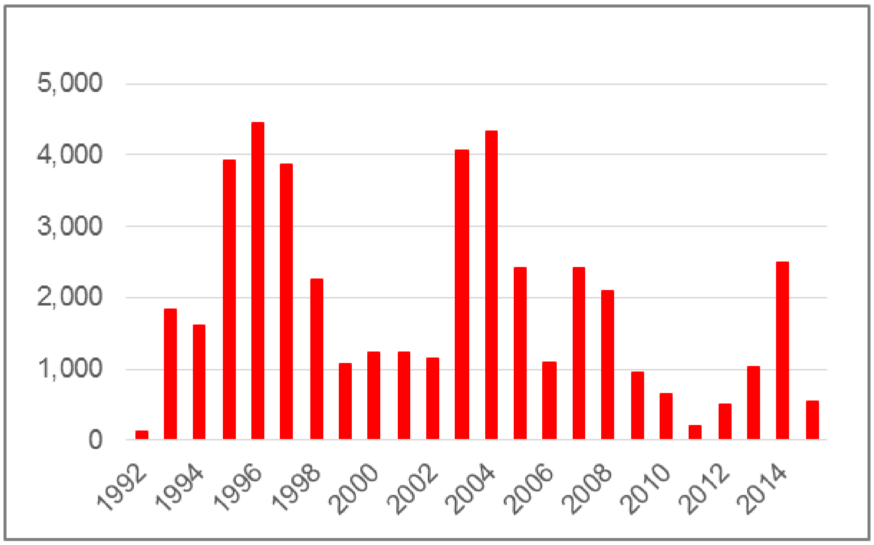


Figure 6. Acres of Douglas-fir beetle damage 1992 to 2015.

Mountain Pine Beetle

Mountain pine beetle has caused significant limber pine mortality on the Wasatch Plateau in southcentral Utah since 1999. Sanpete and Ferron Ranger Districts have the most recorded mountain pine beetle-caused mortality. Field observations and data indicate that mountain pine beetle-caused mortality has declined. Susceptible pine still occurs in all limber pine sites, those that are dry mixed conifer vegetation type, and additional mortality is anticipated. Tree mortality has modified stand and age-class structure in several stands and altered the amount, composition, and arrangement of living and dead biomass in both the pine and mixed conifer communities inventoried (Malesky 2016). Mountain pine beetle is not currently active on the Forest in ponderosa pine, but forest inventory data indicates that many stands are at moderate to high hazard levels as shown in Figure 7 (O'Brien and Woudenberg 1998).

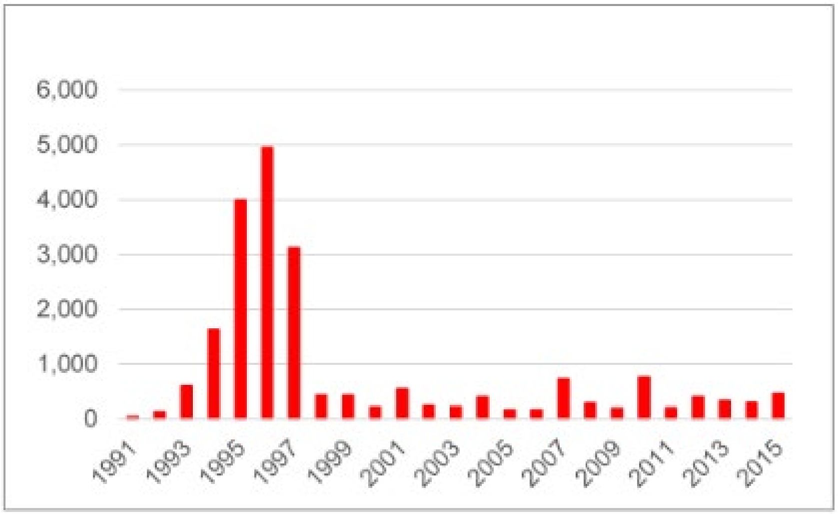


Figure 7. Acres of mountain pine beetle damage 2002 to 2014.

Pinon Ips

Drought combined with outbreak Pinyon Ips populations contributed to considerable pinyon pine mortality from 2003 to 2005 (USDA 2012). Pinyon Ips populations have been and continue to be most active on the Moab and Monticello Ranger Districts. Fuel reduction treatments have been focused in this type, which may affect susceptibility in treated areas. Currently, mortality caused by this insect is relatively low as shown in Figure 8.

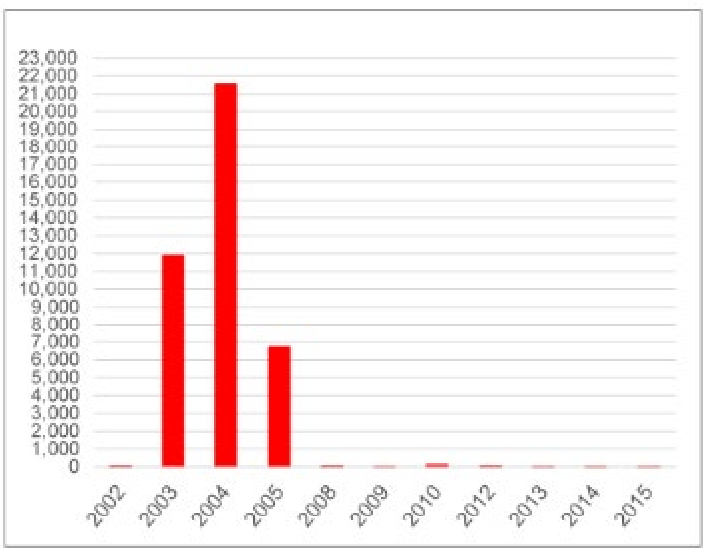


Figure 8. Acres of pinyon ips damage 2002 to 2014.

Aspen Defoliation and Decline

Increasing symptoms of dieback and decline were recorded following a drought from 2001 to 2004 that peaked in 2007 to 2008. Subsequent symptoms and mortality rates have since returned to near pre-drought levels. The agents involved in dieback and decline varied depending on location but tend to be a complex of wood boring beetles and canker diseases (Guyon and Hoffman 2009). Figure 9 shows the acres of aspen affected by defoliation and decline between 1997 and 2015.

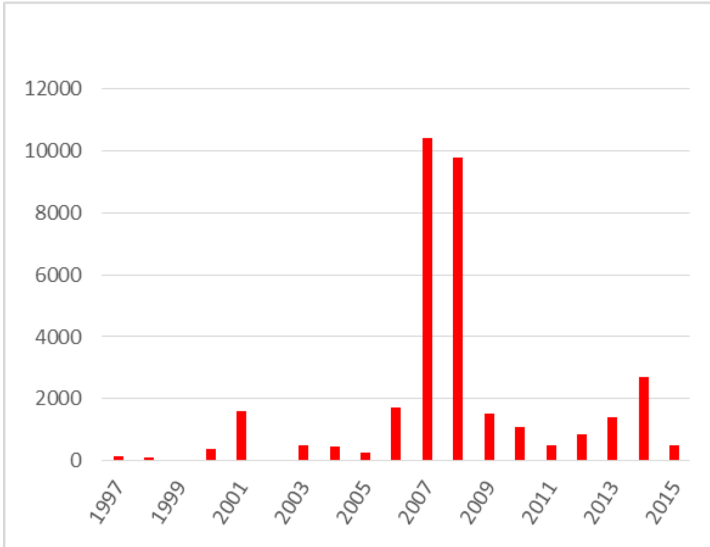


Figure 9. Acres of aspen affected by defoliation and decline 1997 to 2015.

Spruce Beetle

In the spruce/fir vegetation type on the Wasatch Plateau, spruce beetles killed more than 90 percent of Engelmann spruce greater than 8 inches in diameter between 1991 and 2015. This mortality affected approximately 47,983 acres of the spruce-fir vegetation type. Figure 10 shows the annual amounts of spruce killed by spruce beetle during that time period. Decreases in spruce mortality following 2001 are due to the decreased availability of susceptible spruce.

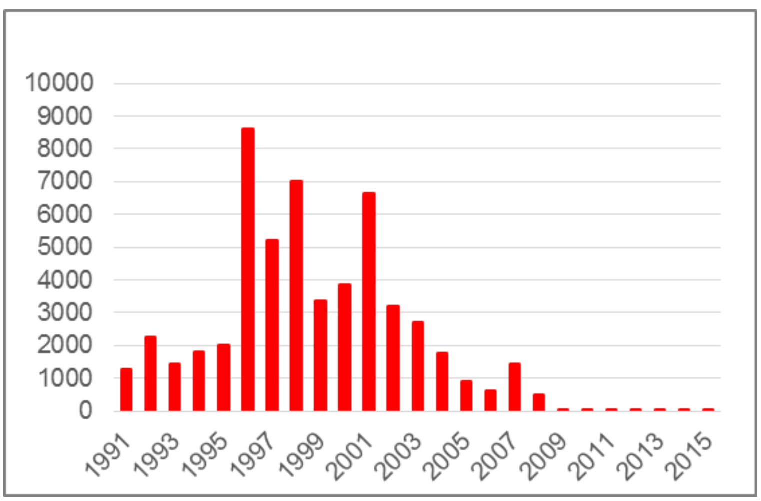


Figure 10. Total acres of spruce beetle damage 1991 to 2015.

Western Spruce Budworm

Before 2014, western spruce budworm activity has been low. Recently, surveys show that western spruce budworm have increased. In 2014, almost 6,000 acres were defoliated, particularly in Douglas-fir on the Forest as shown in Figure 11. Most of the activity is on the Ferron, Price and Moab Ranger Districts. In 2015, the defoliation fell back to slightly over 1,000 acres defoliated, at varying intensities.

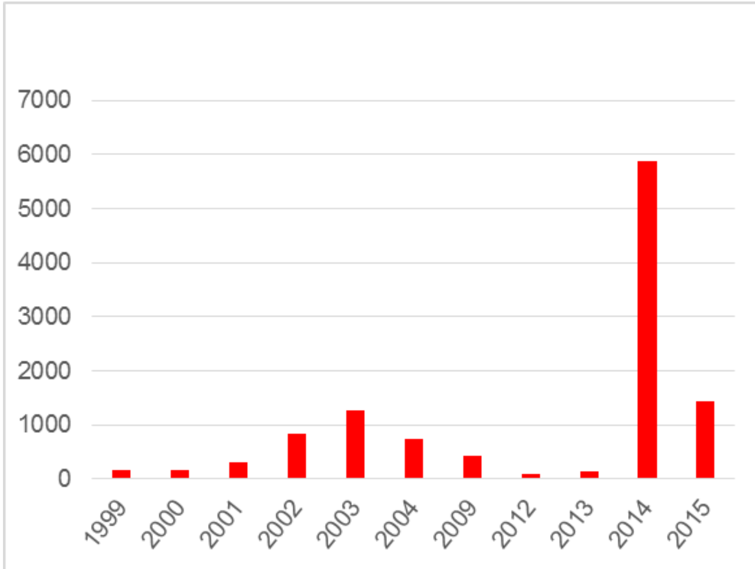


Figure 11. Total acres of Western spruce budworm damage 1999-2016.

2.6.5 Management Tools

Prevention treatments or indirect control are generally associated with silvicultural practices to modify stand and host type/vegetation conditions, so they are no longer favorable to insects and disease. Prevention treatments are most effective before insects or diseases reach unmanageable outbreak levels. If insect or disease frequency builds to damaging levels, suppression strategies (or direct control) may be necessary.

Thinning tree stands is the preferred strategy for bark beetle management in Western forests (Fettig et al. 2007, Goyer et al. 1998). Thinning effectively reduces a particular host resource base that supports bark beetle populations, reduces competition for water and nutrients, and disrupts the effectiveness of pheromone communication. The higher temperatures in thinned stands also reduce beetle survival and alter attack behavior of the insect (Schowalter et al. 1992, Amman et al. 1998, Schmid and Frye 1977, Sartwell and Stevens 1975).

Site specific management actions (direct control) can reduce insect populations and levels of disease, particularly if treatments encompass the infested or affected area and are timed appropriately. Suppression treatments to protect high value trees or sites including the use of insecticide or pheromones are limited in scope due to costs, access and resource objectives. Environmental concerns and treatment costs often limit suppression alternatives to smaller affected sites. Vegetative treatments, such as sanitation, that do not modify stand conditions conducive to insects or disease often result in short term benefits. Restoration activities following outbreaks may mitigate vegetative change or loss and promote the growth of desired species.

2.6.6 Stressor Accumulation

Climatic variability can alter patterns of disease distribution and abundance through: (1) direct effects on development and survival of a pathogen, (2) physiological changes in tree defenses, (3) indirect effects on abundance of natural enemies, mutualists and competitors, (4) interactions with other disturbance agents such as fire, and insects (Guyon IAP). Climate change will affect pathogens, hosts, and their interaction;

changes in these interactions may become the most substantial drivers of future disease outbreaks. Some diseases may be considered damaging only under certain climatic conditions, and one of the key triggers is the onset of drought (Guyon IAP).

Large and consistent decreases in snowpack have been observed throughout the western United States between 1955 and 2015 (EPA 2015). Because insect species, in general, have relatively short life cycles, high reproductive capacity and high degree of mobility, the physiological responses to warming temperatures can produce large and rapid effects on species population dynamics (Stange and Ayres 2010).

2.7 Invasive Species

2.7.1 Stressor or Driver Description

Invasive species are non-native to an ecosystem including plants, animals, and other organisms. Invasive species are not the same as noxious weeds, although many noxious weeds are invasive. Invasive fish or wildlife species and disease may affect native wildlife species by directly competing for food or habitat, reducing reproductive success, or increasing mortality. The introduction and spread of aquatic invasive species can have significant adverse impacts on native fish species and harm aquatic ecosystems. In some cases a non-native species may be introduced into a system to achieve a management goal, but impacts of this species must be monitored to ensure no long-term habitat degradation occurs. One such example is the mountain goat introduction to the La Sal Mountains.

Both noxious weeds and non-native invasive plants are considered opportunistic species that flourish in disturbed areas and prevent native plants from establishing. Generally, these effects are greatest when disturbance is high and site conditions are poor. Non-native, invasive plants may spread aggressively and out-compete native plants and reduce overall native community biodiversity. There is considerable evidence suggesting that future climate change will further increase the likelihood of invasion of forestlands and rangelands as well as the consequences of those invasions.

2.7.2 Indicators

The indicator used to measure invasive plants is number of inventoried acres monitored. Inventoried acres may not necessarily represent all acres with invasive plants species and also considers only noxious weeds. The indicator used to measure aquatic invasive species is the presence of species on the Forest. The indicator for invasive wildlife species is presence/absence by LTA. The number of honey bee apiary permits issued could be used as an indicator of potential exposure. The Forest currently does not issue apiary permits pending finalization of a pollinator study initiated in 2015.

2.7.3 Scale

LTAs and vegetation types are the scales used in analyzing invasive species. Aquatic invasive species are identified by watershed boundaries.

2.7.4 Existing Condition of the Indicators

Invasive plants impact many habitats, especially in the lower elevation and boundary areas in the La Sal Mountain borderlands, Mancos Shale lowlands, Abajo Mountain alluvial plains, and Sevier-Sanpete Valleys. In some lower elevation pinyon juniper and sagebrush habitats, cheatgrass has invaded in areas that have experienced a disturbance which reduced the amount of desirable perennial species and thus created conditions that were more favorable to cheatgrass invasion. Trace amounts of cheatgrass (less than 5 percent cover) generally do not impact the natural plant community, however higher amounts can increase fire frequency and size by providing continuous fine fuels (University of Wyoming 2013). Other common invasive plants such as musk thistle, Canada thistle and knapweed reduce the production and availability of desirable forage for wildlife, including mule deer, greater sage-grouse and Brewer's sparrows. Based on the most current Forest data, there are 22,000 acres (about 15,900 is within the Forest and about 6,300 outside the Forest) that are infested by invasive species, which represents less than 2 percent of the Forest. In 1986, six invasive species were identified in the Forest Plan, although nine were actually reported. By 2016, that number has risen to 14.

Currently, there is limited information available on aquatic invasive species on the Forest. Occurrences of aquatic invasive species have been contained in the watersheds that they were found within; working with the partners has been a key to this success. At least 10 years of fish surveys, aquatic invasive species information, and amphibian surveys from the Utah Department of Wildlife Resources emphasize the importance of prevention and early detection and rapid response to aquatic invasive species.

Invasive terrestrial wildlife species that occur on the Forest include Eurasian collared dove, European starling, house sparrow, bullfrog, and house mouse. These species may have adverse impacts due to high populations, which can affect the breeding success of native species or spread disease. At the current time, there are limited populations of these species on the Forest, generally in association with human development, inholdings, and altered ecosystems adjacent to the Forest boundary. Increased human development and use could cause an increase in numbers which result in detrimental impacts on native species. The establishment of brook trout has led to the decline of native cutthroat trout populations. Emerging aquatic invasive species include animals such as zebra and quagga mussels, plants such as Eurasian watermilfoil, or pathogens such as whirling disease.

Introduced pathogenic organisms, including fungi, viruses and bacteria, have the potential for direct adverse impacts to wildlife populations. In addition, aquatic invasive organisms such as *Chytrid* and whirling disease, has negatively impacted native trout., Other invasive pathogens include West Nile virus that affects birds, and chronic wasting disease that affects native ungulates. White-nose syndrome, very harmful to bats, has not been identified yet in Utah or Colorado, but is spreading across the country. Sylvatic plague, carried by fleas, can decimate prairie dog colonies.

2.7.5 Trends

Eurasian collared doves have increased dramatically in the national, regional, and Utah survey trend estimates (Sauer et al. 2017). This species, associated with urban and suburban areas adjacent to the Forest boundary and avoids heavily forested areas (Romagosa 2012). It remains undetermined what effects the Eurasian collared-dove will have on native species such as the mourning dove (Romagosa 2012).

Data on European starling show a small decrease in survey trend estimates across Utah for this species from 1966-2015 (Sauer et al. 2017). House sparrow populations show a small increase in the survey trend estimate across Utah from 1966-2015 (Sauer et al. 2017).

Most of the weeds inventoried are near highways or main roads. Weeds tend to establish in disturbed areas such as road shoulders and ditches. Roads and motorized trails are known to be effective vectors for transporting invasive plant seeds. Since the 2006 inventory, new species have been located on the Forest, which indicates that invasive species are continuing to grow and spread.

Natural and human-caused disturbances, such as fire, landslides, logging, and road building, alter resource availability in forests by opening canopies, reducing above- and below-ground competition, exposing mineral soil, or by directly increasing resources available to invasive species. (Kerns and Guo 2012). Most invasive species reach new regions by purposeful or accidental human-aided transport, and tourism and commerce are likely to be altered by future climate change (Hellman et al. 2008).

Cheatgrass is one of the most common and aggressive invasive weeds in the Western United States. Cheatgrass occurs in mostly lower elevation areas on the Forest and generally in sagebrush, mountain brush, and pinyon-juniper. On the Forest, cheatgrass is mainly found in areas that have been disturbed such as roadways, trails, reservoirs, communication sites, corrals, water troughs, campgrounds and dispersed camping sites, and mining sites. The 1986 Forest Plan does not mention cheatgrass and only addresses noxious weeds and poisonous plants; however, there is range trend data that goes back to the 1960s that recorded the presence and relative amount of cheatgrass at study sites, which could give an idea of trend of cheatgrass invasion. The Forest has generally not targeted cheatgrass as a species to inventory and treat them as noxious weeds that are listed on the Utah and Colorado State Noxious Weed lists.

Bradley (2009) developed a model to predict how the distribution of cheatgrass may change with a changing climate. She found the summer, annual and spring precipitation have a strong influence on cheatgrass distribution. Depending on the projection used, summer precipitation was projected to either decrease by as much as 47 percent or increase by as much as 72 percent. Under the scenario of decreased summer precipitation, cheatgrass is favored and is predicted to expand. A scenario with low spring precipitation and higher summer precipitation predicts contraction of cheatgrass distribution. Specific to the southern part of Utah, Bradley states: “Portions of southern Nevada and southern Utah are the most likely areas to become climatically unsuitable under the climate scenarios tested.”

2.7.6 Management Tools

- Education related to identification of invasive species, presence of invasive species and ways to prevent spread of invasive species.
- Clean boots, boats, tires and other equipment used outdoors.
- Require washing stations for fire and vegetation management activities. The Forest requires washing stations for any large fire where water will be transferred from one location.
- Prohibit release of non-indigenous species.
- Grazing management
- Weed treatment
- Require use of weed-free hay on the Forest.
- The Forest is included in Cooperative Weed Management Areas, which allows combination of Forest efforts with local, county, and state agencies to treat and identify noxious weeds.
- Early detection and rapid response systems could consider how climate change may alter invasion patterns in the future. Closely monitoring the directional spread of introduced species under climate change could help identify the potential of future spread for the many species with a relatively restricted distribution in their nonnative range.
- Should apiary permitting become feasible in the future, hive placement will follow best management practices.
- Seeding with native seeds and desirable non-native seeds where needed.

2.8 Recreation

2.8.1 Stressor or Driver Description

Increasing human populations in Utah and increasing tourism to Utah are contributing to increasing use of the Forest for a multitude of consumptive and recreational uses.

2.8.2 Existing Condition of the Indicators

Increased demand for recreation

Outdoor recreation is extremely popular and important to people living near the Forest and to visitors. The Utah Statewide Comprehensive Outdoor Recreation Plan (Utah State Parks, 2013) states "Outdoor recreation in Utah is extremely important throughout the state. Public opinion surveys show that about 50 percent or more of residents in each area of the state rate recreation as "Extremely Important." Most residents travel more than 25 miles to participate in recreational activities, indicating that recreation on the Forest is "worth the drive."

Recent technological changes that impact recreation use on the Forest include: the popularity of wider utility terrain vehicles, many of which are not allowed on Forest trails designed for vehicles 50 inches or less; lighter, more powerful snowmobiles and motorized snow bikes that can reach areas once never considered accessible to vehicles; and lighter mountain bikes with high-quality suspension and wide tires allowing mountain bikes to travel in terrain once impassable. Another change in technology impacting the amount of use and altering use patterns is the availability of information on the Internet and the popularity of social media. Directions to areas that were once well kept secrets are now being published online and marketed. This information has led to increases in use to sensitive areas such as remote cultural sites and sensitive riparian areas.

With increased use, changing technologies, and more specified expectations, an increase in user conflicts is also evident. Popular mountain bike trails on La Sal Mountain, which experiences high levels of use, are becoming difficult for hikers and equestrian users due to conflicts with heavy mountain bike use. An increase in motorized (snowmobiles and snow bikes) and non-motorized winter uses (cross country and backcountry skiing and snowshoeing) is leading to conflicts between those seeking solitude and quiet and those wanting more motorized recreation opportunities. Motorized vehicles and utility terrain vehicles are routinely used by the majority of hunters, conflicting with those seeking a more traditional experience (foot and horseback).

Motorized Use

Motorized recreation use has grown exponentially since the Forest Plan was written in 1986. According to the Institute of Outdoor Recreation and Tourism, the use of off-highway vehicles (OHVs) for recreation and other outdoor activities has exploded in popularity over the past two decades. The number of registered OHVs in Utah more than tripled in 8 years, from 51,686 in 1998, to 172,231 in 2006, a 233 percent increase (Smith, Burr, Reiter, Zetlin, 2009). This use peaked at 232,000 and has since declined to 187,000 in 2015 (Haller, 2016).

Concurrent with the increase in registered OHVs, an increase in new trail construction has occurred to manage motorized use demands. Unauthorized user-created motorized routes have increased dramatically. Currently, there are 3,418 inventoried unauthorized routes across the Forest totaling 1,008 miles.

New trails constructed since 1986 when the Forest Plan was put into place, include 53 miles of motorized trail, all within the North Zone, 39 miles of non-motorized trails all within the La Sal Loop/Moab Front area of the South Zone, and 27 miles of non-motorized trails on the North Zone. It is projected that future new trail construction will be restricted to key connections forming loops and reconstruction following major disturbances, such as the 2012 Seeley Fire. Emphasis will instead be placed on maintaining and improving the existing trail system and right-sizing the existing system including decommissioning trails or managing them as primitive routes with minimal or no maintenance.

Non-motorized trail use has grown substantially since 1986. The most heavily used non-motorized trail on the Forest is the Whole Enchilada Mountain Bike Trail in the La Sal Mountains. Trail register data for the Hazard County and Burro Pass Trailheads, which are the two upper most access points for the Whole Enchilada Trail were compiled for the Moab Non-Motorized Trail Project in 2013. From 2008 (when the trail was authorized) to 2013, approximately 430 people registered per year at the Hazard County Trailhead with 95 percent of the use being mountain bikers. Approximately 228 users per year registered at the Burro Pass Trailhead with use of those registering at approximately 50 percent foot travel and 50 percent mountain biking. The numbers of users actually registering on this trail is very low compared to actual use numbers, since few people register at the trailhead.

The majority of use along the Whole Enchilada Trail is associated with one of the authorized shuttle companies operating on the Forest. Approximately 80 percent of mountain bikers on the trail use one of the shuttle companies. This commercial use has seen a steady increase since completion of the Whole Enchilada Trail and is a better indicator of usage on the trail than the voluntary registration numbers. Authorized shuttle companies reported shuttling 1,506 mountain bikers to the Whole Enchilada Trail in 2008. In 2012, reported use had risen to 4,065, with 4,575 users in 2010.

In 2014, reliable trail counters were installed on the Whole Enchilada Trail at the Hazard County Trailhead. In 2014, the counters showed that 9,396 mountain bikes used the trail and in 2015, 9,919 bikes came through. In 2015, an additional counter was added to the trail lower down and 12,781 mountain bikes were counted using the trail during that year.

Recreation Special Uses

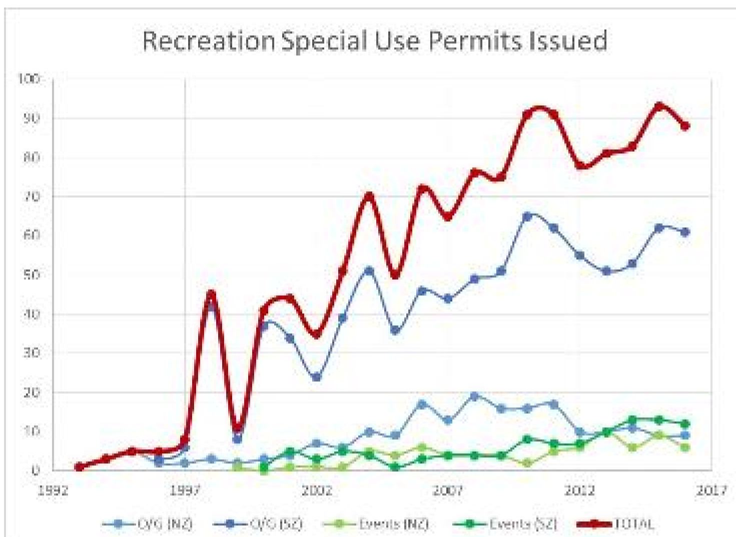


Figure 12. Recreation special use permits, including both outfitter and guide permits as well as recreation event permits 1992 to 2017.

Commercial outfitting and guiding companies operate on the Forest under special use permits. The number of permits provide information on the recreation demands from increasing populations. Special use permits have been issued since the 1990s in two primary categories relevant to recreational users: outfitting and guiding services and recreational events. The trend in numbers of permits issued annually is shown in Figure 12.

Records of permits issued for these purposes indicate a strong increase in outfitting and guiding permits with the bulk of the increase occurring on the South Zone between 2000 and 2010. In 2000, the number of recreation permits issued was 41, by 2010 it had risen to 91 and has continued to increase. The number and types of recreation special use permits vary greatly between the North and South Zones. Permits on the North Zone primarily consist of hunting guides along with climbing and outdoor schools. Permitting on the South Zone is driven by the tourist economy centered in Moab, Utah. Permits for the South Zone include motorized jeep and OHV tours, mountain biking guides and shuttles, climbing, backcountry skiing, horseback riding, hiking, hunting, and wilderness oriented backpacking.

The Forest prepared a Needs Assessment for Recreation Special Use Permits in 2012 and 2013. During preparation of the Needs Assessment, a moratorium on new outfitting and guiding permits was put in place. The moratorium accounts for the reduction in permits during those years as some permit holders did not renew their permits and no new permits were issued. The moratorium was lifted on most permits (except for hunting guides, commercial use in the Dark Canyon wilderness, and mountain biking in the Geyser Pass Use Area) once the Needs Assessment was prepared.

2.8.3 Trends

Visitor Use

The use of developed group sites as well as large dispersed areas for family reunions is experiencing significant growth. These gatherings often exceed 50 people and commonly occur for 2 to 3 days. While data on overall visitation to the Forest is not reliable, data on campground reservations, specific trail and road use numbers, and the number of commercial recreation permits show increases in use.

In addition, to overall recreation use on the Forest increasing, users are expecting more diverse and specific recreation opportunities. Trail users expect specific types of trails such as single track mountain bike trails designed specifically for mountain biking. Utility terrain vehicle and OHV riders expect trails wide enough for their specific type of vehicles. Winter users expect motorized and non-motorized uses to be separated to reduce conflicts with their chosen recreation pursuit.

Climate Change

Potential impacts from climate change may exacerbate the impacts of increased recreation demand. Current climate change models predict that the Forest may begin to experience shorter winters and that the residence time for snow may decrease; meaning a reduction in both season and land area suitable for snow-based winter recreation. As the winter season shrinks, more people may expect recreation facilities to open earlier and stay open longer.

Developed Recreation Facility Water Systems

Drinking water systems in developed recreation sites are impacted by increased Forest use. Water systems require a significant investment to operate and maintain each year. Some systems are necessary to operate rental cabins and campground infrastructure. Drinking water systems serving recreation facilities on the North Zone have decreased from 13 to 7 since 1986. In the South Zone, drinking water systems have been reduced from 6 to 4. Probable reductions in winter snow accumulation has the potential to affect groundwater recharge and output from the spring sources now supplying culinary water. The trend of decommissioning water systems is expected to continue, due primarily to high costs of operation and maintenance.

Campground Reservations

Of the 40 developed sites on the forest, 27 accept reservations. A measure of the growth in recreational users can be gathered by examining campground reservation data at recreation.gov. Annual data was pulled for May 1 through September 30. This data does not include walk-in use or the 12 campgrounds on the Forest that do not accept reservations. In 8 years, from 2008 to 2016, the number of reservations has shown a significant increase indicating that there is growth with regard to recreational overnight demand on the Forest. This trend is shown in Figure 13.

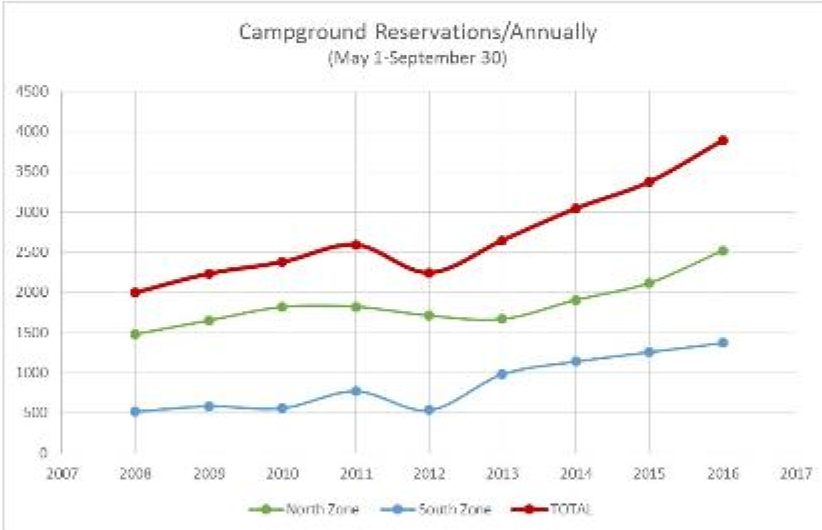


Figure 13. Campground reservation from 2008 to 2016.

2.8.4 Management Tools

- Construct additional group site capacity
- Contain and improve high impact dispersed campsites
- Expand and improve trailhead facilities
- Include additional facilities in the Recreation Enhancement Act (REA) program
- Implement travel analysis plan (TAP) recommendations
- Close and decommission unneeded developed sites as per 2013 Recreation Facility Analysis
- Determine critical water systems in developed recreation sites to retain for public use; decommission other systems
- Close and rehabilitate unauthorized user created trails.
- Widen OHV trails to allow use of side by side OHVs.
- Limit commercial recreation use/outfitter and guides
- Separate incompatible recreation uses and designate trails and areas for specific recreation opportunities
- Manage recreation use through permit systems

2.9 Access

2.9.1 Stressor or Driver Description

The primary areas of focus for access are: providing an adequate road system to meet the needs of the public recreation and multiple uses; maintaining the road system to standards with a limited and decreasing budget; minimizing impacts to natural resources including wildlife and fish habits and municipal water supplies resulting from soil erosion.

2.9.2 Indicators

There are 4,162 miles of road on the Forest's designated road system. There are 418 miles of maintenance level 1 roads that are closed to motorized use, 2,607 miles of maintenance level 2 roads that are maintained for high-clearance vehicles, and 1,136 miles of maintenance level 3 and 4 roads that are maintained for standard passage cars during usual seasons of use.

2.9.3 Existing Condition of the Indicators

Table 7 shows the miles of road on the Forest by ranger district.

Table 7. Miles of road on the Forest by lumped ranger districts.

Ranger District	Miles of Road
Ferron/Price	349
Moab/Monticello	1057
Sanpete	896

2.9.4 Trends

It is expected that the Forest's road system will see a decline in road condition due to a large backlog of deferred maintenance and funding levels decreasing. As a result of decreasing budgets, routine maintenance is reduced, maintenance cycles are extended, and selective repairs are made to ensure public safety and prevent significant resource damage. Over time, roads may develop severe public safety or resource damage issues and may need to be evaluated for closure.

The 2005 Travel Management Rule (36 CFR 212, Subpart A) requires forests to identify the minimum road system necessary for management at the Forest level. The recommended minimum road system is evaluated through a Travel Analysis Process and documented in a Travel Analysis Report. The Forest completed the Travel Analysis Report in 2015 and develops goals each year to conduct NEPA analysis to make changes to the road system to implement the travel analysis recommendations.

Subpart B of the Travel Management Rule requires forests to designate the road system open to motorized use and prohibited to motorized cross country travel off the designated system. The motor-vehicle use map (MVUM) shows the designated road system open to motorized travel. The MVUM is legally enforceable. The Forest has an MVUM and publishes an updated version each year.

2.9.5 Resources Affected

Fisheries are affected by roads, primarily through sedimentation from runoff. Sedimentation can enter streams that can affect water quality and watershed health. Roads can contribute to habitat fragmentation and increase disturbance to species from noise, dust, and human disturbance. Recreational demand will increase with increased local and nearby urban populations. Roads to access recreational sites will require increased maintenance. Increased interest in cultural sites may result in additional user created roads and looting. Property owners within areas considered to be part of the WUI often make requests for access across Forest Service lands. When wildfires threaten large-scale destruction of private property, millions of dollars are spent defending these private lands and property, and additional pressure is placed on forest management to accommodate the rebuilding process, including road and other infrastructure reconstruction, after damage occurs.

2.9.6 Management Tools

The Travel Analysis Process (TAP) provides management a process for prioritizing and minimizing the extent of roads infrastructure on the landscape. The 2015 TAP recommended a minimum road system that is safe and responsive for public needs, is affordable and efficient, has minimal adverse effects on ecology, and is balanced with available funding. Decommissioning unauthorized non-system and user-created routes is an available management tool.

2.9.7 Stressor Accumulation

Mineral exploration and development is an added need for access as well as increasing populations that will result in increased demand for access and a variety of motorized uses. Observation of access trends and road system changes over time to determine if road densities increase or decrease and monitor the subsequent ecological affects while continuing to implement road operations and maintenance using best management practices.

2.10 Cultural and Historic Resources and Uses

2.10.1 Stressor or Driver Description

The primary drivers affecting cultural resources are climate change, wildfire, and landslides and geologic hazards. These have the potential to affect the condition of sites due increased erosion of archaeological deposits due to more frequent high intensity precipitation, destruction of wooden features from wildfire, increased water and wind erosion after a wildfire, and complete site destruction due to landslides and geologic hazards.

Stressors affecting cultural resources can be divided into ecological stressors and social/multiple use stressors, which the potential to effect the condition of sites due to destruction of features or artifacts (for example, wildfire, illegal road/trail use, and looting), damage to site features or artifacts (for example, livestock and big game over-grazing and illegal artifact collection), or increases in indirect threats to site condition (for example, increased homes in WUI, increased motorized access to sites, and increased mineral exploration or development.

2.10.2 Indicators

Location, number, and types of cultural sites.

2.10.3 Scale

Forest and Ranger District boundaries.

2.10.4 Existing Condition of the Indicators

There are 4,832 documented sites on the Forest, with the majority, about 80 percent, located on the Moab/Monticello Ranger Districts Table 8. Forest sites include a wide range that date from both ancient American Indian and historic European American eras. Ancient American Indian sites include villages, single- and multiple-residential sites, agricultural terraces, check dams, kilns, isolated storage sites (granaries and slab-lined cists), rock art, rock shelters, low stone observation rooms, and artifact scatters. Historic sites include sawmills, mines, livestock camps, and cabins, Civilian Conservation Corp camps, roads and trails, culinary water systems, trans-basin canal systems, and artifact scatters.

Table 8. Documented sites on each district of the Forest.

District	Number of Sites
Sanpete	137
Ferron	708
Price	141
Moab	636
Monticello	3,207
TOTAL	4,829

Forty-three percent of Forest sites for which we have site condition data are in good to fair condition, and 12 percent are in poor condition. The Monticello District has a slightly higher percentage of sites in poor condition. This may be attributed to large numbers of sites on the Monticello District that were badly damaged by Forest vegetation management projects before the 1980s when the National Historic Preservation Act of 1966 required federal agencies to assess the potential effect of undertakings on cultural resources. Most sites on the Forest (71 percent) have been evaluated for their eligibility for listing on the National Register of Historic Places, and 42 percent of that group are eligible. However, large portions of the Forest have not been surveyed for cultural resources so there are many unidentified and potentially eligible sites to be found. Table 9 shows how much of the Forest has been surveyed as of 2016. The two sites currently listed on the National Register are the Great Basin Station on the Sanpete District and the Pinhook Battle Site on the Moab District.

Table 9. Acres and percent of each district on the Forest that have been surveyed through 2016.

District	Acres Surveyed	Percent Surveyed
Sanpete	18,582	8
Ferron	65,074	20
Price	47,582	21
Moab	37,098	22
Monticello	94,990	26

2.10.5 Trends

Implementation of the National Historic Preservation Act of 1966 was a turning point in the condition of sites. Before that time, sites were intermittently damaged or destroyed at the landscape level through chaining, disking, erosion control terracing, and other activities. Permitted activities also impacted large numbers of sites, especially areas such as the uranium mining landscape in South Cottonwood Canyon on the Monticello Ranger District.

Other positive trends that have occurred include technological changes, such as geographic information systems, global positioning systems, digital cameras, light detection and ranging remote sensing, photogrammetry, and other tools. This improved documentation of current and changing site conditions. Increased public education programs on the Forest have increased general knowledge of appropriate site visitation behaviors and result in larger number of site stewards and volunteers participating in survey projects.

Existing and illegal motorized routes across sites are increasing impacts to those sites, even though new road and trail projects avoid direct impacts to sites. Past studies of site vandalism (e.g., Wylie 1989), combined with current observation, indicate that there is a strong correlation between artifact collection and other damage to sites and roads and motorized trails. Recent surveys of roads on the Moab District indicate a high correlation between roads and the presence of collector's piles and scarcity of artifacts at sites adjacent to roads.

There is an increasing trend in the availability of site location information on Web sites. This has led to an increase in visitation to the most sensitive and vulnerable sites, including Ancestral Puebloan sites with standing architecture and extensive middens. Recent monitoring observations of alcove sites on the Monticello District have indicated that recent erosion resulting from foot traffic is exposing a variety of cultural materials including sandals and other perishable materials. Recent firewood piles and hearths are found at some sites, indicating an expansion of visitation into the colder months as winter conditions change on the Forest, particularly on the Moab/Monticello District.

Ancient American Indian sites have considerable traditional value as sources of connection for the modern descendants of ancestral Puebloan, Navajo, and Ute peoples. There has been a trend in the last 20 years toward more tribal involvement in identifying and resolving project effects and in evaluating the value of sites. Three traditional cultural properties have been officially identified on the Forest.

2.10.6 Management Tools

Direct protection actions include:

- Fencing sensitive sites to exclude livestock or ungulates
- Stabilizing walls and archaeological deposits on sites
- Closing or rerouting existing roads/trails that are adversely affecting archaeological sites
- Burying sites exposed in roads or trails
- Installing markers along roads that are bisecting sites that encourage users to stay on the road

Indirect protection actions include:

- Interpretive signs at sites or in areas with sites
- Site monitoring
- Site visitation etiquette training for visitors, youth groups, school kids, etc.
- Partnership and volunteer projects that educate about the value of Forest sites
- Selected surface artifact collection at highly visited sites
- Research projects at sensitive sites, such as collecting dendrochronological dating samples at sites with wooden elements.

2.11 Wildlife

2.11.1 Stressor or Driver Description

By impacting habitat components, people affect an animal's food supply and shelter. In turn, impacts on food and living space influence behavior, survival, reproduction, and distribution of wildlife (Cole and Landres 1995). An increase in the number of people recreating can heighten the affects to wildlife and wildlife habitat in a variety of ways. Direct impacts, such as loss of available habitat, or modification of behaviors, such as reactive flight and altered foraging and reproductive behaviors, can occur. Indirect impacts can also occur, such as habitat change and the introduction of pests, pathogens, and weeds. This increased use can interrupt certain biological functions during critical life stages for some wildlife species. Also, an increase in use may impact habitat directly by the removal of forage, cover, and water as a result of camp-site expansion and an increase in user created trails, which leads to habitat fragmentation.

Some species may tolerate disturbance better than others; however, this depends on the time of year when the disturbance occurs. Larger species, such as elk and deer, may habituate better to noise and traffic during the summer and fall, due to their ability to move greater distances. Elk and deer are more sensitive to disturbance during the spring when calving and fawning occurs and also during the winter months when food is less available, of poor quality, and they are burning through stored fat and losing weight. Smaller animals may be more susceptible at all times because they have smaller niches and are confined to smaller areas where movements are impossible. Additionally, roads and trails result in gaps between suitable habitat locations. Larger gaps result in increased risk for small animals as they move between locations.

2.11.2 Indicators

Habitat quality and habitat connectivity based on road and trail density (miles), unauthorized trail density (miles), and number of Forest visitors are the measures of sustainability of wildlife.

2.11.3 Scale

LTAs, vegetation, and recreation zones are the scales used in analyzing wildlife.

2.11.4 Existing Condition of the Indicators

The Forest is comprised of a variety of vegetation types creating habitat for an array of wildlife species. Vegetation types are broken down into nine categories; alpine, aspen/mixed conifer, barren rock, mixed conifer dry, spruce fir conifer, perennial forb/grasslands, woodlands, riparian wetlands, and sagebrush. Many different types of recreation occur throughout these different vegetation types, whether it is bouldering and rock climbing within the barren rock and cliff habitats, hunting and fishing in the alpine, aspen/mixed conifer, and spruce fir conifer types, shed-antler gathering within the woodlands and sagebrush lands, or motorized recreation.

Roads and trails can affect wildlife habitat quality by fragmenting habitat and, as Forest use increases, disturbance from an increase in traffic on Forest roads and an increase in noise levels in areas may displace wildlife into areas of less optimal habitat. An increase in Forest use is leading to an increase in the development of unauthorized motorized roads and trails across the Forest. These unauthorized roads and trails can reduce the size of refugia for wildlife and can affect habitat quality.

2.11.5 Trends

Motorized recreation use has grown exponentially across the West since the time the Forest Plan was written in 1986. According to the Institute of Outdoor Recreation and Tourism, OHV use for recreation has exploded in popularity over the past two decades. The number of registered OHVs in Utah more than tripled in 8 years from 51,686 in 1998 to 172,231 in 2006, a 233 percent increase (Smith, Burr, Reiter, Zetlin, 2009). This use peaked at 232,000 OHVs and declined to 187,000 in 2015.

Concurrent with the increase in registered OHVs, an increase in new trail construction has occurred to manage the motorized use demands. Unauthorized user-created motorized routes have also increased dramatically. Currently, there are 3,418 inventoried unauthorized routes across the Forest totaling 1,008 miles.

New trails constructed since 1986, include 53 miles of motorized trail, all within the North Zone of the Forest, 39 miles of non-motorized trails all within the La Sal Loop/Moab Front area of the South Zone, and 27 miles of non-motorized trails on the North Zone. It is projected that future new trail construction will be restricted to key connections forming loops and reconstruction following major disturbances, such as the 2012 Seeley Fire. Emphasis will be placed on maintaining, improving, and right-sizing the existing trail system including decommissioning some trails or managing them as primitive routes with minimal or no maintenance.

2.11.6 Management Tools

- Limit campsite expansion by installing barriers.
- Reduce erosion around campsites by hardening sites, close sites impacting fragile ecosystems such as streams and wetlands.
- Close user created trails and multiple access routes to sites.
- Improve trails to reduce erosion.
- Install educational kiosks.

- Designate play areas for motorized recreation, while restricting certain types of use in more sensitive areas.

Tools to improve wildlife habitat include:

- Thinning forests
- Managing the road system
- Using prescribed fire
- Recreation management
- Grazing management
- Educating homeowners about the benefits of thinning in WUI
- Stream improvements, such as woody debris, shade, culverts
- Monitoring sites for climate change effects.

2.12 Groundwater Withdrawals

2.12.1 Stressor or Driver Description

Multiple forms of groundwater withdrawal occur within the Forest. Direct groundwater withdrawals include dewatering of underground coal mining operations and pumping from water wells for municipal culinary water systems. Indirect groundwater withdrawals include the development of springs to supply water systems in developed recreation sites and providing reliable water for livestock use. Surface water diversions from streams and impoundment in reservoirs for use on and off the Forest may locally impact groundwater recharge, by decreasing (stream diversion) or increasing (reservoir), surface water residence time. Ground and surface water may locally form an interconnected system, where effects to one may affect the other. A reduction in available surface water and a commensurate decrease of the recharge rate, may result in local springs going dry as illustrated by seasonal springs. The reverse is also true, as increased surface water increases the recharge rate.

Most springs are sourced by relatively shallow, up-gradient aquifers that are recharged by local seasonal precipitation events. Springs are commonly localized by a combination of subterranean topography (folds, dikes), lithology (permeability, karsting, lithological contact zones), and structural controls (fractures and faults). Larger springs, generally located near the base of the mountains, may be connected to a fault or system of faults and fractures. These structures may extend for a significant distance, enabling them to collect and channel large quantities of water to a distant focal point such as a spring or seep.

2.12.2 Indicators

- Drawdown in aquifers is affected by water withdrawal exceeding recharge. This is estimated by measuring the change in elevation of the potentiometric surface or the water table over time, while allowing for naturally occurring seasonal variations.
- Change in the number of or rate of flow from springs or seeps indicates how natural environmental, or human induced stressors may negatively impact local springs/seeps.
- Changes in water chemistry, such as increases in temperature, alkalinity, and total dissolved solids, indicates how stressors are affecting local water quality.
- Locally decreased flow in surface streams may indicate mining or other stressors such as diversion. However, natural causes, such as earthquakes, may also be responsible. Monitoring the flow in perennial streams acts as a check on whether Forest management practices are effective in protecting these features.

- Condition of riparian and groundwater dependent ecosystems is an indicator of how mining and other stressors are locally impacting these habitats.
- Annual coal mine hydrologic reports to the Utah Department of Oil, Gas and Mining are submitted by each mine. The reports include tabulated quality and quantity data for specific springs, seeps, and surface water features located within the permitted area. These reports also describe water discharges as a result of mine dewatering.
- Points of diversion occur where water is diverted from its natural source for use elsewhere. On the Forest, points of diversion occur from streams, springs, and wells, which is then used for municipal culinary water, irrigation of crops, and livestock grazing.

2.12.3 Scale

Forest boundary

2.12.4 Existing Condition of the Indicators

- Recent hydrologic monitoring reports generated by the mining companies and submitted to the Utah Department of Oil, Gas, and Mining provide a general overview of existing conditions for surface water features within and bounding permitted mine areas.
- Flow records submitted to the Utah Department of Natural Resources by municipalities withdrawing culinary water from developed spring systems within the Forest, provide a long-term data source.
- Meteorological, snow pack, and other hydrologic records, such as stream flow and lake levels collected by various government agencies at the local, state, and federal levels, provides hydrological system input data relative to determining groundwater system recharge rates or potential.
- Streams and associated riparian areas are periodically assessed by the Forest.
- Groundwater dependent ecosystem assessments provide guidance on how to acquire, analyze, and apply groundwater data to inform management decisions.

2.12.5 Trends

Changes in population affect water usage. U.S. Census Bureau data shows that the states of Colorado and Utah experienced population increases of about eight percent between the 2010 census and the estimated population in 2015. Table 10 shows the U.S. Census Bureau population change estimates for the eight counties, six in Utah and two in Colorado, which overlap with the Forest over the same time period. Communities within these counties that have culinary water withdrawal facilities located on the Forest, must increase water withdrawals to accommodate increasing populations.

Table 10. County population change between 2010 census and estimate for 2015 (U.S. Census Bureau).

County	Population Change	Percent Change
Carbon, UT	-1,012	-5
Emery, UT	-617	-6
Grand, UT	326	4
San Juan, UT	493	3
Sanpete, UT	832	3
Sevier, UT	56	0
Mesa, CO	1,302	1
Montrose, CO	-714	-2

Historical climatic and precipitation data may show trends over time. It may be possible to make long-term future projections from these data regarding precipitation and ecological changes. These changes, considered together with projected population growth, could provide future indications of groundwater recharge and withdrawal rates.

Coal is a finite resource. Economically recoverable coal reserves on the Wasatch Plateau are gradually being depleted. Estimates are that by the year 2040, the high-quality reserves will be exhausted (USGS, 1995). However, as the coal mining gradually winds down on the Wasatch Plateau, this may not result in a corresponding reduction in groundwater withdrawal. This is a consequence of not permanently plugging mine portals, which will then continue to hold the mine water underground rather than restoring some springs that were previously affected. Conversely, mine water discharge is mandated to be treated and disposed of through other means, such as discharge into a nearby creek, which removes water from perched aquifers and results in a slow recharge rate. This continued removal may further negatively impact springs, seeps, riparian areas, and groundwater dependent ecosystems in the area, including those that were not previously or were only somewhat impacted. Future drought conditions will only serve to enhance the negative impact.

2.12.6 Resources Affected

Groundwater and surface water are co-dependent, as changes in one may affect the other. In 1986, there were already more water appropriations on the Forest, than available water to fulfill them. Greater demand for limited water resources will continue to increase stresses on the following resources:

- Wildlife – Diminishment of size and marginalization of quality of primary habitat increases competition for these limited resources, resulting in reduced wildlife numbers. Reduced water availability affects habitat quality and use, reproductive success and survival for most wildlife species. Greater physical stress also increases the prevalence of disease within the various wildlife communities.
- Timber/vegetation – Local changes in tree species and vegetative cover may negatively affect groundwater recharge by increasing runoff and decreasing retention time. This may also provide for negative effects for wildlife and water quality. The lack of water also stresses trees and other plants increasing their susceptibility to disease and insect attack and, ultimately, increasing the potential for catastrophic fires.
- Range – A greater demand for water, coupled with less annual precipitation, may mean less water and forage available for livestock on the Forest. This also serves to increase competition between native wildlife and domestic livestock.
- Recreation – Decreased water availability and accessibility has a negative effect on camping and fishing. Reduced wildlife numbers also negatively impact potential for hunting.
- Streams – Reduction of stream flows may have a deleterious effect locally on fisheries, riparian areas, wildlife, and recreation.
- Springs/seeps – Decreasing size or abundance of springs and seeps has a local negative effect on wildlife, riparian areas, and groundwater dependent ecosystems.
- Riparian Areas/groundwater dependent ecosystems – Groundwater in an arid environment is often the primary water source for riparian areas and groundwater dependent ecosystems. Locally, a decrease of groundwater flow may have detrimental effects on these areas.

2.12.7 Management Tools

The state controls issuance of water rights on the Forest. The Forest stipulates the terms and conditions for access to and use of the water resource.

The Utah Division of Oil Gas and Mining, authority granted by the Office of Surface Mining and Reclamation permits and oversees underground mining operations and reclamation on the Forest. The Forest reviews mining plans to ensure protection of surface resources. Forest concurrence must be given before mining plan approval. Stipulations protecting surface water resources may be attached to mineral leases.

The National Best Management Practices Program was developed to improve management of water quality consistently with the Federal Clean Water Act and state water quality programs. Best management practices are specific practices or actions used to reduce or control impacts to water bodies from nonpoint sources of pollution, such as roads, campgrounds, parking lots, and buildings. The Watershed Condition Framework is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. Primary emphasis is on aquatic and terrestrial processes and conditions that Forest Service management activities can influence.

2.12.8 Stressor Accumulation

Houses with well systems may locally draw down the water table. If the source aquifer is small and restricted, the draw down may result in the lowering of the water table, which may cause nearby stream or spring flow to decrease or cease entirely. Subsurface mining alters groundwater flow paths by creating new underground pathways. During mining, subsidence cracks may spread to the surface. When the subsidence cracks intersect a creek, the surface water is redirected into the crack. Subsidence cracks may intercept perched aquifers located above the mine and, by draining those aquifers, negatively affect springs and seeps. Where the regional aquifer is intercepted, the water table will be lowered as water is pumped from the mine.

2.13 Mineral Exploration and Development

2.13.1 Stressor or Driver Description

Mineral exploration on the Forest is typically conducted for coal resources in the North Zone. The lower 150 feet of the Blackhawk Formation in the Mesa Verde Group is the target formation for coal exploration on the Forest.

Although oil and gas exploration has been conducted in the North and South Zones of the Forest, drilling is not currently economically viable. It has been recent Forest policy not to consent to additional oil and gas leasing, but that NEPA analyses will be done to address new information. Coal bed methane exploration is mostly outside the Forest boundary in topographical lows within the stratigraphically older Mancos Shale. At present, 16 coal bed methane gas wells are on the North Zone of the Forest, nine of these are producing and seven are shut in. The target formation for coal bed methane is the Ferron Sandstone Member of the Mancos Shale. This formation contains major coal seams that are the origin of the methane resource.

Uranium exploration has been conducted in the South Zone of the Forest, but currently, no new exploration has been requested. Politically driven uranium exploration was prevalent on the Forest in the early 1950s due to U.S. demands for uranium, which was the only legal purchaser of the ore at the time. During that time, the Energy Commission regulated the price of uranium setting minimum prices at guaranteed rates of up to 10 years and adding a $10,000 bonus for each separate discovery of high grade ore (Ringholz, 1989). The Energy Commission regulation triggered the uranium boom on the Colorado Plateau. Today the price of uranium is dictated by the supply and demand of nuclear power generation and nuclear propulsion reactors for the U.S. Navy.

The La Sal Mine complex is a dormant uranium/vanadium mine partially on the Forest currently in the permitting process. It is expected that when market conditions are right, this company will proceed with its operation.

2.13.2 Indicators

The amount of mineral exploration activity on the Forest is generally a function of the economics of the industry, the quantity/quality of mineral resources on the Forest, and political climate of the country. Knowing the cyclical nature of each commodity both past and present, helps predict the amount of exploration, measured using past and present mineral prices, which may occur in the future. Utah Division of Oil, Gas and Mining reporting reflects market conditions.

The remaining economic quantity and quality of coal and gas resources on the Forest, since implementation of the 1986 Forest Plan, dictates whether future exploration will occur. At present, natural gas is the dominant form of energy for generating electricity. Low natural gas prices combined with its relatively clean combustion allows for more economic compliance with EPA regulations. Therefore, it is more cost effective to produce energy from natural gas, which reduces the need for further exploration and development of coal and uranium. High construction costs, negative public opinion, and waste storage issues restrict future expansion of the nuclear power industry in the U.S.

2.13.3 Existing Condition of the Indicators

The existing condition of the indicators is based on the current market prices for the individual mineral resource. As of October 2016, coal is $39.40/ton, natural gas is $3.14/one million British thermal units, and uranium spot price is $21.25/lb. Leasable minerals, such as oil/gas and coal, on the Forest are administered through the Bureau of Land Management. Current information for potentially leasable and locatable resources on Forest lands is maintained by the Bureau of Land Management. The BLM LR2000 database shows active unpatented mining claims and master title plats where patented claims exist as well as other potential locatable minerals claims (ex: potash plants). BLM has provided a coal resource map (Appendix 1, pg. 254) and they also determine where fluid mineral deposits occur, as they are leasable. Locatable mineral deposits are not explicitly defined by the BLM, but they manage claims. The Forest Service is the surface management agency for leasable mineral resources.

2.13.4 Trends

Exploration is largely dictated by the current economic trends imposed on each particular mineral industry. For example, there is an inverse relationship between coal and natural gas production, Coal production has been decreasing and natural gas production has been increasing. Historical information regarding these trends can be found on the eia.gov website.

Uranium market trends affect the amount of exploration occurring on the Forest. In this case, the decline in the spot price in 2011 correlates with the decreased number of people employed by the industry. This is largely attributed to the 2011 Fukishima reactor incident in Japan. After the accident, Japan and Germany shut down their nuclear reactors, which drove the uranium spot price down and restricted the ability of uranium companies to obtain long-term contracts with utility companies thereby, affecting long-term uranium prices.

3. ECOLOGICAL ASSESSMENT

3.1 Introduction

This chapter, describes the overall ecological integrity—the structure, composition, and function of an ecosystem operating within the bounds of natural or historic range of variation—of terrestrial (vegetation, air, soil, wildlife) and aquatic (wetlands and riparian) ecosystems, and of watersheds on the Forest. Included in this chapter is information about the current conditions and trends of the key characteristics of each ecosystem as well as relevant ecosystem drivers and stressors. Assessment topics 1, 2, 4, and 5, noted in Table 1 above, are covered in this chapter.

3.2 Terrestrial and Aquatic Ecosystems

Existing Conditions

This report addresses both terrestrial and aquatic ecosystems. Terrestrial ecosystems are broken down into vegetation communities plus barren rock habitat. Aquatic ecosystems include watersheds, water and riparian ecosystems.

3.2.1 Forested Vegetation Communities

Vegetation communities are broken down into two categories: forested and non-forested. Forested communities include spruce-fir, aspen-mixed conifer, mixed conifer dry, and woodlands.

Indicators

There are five indicators used to determine the integrity of vegetation communities on the Forest. They are species composition, density and stocking, structural diversity, productivity, and snags and down wood.

Species Composition

The composition of tree species is one component of forest vegetation diversity, and an indication of timber resources. The measure of this indicator is percent composition.

Density and Stocking

Stand density index (SDI) is a measure of absolute density and can be a measure of tree vigor and stand health. Extremely high or low density and stocking can lead to poor stand health. The measure of this indicator is percent stocking by class.

Structural Diversity

Vegetation structural stage (VSS) is a classification of tree diameters. Tree diameter classifications are one measure of forest wide vegetation community structural diversity. The measure of this indicator is percent VSS by class.

Productivity

In general, gross annual vegetation growth is an indication of stand health and a site will dictate a stand's potential. The measure of this indicator is hundred cubic feet.

Snags and Down Wood

Down woody debris is an important element of productive and biologically diverse forests. It is an important component of forest productivity, wildlife habitat, fuel loading, soil erosion, and carbon storage. As down woody debris decomposes, the soil is enriched with organic matter, nutrients, and moisture. Larger down tree boles provide dens for wildlife. Both large and small debris provide shelter and food for insects, germination sites for tree, herb and shrub species, a substrate for fungi and microorganisms, and long-term storage for water, carbon and other nutrients. The measure of this indicator is trees per acre.

Vegetation Succession

Vegetation communities are selected based on the interactive components that make up that specific ecosystem (for example, species, connectivity, function, processes, etc.). Figure 14 is a successional model used to represent the different vegetation communities (spruce-fir, aspen and mixed conifer, mixed conifer dry, and woodlands) and associated disturbance.

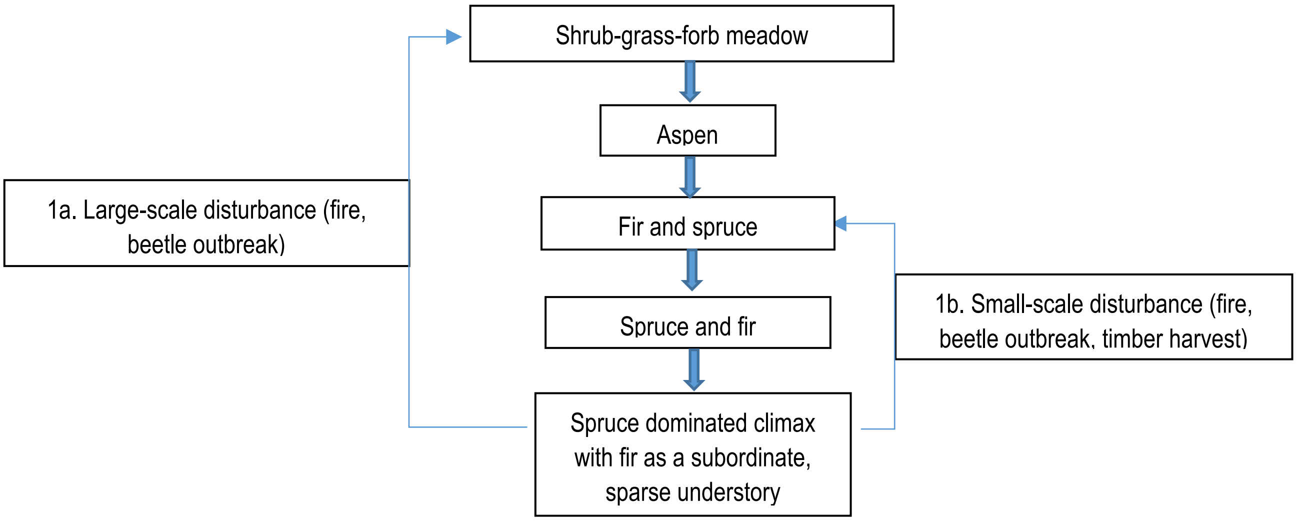


Figure 14. Disturbance regime model for spruce fir communities, based on work from Jenkins et al. 1998.

Small-scale ecological disturbances such as root disease, insect outbreaks, snow avalanches, and timber harvests create gaps that maintain vegetative diversity as shown in Figure 14, Box 1b. Fire occurrence may or may not be associated with small-scale disturbances. The abundance representation of aspen may increase following disturbances that result in the mortality of conifer over stories where aspen clones exist. The following section discusses each vegetation community, the factors that resulted in its present composition and structure, and how management tools will serve to achieve desired conditions.

Spruce-Fir Communities

The spruce-fir and conifer community is found among 15 different LTAs on the Forest and covers approximately 54,754 acres.

Spruce-fir communities support a wide variety of bird species including three-toed woodpecker, pine siskin, ruby-crowned kinglet, mountain chickadee, and dusky grouse. They also provide important nesting and foraging habitat for the northern goshawk, Cooper's hawk, sharp-shinned hawk, and red-tailed hawk. They are a common vegetation type used by red squirrels for habitat and food, and by elk and deer for thermal and hiding cover during the summer and fall.

Engelmann spruce-subalpine fir forests are typically found on the top of the Wasatch Plateau; in the La Sal Mountains from Geyser Pass to La Sal Pass; and in the Abajo Mountains in the La Sal Division of the Forest. In these ranges, these communities are found on northerly aspects with slopes that range from flat terrain to extremely steep. The Wasatch Plateau is a high elevation site, above 9000 feet, where extreme cold, moist conditions prevail most of the year.

This forest type is complex with stands comprised of various mixtures and densities of Engelmann spruce and subalpine fir. Aspen is a common associate and often intermingles with spruce-fir stands. Engelmann spruce is a long-lived (>300 years) tree species and is found on cool moist to wet sites. The stands on the Wasatch Plateau range in age from 150 to over 250. There are areas where the trees are greater than 300 years old. Generally, Engelmann spruce is present in a few age classes that comprise the overstory. Subalpine fir, being more shade tolerant, dominates the understory. Aspen is interspersed and takes over canopy gaps created from individual trees or small patch mortality events. Stands below 9800 feet elevation on the Wasatch Plateau tend to be multispecies and are described as more uneven-aged than other Engelmann spruce stands on the Forest (Pfister 1972; Hanley et al. 1975).

Species composition

Aspen typically comprises a low percentage of the composition, especially when stands are left undisturbed. However, when a disturbance like fire occurs aspen will usually establish in canopy openings. Currently, subalpine fir comprises 49 percent of stands, Engelmann spruce 30 percent, and aspen 21 percent. There are minor amounts of white fir, Douglas-fir, limber pine, and blue spruce in transition areas where Engelmann spruce-subalpine fir, aspen and mixed conifer, and dry mixed conifer communities converge. The amount of Engelmann spruce can range from 10 to 90 percent of the species composition and average greater than 40 percent in Properly Functioning Condition (PFC) spruce/fir communities. On the Wasatch Plateau (North Zone) spruce beetle effects have resulted in a lack of Engelmann spruce seed source in many stands in this vegetation community.

Density and Stocking

Density classes of spruce-fir stands are 0 to 25 percent, 25 to 35 percent, 35 to 60 percent, and greater than 60 percent of maximum stand density index (SDI; a measure of the stocking of a stand of trees based on the number of trees per unit area and diameter at breast height of the tree of average basal area). Maximum stand density index for the spruce/ fir vegetation community is 599. More than 53 percent of spruce-fir communities are within the 0 to 150 SDI range, which is also the on-set of crown closure and competition. Eighteen percent of the spruce/fir acreage falls within the 150 to 210 SDI range, or lower limit of full site occupancy. Ten percent of the spruce/-fir acreage has stand densities within the 210 to 359 SDI range, or the lower limit of self-thinning. Nineteen percent of the acreage falls within the greater than 359 SDI range or zone of imminent competition-induced mortality. Due to the spruce beetle, 71 percent of the acres in this community are relatively low density. The 19 percent of high density acres are on the South Zone, which has not been subject to the spruce beetle epidemic.

Growth and Mortality

Spruce beetle has resulted in large-scale mortality of Engelmann spruce and an increase in subalpine fir growth. Currently, silvicultural treatments on the North Zone are focused on removing dead standing spruce. Additionally, there is an overabundance of snags. There are 56 snags per acre with diameters ranging from 5 to 12 inches, 25 snags per acre ranging from 12 to 18 inches in diameter, and 18 snags per acre greater than 18 inches in diameter.

Trends

In the past, there has been very little management in spruce-fir communities on the Forest. Spruce beetle-caused tree mortality was identified in Timber Canyon in 1980. At that time, approximately 10,000 acres of Engelmann spruce type were evaluated and one third of the affected stands were harvested and sold. During the outbreak, stands experienced more than 90percent loss of mature spruce.

Species Composition

A species composition comprised of 40-60 percent Engelmann spruce is desirable (USDA2006b). However, the lack of management in spruce fir stands historically, and the recent spruce beetle outbreak has shifted species dominance from Engelmann spruce to subalpine fir. Over the next 40 years, it is expected that subalpine fir will continue to dominate in this community. The return to spruce-dominated communities will take several more decades.

Density and Stocking

In 1993, more than 50 percent of the acres in the spruce-fir vegetation community were at high risk of insect and disease outbreak, as well as, catastrophic fire. By 2010, most of the damage from spruce beetle had occurred and proportions were more evenly distributed, which, to some extent reflect spatial diversity. Currently, stands are sparsely stocked with mature Engelmann spruce. Stands are expected to follow natural successional trajectories over the next several decades. In the absence of management, stands will eventually have similar densities as those prior to the recent spruce beetle outbreak.

Structural Diversity

Major changes in stand structure resulted from in the loss of mature Engelmann spruce during the spruce beetle outbreak on the Wasatch Plateau. The death of mid-aged, mature, and old trees between 1994 and 2014 has created openings that allowed for the establishment of Engelmann spruce, subalpine fir, and aspen regeneration. This has resulted in a more uneven-aged, multi-layered stand structure. Over time, and without major disturbance, the forest will move toward a mature structure.

Mortality and Growth

For the past 20 years, insects and disease have been active in both Engelmann spruce and subalpine fir. Forest Inventory and Analysis data averaged over time and shows a drastic increase in Engelmann spruce mortality. With the loss of spruce, stands are beginning to regenerate to subalpine fir. For the next few decades, it is expected that there will be a significant reduction in Engelmann spruce mortality and an increase in subalpine fir mortality. This prediction is based on natural thinning of advanced regeneration of subalpine fir, and artificial and natural regeneration of Engelmann spruce. Growth will likely increase from regenerating stands of Engelmann spruce. Harvested areas that were artificially planted will add to future growth. For the next 40 years, growth should look similar to the 1993 data; endemic insect and disease populations should affect less than 10 percent of the host type and root disease and insect activity should occur in groups of less than 50 trees. Aspen mortality is expected to remain stay static or increase slightly.

Stressors and Drivers

Fire

Most of the spruce-fir vegetation communities on the Forest fall within a fire regime that experiences fire return intervals every 200+ years that are of high severity and stand replacing as shown in Table 11.

Table 11. Spruce-fir vegetation community acres in fire regime groups.

Classification	Acres	Percent	Description
FRG1	16048	29	Frequent fire return interval and typically low fire severity
FRG2	430	1	Frequent fire return interval and typically high fire severity
FRG3	1590	3	Moderate fire return interval and mixed fire severity
FRG4	361	1	Moderate fire return interval and typically high fire severity
FRG5	34675	63	Long fire return interval and typically high fire severity

Most spruce-fir communities are within moderate departure from historic conditions. Fire exclusion, or the lack of fire on the landscape, has led to a low diversity stands and increased stand densities. Lack of fire and increased stand densities are associated with insect outbreaks. Insect-caused tree mortality can alter fuel complexes and fire potential Table 12.

Table 12. Amount of departure for spruce-fir vegetation community.

Departure	Acres	Percent	Description
VCC1A	37	0	Very low departure from historical conditions at a minimum.
VCC1B	344	1	Low departure from historical conditions at a minimum.

VCC2A	35,903	66	Low to Moderate departure due to missed fire return interval & Beetle kill.
VCC2B	15,009	27	Moderate to High departure due to missed fire return intervals & Beetle kill.
VCC3A	1,042	2	High departure from historical conditions at a minimum.
VCC3B	412	1	Very high departure from historical conditions at a minimum.

Insects and Disease

Spruce-fir stands that are over mature, with a basal area greater than 150 square feet per acre and average stand diameter greater than 16 inches and greater than 65 percent spruce in the canopy are highly favorable for spruce bark beetle outbreak (Munson 2005). In the mid-nineties, on the Wasatch Plateau, stands were in this condition. Over 90 percent of the spruce greater than 8 inches in diameter underwent mortality due to the spruce bark beetle. This event affected approximately 47,983 acres of this vegetation type. The spruce beetle epidemic occurring on the North Zone has resulted in sparsely stocked spruce-fir stands.

As a result, there is a lack of spruce, mature structure, and thermal cover particularly on the Wasatch Plateau. There is a dynamic cycle between spruce and subalpine fir dominance, depending on stand conditions and insect activity. Recent Engelmann spruce beetle epidemics have affected extensive landscapes, favoring a shift to more dominance by subalpine fir.

Aspen and Mixed Conifer Communities

The aspen/mixed conifer community type is found among 44 different LTAs on the Forest. There are approximately 96,017 acres of persistent aspen and 246,722 seral aspen with mixed conifer.

This community, important for many species throughout the stages of succession. Aspen is considered an early seral species on these sites and is important for many bird species such as Cassin’s finch, and western tanager, cavity nesters, and raptors. It is one of the most important cover types supporting northern goshawks in Utah. If quaking aspen continues to decline in this community type, it will likely impact goshawks. It is also important summer range for big game such mule deer and elk, providing both forage and cover components. Quaking aspen provides forage and cover for livestock. Quaking aspen maintains watershed condition, enhances soil productivity, and is aesthetically pleasing.

Seral quaking aspen stands are widely distributed throughout the Forest. Generally, tree ages vary from 60 to 150 years. Quaking aspen provides forage and cover to a variety of wildlife species and livestock. Quaking aspen maintains watershed condition, enhances soil productivity, and is aesthetically pleasing.

Species Composition

In the aspen and mixed conifer community, 44 percent of total trees per acre are aspen, including stable aspen. Stable aspen is self-perpetuating with minimal nor no conifer presence. Conifers comprise 32 percent of the overall species composition. Gambel oak is 24 percent composition, occurring at the lower elevation range (8000 feet) of the aspen mixed conifer community. Generally, tree ages vary from 60 to 150 years.

The lack of disturbance allows the natural progression of aspen to succeed to conifers (Bartos et. al, 2001). Increases in the abundance and density of conifers make the Forest more susceptible to large-scale insect infestations, disease outbreaks, and severe wildland fires, possibly endangering overall forest ecosystem health (Hood and Miller 2007). Properly functioning conditions for the aspen and mixed conifer vegetation community is conifer composition less than 10 percent. Shrub and herbaceous layers should be well developed with ground cover at least 85 percent.

Density and Stocking

There are approximately 106,314 acres that are sparsely stocked (SDI ranging 0-144) with aspen and mixed conifer due to insects and disease and wildfire. There are 53,935 acres moderately stocked. There are 109,461 acres on the Forest that are densely stocked. There are 56,330 acres that are overstocked. Overstocked condition causes tree growth to slow and can lead to susceptibility to successful insect attacks, most of the overstocking occurs on the Moab/Monticello Districts. Forty percent of the stands should have multiple canopies with stand density index not greater than 335 or basal area less than 150.

Structural Diversity

In the aspen and mixed conifer vegetation type, most of the species are less than 5 inches diameter and form stands that comprise a total of 264,961 acres. The large amount of smaller diameter trees are a result of past disturbances, such as wildfires, insects, and disease. These size classes are within an acceptable range for the aspen component. However, aspen/mixed conifer stands across the Forest presently lack mature structure or large diameter conifers. Ideally, stands would be comprised of a broad distribution of conifer size classes with some trees exceeding 19 inches in diameter. Properly functioning conditions include grass/forb 40 percent, saplings 40 percent, young 30 percent, mid-aged 30 percent, mature 30 percent and old forest 30 percent. Aspen growing in mixed conifer stands where conifers comprise greater than 25 percent of the cover may be at risk of loss (Bartos and Campbell 1998).

Growth and Diversity

Snags greater than 18 inches diameter are approximately 6 per acre, which are optimal for wildlife habitat. In the 5 to 12-inch diameter class of snags there are approximately 38 snags per acre. Many of these snags are a result of increasing dieback and decline was reported across the western United States following a drought from 2001-2004. Mortality rates peaked in 2007-2008 and have since returned to pre-drought levels. The agents involved in dieback and decline varied depending on location but tend to be a complex of wood boring beetles and canker diseases in Utah (Guyon and Hoffman 2011). Within aspen and mixed conifer stands the forest has seen more mortality than growth for all conifer species as shown in Figure 15.

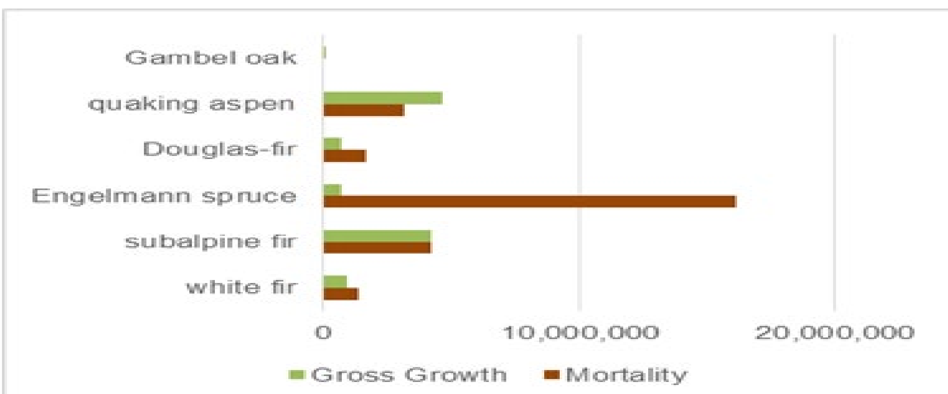


Figure 15. Annual gross growth and mortality in cubic fee (USDA Forest Service, Manti-La Sal National Forest 2016f).

Trends

Harvests and wildfires that have occurred since 2010 have reduced the subalpine fir component and increased aspen and gamble oak. The Douglas fir, white fir and Engelmann spruce components in these communities, have remained stable. The 1915 and 1965, timber inventories on the Manti Division showed that aspen declined 34 percent from 194,245 acres to 127,831 acres; from which the Forest estimated that 1600 acres would need to be treated annually to return aspen to historic conditions (USDA, 1986). All documented fires, prescribed and natural, timber harvests, fuels treatments, and insects and disease averaged across the past 30 years show 1200 acres annually being effectively treated.

Structural Diversity

Aspen is perpetuated on site by fire and disease (Bartos 2001). Structurally, diameter distributions have remained the same from 1993 to 2014.

Density and Stocking

Over time, stands have become less dense, likely due to insects and disease. Twenty percent of stands have a high susceptibility to disease and insect attacks and large-scale stand replacing fire. Fifty-two percent of this vegetation community have moderate to high departure from historical conditions of plant species, stocking amounts, and size and age classes due to missed fire return intervals and conifer encroachment. Active management will improve stand health and move stands toward a mature structure sooner than natural development.

Growth

Gross growth has declined from 1993. Climate change including higher temperatures and reduced moisture have reduced tree growth. In addition, mortality of Engelmann spruce and other conifers have decreased overall.

Mortality

Aspen decline, insects and disease affecting Douglas fir, Engelmann spruce, and true firs are responsible for the increased amount of mortality (USDA 2016 insects) in this vegetation community over the past two decades. Mortality has increased from 1993 more than 5 times. Mortality is beginning to decline, insects and disease are also declining, particularly spruce bark beetle and Douglas fir beetle (USDA 2016 insects).

Stressors and Drivers

Vegetation Succession

Conifers, such as white fir, Douglas-fir, Engelmann spruce, subalpine fir, and ponderosa pine, have been replacing the seral aspen for the past 130 years. Aspen is an early seral tree species in the mixed conifer zone that relies primarily on vegetative suckering to regenerate. Lack of disturbance allows conifer tree encroachment that results in less aspen, increased acreage of conifer stands that are less diverse, and forest stands that are structurally continuous (less mosaic-like). Previous silvicultural treatments at the stand scale have been successful in regenerating aspen when at least 100 acres or more have been harvested or when at least 75 percent of the conifer overstory has been killed by fire. However, even though treatments may regenerate aspen not enough acres are being treated with large enough disturbance. Historically, it was estimated that 160,400 acres of persistent aspen, existed on the Forest. Currently, it is estimated that there are 96,017 acres of persistent aspen on the Forest. There are not a lot of data for the forest as to why this decline in persistent or stable aspen. Some decline are likely biological and climatic factors and some due to mapping and data errors from the 1986 inventory to current. Throughout the west it is evident that aspen have been declining. Aspen succession to conifers is in response to natural forces. The lack of natural disturbances facilitates the succession of aspen forests to conifers. Some disturbances that have been altered by human intervention, such as wildland fire suppression, have given more shade-tolerant conifers a competitive advantage over aspen (Bartos 2001). Numerous landscapes on the Forest, that were once dominated by aspen, are now in late successional stages dominated by mixed-conifer species (Bartos and Campbell 1998). On the Wasatch Plateau of Utah, undergrowth production can be reduced by 50 percent when conifers make up as little as 15 percent of the total tree basal area (Bartos 2001). Mueggler (1988) observed that undergrowth production was reduced 67 percent when conifers made up 15 percent of the total tree basal area. According to Bartos 2001, once conifer invasion approaches 50 percent of the total tree basal area in aspen stands, undergrowth production is only a small fraction of what it once was on these formerly excellent grazing lands. Existing conditions indicate that most aspen stands will eventually be replaced by conifers, sagebrush, or possibly other shrub communities (Bartos and Campbell 1998). Based on the assessment done in 2006 (PFC), if aspen are less than 15 percent of the composition, stands are at risk of becoming converted to conifer stands.

Increasing aspen decline and dieback due to insect and disease agents has been mapped since 1997. This dieback and decline was part of a trend of increasing damage reported across the Western United States, which peaked in 2007. Decline and dieback damage was largely caused by canker diseases and insect borers, but defoliators played a role in some areas (USDA 2012).The lost acres have converted to ponderosa pine, Engelmann spruce- subalpine fir, Douglas fir, or white fir forest types. There are approximately 246,722 acres of aspen in transition state.

Grazing and Fire

The increase in stands succeeding to conifers is the result of changes occurring in the understory from past overgrazing by sheep and cattle, and fire exclusion. Livestock grazing for the past 120 years has reduced accumulations of fine fuels (shrubs and herbaceous layers). This situation has produced fewer fires and generally smaller fires. A majority of the aspen and mixed conifer vegetation community experiences a frequent, low severity fire return interval. The other 12 percent is within a long fire return interval (200+ years) and high fire severity resulting in complete stand replacement. Fire suppression maintains the conifer-dominated overstories as shown in Table 13.

Table 13. Aspen and mixed conifer vegetation community acres in fire regime groups.

Classification	Acres	Percent	Description
FRG1	269,638	79	Frequent fire return interval and typically low fire severity
FRG2	917	0	Frequent fire return interval and typically high fire severity
FRG3	24,623	7	Moderate fire return interval and mixed fire severity
FRG4	6,212	2	Moderate fire return interval and typically high fire severity
FRG5	39,668	12	Long fire return interval and typically high fire severity

Most of the aspen and mixed conifer vegetation community is within a moderate to high departure from historical conditions. The next 23 percent is within a low to moderate departure, followed by 20 percent within a high departure from historical conditions as shown in Table 14. This indicates a seral transition from aspen dominated to more shade tolerant mixed conifer species due to lack of several fire return intervals. Frequent low severity fires within this vegetation community are typical until several fire return intervals are missed. Once aspen has been converted to a mixed conifer stand then probability of less frequent/high severity stand replacement fires increase. This is prevalent on all districts.

Table 14. Amount of departure for aspen and mixed conifer community.

Departure	Acres	Percent	Description
VCC1A	26	0	Very low departure from historical conditions at a minimum
VCC1B	12,782	4	Low departure from historical conditions at a minimum
VCC2A	79,450	23	Low to Moderate departure due to missed fire return intervals
VCC2B	179,366	52	Moderate to High departure due to missed fire return intervals and conifer encroachment
VCC3A	66,432	19	High departure from historical conditions due to missed fire return intervals and vegetation type change
VCC3B	904	0	Very high departure from historical conditions at a minimum

Mixed Conifer Dry Communities

Dry mixed conifer forests generally grow on drier sites and are variously composed of Douglas-fir, white fir, subalpine fir, Engelmann spruce, blue spruce, limber pine, ponderosa pine and aspen. The dry mixed conifer forest has a multi-layered canopy, primarily as a result of natural and small-scale man caused disturbances occurring over time. The mixed conifer dry community is approximately 106,133 acres.

Endemic levels of insect and disease are present in this type. Insects (Douglas-fir beetle and western spruce budworm), disease, and fire have had a major role in maintaining the diversity of composition and structure of this community type. Historically, fires burned every 30 to 50 years as mixed-severity events (Amundson et al. 1996). Fire suppression in this type has resulted in increased stand densities predisposing them to increased insect mortality.

Dry mixed conifer stands provide important habitat for many wildlife species, some of which include threatened, endangered and regionally sensitive species. The diversity of vegetation composition, structure, and multi-layered canopy all contribute to the important attributes for the many wildlife species that depend on this type, particularly late seral-dependent species. Burned stands provide habitat for some bird species, especially species such as Lewis woodpecker, three-toed woodpecker and cavity-nesting species such as western bluebirds. Other species such as Grace’s warbler, flammulated owl, and Allen’s big-eared bat require habitat components associated with mature forests such as higher canopy cover, large trees, and snags. Wild turkeys also occur across the Forest in ponderosa pine habitats, where mature stands mixed with openings provide large trees for roosting and a productive understory herbaceous component for foraging.

Abert's squirrels are the species most directly dependent on ponderosa pine habitat on the Moab/Monticello District. Tree characteristics largely determine the quality of squirrel habitat, with a direct relationship between the number of interlocking crowns and the quality of habitat (Brown 1984).

Species Composition

At the forest level in the dry mixed conifer community, aspen are 48 percent of the species composition. The composition of aspen are high because some of the data collected encompass south facing persistent aspen stands, which have drier and hotter soils and lower elevations. White fir (21 percent), Douglas fir (13 percent), ponderosa pine (13 percent), subalpine fir (1 percent), Engelmann spruce (1 percent), blue spruce (3 percent), and limber pine (1 percent), make up the remaining percentages of species composition.

Density and Stocking

Past timber harvesting eliminated the large, older ponderosa pines from stands while ignoring the dense ponderosa pine and conifer understory components. Fire exclusion resulted in the second growth ponderosa pine stands to have higher stand densities than would have occurred under historical fire regimes. In addition, the density of small trees surrounding mature trees has been increasing (USDA MLNF 2006).

Approximately 85,000 acres are SDI 141-337, meaning stands are densely stocked, with large and small trees. The crowns of trees are interlocked and go from the forest floor to the tops of the canopy. This situation is at risk of large-scale stand replacing fire.

Structural Diversity

Historical stand structures were typically multi-layered with a range of tree sizes. In ponderosa pine stands in the South Zone, past timber management practices have resulted in uneven-aged structure. The majority of acres are dominated by 8-14 inch diameter trees. Structures are predominantly made up of trees in the mid-aged classes, with very dense understories and varying size classes (USDA 2006 assessment). Old growth ponderosa pine has been reduced and is fragmented across the Forest.

Growth and Mortality

In the mixed conifer dry community, growth has been exceeding mortality for Douglas fir and ponderosa pine. Aspen and white fir have had more mortality than growth in cubic feet.

Trends

There is a strong representation of old growth forest as indicated by decadence, structure, and old trees. Adequate mixes of structural classes exist across the landscape. Stands are multi-aged and multi-canopied, and the lower canopy layer has become denser. Past management practices have had variable impacts to structure and species composition. Insect and disease are species-specific within a stand. Because of the intermixed species composition, insect and disease events do not result in significant losses in forest cover.

Species Composition

The reduction in numbers of trees for white fir and Douglas fir are partly due to Western spruce budworm and Douglas fir beetle, which have impacted Douglas fir and other true firs on the forest (USDA 2016 insects). Increasing symptoms of dieback and decline were recorded following a drought from 2001-2004 that peaked in 2007-2008 in aspen. Subsequent symptoms and mortality rates have since returned to near pre-drought levels. The agents involved in dieback and decline varied depending on location but tend to be a complex of wood boring beetles and canker diseases (Guyon and Hoffman 2011).

Structural Diversity

Stands are uneven aged and within this community there are a lot of small diameter trees. The high amount of small diameter trees is likely due to wind events, insects and disease, and wildfires. Within this vegetation community, there has not been much timber harvest activity on the North Zone. Mature and old growth structure are hard to achieve due to the species of trees and relatively hot dry low elevation sites.

Density and Stocking

More than 50 percent of the acreage are considered dense. If stands continue to increase in density large stand-replacing fires, and/or the continued exclusion of low intensity fires may compromise the historical balance of patterns and structures within the ecosystem. Uncharacteristic wildfire would further reduce old growth that has already been reduced due to past management activities (USDA 2006b).

Growth and Mortality

Gross growth in the mixed conifer dry vegetation community has decreased from 1993 to current. Climate change influencing warmer winters and summers is likely a big contributor to such changes in growth. In addition, if the number of trees is reduced by disturbances such as fire, insects, and disease, the gross growth of stands comprising the mixed conifer vegetation community will decrease.

Stressors and Drivers

Fire

As a result of fire exclusion for the last 100 years, ladder fuels and extremely dense stands of ponderosa pine could contribute to wildfires outside the historical range of intensity and size. In addition to ladder fuels, there is a buildup of forest litter that increases potential fire hazard and lethal fire effects on vegetation by concentrating heat on the upper soil layers and around the stems of trees and shrubs. Past harvest and thinning have contributed to the high fuel loads because of accumulations of slash. In addition to unplanned vegetation changes, more intense disturbances have significant negative effects on soil and water quality. Potential loss or reduction of habitat conditions for late-seral dependent wildlife species is high.

Most of the mixed conifer dry vegetation community could experience a frequent fire return interval (0 to 35 years), with mixed severity fire resulting in less than 75 percent of the dominant over story vegetation being replaced. This is typical for this forested community. The next 28 percent within this vegetation community could experience a longer fire return interval (35 to 100 years) with less than 75 percent of the dominant over story vegetation being replaced. Analysis indicates most fires in this vegetation community should occur on the Moab and Monticello Districts with frequent low severity fires as shown in Table 15.

Table 15. Mixed conifer dry vegetation community acres in fire regime groups.

Classification	Acres	Percent	Description
FRG1	72396	68	Frequent fire return interval and typically low fire severity
FRG2	21	0	Frequent fire return interval and typically high fire severity
FRG3	29773	28	Moderate fire return interval and mixed fire severity
FRG4	1850	2	Moderate fire return interval and typically high fire severity
FRG5	1728	2	Long fire return interval and typically high fire severity

Most of the mixed conifer dry vegetation community is within a low to moderate departure from historical conditions. The next 23 percent is within low departure, followed by 23 percent within a moderate to high departure from historical conditions as shown in Table 16. This indicates that this vegetation type is trending away from open park-like stands to denser stocked stands allowing for more shaded tolerant species, thus transitioning from historically frequent/low severity fire return intervals to less frequent/higher severity fire return intervals.

Table 16. Amount of departure for mixed conifer dry community.

Departure	Acres	Percent	Description
VCC1A	2	0	Very low departure from historical conditions at a minimum.
VCC1B	24432	23	Low departure from historical conditions.
VCC2A	55674	52	Low to Moderate departure due to missed fire return intervals and increased stand densities.
VCC2B	21011	20	Moderate to High departure due to missed fire return intervals and increased stand densities.
VCC3A	4095	4	High departure from historical conditions due to missed fire return intervals and vegetation type change.
VCC3B	19	0	Very high departure from historical conditions at a minimum.

Insect and Disease

Mountain pine beetle mortality has been increasing in the Elk Ridge area on the Monticello District. The Kigalia timber sale removed almost 80 percent of the pine stands due to the mountain pine beetle caused mortality.

Woodland Communities

Two needle pinyon and Utah juniper woodlands cover 21 percent of the Forest. Pinyon Pine is generally more abundant in stands at middle elevations where annual precipitation exceeds 15 inches. At lower elevations, juniper dominates most sites. Utah juniper grows on relatively dry sites with an annual precipitation of 10 to 12 inches. This species grows in pure stands on portions of the La Sal Division. It grows in pure stands on the west side of the Manti Division. The distribution and density of Utah juniper has increased at lower elevations with deeper soils due to grazing and lack of fire. As it increases on these sites, it displaces sagebrush and, in some instances, mountain shrub communities. Rocky Mountain juniper occupies sites where annual precipitation averages 14 inches. It grows in pure stands at 7500 to 8000 feet, specifically, at Joe's Valley, South Horn, and Lake Fork. The greatest need for management occurs in communities, such as sagebrush, that have been encroached by pinyon-juniper.

Pinyon-juniper woodlands are typically found between conifer forest and sagebrush vegetation communities. These woodlands have expanded beyond their historical distribution in geographic extent, as well as, density due to fire suppression. Unproductive, rocky and bare sites need less management (thinning and mastication to improve understory productivity).

Historically, pinyon-juniper occupied two site conditions. On better sites, it grew in a savannah-like community. Grass and forb species occupied the understory below open-grown trees. Frequent surface fires kept these communities from becoming overly dense. Pinyon-juniper also occupied rocky, bare ridgelines, and hillslopes. The lack of a fine herbaceous understory prevented fire from spreading into these sites. Early settlers cut pinyon-juniper for railroad ties, fence posts, etc. from its historic range. This cutting, in addition to overuse by livestock, altered the ecology of these sites. Many native species were lost as well as most of the topsoil. Today, these areas have rocky, shallow soils that are incapable of supporting an herbaceous understory that could be burned by fire.

Pinyon-juniper provides habitat to a very diverse group of migratory bird species.

Species Composition

Utah juniper and two needle pinyon pine are almost 70 percent of woodlands communities on the Forest. Scattered amounts of Douglas fir and white fir are found. Gambel oak is found in woodlands, mixed conifer dry, aspen and mixed conifer as well as some non-forest vegetation communities.

Density and Stocking

Stands in the woodland community are at high density. The grass/forb component in over mature and dense stands of pinyon-juniper has been substantially reduced as a result of competition for available light, space, and moisture by pinyon-juniper plants. Currently, in some stands the herbaceous understory may be unable to respond following a fire. Opportunities exist to burn these areas to remove pinyon-juniper overstory and restore to an open condition through mechanical treatments and mixed-severity fire.

Structural Diversity

Similar to the other vegetation communities, 80 percent of the woodland tree population are less than 1-inch diameter. Less than 5 percent of the population are 12-18 inches diameter. This is an indication of disturbance. Woodland tree species will reach mature diameter sizes (12 to 18 inches diameter) which are typically the largest diameter tree size for this community. Even though small diameter trees indicate disturbance, piñon-juniper are still invading sagebrush and grassland communities. Some discrepancies regarding disturbance and expansion of piñon juniper are due to community delineation and how data are collected.

Growth and Mortality

Insects, such as pinyon *Ips*, as well as, natural weather events and fire disturbances are the cause of tree mortality. Gambel oak, Douglas- fir, Rocky Mountain juniper, and Utah Juniper have undergone similar disturbances, however, the number of trees killed and the amount of live healthy trees indicate that gross growth has exceeded mortality.

Trends

Species Composition
All species in the woodland vegetation community have remained constant over the past 24 years except for Utah and Rocky Mountain juniper. Pinyon-juniper stands have established in sagebrush, mountain shrub communities, and somewhat in Gambel oak and mountain mahogany communities.

Structural Diversity
Diameter distributions from 1993 to current have remained unchanged.

Density and Stocking

Stands that have a stand density index greater than 172 are reaching conditions where fires can be larger and more severe than normal. About 70 percent of woodlands communities have been at 172 to 295 stand density index since 1993.

Stressors and Drivers

Fire and Encroachment

Watersheds with large areas of pinyon-juniper encroachment may become susceptible to increased erosion if large, high-intensity fires were to denude the landscape. Unbalanced densities, composition, and pattern are indicators of improperly functioning conditions and have affected the value of this wildlife habitat. There may be cases of other invasive, non-native species, such as cheatgrass, occurring within the pinyon-juniper cover type. The existence or potential establishment of these species should be considered when identifying areas to treat.

Most of the pinyon juniper vegetation community could experience moderate fire return interval (35-100+ years), with mixed severity resulting in less than 75 percent of the dominant over story vegetation being replaced. This is typical for this forested community. Seventeen percent could experience frequent fire/low severity. All districts on the Forest will have infrequent fire return intervals with mixed severity along the lower elevations within this vegetation type as shown in Table 17.

Table 17. Pinyon-juniper vegetation community acres in fire regime groups.

Classification	Acres	Percent	Description
FRG1	45049	17	Frequent fire return interval and typically low fire severity
FRG2	42	0	Frequent fire return interval and typically high fire severity
FRG3	184075	70	Moderate fire return interval and mixed fire severity
FRG4	21943	8	Moderate fire return interval and typically high fire severity
FRG5	3839	1	Long fire return interval and typically high fire severity

Most of the pinyon juniper vegetation community is within low departure from historical conditions. The next 24 percent is within low to moderate departure from historical conditions. This indicates a stable vegetation community within its historical areas but increasing in density as shown in Table 18.

Table 18. Amount of departure for pinyon-juniper community.

Departure	Acres	Percent	Description
VCC1A	2	0	Very low departure from historical conditions at a minimum
VCC1B	160573	61	Low departure from historical conditions indicating a stable community
VCC2A	63437	24	Low to Moderate departure due to missed fire return intervals and increasing tree densities
VCC2B	27139	10	Moderate to High departure due to missed fire return intervals and increasing tree densities
VCC3A	2499	1	High departure from historical conditions at a minimum
VCC3B	40	0	Very high departure from historical conditions at a minimum

The expansion of woodlands now covers an average of three to four times the pre-Euro-American settlement area. These areas represented some of the more diverse and productive sagebrush ecosystems in the region and currently support, or will support, some of the highest levels of tree dominance and fuel loads. Consequently, sagebrush communities continue to decline as tree dominance continues to increase (Despain and Mosley 1990). The rate of the transition from sagebrush ecosystem to tree-dominated woodland is variable depending on the site potential. In general, a minimum of 60 to 90 years is required for trees to dominate a site (Barney and Frischknecht 1974).

With a reduction in fire frequency, tree seedlings can survive, and the areas of woodlands expand. Additionally, livestock grazing that removed the herbaceous vegetation or fine fuels carrying fire (Heyerdahl et.al. 2001), and wet conditions created an ideal situation for tree establishment.

In addition to expansion, stand density has increased resulting in increased vulnerability to crown fire (Kaufmann et.al. 2005). Ponderosa pine forests have gained some acreage from riparian zones, aspen, sagebrush, and mountain brush, but have lost significant acreage to Douglas-fir and white fir invasion (Kaufmann et.al. 2005). In the absence of fire, the trees are well adapted and competitive in these more productive locations (Hood and Miller 2007). As the canopy of the woodlands close, understory plants, especially shrubs, rapidly decline (Chambers 2008).

Pre-settlement trees were generally widely scattered and more common in lower elevation stands with greater surface rock cover and higher solar exposure (Chambers 2008). With the loss of fine fuels (grass) for frequent fire, ponderosa pine was able to expand into communities such as sagebrush and mountain brush. Since Euro-American settlement, increasing homogeneity of the vegetation has resulted in increased fuel loads and continuity. The vegetation heterogeneity that resulted from differences between sagebrush species and subspecies is generally disappearing (Miller and Tausch 2001).

Due to the lack of disturbance, pinyon and juniper has expanded onto sagebrush and grasslands sites. Woodland development across sites can be separated into three phases. In phase one, trees establish, and seedling and sapling trees are scattered throughout mountain big sagebrush and perennial grasses. In phase two, trees rapidly encroach and co-dominate with shrubs and herbs. Growth rates of trees increase until they mature; then the growth rate declines as the canopy closes. In phase three, trees dominate (Chambers 2008). Currently, there are approximately 270,723 acres in phase 1 (43 percent), 171,082 acres in phase 2 (27 percent), and 193,905 acres in phase 3 (30 percent). Acres in phase 2 have potential for encroachment.

3.2.2 Non-forested Vegetation Communities

Vegetation communities are broken down into two categories: forested and non-forested. Non-forested communities include forbs and grasslands, riparian, sagebrush, mountain brush, and alpine.

Indicators

Percent ground cover and species composition

Perennial Forbs and Grasslands

Perennial forbs and grasslands vegetation occupy 6 percent of the Forest. These community types occur at elevations of 8,500 to 11,500 feet, and in patches less than 1,000 acres (The Nature Conservancy, 2007).

Perennial forb land high to low elevations and perennial grassland high, mid, and low elevations cover approximately 81,922 acres and is found among 43 different LTAs on the Forest. Perennial forbs and grasslands communities can be found in areas of active landslides with little or no vegetation cover. Original species of the more mesic primary succession perennial forb and grassland ecotype are low in numbers or extinct.

Perennial forbs and grasslands on the Forest are rich in wildlife species diversity; it is important for a variety of wildlife species, including sage grouse, mule deer, rocky mountain elk, Richardson’s ground squirrel, and provides nesting habitat for many bird species including sage grouse, Brewer’s sparrow, and vesper sparrow. Perennial forbs and grasslands or meadows are habitat for Uinta ground squirrels (North Zone) and Gunnison’s prairie dogs (lower elevations on South Zone), which in turn are important prey species for golden eagles and other raptors. Perennial forb and grassland ecotypes provide forage for livestock, habitat for wildlife, soil stability, recreational sites, water infiltration/aquifer recharge, water quality within watersheds, and landscape diversity. This habitat is also utilized by mountain goats; the impacts of this introduced species on vegetation composition and diversity is currently being monitored.

Trends

The Forest is fortunate to have more 100 years of established photo points in perennial forb and grassland ecotypes from which vegetation trend can be extrapolated. Current use is an indicator of trend within perennial forb and grassland ecotypes (Ellison, 1951). In 1993, a study was published highlighting comparative photos from 1902 to 1992. In nearly every instance, the 1992 landscape looks better, meaning higher vegetation and litter cover, and less exposed barren soil than the historic photo. Crevice species found in the perennial forb and grassland community are evidence of major storm events and uncharacteristic conditions in 1947 and 1948. Wetter than average precipitation in the late 1800s to early 1900s, fewer fires, and intensive livestock grazing has facilitated the loss of top soil.

Stressors and Drivers

Climate

Perennial forbs and grasslands distribution and dynamics are primarily driven by climate and topographic factors. By 2100, median and maximum temperature is projected to rise between 5° and 10°F (RCP 4.5 and 8.5 respectively). Snowpack has declined across the Western United States since about 1950, with milder climates (USDA 2016f). Present perennial forb and grassland species depend primarily on snowpack for spring/summer soil moisture. When dry summers occur, plant growth is markedly curtailed (Ellison, 1951). Although perennial forb and grassland communities are mainly driven by climate, they are highly dependent on deeper soils that are relatively rock free. Accelerated erosion induced by past overgrazing on the Forest has pushed the original perennial forb and grassland ecotype into a secondary successional state composed of less mesic forbs and grasses. With the elimination of extreme overgrazing in the mid-1900s, a less mesic vegetation has emerged (Ellison, 1954).

Sagebrush Communities

The sagebrush community is comprised of sagebrush with a native grass and forb understory. It covers approximately 7 percent and is found among 42 different LTAs on the Forest. Sagebrush communities are often associated with perennial forbs and grasslands, mountain brush, and pinyon juniper woodland types. Sagebrush communities usually occur on relatively dry sites at all elevations. Owing to climatic conditions, sagebrush is most common to mid and lower elevations, although it is found above 8,500 feet. Most of the sagebrush on the Forest is in intermediate and late structural stages, which reflects the lack of recent natural disturbance, specifically, fire. This community is used by livestock in the spring, summer, and fall. Big game (deer and elk) and greater sage-grouse populations in Utah use sagebrush communities extensively for winter and summer range.

Expansion of pinyon juniper into sagebrush communities in the Western United States has been attributed to overstocking of livestock, the reduced role of fire, and optimal climatic conditions during the late 1800s into the early 1900s (Tausch et al. 1981; West, 1984; Miller and Wigand, 1994).

Current expansion of pinyon juniper has occurred on more productive sagebrush sites with deep well drained soils. Fire is believed to have been important in shaping sagebrush communities in the Intermountain West before Eurasian settlement (Wright and Bailey, 1982; Miller et al., 1994). The decline in fire has been attributed to the reduction in fine fuels due to heavy livestock grazing in the late 1800s, reduced anthropogenic set fires during the 19th century (Burkhardt and Tisdale 1969, Miller et al., 1994), and suppression of wildfire from 1910 to 1930 (Agee 1993; Miller and Rose, 1999).

Sagebrush ecotypes provide forage for livestock, habitat for wildlife, soil stability, recreational sites, and landscape diversity. This habitat is important for a variety of wildlife species including sage grouse, mule deer, rocky mountain elk, and many songbirds. It also provides nesting habitat for many bird species including sage grouse, Brewer's sparrow, and vesper sparrow as well as the ferruginous hawk. It is also common to see a variety of other species such as Richardson's ground squirrel and coyote. Sagebrush habitats are crucial to wintering big game and greater sage-grouse. Wildcat and south horn sage grouse leks are found on the North Zone or Manti Division. This sage grouse population is non migratory and stays all winter on the sagebrush plateau at approximately 8,500 to 9,000 foot elevation.

Trends

Trend data shows pinyon and juniper trees are invading sagebrush ecotypes across the forest, reducing the quality and quantity of sagebrush communities. In addition, increases of sagebrush-cheatgrass ecotypes shows that cheatgrass may be increasing and shortening fire return intervals within sagebrush ecotypes. Management decisions (fire suppression), climate change, and overgrazing by livestock have attributed to the expansion of piñon juniper into sagebrush ecotypes on the Forest and many other areas in the intermountain region.

Specific trends from observed and quantified data lend evidence that pinyon juniper stands in some areas are indeed expanding into sagebrush and other ecotypes. Management decisions (fire suppression), climate change, and overgrazing by livestock have attributed to the expansion of pinyon juniper into sagebrush ecotypes on the Forest and many other areas in the intermountain region.

More frequent and large-scale fires are predicted in the future within pinyon juniper/sagebrush ecotypes. Climate influences size and frequency of fire where perennial native herbaceous understories have been replaced by exotic annuals such as cheatgrass. Growing conditions induced by climate that favor cheatgrass can influence the size of the area burned (Knapp 1996; Miller and Tausch 1999).

Wetter than average precipitation in the late 1800s to early 1900s, fewer fires, and intensive livestock grazing facilitated the expansion of pinyon juniper trees into sagebrush ecosystems (Tausch et al.1981; Tausch 1999; Miller and Tausch 2001). Expansion of pinyon juniper into sagebrush areas is likely not generally due to fire exclusion, but to other factors (for example, climate, overgrazing) (Arno and Gruell 1983; Miller and Rose 1999; Baker 2006). Expansion of pinyon juniper and the introduction of exotic annual grasses, such as cheatgrass, has changed the fire return interval within both sagebrush and pinyon juniper woodland ecosystems.

Results from Walker (1997) show after 23 years following the introduction of exotic grass species, the communities, though changing in density and cover, have not yet stabilized in plant dominance. The introduced grasses are increasing in density, cover, and production at a greater rate than are the native grasses that have shown a reduction in diversity.

Stressors and Drivers

Climate

Sagebrush plant community distribution and dynamics across the landscape are primarily driven by climate. In the last 30 years, the average maximum temperature within the IAP Plateau Region where the Forest resides has increased 0.081°F per year, with an estimated 5°- 10°F increase in the maximum temperature by the mid-21st century under RCP 4.5 and 8.5 (USDA 2016f). Snowpack has declined across the Western United States since about 1950, with milder climates. Snowpack losses are likely to increase in the future (Chambers and Pellant 2008). Sagebrush species depend primarily on snowpack for spring moisture.

Cheatgrass has spread rapidly through sagebrush rangelands. The ecology of cheatgrass cannot be separated from the occurrence of wildfires in sagebrush communities. Cheatgrass provides an easily ignitable fuel that allows fire to spread from shrub to shrub (Young et al., 1987) thus, cheatgrass reduces the fire return interval in sagebrush ecotypes. If burned areas are not reseeded with other grass, forb, and shrub species, cheatgrass will dominate the area and the stable state will shift towards a sagebrush-cheatgrass ecotype. Sagebrush-cheatgrass ecotypes generally have less species diversity as a result of competition.

Mountain Brush Communities

The mountain brush community covers approximately 370,429 acres (about 26 percent) and is found among 45 different LTAs on the Forest. This community is a mix of curl leaf mountain mahogany, high mountain brush, manzanita, mountain maple, oak brush, true mountain mahogany, and high-low-salt desert shrubs. The mountain brush community is rich in diversity of forbs and associated grasses. Mountain brush communities usually occur between 5,000 and 9,500 feet. Most of the mountain brush on the Forest is in intermediate and late structural stages, which reflects the lack of recent natural disturbance, specifically fire.

Since European settlement, the natural disturbance regime, usually fire, has been interrupted. Mountain brush communities are used by wildlife year-round. It is also important spring, summer, transition, and winter range for big game, such as rocky mountain elk, mule deer and black bear, providing both forage and cover components. Mountain brush ecotypes also provide forage for livestock, soil stability, recreational sites, and landscape diversity. This cover type is used by livestock in the spring, summer, and fall.

Trends

Mountain brush species have increased in height, density, and aerial extent. This is most likely due to an absence of fire combined with a reduction in livestock grazing since the mid-1900s (Austin et al. 1986). Cattle prefer available herbaceous vegetation over unpalatable woody species, such as mountain brush (including sagebrush). Increased grazing pressure from cattle will result in an increase in these woody species (Young 1989). Expansion of pinyon juniper into sagebrush, mountain brush, and other communities in the Western United States has been attributed to accumulation of stressors relating to grazing impacts, the reduced role of fire, and optimal climatic conditions during the late 1800s into the early 1900s (Tausch et al. 1981; West 1984; Miller and Wigand 1994).

Before Anglo-American settlement of the West, fires burned through much of the mountain brush communities as frequently as every 5 to 100 years (Wright and Bailey 1982). Active fire prevention policies and the reduction in the number of fires set by Native Americans has contributed to additional decreases in fire frequency (Miller et al. 1994, Chambers et al. 1999) which reduce mountain brush and other community types on the Forest. Additionally, pinyon-juniper have also expanded into un-grazed sagebrush/mountain brush communities (Knapp and Soule 1998; Soule and Knapp, 1999, 2000).

Stressors and Drivers

Climate and Fire

Mountain brush plant community distribution and dynamics across the landscape are primarily driven by climate and fire. In the last 30 years. The average maximum temperature within the IAP Plateau Region where the Forest resides has increased 0.081°F per year within an estimated 5°-10°F increase in the maximum temperature by the mid-21st century under RCP 4.5 and RCP 8.5 (USDA 2016f). Snowpack has declined across the Western United States since about 1950, with milder climates. Snowpack losses are likely to increase in the future (Chambers and Pellant 2008). Mountain brush species depend primarily on snowpack for spring moisture and monsoon for summer moisture.

Snowpack losses are likely to increase in the future (Chambers and Pellant 2008), and spring melt-off has begun earlier in the season. These types of climatic condition shifts will effect perennial mountain shrub communities on the Forest, especially high elevation shrub communities.

Alpine Vegetation Communities

Alpine communities occur above tree line and are dominated by herbaceous or shrubby vegetation (TNC 2006). The alpine community above 11,000 feet represents about 0.6 percent (about 1,361 acres) of the Forest plant communities. True alpine communities are found only on the La Sal Mountains. Low-growing cushion plants are prevalent to dominant in many parts of the system. The plants found in the alpine communities are often unique to that harsh environment and include an endemic La Sal Mountain species, the La Sal daisy (*Erigeron mancus*), and several other species of interest. Alpine ecosystems are strongly influenced by position in the topography, wind, snow deposition and the short growing season.

Since 2015, the Forest in partnership with the Utah Division of Wildlife Resources has been collecting data from vegetation study sites in La Sal Mountain alpine communities. Besides monitoring the frequency of occurrence of several rare plant species, the data illustrates the high diversity and unique species composition of these high elevation plant communities.

Wildlife species that occur predominantly in alpine habitats are pika and black rosy-finch. Other wildlife such as mule deer, black bear, yellow-bellied marmots and golden eagles also use alpine communities. Mountain goats were introduced to the range in 2014 by the Utah Division of Wildlife Resources. These ungulates are year-round residents of the alpine and barren rock/talus habitats.

Trends

The Forest is currently collecting vegetation and ground cover data from numerous alpine sites on the La Sal Mountains. Preliminary analysis of the data found no evidence that either of the target plant species monitored (La Sal daisy or boreal rock-jasmine) were decreasing over time. However, the number of sites where dung and grazing were observed increased from 2015 and 2017. Treatment differences were difficult to detect due to relatively low sample sizes for the treatment combinations and high variability in counts among sites, but mean counts for La Sal daisy were higher for low recreation use than high recreation use, and for low ungulate use than high ungulate use. This indicates that continued monitoring is warranted. Synthesis of the ground cover data indicated no trend in the probability of graminoid occurrence, the probability of forb occurrence declined over time. Also, sites with high ungulate use in 2017 had lower probability of forb cover than those with low ungulate use in 2015 and 2016.

Stressors and Drivers

Drivers of the community include elevation, cold, snow, short growing season, and facilitation (nurse plants) for seed and seedling protection (TNC 2006). Stressors include ungulate use and herbivory by small mammals (pika, vole, gopher, etc.) (TNC 2006), recreation, and projected climate change. Tundra (i.e., alpine) habitats are sensitive to persistent trampling by humans and are extremely slow to recover (St. Clair et al. 2007). An additional stressor on the alpine community in the La Sal Mountains is the introduction of non-indigenous mountain goats in 2013. The number of mountain goats continues to increase, with a population objective of 200 animals (UDWR 2013).

Barren Rock Communities

The barren rock community covers approximately 73,516 acres, is comprised of barren rock outcrops and ledges, and is found among 44 different LTAs on the Forest.

Barren rock communities are interspersed with all other vegetation communities and predominantly the woodland community, which includes pinyon/juniper and mountain brush habitats. The largest composition of barren rock and ledges on the North Zone or Manti Division is within the eastern escarpment LTA, which is found along the eastern boundary of the Manti division. This LTA, as well as the desert mesas and Book Cliff Mountains to the east, supports one of the largest nesting densities of golden eagles in the Western United

States. On the South Zone or La Sal Division, the Dissected Mesa's and Canyon Slopes LTAs comprise the largest composition of barren rock and ledges.

This community is important for a variety of wildlife species, including golden eagles, peregrine falcons, mountain lions, ringtails, cliff swallows, and provides roosting habitat for many bat species including spotted bats, western pipistrelles, Allen's big-eared bat, big free-tailed bats, pallid bats, Brazilian free-tailed bats, western small-footed myotis, and Yuma myotis. The areas are used by golden eagles for nesting and foraging, and are important during raptor migration. It is also common to see a variety of reptiles such as gopher snakes, ornate tree lizards, and eastern fence lizards. Bare ground habitat is an important component to some pollinator habitat, providing for ground-nesting bees (Gilgert and Vaughan 2011) such as the Western bumblebee found within the plan area. Lichens are also associated with exposed rock surfaces, drier sites and bare ground (Maccacken et al. 1983). The Forest currently has a lichen air monitoring program (Gatherum et al. 2014).

Rangelands

Rangelands are defined as all lands producing, or capable of producing, native forage for grazing and browsing animals, and lands that have been revegetated naturally or artificially to provide a forage cover that is managed like native vegetation. They include all grasslands, forb lands, and shrub lands; and those forested lands that can, continually or periodically, naturally or through management, support an understory of herbaceous or shrubby vegetation that is forage for grazing or browsing animals (USDA Forest Service 2005). All of the vegetation communities in which rangelands are found are discussed above in this assessment under Forested and Non-Forested Veg Communities.

Soil type and health is a principal factor determining the potential for forage production of a rangeland within a particular climate, and it is critical that enough vegetation cover is maintained to protect the soil from erosion. (Holechek et al. 2011).

Livestock grazing influences ecological processes such as the water cycle, nutrient cycling, energy flow, and community dynamics. Activities related to livestock grazing can impact species through habitat disturbance, modification, or a direct loss of individuals by grazing or trampling. Historical grazing practices altered plant composition and density. Before establishment of the Forest in the early 1900s, livestock grazing was unmanaged, causing long-lasting environmental effects. There are still areas exhibiting remnants of those effects, but for the most part the ecological integrity and diversity of vegetation species has since rebounded through years of proper stocking management of the intensity, duration and timing of grazing use

The most recent data used in this assessment is from the draft planning efforts in 2006 and the 2011 Forest Plan Monitoring and Evaluation Report: 2001-2010. These sources indicate an overall condition of rangeland acres divided into riparian and upland acres on the Forest. However, these reports do not provide enough information to be able to discuss rangeland health by vegetation group, which will be done when the Forest Inventory Analysis Program data is received. Additionally, the draft planning efforts in 2006 used suitable acres, while the current planning effort will be using capable acres, which are acres that have physical/biological attributes that would support long-term sustained cattle and sheep grazing, as the definition of suitable has changed.

There are 7,800 capable riparian acres and 870,900 acres of capable upland range (USDA 2016e). Total capable acres on the Forest is about 878,700.

Rangeland health is defined the Region 4's Rangeland Ecosystem Analysis and Monitoring Handbook (FSH 2209.21) using the terms functioning and functioning-at-risk.

- Rangelands are functioning when they are meeting a desired condition identified in long term specified management objectives, standards, and/or guidelines; and have the capability across the landscape for renewal, for recovery from a wide range of disturbances, and for retention of its ecological resilience.
- Rangelands are functioning-at-risk when short-term objectives are being met but functionality criteria are not yet present.

The four indicators used to determine rangeland health are: ground cover, presence of invasive/noxious species, shrub cover and species composition. Since 2006, there have been 40 greenline studies established in riparian areas across the Forest. Data from 2011 and 2016 showed upward trends in these riparian areas and that most of the areas were meeting desired conditions. Therefore, it is likely that several riparian acres would be moved from the undetermined, with most now functioning and some functioning at risk. There have also been new upland range trend study sites and other types of range monitoring sites established in new upland areas. In general, the upland range trend studies done between 2001 and 2010 showed an improvement in ground cover and species composition (USDA 2011a). Therefore, it is also likely for upland acres that acres have moved from undetermined, with most now functioning and some functioning at risk as shown in Table 19.

Table 19. Rangeland health on the Forest based on percentage of acres determined to be meeting or moving toward 1986 forest plan desired conditions.

Capable Acres	Functioning	Functioning at Risk	Undetermined
Riparian Acres	3,120	620	4,060
Upland Acres	365,770	60,970	444,160
Total Acres	**368,890**	**61,590**	**448,220**

Areas exist, where there are issues with the amount of ground cover and species composition. The Forest has 15,900 acres of inventoried noxious weeds, which includes weeds that have been inventoried and treated on private land inholdings. Some of these acres would be considered as rangelands at risk, depending on the type of noxious weeds present and density. There are areas on the Forest where shrub cover is higher than what is desired or expected for the site.

Trends

The draft planning efforts in 2006 and the 2011 Forest Monitoring Report state that generally, data from the range trend studies show the composition of desirable plant species and ground cover has increased. The data indicate that generally, ground cover has improved in the past 30 years. This trend may be in part due to decreases in stocking, but also improvements in grazing management.

A NRV considers ground cover (especially canopy cover and litter), which can change from year to year and is dependent on climate (Holechek et al. 2011). Thus, the precipitation and timing of precipitation should be considered when analyzing ground cover data. Range trend studies and photos and field notes show that in the dry years of 1999 to 2004, there were some decreases in ground cover. Also, the amount of gopher activity can greatly influence ground cover in higher elevation grass and forb lands (Goodrich et al. 2015).

3.2.3 Watersheds and Water

Indicators

Water quality, water quantity, and watershed condition.

Water Quality

Existing and Historical Influences

Underlying bedrock geology may influence sediment levels and associated water quality analytes such as turbidity where underlying bedrock is easily erodible. The underlying bedrock geology also functions as a source of soluble salts in formations such as the Mancos and Arapien Shales common on the Forest (U.S. Geological Survey 1981, 1986, Millennium Science and Engineering 2003, USDOI BLM 2008). These salts go into solution, and into the water column, where groundwater daylights at the base of topographic breaks, such as the Book Cliffs, along fault zones, or where saline rich springs merge with surface water, (U.S. Geological Survey 1981, 1986, Millennium Science and Engineering 2003, USDOI BLM 2008). These influences are present in the North Zone, especially in the San Pitch River Valley and in areas associated with the South Zone (USDOI BLM 2008). These areas with high salt concentrations are tied directly to high levels of total dissolved solids. State of Utah water quality criteria exist for both turbidity and total dissolved solids.

Land management activities common on the Forest include grazing, agriculture, timber, recreation, and mining. Irrigation, in addition to natural sources, contributes to increased dissolved solids. Evapotranspiration concentrates salts either in soils or on soil surfaces (U.S. Geological Survey 1981, Millennium Science and Engineering 2003). Land management activities, such as timber harvest and vegetation management, road-related activities, dams and diversions, fire, and livestock grazing, in higher elevation riparian areas are also noted to impact water quality criteria such as stream temperature and turbidity, resulting in impacts to water quality (USDA Forest Service 2014).

Water Quality Limited Streams

Review of Colorado's 2012 Integrated Report, shows there are no 303d listed streams within the portion of the Forest located in Colorado (State of Colorado 2012a, b and c). GIS data for Colorado shows that the 303d limited segment for Roc Creek ends at the Forest boundary, although the headwaters for that stream, which are not water quality impaired, are on Forest.

In Utah, 303d data shows that 42 of the 44, 5th level watersheds on the Forest have impaired stream acreages. This means that 95 percent of the 5th level watersheds contain a Category 4A, 5, or 4A/5 stream. Twelve 5th level watersheds contain Category 4A or 5 streams (streams w/ total maximum daily load (TMDL) prescriptions for a water quality analyte(s) or needing a TMDL). Primary causes of impairment in these twelve watersheds are temperature, total dissolved solids, selenium, bio-assessment (an observed versus an expected assessment for macroinvertebrates), dissolved oxygen, gross alpha (a measure of radioactivity), pH, phosphorous, and sedimentation.

Trends

Past Conditions (30 years or more)

Water quality is assumed to have improved over time with the implementation of grazing management and watershed restoration activities. Continued improvement is assumed with the development and implementation of best management practices. Past data was not available to determine how miles of 303d listed streams have changed over time. Table 20 and Table 21 summarize water quality and quantity ratings for 2011 and 2016. Generally, these numbers indicate an improvement (USDA 2011c, USDA 2016e).

Table 20. Summary of water quality ratings by number of 6th level watersheds in each rating in 2011 and 2016.

Rating	2011	2016
Fair	17	11
Poor	10	9

Table 21. Summary of water quantity ratings by number of 6th level watersheds in each rating in 2011 and 2016.

Rating	2011	2016
Fair	30	28
Poor	4	1

Potential Future Conditions (40 years)

Adequate water quality is fundamental to support aquatic habitat and geographic ranges of aquatic habitat and wetland species (Poff et al. 2002). The primary driver for determining future potential water quality conditions is climate change. Potential stressors include wildfire and other natural disasters, alteration of vegetative cover, increasing water demands (grazing, industrial, municipal, and recreational), coal mining and methane production, increasing demand on riparian areas and land management activities including grazing, road construction and maintenance and timber harvest.

Climate change analysis indicates that maximum daily temperatures and minimum daily temperatures have been rising since the 1960s and are predicted to continue rising, by as much as 50° F, through the year the mid-21st century (USDA 2016f). For the past 50 years, hydrologic regimes of the Western U.S. have trended towards earlier snow melt runoff, reduced water yield, lower summer flows, and increased or altered flood risk (Wenger et al. 2010). Each of these alterations play a role in changes to water quality, especially for stream temperature (Poff et al. 2002, Wenger 2010, and U.S. Geological Survey 2005). The primary effects to water quality, from altered flows are increased salinity, sedimentation, and water temperature (US E.P.A and US Geological Survey 2015). As water dependent ecosystems adjust to lower flows, warmer water and increased risk of flooding and the timing of those floods, impacts to water quality would occur. Such modifications may degrade aquatic habitat and channel morphology.

Adaptations in land management will need to focus on the conservation and protection of water quantity to mitigate the effects of decreased water yield and earlier snowmelt to help protect water quality. Conservation and protection of riparian and wetland vegetation will be needed to provide shade cover and bank stabilization in order to mitigate stream temperature increases and potential sources of sediment. Management of ground disturbing activities, such as road building and construction, grazing, timber harvest, and mining, will need to focus on preventing or minimizing the introduction of sediment into streams and preventing or minimizing disturbance. Recreational activities will need to focus on minimizing bank disturbance, human waste management and shade preservation.

Water Quantity

Stream hydrology (quantity and timing of peak flows) is known to strongly affect aquatic community structure and the health of fisheries and macroinvertebrates (Wenger et al. 2010, Cummins 2016). Water quantity is fundamental to shaping channel morphology (the dimensions of a stream channel-width, depth, and meander wavelength and gradient) and maintaining stream flow and temperatures.

Mountain precipitation in the form of snow, the amount of snow and the length of time its stored in the mountains, forms the chief source of water that supports agricultural, industrial and domestic use, as well as the Forest's hydrologic and aquatic ecosystems. It is estimated that up to 75 percent of water supplies for the Western United States are from snow melt (USDA Forest Service 2013 # 095, U.S. Geological Survey 2005). Location on the forest also influences the amount of precipitation, with the Book Cliffs area receiving less precipitation (rain and snow) than the Wasatch Plateau (U.S. Geological Survey 1981). In addition, higher elevation mountainous areas receive more snow than low elevation valley or basin floors.

Water Quantity Ratings

Water quantity ratings were determined for each sixth level watershed involved with the Forest as part of the watershed condition framework/watershed condition class process defined in Potyondy and Geier 2011. This process is required for use on national forests and is discussed in more detail under the section "Watershed Condition", subsection Current Watershed Condition Classes.

In 2016, there were 91 sixth level watersheds with a class 1 rating (good), 28 with a class 2 (fair), and one watershed (Left Fork of Huntington Creek) with a class 3 (poor) rating. Natural variability of flow is healthiest in receiving class 1 watersheds. Dams and reservoirs, erosion, inholdings, flooding, mining, fire, logging, roads, historic and current cattle and sheep grazing, landslides, oil and gas exploration, private inholdings, and sagebrush treatments contributed to the rating of class 2 on the 28 watersheds with a fair rating. The 5th level watersheds, that include 6th level watersheds with a class 2 rating for water quantity, are: Chicken Creek, Cottonwood Creek, Coyote Wash, Ferron Creek, Headwaters Muddy Creek, Huntington Creek, Indian Creek, La Sal Creek, Lower San Pitch River, Middle San Pitch River, Mill Creek, Recapture Creek, Twelve mile Creek, Upper San Pitch River, West Creek and West Paradox Creek-Dolores River.

The class 3 rating for the Left Fork of Huntington Creek is due to the presence of the Miller's Flat Reservoir, Rolfson Reservoir, Huntington Reservoir, and Cleveland Reservoirs (USDA 2016e). The Seeley fire also played a role in designating the watershed condition as poor. A rating of class 3 assumes that quantity and timing for water quantity are outside the NRV. The 5th level watershed, Huntington Creek contains the Left Fork of Huntington Creek 6th level watershed.

Water Quantity Uses

Points of diversion are a leading cause of human-related flow alteration on the Forest. In the North Zone, 74 percent of the point to point diversions are located on-forest and in Moab, the South Zone, approximately 50 percent of the surface diversions are located on-forest. It should be noted that in the Monticello, South Zone 48 percent of the surface diversions are located on-forest. Basic uses for diversions, are domestic, irrigation, municipal, power, stock watering, and mining (State of Utah 2016b). The principal uses within the 5th level watersheds, and within the forest boundaries, are domestic use, municipal, irrigation, and stock watering.

Irrigation diversions and transport facilities are widespread across the forest, as actual irrigation use occurs off-forest.; there are 27 irrigation ditch and pipeline permits authorizing 34 miles of irrigation ditches and 5 miles of irrigation pipelines. Consumptive use for irrigation across the Forest ranges from moderate to high. Irrigation diverts flow and alters natural flow regimes and contributes to increasing concentrations of total dissolved solids.

Municipal/Domestic Water Use

Documented municipal water use on the Forest extends back to at least 1928 and includes recreation sites and camps, water districts, mills, national monuments and government offices, communities, special service districts, rest stops, water companies, and subdivisions. At least 34 communities obtain water from the Forest. There are 37 water transportation pipeline permits authorizing 73 miles of water pipeline. There is one municipal watershed designated on the Forest. There are 318 water system facilities, consisting of consecutive connections, intakes, springs and wells, across the 5th level watersheds. The Huntington Creek, Lower San Pitch River, Middle San Pitch River, Mill Creek, Scofield, Upper San Pitch River and West Creek 5th level watersheds have the highest numbers of water system facilities, consisting mainly of springs and wells. Eighty-eight of the 318 water systems, or 28 percent, are located on-Forest in the Huntington Creek, Lower San Pitch River, and Middle San Pitch River 5th level watersheds. Seventy-five of these 88 water systems are springs.

Utah Drinking Water Protection Zones

Drinking water protection zones are required for both surface and groundwater (State of Utah 2016a (R309-605-7, R316-6), Foster, 2007). Twenty-one of the forty-four 5th level watersheds on the Forest, in Utah, contain surface water protection zones and cover a total of 676,795 acres. Within Forest boundaries 416,850 acres are involved with surface water protection zones or 62 percent of the total protection zone acreage.

Drinking water protection zones are predominantly located on the North Zone, with only minor amounts on the South Zone, Monticello District.

Colorado Drinking Water Protection Zones

Less than 2 percent of the Forest is located within the State of Colorado. Within this area in the State of Colorado no surface water protection zones were noted based on GIS data received from the state. However, a 5.5 mile segment of Roc Creek (Rock Creek 5th level watershed) and a 0.8 mile segment of La Sal Creek (La Sal Creek 5th level watershed) were present and are designated as water supply stream segments. Both segments flow into the Dolores River and contribute to water supplies for Dolores, Montezuma, and surrounding communities.

Three groundwater source points are Paradox Pipeline (spring #1), Gateway Canyons WS (Office Well #2), and John Brown Creek well. These groundwater sources are in the West Paradox Creek-Dolores River, John Brown Creek-Lower Dolores River, and John Brown Creek 5th level watersheds, respectively. These three groundwater sources are for a community water system (State of Colorado 2015). The Paradox Pipeline Co. groundwater source is surrounded by groundwater protection zones 1-2. The Gateway Canyons and John Brown Creek wells are surrounded by groundwater protection zones 1-3.

Sole Source Aquifers

There are several sole source aquifers—an aquifer that has been designated by the United States Environmental Protection Agency as the sole or principal source of drinking water for an area—located within the 5th level watersheds involved with the Forest. The Moab District contains two sole source aquifers: the Moab/Glen Canyon Group, and the Castle Valley-Fill Aquifer.

Developed drinking water in Castle Valley is primarily from private water sources that do not require protection zones. However, the use of valley-fill and fractured rock aquifers (sands, gravels, and colluvium) for municipal use does require protection zones because contaminants can move rapidly throughout recharge zones and the aquifer. The fractured rock Moab/Glen Canyon aquifer is vulnerable to contamination through exposure at the earth's surface, poorly constructed oil wells, increasing housing development, effects of septic system effluent, and other activities in the defined recharge area.

Supporting these concerns are requests by communities for the protection and management of NFS lands within recharge areas (USDA Forest Service 1986 and 2006a, Foster 2007, City of Monticello 2010). USDA Forest Service 2006b notes that additional Forest Plan direction is needed to prevent or limit impacts to drinking water protection zones. Further definition of drinking water protection zones on the Monticello District may be needed.

Reservoirs

Reservoirs are used as a source for storing snowmelt to supply water for irrigation, municipal, and industrial use. Forest corporate GIS data indicated that approximately 21 reservoirs covered about 819 acres of reservoirs located within the 13, 5th level watersheds containing reservoirs. In the 1986 Forest Plan, Chapter 2 (Management Situation) Table II-2 indicates that there are more than 1,818 acres involved with 69 lakes and reservoirs. During analysis of GIS data, the overlap of the Duck Fork, Ferron and Cleveland Reservoirs with North Zone drinking water protection zones was noted. In the South Zone of the Forest, the Camp Jackson Reservoir overlapped a drinking water protection zone but Scofield Reservoir, a known municipal source, did not show an overlap.

Power Plants

Two power plants are located near the Forest. The Huntington power plant is located near the town of Huntington and is located in the Huntington Creek 5th level watershed. The Hunter power plant is located near the town of Castle Dale and is located within the 5th level Cottonwood Creek watershed. Both plants are *recirculating tower types*, where coal is burned to heat water and create steam. The stream is then used to turn turbine blades, producing electricity (PacifiCorp 2011a and b, USGS 2010). Hunter consumes 4.5 million tons of coal and Huntington consumes 3 million tons (PacifiCorp 20011a and b).

At the Hunter power plant, water is withdrawn from the Joe's Valley and Millsite reservoirs. Water in these reservoirs comes from Cottonwood and Ferron Creek. During 2015, a total of 5,002 acre feet were used from the power plant's shares of water in the Cottonwood Creek Consolidated Irrigation Company and a total of 3, 645 acre feet were used from the Joe's Valley Reservoir (Humphrey 2015). The Huntington plant water is withdrawn from shares in the Huntington-Cleveland Irrigation Company and from Electric Lake Reservoir. The plant owns Electric Lake reservoir and surrounding lands. A total of 9,887 acre-feet was used in 2015 by the Huntington Plant (Leamaster 2015). Both plants withdraw more than 2 million gallons per day and use an estimated 96-98 percent of the water for power plant operations, with the remaining 2 to 4 percent lost to evapotranspiration (PacifiCorp 2015).

Trends

Past Conditions (30 years or more)

Data analysis of water quantity show four major trends: increasingly earlier runoff, lower summer flows, reduced total water yield, and increased or altered flood risk (Wenger et al. 2010, U.S. Geological Survey 2005). These alterations will modify snowpack residence time, the timing and volume of peak flows, center of flow mass, summer low flow volumes, and the amount of water available for use on the Forest (Cummins 2016). Reduced discharge will also result in alterations to groundwater aquifers and groundwater dependent ecosystems.

Potential Future Conditions (40 years)

Potential future stressors are wildfire and natural disasters; increased water quantity demands via grazing; increases in population driving increased industrial, irrigative/agricultural, recreational and municipal needs; coal mining and possible surface flow alteration and the alteration of discharge; low and peak flow volumes; and related effects to channel morphology and habitat.

Projections for precipitation amounts is variable and no clear trends have been defined. While air temperature is projected to increase over time, combined with changing amounts of precipitation, continued reductions to snow residence time, increased evapotranspiration, and reduced groundwater recharge define a picture of severely increasing pressure on water quantity (Cummins 2016, Jaworski 2016).

Adaptations in land management will need to focus on measures that reduce water consumption, reduction of losses through evapotranspiration, and inefficient use of water in human related activities, such as irrigation, household and municipal use. Adaptations to conserve water has the potential to play the lead role in reducing the amount of water needed to meet future demands. Improvements in securing favorable flows to meet Forest purposes and ecological function are needed. In addition, adaptations will need to examine the potential for transfer of agricultural waters to help close the gap on the demands for municipal and industrial waters (State of Utah 2014).

3.2.4 Aquatic Ecosystems

Aquatic habitats, both riparian and wetlands, on the Forest consists of 680 miles of stream fisheries and 1,765 acres of lakes and reservoirs. Riparian areas are the richest habitat type in terms of species diversity and wildlife abundance in Utah. Riparian and wetland habitats occur in all LTAs across the Forest and make up from less than 1 to 10 percent of the total area of each LTA.

Resources directly associated with these habitats include aquatic macroinvertebrates, fish, amphibians, reptiles as well as a variety of terrestrial species. These habitat components can be adversely impacted by improper grazing by livestock or big game, roads, recreational activities, invasive plant species, water developments, and drought.

Aquatic Species

Aquatic Macroinvertebrates

Aquatic macroinvertebrates including spring snails and the Utah sallfly (Swelta exquisite), serve as natural indicators of management activities undertaken within each watershed. The composition of the macroinvertebrate community is an indication of the quality of the aquatic habitat and reflects the condition of the entire drainage.

The 1986 Forest Plan includes aquatic macroinvertebrates as management indicator species. The Forest Plan was amended in 2006 to update the protocols used to collect macroinvertebrate data and to change the method used to analyze the data. The 2006 amendment did not alter the language regarding macroinvertebrate monitoring as an optional technique for selected projects. The Manti-La Sal National Forest has continued monitoring aquatic habitat using macroinvertebrate sampling but changed the type of appraisal method used. The methodology is similar to that being used by the Utah Division of Water Quality for macroinvertebrate monitoring. The State program selected relatively unimpaired representative streams as reference sites for different stream types. Monitoring has continued at baseline stations to characterize Forest-wide conditions; data analysis has been in cooperation with the Utah Division of Water Quality.

Since 2006, only two streams have been categorized as poor based on the macroinvertebrate sampling results. Johnson Creek on the south zone and Muddy Creek on the north zone of the forest. Both of these sites were monitored again and categorized as good and fair respectively based on updated results (USDA Forest Service 2014).

Fish

Water quality, temperature, flow rate, and timing of flow also impact fish species throughout the plan area. Changes in these variables can result in the movement of impacted species to other suitable, connected, habitat, or to population decline. Potential species of conservation concern include, the Bonneville and Colorado River cutthroat trout, and the bluehead sucker. Fragmentation of streams and other waterbodies can impede relocation and repopulation efforts. The distribution of the Bonneville, Colorado River, Yellowstone and Westslope cutthroat trout has declined >50 percent (IAP 2016). On the Forest, populations are sparse due to diversion and other non-native species, mostly in headwaters, the trend is stable moving slightly upward with conservation efforts (P. Manders pers. obs. 2016).

Watershed Condition

The Forest has 38, 5th level watersheds that intersect the Forest boundary or are located entirely within the Forest boundary. The Forest has 142 6th level watersheds located partially or entirely within the Forest boundary.).

Watershed Historical Background

Grazing of areas on the Forest began in as early as 1850 with the introduction of cattle, which dominated grazing into the 1880s, although heavy grazing by horses was also present. Sheep were introduced onto the land with increasing settlement and dominated grazing from roughly 1882-1903. Stocking levels during this time were excessive and range capacity exceeded. Grazing was focused in the higher elevations, which resulted in drainage headwater areas receiving the greatest impacts. In some areas on the Wasatch Plateau, vegetative cover had been reduced to only 16 percent. Reduction in cover though was noted throughout the Forest. In addition to grazing, fires were often set to “improve the range”. This practice also contributed to reduction of vegetative cover (Reynolds 1911, USDA Forest Service 1935, 1946, 1948, 2013 numbers 026, 151, 2016b). The commencement and continuation of flooding has been definitively tied to grazing and the loss of ground cover. With the loss of groundcover, infiltration rates and quantity are modified. As cover increases, runoff and sedimentation decrease and as cover is lost the reverse occurs.

The timing of concentrated precipitation, in combination with drastically reduced vegetative cover, led to a catastrophic situation on the Forest, with regards to flooding. The devastating cycle of catastrophic flooding began between 1881 and 1888 (Reynolds 1911, 1911, USDA Forest Service 2016b), and occurred across the Forest, with literature showing floods in 1883-1901, and 1905-1938, 1946 and 1983-1984 (USDA 1947, Reynolds, 1911, USDA Forest Service 1935, 1948 and 1957, 1986 and 2016a and b). Past catastrophic flooding has devastated the areas natural channel morphology. The floods have extended out to valley floors, depositing mud, boulders, trees and other debris into towns including Manti, Ephraim, Mt. Pleasant, Huntington, Orangeville, Ferron, and Salina. Landslides occurred in Manti and Cottonwood Canyon in 1974, 1980, 1983, and 1984 (USDA 1986, 2016b). Damages included washed out/buried roads, buried trails, lost or damaged bridges, campgrounds, range fencing, farms, irrigated crops and fields, livestock, water reservoirs, lakes and flood control structures were washed out, destroyed or buried under massive deposits of sediment. Dam failures also occurred and municipal watersheds were damaged. In addition damage to streams, fisheries and riparian areas were impacted. Impacts included down-cutting, channel over-widening, channel degradation and shifting. (Reynolds 1911, USDA 1947, USDA 1957, 1983b, 1984f, 1986).

Recorded fire history extends from 1910 to 2015. Approximately 196,007 acres have burned in 38 watersheds during this time with about 161, 862 acres being within the Forest boundary. In 2012, the large and devastating Seeley Fire began on the Forest, with a lightning strike on June 26. By the time it was contained, the fire had burned 48,050 acres located in the Huntington Creek, Scofield Reservoir, Gordon Creek, and Miller Creek 5th level watersheds. In the past, the area provided opportunities for scenic viewing, camping, hiking, fishing, and hunting, but during the fire several campgrounds were consumed by fire. In the aftermath of the Seeley Fire, the area has been a hazardous landscape with flash floods, debris flows, road damage, hazard trees, damage to recreation sites, rolling logs and boulders, stump holes, unstable soils, and landslides. The fisheries in Huntington Canyon were wiped out by debris flows and flooding, which threatened the culinary water supply for the City of Huntington (http://etv10news.com/huntington-canyon-continues-to-recover-from-seeley-fire/). Forest personnel indicate that this watershed has stabilized and has not experienced recent flooding (Meccariello 2016).

Watershed restoration efforts started in 1903, with the establishment of the Manti National Forest. The first efforts included removing sheep and the prohibition of grazing in the head of Manti Canyon and another request in 1910 to ban grazing in steep sloped headwaters; however, there was a lack of enforcement with these bans (USDA Forest Service 2013 numbers 056 and 151, Reynolds 1911). With the establishment of the Great Basin Research Station, and establishing the definitive relationship between grazing and erosion, range management gradually became established as an accepted practice (USDA 2013 008, 026, 049, 050, 056, 108, 110, 151, 173-175, 181, Stevens et al. 1991, USDA Date Unknown). Watershed restoration efforts in the 1950s in areas within the Wasatch Plateau, Johnson and Recapture Creeks included plowing, furrowing, trenching, and seed to prevent soil erosion. In the late 1950s, continued actions were taken to balance livestock uses with allotment capacities. Into the mid-1960s, rangeland analysis was initiated and extensive trenching furrowing and reseeding in the Ferron Creek watershed and additional work in the Cottonwood Creek drainage occurred for watershed restoration. Common use by sheep and cattle ended (USDA Forest Service 2016b). Extensive and well documented restoration efforts, such as control of erosion and sediment production, stream clearing, stream bank stabilization, are associated with the 1983-1984 floods (USDA 1983b, 1984b, c, d, e and f, 1985b, c, d and e, 1986). By 1989, the Bureau of Reclamation noted that sediment loads were decreasing and that grazing restriction, seeding programs and upstream water storage features were effective (USDA 2016b). In 2016, 15 of the 120 watersheds, given a watershed condition framework rating, were rated as in fair condition for rangeland vegetation. None received a poor rating (USDA 2011a, 2016e).

Recently, Forest restoration activities have included vegetation treatment, prescribed burning, wildfire use, pesticide applications for insects, and watershed restoration. In 2015, the practice of designating priority watersheds was established (USDA 2015a). For fiscal year 2016, the Right Fork Huntington Creek, Johnson Creek, Dry Wash, and Cottonwood Creek were designated as priority watersheds for the Forest. Two 6th level watersheds, Dry Wash and Cottonwood Creek were also designated in 2016 as priority watersheds. Reasons for listing Johnson Creek and the Right Fork Huntington Creek include fire, dewatering of streams, extensive unauthorized road systems, vegetative cover and health and fuel loading. Rationales for Dry Wash and Cottonwood Creek were identified as data gaps (Appendix 5).

Current Watershed Condition Classes

Sixth level watersheds involved in the national forest system are currently required to have a watershed condition classification assigned to them (Potyondy and Geier 2011). Watershed condition classification (WCC) is the process of describing watershed condition in terms of 3 classes that reflect the level of watershed health or integrity.

- Class 1 watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. This rating equates to functioning properly.
- Class 2 watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. This rating equates to functioning at risk.
- Class 3 watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. This rating equates to impaired function.

The basic model used in the WCC provides a systematic, flexible means of classifying and comparing watersheds based on a core set of national watershed condition indicators. These indicators are grouped according to four major process categories: aquatic physical, aquatic biological terrestrial physical and terrestrial biological. Each of these four process categories, are assigned a rating, for each 6th level watershed on the Forest. The Forest has 142 6th level watersheds located partially or entirely within the Forest boundary.).

In 2011 all 6th level watersheds on the Forest were rated as to their general condition following direction within the National Forest Service Watershed Condition Framework (WCF) (USDA 2011a and b). In 2011, 113 sixth level watersheds were rated as class 1 and 30 were rated as class 2 (USDA 2011a). In 2016, WCC ratings were conducted on 120 of these watersheds and 102 were rated class 1 and 18 were rated as class 2. The only watershed to change categories was Left Fork of Huntington Creek due to the 2012 Seeley wildfire. Twenty-two watersheds were not rated as the percent area of the watershed located on NFS land was minimal or ratings were not done. In the watersheds rated as class 1, since they are defined as functioning properly, it is assumed that natural ranges of variability are generally present.

Proper Functioning Condition Data

Another measure of riparian and stream condition are Proper Functioning Condition (PFC) surveys (USDOI BLM 1998) which is often used in conjunction with range management. PFC surveys have been conducted at selected sites Forest's South Zone to assess stream and riparian health. PFC data was not collected on the North Zone.

PFC data was collected in the Comb Wash-San Juan River, Cottonwood Wash, Dark Canyon, and Indian Creek, La Sal Creek, Mill Creek, and Roc Creek 5th level watersheds between 2005 and 2012. Survey results in Cottonwood Wash, Dark Canyon, Indian Creek, Mill Creek and Roc Creek 5th level watersheds were mostly in proper functioning condition. However, the La Sal Creek 5th level watershed had the majority of its surveys showing a functional at risk result. The functional at risk ratings found in 5th level watershed La Sal Creek were related to impairment of channel, floodplain and/or riparian impairment, and degradation.

Trends

Past Conditions (30 years or more)

Major degradation of watershed conditions occurred from around 1880 to 1903 due to overgrazing, which lead to a lack of vegetation, excessive erosion, and flooding. Since 1903 watershed restoration activities have occurred, beginning mainly in the 1950s with contouring, furrowing, and seeding. Restoration activities have also been implemented to deal with the aftermath of severe flooding and landslides in the early 1980s. The combination of improved land management practices and best management practices implementation have, overall, resulted in improved watershed condition since the period of 1880 to 1903.

Potential Future Conditions (40 years)

Potential stressors include the consequences of altered precipitation amount and type, snow storage time, and increasing temperatures as well as increased riparian and recreational area use, increased water demand associated with increasing populations, agricultural/irrigative use and industry, grazing and natural disturbances.

Changes can be expected to modify aquatic habitat type and extent, alter vegetation community types and accelerate evapotranspiration, reducing available flow volume, and drying out soils faster. The inter-connectedness of these components cannot be over-emphasized, and changes in one element can act synergistically with others, compounding magnitude and severity of effects (Poff et al. 2002).

Adaptations in land management will need to focus on both the programmatic and project level. Water resource management will need to be a priority at all levels to ensure healthy ecosystems. Changing water use practices to more efficient methods and updating and improving infrastructure planning, so that the most efficient options for using water are incorporated, will be important. Developing strong working relationships with partners and other agencies, involving watershed condition and restoration, water quantity, and water quality would provide opportunities for prevention, mitigation, and conservation, as well as for coordinating demands and needs.

3.2.5 Riparian Ecosystems

Drivers, Stressors, and Indicators

Key Ecological Characteristics (KECs) were developed to measure composition, structure, function, and connectivity, as it relates to riparian ecosystems. Scientific literature and agency reports were used to develop a list of drivers and stressors that influence the KECs. Indicators of KECs status that could be evaluated with available data were identified as shown in Table 22.

Table 22. Drivers, stressors, and indicators for key ecological characteristics to assess riparian ecosystems.

Key Ecological Characteristics	Drivers	Stressors	Indicators
Distribution of Riparian Ecosystems	Surface flows, groundwater availability, groundwater discharge	Conifer encroachment, Upland vegetation encroachment, Fire suppression, Diversions, Dams, Agriculture, Development	Field-sample Riparian Vegetation, Aerially Mapped Riparian Vegetation, Riparian Vegetation Departure Index
Groundwater and Surface Water Fluctuation	Precipitation, temperature, geological setting, beaver activity	Dams, Diversions, Mines, Roads, Recreation, Spring development, Livestock use, Timber harvest, Insects and disease, Wildfire, Conifer encroachment,	Precipitation and Temperature Change, Spring Distribution, Water Levels
Floodplain condition	Beaver activity, geological setting	Dams, Diversions, Invasive plants, Wild Ungulate use, Livestock use,	Riparian Vegetation Conversion Type, Riparian Condition

Key Ecological Characteristics	Drivers	Stressors	Indicators
		Roads, Recreation, Timber harvest, Wildfire, Fire suppression, Beaver removal	Assessment, Terrestrial Condition Assessment
Channel and bank stability	Beaver activity, stabilizing vegetation	Livestock use, Roads, Recreation, Beaver removal, Floods	Vertical stability; Ground cover; Stability rating, Percent late seral vegetation

Additional information on riparian function and condition in this report is found under “Watershed Condition, Proper Functioning Condition Data”, which is found above this riparian section.

Distribution of Riparian Ecosystems

Riparian ecosystems are characterized by unique vegetation communities that provide physical, hydrological, and biotic services across forest landscapes. Essential physical functions, such as flood abatement and soil stabilization, are performed (Hubert 2004). Riparian vegetation is valued as critical wildlife habitat. Distribution of riparian ecosystems is therefore important to watershed function and habitat connectivity on the Forest.

In Western national forests, riparian ecosystems are largely associated with floodplains (Cooper and Merritt 2012). In general, floodplains of intermittent and perennial stream channels have surface flows and groundwater adequate to support riparian vegetation. Significant changes to surface flows and vegetation communities have occurred throughout the arid West, leading to changes in distribution of riparian ecosystems (Webb et al. 2007). A first step in assessing the current status of riparian ecosystems is determining how current distribution differs from pre Euro-American conditions.

Abajo Mountains, Mesas, and Canyonlands

This topographically diverse landscape consists of domed igneous mountains and sandstone cliffs, mesas, and canyons. The Abajo Mountains are composed of two unequal parts, both domed igneous mountain groups (Kilbourne 2016, Witkind 1964). The smaller Shay Mountain in the north is separate from the more southern, main mountain masses that include Abajo Peak (Witkind 1964). Both groups are surrounded by sedimentary rocks that are highly dissected at their base (Kilbourne 2016). There are 10 LTAs in this region, and they are subdivided into the Abajo Mountains types in the northeast and the Mesas and Canyons types in the west.

Riparian vegetation types vary with elevation and geological setting in the Abajo Mountains, Mesas, and Canyons. A relatively small proportion of streams are perennial, 0 to 17 percent among LTAs, and intermittent streams and spring are scattered resulting in a similarly scattered distribution of riparian ecosystems as shown in Figure 16.

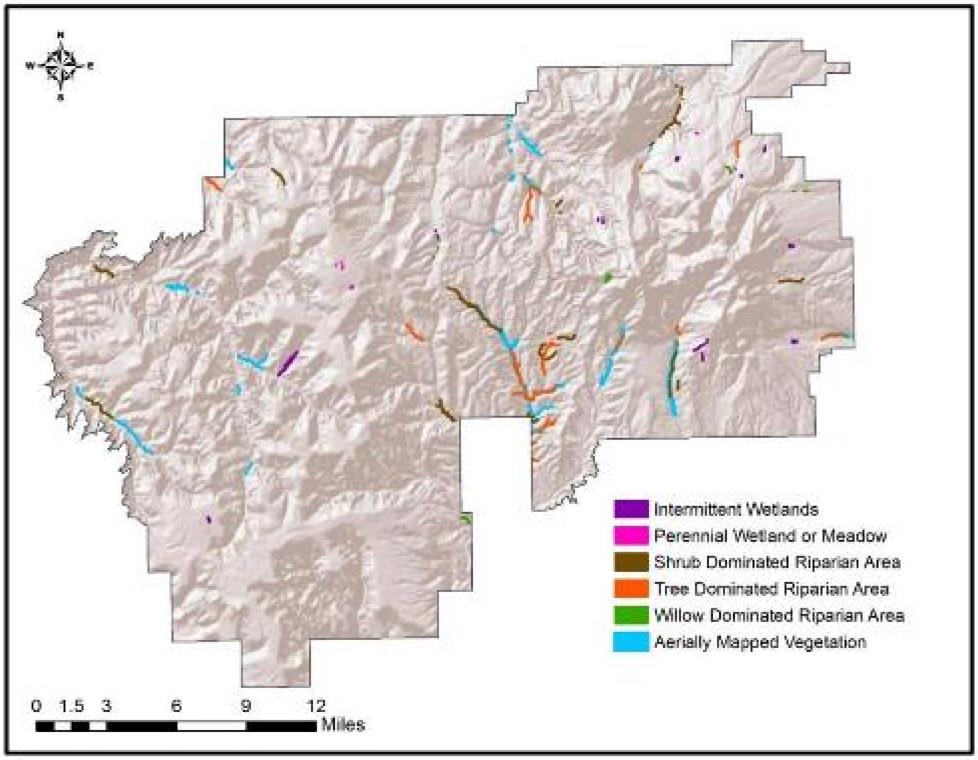


Figure 16. Distribution of field-sampled and aerially mapped riparian vegetation in the Abajo Mountains, Mesas, and Canyons.

Conditions for riparian tree-dominated communities exist at lower elevations where alluvial channels form and surface and groundwater support cottonwoods and other deciduous trees. In general, woody riparian vegetation is greater in the Mesas and Canyons LTA than in the Abajo Mountains LTAs. These sites occur from the swampy headwaters of Abajo Mountain streams to the lower reaches of the Dark Canyon Wilderness.

Extent of riparian vegetation, an indicator of riparian ecosystem distribution, is limited by diversions of surface flows in the Abajo Mountains. These diversions provide the municipal water supply for the towns of Blanding and Monticello (USFS 2005). Springs have been developed for livestock use throughout these mountains, likely contributing to reduction in riparian extent. These reductions are minimal, relative to other geographic areas, so distribution of riparian ecosystems was within or trending towards the NRV in the Abajo Mountains LTAs. There are fewer water developments in the Mesas and Canyons LTAs and, as a result, the KEC is within the NRV throughout these types.

La Sal Mountains and Borderlands

The La Sal Mountains and Borderlands area is centered on an isolated mountain range in eastern Utah. The area is divided into two distinct types of LTAs. The high elevation, La Sal Mountains LTAs include igneous mountains that were shaped by glaciers, leaving behind alluvial fans with glacial moraines. Surrounding the mountains are the Borderlands LTAs, which are dominated by glacial rock debris, alluvial fans, and sandstone mesas, subject to stream erosion. The high elevation environments of the La Sal Mountains are rare, representing one of the few true alpine communities in the region, and their presence has large influences on surface and groundwater systems.

A variety of riparian ecosystems are found along the streams that radiate from the La Sal peaks. These ecosystems include herbaceous-dominated wetland communities at high elevations, canyon-bound streams with shrub- and tree-dominated riparian stands, and small streams that are stabilized by willows, sedges, and other riparian plants as shown in Figure 17. Mid-elevation canyons contain mixtures of deciduous shrubs and coniferous trees, which are often unmapped as riparian ecosystems, even along perennial streams. Lower elevation alluvial floodplains in areas such as Beaver Creek Canyon and Roc Creek Canyon support extensive stands of riparian forests dominated by cottonwoods, alder, boxelder, and other woody species.

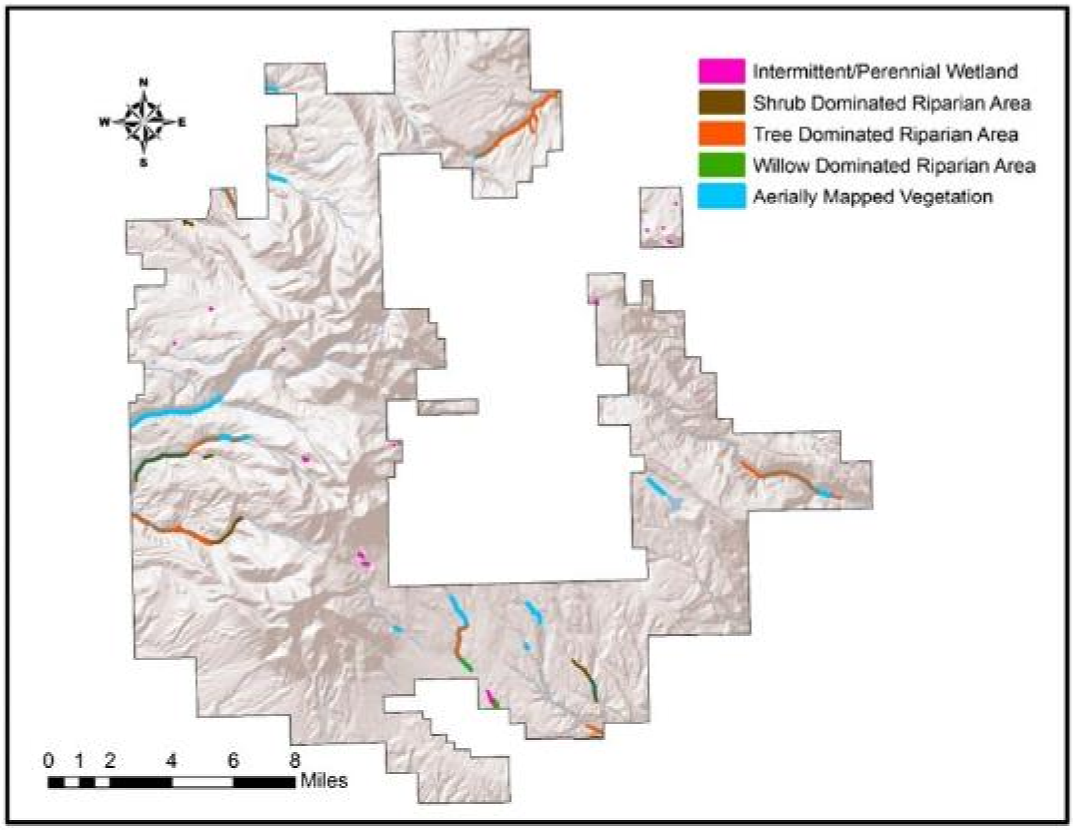


Figure 17. Distribution of field samples and aerially mapped riparian vegetation on the La Sal Mountains and Borderlands.

Extent of riparian ecosystems in La Sal Mountains and Borderlands is limited by diversions, spring developments, and livestock grazing (USFS 2006a). The status of this KEC was variable among the LTAs in this area, indicating the patchy nature of anthropogenic effects on streams.

San Pitch Mountains and Wasatch Plateau

The San Pitch Mountain region is part of the Gunnison Plateau, which has a complex geology affected by thrust faults and salt structures. There are six LTAs in this region, and they are grouped by location as those on the western front, eastern front, and central plateau (Kilbourne 2016). The major stream drainages of the western front include Chicken, Pigeon, and Deep Creeks. There are few streams that drain eastward into the San Pitch River. The central plateau has generally gentle topography, but the northern end is dissected by steep ridges and canyons. Many streams of the western front have their headwaters in the central plateau (Kilbourne 2016).

Perennial streams and intermittent streams with riparian vegetation are relatively limited in the San Pitch Mountains. Several perennial streams are diverted near the Forest boundary and these diversions have likely decreased the extent of riparian ecosystems (Kuehn 1984). Woody-dominated riparian ecosystems are scatted among canyons on the east and west side of the mountains, and at headwater streams in the central portion of the range. Narrowleaf cottonwoods dominate riparian stands in lower canyons where perennial and intermittent flows occur. Willows and other shrubs are present in the upper portions of these streams. Distribution of riparian ecosystems were trending towards its NRV in five of the six LTAs in the San Pitch Mountains. This KEC is outside of its NRV at an LTA on the western front, where several streams are diverted for irrigation and municipal use (Kuehn 1984, USFS 2006a).

The Wasatch Plateau region is a highland in central Utah that represents a transition between the Colorado Plateau to the east and the Great Basin to the west. There are 16 LTAs in this region, which can be grouped as the western front (Wasatch Monocline), the central plateau, the eastern escarpment, and the north end (Kilbourne 2016). The western front is composed of sedimentary rock formations that are steeply tilted and cut by several north-south trending faults. The central plateau consists of north-south trending mountains with historic glaciation and fault valleys that separate a high mountain block to the west from a lower mountain block to the east. The eastern escarpment consists of steep and barren shale slopes that lead up to sandstone cliffs all with sparse vegetation. The north end tilts downward with vegetation typically changing with elevation. Parts of the north end are isolated canyons, ridges, and rocky buttes that have formed along eroded salt anticlines and fault systems (Kilbourne 2016).

The Wasatch Plateau, the largest of the Forest’s geographic areas, has a large variety and area of riparian ecosystems. Herbaceous-, shrub-, and tree-dominated riparian areas are located throughout the central plateau. Tree- and shrub-dominated stands are located along streams and in canyon draining the western front, eastern escarpment, and north end (Figure 19). Anthropogenic effects on streams are numerous and varied as well (PREC 2016, SRCD 2016). LTAs in the north end of the plateau were within the NRV of riparian ecosystem distribution, but LTAs of the central plateau, Wasatch Monocline, and eastern escarpment are either within, trending towards, or outside of the NRV. Likely causes of departure include diversions, reservoirs, spring developments, and long-term effects of livestock grazing (USFS 2006).

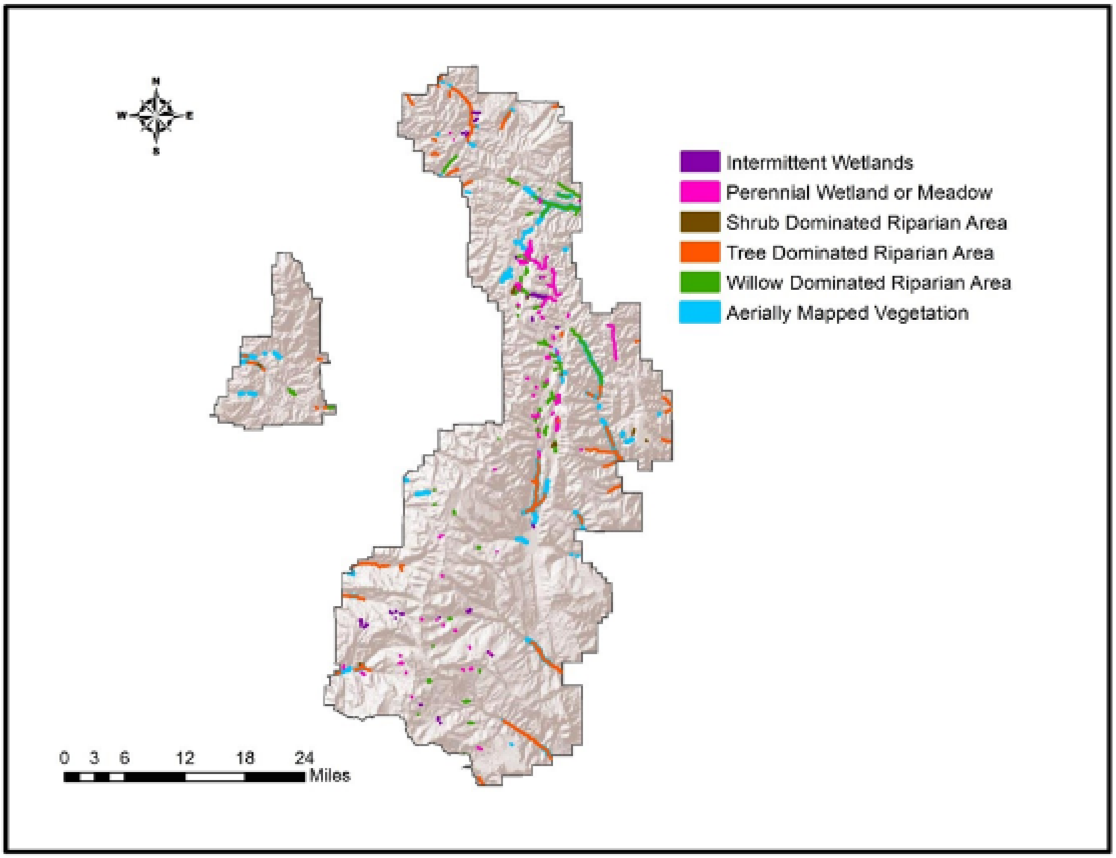


Figure 18. Distribution of field sampled and aerially mapped riparian vegetation in the San Pitch Mountain and Wasatch Plateau.

Groundwater and Surface Water Fluctuations

Fluctuations in groundwater and surface water is a KEC that influences the structure and function of all riparian and aquatic systems. Groundwater systems rely on infiltration from rainstorms and snowmelt to recharge aquifers that slowly release discharge to surface water systems, maintaining base flows throughout the year. The natural flow regimes of both groundwater and surface water systems on the Forest are driven by temperature and precipitation as well as the geologic setting.

Groundwater-dependent Ecosystems

Springs

High densities of springs on the Forest occur in glaciated terrain and are frequently associated with glacial moraines, slide areas, and faults. The highest density of springs on the Forest are found in the landslide terrain of the Abajo Mountains (A_LTAG4), on the alluvial fans and glacial moraines (LSM_LTAG1, and the high mesas covered with glacial till on the La Sal Mountains (LSM_LTAG1).

Existing information on the condition of spring groundwater-dependent ecosystems is very uneven on the Forest as well as across the LTAs. We found no field-based information on springs for the San Pitch Mountains, so insufficient information was available to determine current condition of groundwater-dependent ecosystem resources for this portion of the Forest. On the Wasatch Plateau, field collected information was available for 6 of the 15 LTAs with known springs.

Information was most available for the water quantity KEC, largely due to the qualitative point-of-diversion assessments that were conducted on springs of the La Sal and Abajo Mountain portions of the Forest. Information was least available for the water quality and soil quality KECs across all parts of the Forest.

For the biotic community KEC on Wasatch Plateau springs, one LTA was outside the NRV (WP_LTAG11) and five LTAs were assessed as trending towards the NRV. In the La Sal and Abajo Mountain LTAs, determinations of trending towards NRV were made for three LTAs. These assignments were partly due to the occurrence of non-native and/or invasive plant species at most of the sampled springs. The presence of non-native pasture grasses, including orchard grass, smooth brome, and Kentucky blue grass, and dandelions is common across the grazed portions of the Forest (and most public lands), and resulted in the trending towards assignments. But abundant cover of weedy species, including Canada thistle, bull thistle, and hounds tongue (WP_LTAG19) is of management concern and resulted in the determination that this KEC is outside its NRV for this LTA. Invasive plant species need to be managed at springs and other water sources to reduce their spread and maintain the ecological integrity of GDE resources.

The ratings for the soil quality and stability KEC are also related to the impacts of livestock use on springs. Determinations for this KEC were outside the NRV for four LTAs on the Wasatch Plateau and two LTAs in the La Sal Mountains, largely due to the impacts of livestock trampling and hummocking but also to illegal recreational all-terrain vehicle use.

The condition of the spring runout channel was compromised at many sampled springs, and was found to be outside its NRV at four LTAs on the Wasatch Plateau, two LTAs on the La Sal Mountains, and three LTAs on the Abajo Mountains. Some impacts are due to livestock use, mostly trampling near the points of emergence, particularly at undeveloped springs. However, the poor condition of spring runout channels is also attributed to the actual spring developments, many of which have directly impacted (and sometimes eliminated) the spring point of emergence, as well as poor maintenance of spring infrastructure. As noted in this report, fencing of springs and other range improvements are underway at some locations in the La Sal Mountains, but are also needed at many more spring locations.

Springs in certain Abajo Mountain LTAs (especially A_LTAG3 and MC_LTAG3) are generally in worse condition than springs elsewhere on the Forest. On A_LTAG3, 12 of the 40 of the visited springs (30 percent) were considered in fair condition, while 10 percent were in poor condition. On MC_LTAG3, nearly 30 percent of the visited springs were considered in fair condition, while nearly 33 percent were in poor condition. In contrast, the springs assessed in the La Sal Mountains were mostly rated as being in good condition. Because similar information is not available for the Wasatch Plateau or the San Pitch Mountains, comparisons cannot be made across all units on the Forest. Based on limited field-based data, it appears that springs are most heavily impacted in the Abajo Mountains portion of the Forest.

Wetlands

High densities wetlands on the Forest tend to occur in glaciated terrain, and are frequently associated with glacial moraines, slide areas, and faults. On the Forest, the highest density of wetlands occur within the fault valleys of the central Wasatch Plateau (WP_LTAG8), followed by the southern Wasatch Plateau (WP_LTAG5). High densities are also found on the glacial moraines and slide areas of the La Sal Mountains (LSMB_LTAG5) and in the landslide terrain of the Abajo Mountains (A_LTAG4).

Information on wetland resources of the Forest is largely limited to the WP_LTAG8 LTA on the Wasatch Plateau. Field sampling of 353 wetlands by the Forest resource staff in 2008 assisted in basic characterization of these wetlands, and indicated that they are generally in good ecological condition. Some information on wetlands and wet meadows associated with spring GDEs was recorded during spring site visits in the La Sal Mountains (LSMB_LTAG1, LSMB_LTAG2) and the Mesas and Canyons surrounding the Abajo Mountains (MC_LTAG3) (GCT 2016). Based on brief field notes, wetlands in the La Sal Mountains and the Mesas and

Canyons were noted as heavily impacted by wildlife and livestock grazing and trampling, however these conditions are based on limited data and may not be reflective of conditions today. Very little is known about wetland resources for much of the Forest, even though relatively high densities occur in each of the four portions of the Forest.

Currently, no known fens, or peat-accumulating groundwater-dependent wetlands, have been documented on the Forest. However, the wetland sampling on the Wasatch Plateau revealed that more than 15 percent of the visited wetland sites have peat soils— i.e., they are likely fens.

Abajo Mountains, Mesas, and Canyons

The climate of the Abajo Mountain region is somewhat typical of the Forest. Higher elevation LTAs are comparatively wet and cool, while the surrounding low altitude canyons and valleys have semi-arid to arid climates (Weir et al. 1983). At high elevations, average annual precipitation can exceed 30 inches, which is approximately equal to potential evapotranspiration (Weir et al. 1983). In the mesas and flatlands, average annual precipitation ranges from 7.9 to 9.8 inches, however potential evapotranspiration is estimated to be 41 to 47 inches per year (Weir et al. 1983). Most of the precipitation in this region occurs above 8000 feet and about 5 to 15 percent recharges to bedrock aquifers. Comparatively, an estimated 1 to 3 percent of the mean annual precipitation in lower elevation arid lands infiltrates to groundwater systems (Weir et al. 1983; Spangler et al. 1996).

Many perennial streams form in swampy meadows and talus slopes high in the Abajo Mountains (Gregory, 1938). The flow regimes of these streams include seasonal peak flow from melting snow, typically occurring between April and June (Witkind 1964). Rock glaciers have historically been present in this region (Witkind, 1964). These features supply a constant source of water as they gradually melt throughout the summer. Additionally they act as an impervious surface that limits infiltration and causes higher flows in surface water systems (Geiger et al., 2014). Discharge from groundwater systems via springs is most abundant during early summer months, with many sources drying up during the drier period (Witkind 1964). Perennial springs that provide a water source to surface water systems during drier periods tend to be well known and used for human consumption (Witkind 1964). Many springs in this region discharge from Dakota Sandstone and the Burro Canyon Formation. These springs occur at higher altitudes, are generally perennial, and have an average discharge of about 19 gallons/minute (Weir et al. 1983).

Flow patterns and infiltration capacity are controlled by underlying geology of the region. In the Abajos, these patterns are driven by contacts between more and less permeable substrates. Most springs discharge from sandstone aquifers, such as the Burro Canyon Formation (Weir et al. 1983). Examples have been documented along canyon walls where more permeable rocks overlie beds with less permeability, with fractures acting as a control point for discharge (Weir et al. 1983).

The Abajo Mountain region has been less affected by changes in temperature and precipitation regimes than the Wasatch Plateau or the La Sal Mountains. Average winter temperatures have increased by about 1 ˚C and winter precipitation has not significantly changed. Because climate change has had limited impacts in this LTA, some projects that mitigate impacts from the additional stressors may improve the function of groundwater and surface water fluctuations in the Abajo Mountain region.

La Sal Mountains and Borderlands

In the high elevation La Sal Mountains, groundwater and surface water fluctuations are primarily driven by geology and precipitation. Historic glaciation has shaped the current landscape leaving a complex mix of bedrock and unconsolidated deposits including glacial, mass wasting, and paleo alluvium (Kolm and van der Heijde, 2016). This setting results in a high degree of connectivity between surface and groundwater systems (Weir et al., 1983). The borderlands are composed of sandstone mesas and canyons surrounding the La Sal

Mountains, many with markedly different hydrologic regimes from the high-altitude LTAs. The watersheds of the lower elevations are topographically separated by geologic structures including collapsed anticlines, the La Sal Mountain Tertiary Intrusive Centers, and local bedrock uplands (Weir et al., 1983; Kolm and van der Heijde, 2016). These geologic features disrupt hydrologic connectivity, creating discrete and localized groundwater systems, springs, and connections to surface water systems that are disconnected from adjacent watersheds (Weir et al., 1983; Kolm and van der Heijde, 2016).

Average annual precipitation ranges from 8 inches/year in the borderlands to 40 inches/year in the alpine environments. High potential evapotranspiration (41 to 47 inches/year) in the mesas and flatlands generates arid climates with little recharge potential. In contrast, low potential evapotranspiration (24 inches/year) at high altitudes creates humid climates with excellent natural recharge potential from snowmelt and rain (Weir et al., 1983). Surface and groundwater fluctuations in the La Sal Mountains and surrounding borderlands are driven by snowmelt and intense summer and autumn rainstorms that are typically limited in their areal extent (Kolm and van der Heijde, 2016). Hydrologic regimes in this region are also impacted by the presence of rock glaciers in some drainages. In rock glaciated basins, flood peaks are delayed following precipitation and total surface runoff is greater when compared to un-glaciated systems (Geiger et al., 2014).

Groundwater and surface water fluctuations in the La Sal Mountain region showed impacts from a variety of stressors including installation of dams and diversions, construction of roads, timber harvest, wildfire, conifer encroachment, insects & disease, recreation, livestock and wildlife grazing, and climate change. While many of these stressors are common across the Forest, some are particularly apparent in the La Sal region. A historic clear cut on state lands in the upland watersheds of some LTAs in this region have contributed to degradation of downstream landscapes. Mortality due to insects and disease is especially prevalent in this region. Out of all the LTAs on the Forest, four of La Sal LTAs are ranked highest for percentage of land cover affected by insect and disease. Lastly, impacts from climate change have altered natural flow regimes throughout the La Sal region. The average winter temperature has increased by 1.25 ˚C and the average winter precipitation has decreased by more than 0.35 inches. Disappearance of glaciers, including rock glaciers, has altered the amount of groundwater recharge and surface runoff as well as the timing of high and low flows (Geiger et al., 2014).

San Pitch Mountains

Fluctuations in ground and surface water throughout the San Pitch Mountains is driven by climate and geology. Annual fluctuations in water levels in this region are closely tied to annual precipitation, with regular high flows and infiltration occurring during snowmelt runoff in the spring and declining flows in channels and from springs throughout the rest of the year (Wilberg and Heilweil 1995). The average annual precipitation in the San Pitch Mountains ranges from 14 to 25 inches and the largest amount occurs as snow from November through April (Robinson 1971). Summer months tend to be the driest periods of the year, however heavy, localized thunderstorms can create significant precipitation events.

At lower elevations, evaporation exceeds annual precipitation by about 3.5 times (Robinson 1971), resulting in arid and semi-arid conditions. At higher elevations, the climate is sub-humid and allows for recharge of groundwater systems. Monitoring of wells shows that groundwater fluctuations closely follow climatic cycles and that long term trends in water levels have remained fairly constant since the USGS started monitoring wells in 1935 (Wilberg and Heilweil, 1995).

The San Pitch Mountains have complex geology that influences the infiltration of water to groundwater systems, flow routes, and discharge of groundwater to surface water systems. The major geologic formations in this region is the Indianola Group along the central plateau and in the north, the Colton Formation in the south east portion of the mountains, and Arapien shale in the west. Groundwater in this region is recharged through the Indianola Group and it yields large amounts of water to springs and creeks in several drainages (Robinson 1971; Wilberg and Heilweil 1995).

Several large springs, including Big Springs, discharge at points of contact between the Indianola Group and Arapien Shale (Bjorkland and Robinson 1968; Robinson 1971). Arapien Shale is less permeable than the Indianola Group and upstream canyons are generally steeper than those downstream. These points occur in the Fourmile, Pidgeon, Chicken, Deep, Little Salt, and Criss drainages. Average discharges from these springs ranges from 200 to 900 gallons per minute (Bjorkland and Robinson 1968). The Colton Formation, exposed in the central and southern San Pitch Mountains, is composed of shale, sandstone, and siltstone (Robinson 1971). It has low permeability and limits groundwater recharge and flow to fracture zones (Bjorkland and Robinson, 1968).

Climate change has altered temperature and precipitation regimes of the San Pitch Mountain region to a limited extent. Average winter temperatures have increased by less than 1 ˚C and winter precipitation has increased by 0.56 inches. The density of dams and diversions are the lowest across the Forest, which is also true for density of roads and the percentage of land affected by vegetation mortality from insects and disease. This region has experienced more high severity burns than any other region, but they still only affect about 4 percent of the landscape. With the limited effects of stressors, several San Pitch Mountains LTAs are listed as within NRV.

Wasatch Plateau

The highlands are mostly composed of sedimentary geologic units, the weathering of which has created rugged mountainous terrain dissected by deep canyons (Danielson and Sylla, 1983). The beginning of the lowlands are marked by outcrops of Mancos shale that appear along streams several miles upstream from the mouths of most canyons (Waddell et al., 1981). The Blackhawk Formation, which is part of the Mesaverde Group, overlies the Mancos Shale. It is composed of sandstone, shale, and is the most important coal-producing formation in Utah (Waddell et al., 1981). The North Horn Formation and Flagstaff limestone overlay the Mesaverde Group. This geologic unit features fractures and solution openings with high hydraulic diffusivity and it is the source for most groundwater discharge (Waddell et al., 1986).

The climate of the Wasatch Plateau ranges from semiarid to sub humid. Precipitation general increases with altitude and can average more than 40 inches along the crest of the plateau. Summers are typically dry, with 4 to 10 inches of precipitation falling from May to September (Danielson and Sylla, 1983). At high altitudes, snow accumulates to depths of several feet, with the April 1st snowpack at Buck Flat averaging more than 4 feet in depth (Danielson and Sylla, 1983). Snowmelt in spring and early summer provides the primary input of water to surface and groundwater systems in the Wasatch Plateau (Danielson and Sylla, 1983).

In the Wasatch Plateau region, only 5 to 29 percent of precipitation on a drainage basin becomes streamflow (Danielson and Sylla, 1983). Most of the remaining water is lost to evapotranspiration and only a small percentage recharges to groundwater (Danielson and Sylla, 1983). Recharge potential is greater where Flagstaff limestone is present because its fractures and solution openings provide storage for large volumes of groundwater (Danielson and Sylla, 1983). Locations like on top of North Horn and Ferron mountains have low surface relief, which slows snowmelt runoff and allows more water to infiltrate groundwater systems (Danielson and Sylla, 1983). Likewise, in places like South Horn Mountain, solar radiation and wind decrease the amount of groundwater recharge despite the flat land surface (Danielson and Sylla, 1983).

The majority of groundwater discharge originates from where the Flagstaff limestone meets the North Horn Formations (Danielson and Sylla, 1983, Waddell et al., 1986). Rapid responses of natural groundwater discharge to changes in recharge indicate that water moves quickly through these groundwater systems. These springs, and seeps in valley walls, maintain base flows in streams during the drier months (Waddell et al., 1986), discharging a range of 0 to 1080 gallons per minute (Waddel et al., 1981). As for surface water, 50 to 70 percent of streamflow occurs from May to July from melting snow (Waddel et al., 1981).

Decades of intense grazing and the following restorative efforts have transformed the landscapes, floodplains, stream channels, and sediment sources of the Wasatch Plateau. Grazing in the alpine meadows of this region was so intense that townsfolk could count sheep herds from ten miles away by the plumes of dust trailing the herds (Hall, 2001). Studies show that heavy grazing in watersheds in this region led to a transition from a relatively stable landscape to a serious flood source (Meeuwig, 1960). Furthermore, grazing exclusion does not satisfactorily reduce erosion and flooding. Watersheds require restoration to return to a stable state that can support some degree of controlled grazing (Meeuwig, 1960). Hall (2001) argues that today's plateau is rehabilitated, but not restored and that more work is required to counteract the negative impacts of overgrazing.

There is an extensive network of dams and diversions in the Wasatch Plateau and several large reservoirs. Examples of these alterations are observed in the Huntington Creek system (Winget, 1984). In this drainage, the construction of the Electric Lake Dam lead to deposition of fine sediments and an unbalance between water and sediment sources. Additionally, the Huntington River flow regime changed from a snowmelt dominated runoff to a regulated flow pattern, with the timing of peak flow changing from spring to late summer (Winget, 1984).

Underground coal mining has impacted channel morphology and sediment dynamics in the Wasatch Plateau in various ways. Studies have shown increases in the lengths of cascades and glides, increases in pool length, numbers and volumes, an increase in the median particle diameter of bed sediment in pools, and some constriction in channel geometry (Sidle et al., 1995). Coal mining has also been associated with debris slides and rock falls in the Wasatch Plateau. These events have resulted in the deposition of sediment, boulders, and trees in streams (Slaughter et al., 1995).

The effects of climate change are evident in the Wasatch Plateau. The average winter temperature of the Wasatch Plateau has increased by 1.47 ˚C and the average winter precipitation has decreased by more than 0.35 inches. Because the effects of climate change are especially apparent in this region and there are multiple additional stressors, groundwater and surface water in many of their LTAs are functioning outside their NRV. This region may require more specific planning to mitigate the effects of climate change on groundwater and surface water resources.

Floodplain Condition

Channel, vegetation, and sediment dynamics influence the geomorphological form of floodplains. Diverse habitats overlay the floodplain template and their distribution is controlled by patterns and processes occurring at various scales including flooding, channel avulsion, cut and fill alluviation, wood recruitment, beaver activity, and regeneration of riparian vegetation (Stanford et al. 2005).

Abajo Mountains, Mesas, and Canyons

Stream channel structures depend on geologic setting, elevation, stream size, gradient, width of the valley floor, and the number of intense rainstorms that occur in this area's drainages (Gregory 1938). When settlers arrived in the 1880s, stream channels in this region were described as "canyons floored from wall to wall with level, fertile fields" with "clear streams flowing through willows and alders" (Gregory 1938). By the 1930s, the streams showed effects of land use change with these floodplains transitioning to "washes floored with sand moved about by ephemeral streams and bordered by flat-topped banks of alluvium" (Gregory 1938). Streams were described as "clear and cold mountain streams" that "rippled down through ravines overhung by groves of willow, maple, and quaking aspen, with splendid oaks and stately pines scattered over the uplands, and an abundance of rich, nutritious grass everywhere."

Most streams form in high elevation swampy meadows and talus slopes (Gregory, 1938). As creeks drain the peaks of the Abajo Mountains, they create a highly dissected landscape with streams and floodplains located deep in sandstone canyons. The laccolithic rocks of the Abajo Mountains are resistant to erosion and generate little sediment input to high elevation streams (Graf, 2006). Alluvial fans surround the Abajos to the south and east and stream channels tend to be more active and floodplains more complex in this setting (Scott et al. 2005). The flow paths of drainages, as well as sediment supply and depositional patterns have been highly effected by fault geometry throughout the lower elevations of this region (Trudgill, 2002).

Three ecological zones are present in the region (Witkind, 1964). At lower elevations, the upper Sonoran zone is characterized by sagebrush flats and abundant piñon pine and juniper. The transition zone is identified by open grass valleys and trees that include aspen, willow, maple, alder, and cottonwood. Lastly, the high altitude boreal zone supports spruce and fir forests that are an additional source of woody debris in stream channels (Witkind, 1964). Channel and floodplain structure, as well as sediment dynamics are especially sensitive in the Abajos and killing off of beavers was noted to create far reaching changes (Gregory 1938). Beaver activity is still noted in some locations and has benefited systems where it is present by stabilizing channels.

Floodplains in the Abajo Mountains show impacts from a variety of stressors including dams and diversions, livestock grazing, wild ungulate browse, roads, recreation, and climate change. The systems throughout this region are extremely sensitive to altered precipitation and the amount or type of plant cover (Gregory 1938). Furthermore, Gregory (1938) noted that construction of dams and irrigation ditches, beaver removal, and building of roads had far reaching changes to floodplain systems in the Abajo Mountains. Additionally, historic overgrazing is a well-documented disturbance in this region and has generated major changes in the amount of sediment present in floodplains (Gregory, 1938), as well as channel structure. Recreational issues include disturbance to floodplain vegetation resulting from unauthorized off-road motorized vehicle use in the Dark Canyon Wilderness following washouts on the Peavine Corridor route (Manti-La Sal National Forest 2015). The cumulative effects of these stressors are light relative to other geographic areas, however. Most LTAs are trending towards the NRV of floodplain condition and one is within the NRV.

La Sal Mountains and Borderlands

Floodplain dynamics of the La Sal Mountains and Borderlands are driven by diverse geologic settings, ranging from high altitude bedrock outcrops to highly eroded sandstone mesas (Weir et al., 1983; Kolm and van der Heijde, 2016). In these areas, floodplains are naturally narrow, discontinuous, or even non-existent (Scott et al., 2005). In bedrock valleys, transport of sediment exceeds supply and alluvial material is transported downstream and deposited in lower elevation LTAs. At lower altitudes in glacial moraine and alluvial fans, channels are more active and floodplains tend to be more complex (Scott et al., 2005). The lowest reaches flow through valleys of alluvial material that is easily transported during spring runoff and intense summer rainstorms. These reaches experience high sediment loads, typically composed of sand, silt, and clay (Scott et al., 2005).

La Sal Mountain floodplains have been altered from their historic conditions by many stressors including livestock grazing, dams and diversions, construction of roads, beaver removal, recreation, timber harvest, and wildfire. There are numerous effects from cattle grazing on floodplains including trampling banks, over-widening streams, a decrease in stabilizing vegetation, and unnatural sediment from trailing (Thibault et al., 1999; George et al., 2002). There are many examples of roads that follow stream beds and cross floodplains throughout the La Sal region. Historically, beavers were present in the La Sal Mountains and they continue to persist at lower numbers throughout the region (Muller and Sun, 2003). Hiking and ATV trails are unnatural sources of sediment. Camping that occurs in floodplains can alter streambanks, channel structure, and floodplain dynamics (Pickering et al., 2009). A historic clear cut on state lands in the upland watersheds of this region increased sedimentation and likely altered the timing and magnitude of surface runoff that drives floodplain dynamics. Historic low severity wildfires were natural disturbances to the La Sal Mountain region, however recent large, high severity wildfires that burn entire watersheds can have major influences on flooding and sedimentation (Ice et al., 2004, Doerr et al., 2006). Because of numerous stressors, floodplain dynamics were outside of the NRV at three LTA and trending towards the NRV at seven LTAs.

San Pitch Mountains

Floodplain dynamics in the area show impacts from a variety of stressors that include diversions and wells, wildfires, roads, mines, and climate change. Most of the surface water runoff in this region is diverted and used for irrigation in lowland valleys, reducing the ability of streams to transport sediment and connect to their floodplains. Some LTAs in this region have experienced large amounts of high severity burns and this region is especially vulnerable to post-fire flooding due to intense localized summer thunderstorms (Robinson 1971). A history of overgrazing has severely impacted streams across the Forest including the San Pitch region. Historic descriptions of the area note that hills were rich with grasses and that the range became barren with the introduction of sheep (Christensen and Johnson 1964). Effects of stressors are light relative to other geographic areas, so floodplain condition is within the NRV at one LTA and trending towards the NRV at the others (Table 7).

Wasatch Plateau

Floodplain dynamics in the Wasatch Plateau are driven by geologic setting and natural flow regimes. The beginning of the lowlands in the Wasatch Plateau are marked by outcrops of Mancos shale, which have a pronounced effect on the topography and landscape of floodplains and stream channels because they are easily eroded, have limited plant growth and low permeability that causes precipitation to run off directly into streams (Waddell et al., 1981). The large, broad valleys left behind by glaciers have hardly been modified by stream erosion. These landscapes are slightly notched by post-glacial streams and the channels are notably influenced by the configuration of moraines (Spieker and Billings, 1940).

Sediment yields are dependent on geologic setting and range from 0.1 to 3 acre feet per square mile per year in the Wasatch Plateau region (Waddell et al., 1981). The high yields typically occur in the predominately shale and sandstone lowlands. Lower yields are observed in the higher altitudes where exposed rocks are mostly limestone and dolomite (Waddell et al., 1981). Land instability and flooding are well documented in the Manti division with landslides, debris avalanches, and mudflows common on the North Horn formation. An abundance of steep slopes and the occurrence of intense summer thunderstorms results in high erosion potentials, especially when vegetation is removed (Manti-La Sal National Forest Mud and Flood).

Floodplain dynamics have been altered from their NRV by a variety of stressors including livestock grazing, dams and diversions, installation of reservoirs, construction of roads, coal mining, recreation, timber harvest, and wildfire. The results of these stressors are that six LTAs in this region are functioning outside their NRV and eleven are trending toward their NRV.

Channel and Streambank Stability

Streams in properly functioning condition maintain a balance between the opposing processes of erosion and sediment deposition (Beechie 2008). These streams have natural rates of vertical and horizontal stability and provide high quality habitat for aquatic and riparian organisms.

At low gradient streams, late-seral riparian plant communities include sedges, rushes, and willows, all of which have extensive root systems that protect banks from floods, trampling, and other erosive events. Disturbance to vegetation reduces stability and can lead to widening of streams, change in water quality and temperature, and reduction of aquatic habitat quality. Where grazing allotments include streams and riparian areas, sedges and rushes are often preferred forage and are vulnerable to excessive levels of grazing if timing and intensity of cattle grazing is mismanaged (Plats and Nelson 1989). Additional stressors influencing channel and bank stability include recreation use, beaver removal, roads, and floods (Vanderbuilt 2006, Manti-La Sal National Forest 2015, Pollock et al. 2014).

Historically, abundant riparian shrubs and thick herbaceous layers stabilized banks with large root masses and dissipated energy in streams to decrease erosion. More recently, livestock use has damaged vegetation and soil near streams and reduced streambank stability (Manti-La Sal National Forest 2001). In the Abajo Mountains, sheep grazing was replaced by cattle grazing in the 1950s and 1960s, concentrating grazing pressure on riparian vegetation (USFS 2006a). Currently, many range improvement projects have been proposed or implemented to mitigate these impacts (Curtis-Tollestrup 2015). Most functional reaches in the Abajo and La Sal Mountains continue to have stabilizing plant communities. In addition to stabilizing vegetation, some are also stabilized by rock banks. Beaver activity is still noted in some locations and has benefited systems by stabilizing channels.

In the Abajo Mountains, Mesas, and Canyons, channel and bank stability was within its NRV at one LTA, which includes much of the Dark Canyon Wilderness, was trending towards its NRV at two LTAs. At the La Mountains and Borderlands, this KEC was outside of the NRV at two LTAs, trending towards the NRV at two LTAs, and within the NRV at LSMB_LTAG8. We had insufficient information to evaluate this KEC at most LTAs because they lack perennial streams and riparian vegetation.

The Wasatch Plateau also has been grazed by cattle and sheep for over 150 years (Shamo 2015). Though unchecked sheep grazing resulted in significant impacts to watersheds during the 19th and 20th centuries (Manti-La Sal National Forest 1998), current effects of cattle on riparian areas are generally greater (USFS 2006a). Cattle allotments currently total approximately 273,000 acres and sheep allotments currently total 230,000 on the Wasatch Plateau. The continued grazing and cumulative effects of wild ungulate and domestic livestock grazing may inhibit the recovery of channel structures that were degraded during historic overgrazing. Other effects on channels and banks include lingering effects of large floods, extensive roads, and heavy recreation use (Manti-La Sal National Forest 1998). Overall, indicators of channel bank stability were greater at the Wasatch Plateau LTAs than those in the South Zone. Channel and bank stability were within the NRV at four LTAs, trending towards the NRV at one, and there was insufficient information at the rest.

Riparian Dependent Species

Amphibians and Reptiles

Mountain riparian and wetland habitats are home to many species of wildlife including boreal toads, a potential species of conservation concern, northern leopard frogs and smooth green snakes. Many of these species are also directly impacted by water quality, temperature, flow rate, and timing of flow.

Terrestrial Wildlife

Lowland riparian habitats are most limited in area and are important to species such as Mexican spotted owls and big free-tailed bats. Mountain riparian and wetland habitats are home to broad-tailed hummingbirds and yellow warblers.

Riparian Dependent Vegetation

Important habitat components in these areas are the herbaceous vegetation including nectar-producing flowers, native riparian shrubs and trees and available water. Beavers rely on riparian ecosystems and can also have a major impact on the age and size structure of woody riparian communities. Their dam building modifies local hydrology influencing a wide range of biotic and abiotic processes (Pollock et al.1994).

Trends

Through literature review and data analyses, several issues were identified affecting riparian ecosystems at various scales in the National Forest. Watershed-scale effects influence the delivery of water, sediment, wood, and other materials into channels and floodplains. Extreme watershed changes began in the late 19th century as a result of uncontrolled grazing, particularly on the Wasatch Plateau. Watershed conditions have improved with well-documented, intensive restoration, but lingering effects, such as destructive floods and loss of riparian vegetation, have continued to the present day.

In addition to historic grazing, watershed dynamics have been altered by fire suppression, unnaturally severe wildfires, insect and disease mortality, and timber harvest. These stressors also affect input into channels and floodplains. Changes in wildfire regimes are notable at the San Pitch Mountains, where fuel loads are high and wildfires burn with unnatural severity. At the La Sal Mountains, clear cuts on state land have affected channel and floodplain dynamics on several cutthroat trout streams.

Floodplain dynamics include interactions between stream channels, soils, and riparian vegetation. These interactions have been disturbed by a variety of stressors including roads, recreational activities, invasive species, and encroaching species. The assessment results show that floodplains are especially impacted at the La Sal Mountains and Wasatch Plateau. Given the widespread effects of stressors such as roads and invasive species, floodplain restoration efforts must be prioritized at locations critical to persistence of cutthroat trout and other species of concern.

Water developments have been established or agricultural and municipal use in each geographic area. These features have altered volume and timing of stream flows, resulting in changes to composition or elimination of riparian vegetation. Diversions, dams, and reservoirs are especially numerous on the Wasatch Plateau, altering groundwater and surface water fluctuations. Despite these changes, riparian ecosystems are functioning within their NRV at several LTAs. Changes in water management may be necessary to improve function at other LTAs in the area.

In addition to diversions, surface and groundwater flows have been affected by mining operations. The largest impacts have been documented in the Wasatch Plateau, where coal mining is a major driver of the local economy. Impacts from water development can be mitigated through management activities such as managed flows and increases in water use efficiency.

Livestock grazing has occurred on the Forest for over 150 years and will continue as part of the Forest's directives to provide a sustained yield and support local communities (Shamo 2014, USFS 2014). Grazing management (controlling intensity, duration and timing or use) can prevent damage to riparian ecosystems. Several studies have shown that in in areas that has had continuous grazing use or heavy grazing use, that management can be changed to rotate the use or have light to moderate use and the riparian areas improve (Clary 1999; Martin and Chambers 2001; Sovell et al. 2000; Lyons et al. 2000), therefore, excluding grazing from riparian areas is not the only approach that results in riparian improvement. A use standard, such as herbaceous stubble height is an indicator that is useful in determining if proper duration, timing and intensity is occurring but is not itself the desired condition. (USFS 2014). Recent evaluations of desired conditions indicate that effects of cattle grazing are strongest on streams in the La Sal Mountains and Borderlands geographic area. Trends were upward or slightly upward at most greenline transects in the area in 2016, indicating that current guidelines and practices are improving conditions. In the Abajo Mountains, Mesas, and Canyons and Wasatch Plateau areas, effects of historic overgrazing may require restoration and recovery at the watershed scale. However, current grazing practices are not having as large an effect on stream stability, as evidenced by the many greenline transects rated as stable in 2016.

The extent of riparian vegetation, an indicator of riparian ecosystem distribution, is limited by diversions of surface flows in the Abajo Mountains. These diversions provide the municipal water supply for the towns of Blanding and Monticello. Springs have been developed for livestock use throughout these mountains as well, likely contributing to reduction in riparian extent. These reductions are minimal relative to other geographic areas, so distribution of riparian ecosystems is within or trending towards the NRV in the Abajo Mountains LTAs. There are fewer water developments in the Mesas and Canyons LTAs and, as a result, the KEC is within the NRV throughout these types.

3.2.6 Air Quality

Indicators

National Ambient Air Quality Standards

The CAA requires EPA to set NAAQS (40 CFR part 50) for pollutants considered harmful to public health and the environment. The CAA identifies two types of NAAQS. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (EPA 2016b).

Sensitive Receptors Based on Wilderness Air Quality Values

Per the Clean Air Act federal land managers have an affirmative responsibility to protect Class I air quality related values from degradation. And per the Wilderness Act, congressionally designated wilderness areas are to be managed for their protection and preservation from human-caused degradation, including air quality. The Prevention of Significant Deterioration (PSD) Program is a CAA requirement that, among other requirements, establishes limits to pollutants in Class I and Class II areas. Nearby Class I Areas include Arches, Canyonlands and Mesa Verde National Parks and Class II Areas include Dark Canyon Wilderness Area and non-wilderness, forest lands. The federal land management agencies have identified several sensitive receptors and critical loads that make up Wilderness Air Quality Values, or Air Quality Related Values.

Sensitive receptors are the specific components of an ecosystem through which change in an Air Quality Related Value or Water Quality Value is quantified. Sensitive receptors are selected for known or suspected sensitivity to pollutants; availability for manageable, cost-effective monitoring, sampling, and analysis methods; and relevance for modeling capabilities. Sensitive receptors are water, fauna, flora, lichens, soils, and scenic vistas.

Sensitive receptors are specific types of features or properties within a wilderness that can be negatively impacted by air pollutants, e.g., high-altitude lakes, lichens, and scenic vistas. In other words, sensitive receptors are the specific components of an ecosystem through which change in an Air Quality Related Value (AQRV) or WAQV is quantified. Sensitive receptors are selected for 1) known or suspected sensitivity to pollutants, 2) availability for manageable, cost-effective monitoring, sampling, and analysis methods, and 3) relevance for modeling capabilities. Examples of indicators for sensitive receptors might be a population survey for a particular amphibian, a plankton count and water quality analysis in a sensitive lake, or an assessment of the vista from a particular viewpoint.

Critical loads

Critical Loads include: atmospheric deposition of nitrogen, sulfur, ammonia, phosphorous, mercury and the effects of ozone exposure. Critical Loads are measured for three primary resources. First, the acid-neutralizing capacity (ANC) values of high-altitude lakes and the effects of acidification to Macroinvertebrate and other organisms. Second, the effects of ozone to flora such as Conifers and other ozone sensitive species including *Populus tremuloides* (Quaking Aspen) and Lichen. Third, in addition to acidification, the deposition of nitrogen and phosphorus can cause fertilization stress to vegetation. Increased atmospheric nitrogen deposition is a particular concern in alpine communities where studies have shown a tendency towards increasing grasses and decreasing forbs due to the fertilization effect of nitrogen. The Critical Load values for nitrogen is 2.3 kg/ha-yr in Utah except for 3.0 kg/ha-yr for Dinosaur National Monument. The Critical Load of atmospheric deposition for sulfur is 5.0 kg/ha-yr everywhere.

Visibility

In addition to setting the National Ambient Air Quality Standards, the Clean Air Act specifically addresses visibility. The law requires states to develop long-term strategies to improve visibility in Class I areas over the next 60 years. Visibility improvement in these areas will have a complementary effect of improved air quality throughout the nation. Nearby Class I Areas include Arches and Canyon Lands National Parks. Class II Areas include Dark Canyon Wilderness Area and other Forest lands specifically addressed in the Clean Air Act.

There is no quantitative visibility standard for Utah and Colorado's pristine and scenic rural areas. However, in the 1977 amendments to the Federal Clean Air Act, Congress added Section 169a (Clean Air Act as amended in 1977, Section 169a 1977) and established a national visibility goal that created a qualitative standard of "the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from man-made air pollution." The implementation of Section 169a has led to federal requirements to protect visual air quality in large national parks and wilderness areas (Visibility Protection for Federal Class 1 Areas). Federal and state law prohibits visibility impairment in national parks and wildernesses due to major stationary sources of air pollution. Both states of Colorado and Utah have developed Regional Haze State Implementation Plans in various stages of compliance with the Regional Haze Rule.

Existing Conditions

There are two primary types of air quality effects concerning the Forest and Forest operations. First, the effects of regional air pollution on Forest natural resources and human health. Second, the effects of Forest emissions on Forest natural resources, human health and regional air sheds. Air pollution affects the natural quality of Forest lands, particularly wilderness areas or Wilderness Air Quality Values (WAQV). High ozone concentrations can injure sensitive vegetation. Fossil fuel burning emits sulfur dioxide (SO2) and nitrogen oxides (NOx) into the atmosphere. Certain types of agricultural activities emit ammonia (NH3) to the atmosphere. Such emissions can lead to atmospheric deposition of sulfuric acids, nitric acids, and ammonium to national forest ecosystems. Atmospheric deposition can cause lake body acidification, eutrophication, and hypoxia, soil nutrient changes, and vegetation impacts. Deposition of toxic metals such as mercury and lead can be harmful to both aquatic and terrestrial ecosystems. Visibility in most national forests is obscured some portion of the year by anthropogenic haze of fine pollutant particles. In addition, the Clean Air Act (CAA) requires Forest Service operations and permitted operations such as prescribed burning, fossil fuels development and production, and mining to comply with National Ambient Air Quality Standards (NAAQS) and protection of Air Quality Related Values (AQRV) and Wilderness Air Quality Values.

Natural Range of Variability

Natural background air quality conditions include measures of ozone and visibility.

- Ozone - Natural background tropospheric ozone concentrations in the Forest area are believed to range from 25 to 40 ppm based on studies in the Utah area (Nick and McCorison). Ozone pollution is a concern because besides human health impacts, elevated ozone concentrations also damage ecosystems. Ozone is the gaseous pollutant most harmful to crops, trees, and native vegetation, and the only large-scale gaseous air pollutant that has been measured at phytotoxic levels in remote locations. Ozone is a strong oxidizing agent that damages plant cells when taken up through stomates, requiring plants to expend energy for detoxification and repair rather than growth. The plant injury response can be used to evaluate overall ozone stress in forests and shrub lands. Bio-indicators of ozone presence are native, ozone-sensitive plant species, which will exhibit characteristic foliar injury symptoms when exposed to ambient ozone. Ozone can affect entire ecosystems as well as sensitive individuals, for example, species composition in ozone-impacted areas may shift in favor of individuals and plant species with greater ozone tolerance (Nick and McCorison).

- Visibility - Visibility is expressed in deciview (dv), a metric which is calculated using the light extinction coefficient. A one-deciview increase (or decrease) represents a change in conditions just perceptible to most human observers. The currently accepted estimate for natural visibility in the west is between 4.5-5 dv (110-115 miles). The lower the deciview value, the greater a distance can be seen - less haze present (Nick and McCorison).

Anthropogenic Emissions Affecting National Ambient Air Quality Standards

The Manti La Sal National Forest is located in eight Utah counties and all are air quality attainment areas for NAAQS criteria pollutants except for Utah County (Carbon, Emery, Grand, Juab, San Juan, Sampete, Sevier, and Utah counties). Utah County is a nonattainment area for PM10 and PM2.5 and the Provo area is a maintenance area for carbon monoxide. Portions of the Salt Lake City metropolitan area to the north of the Forest are nonattainment for PM10, PM2.5, sulfur dioxide and in maintenance areas for ozone and carbon monoxide (UDAQ 2017). The far eastern portion of the Forest is located in two Colorado counties and they are attainment areas for NAAQS criteria pollutants (Mesa and Montrose counties) (CAPCD 2016). An exceedance of a NAAQS is defined in 40 CFR 50.1 as “one occurrence of a measured or modeled concentration that exceeds the specified concentration level of such standard for the averaging period specified by the standard.” A violation of the NAAQS consists of one or more exceedances of a NAAQS. The precise number of exceedances necessary to cause a violation depend on the form of the standard and other factors, including data quality, defined in federal rules such as 40 CFR 50 (UDAQ 2017).

Past Air Quality Conditions

Utah Air Quality Monitoring

The Utah Department of Air Quality (DAQ) reported in 2017 that the Utah’s increasing population, industrial base, and more stringent federal air quality standards has made meeting air quality objectives challenging. In 2017, emissions for criteria air pollutants either stayed the same or continued their downward trends. The annual monitoring results for four criteria pollutants that could affect Forest ecosystems and human health - nitrogen dioxide, ozone, particulates and sulfur dioxide. The nearest ozone monitoring station to Dark Canyon Wilderness is located in Palisade, Mesa County, Colorado and in Utah the stations nearest the Forest are located at Hurricane, Price, Roosevelt, Spanish Fork and Vernal. Except for ozone levels in mostly the Salt Lake City metropolitan area, the monitoring shows an overall reduction in air pollution. Monitoring time periods vary and are based on the year monitoring was initiated (UDAQ 2017).

In October of 2016, the EPA strengthened the ozone NAAQS from 75 ppb to 70 ppb, based on a three-year average of the annual 4th highest daily eight-hour average concentration. Ozone monitors operated by the UDAQ along the Wasatch Front show exceedances of the new standard in Weber, Davis, Salt Lake, and Utah Counties. A portion of the Manti La Sal NF is in Utah County. There were also exceedances in Uintah County and Duchesne County during the winter. In 2016 the governor recommended that portions of the Wasatch Front and Uinta Basin be designated nonattainment, and that the rest of the state be designated attainment/unclassifiable. The EPA recently concurred with part of the Governor’s area designation recommendation and designated the counties in the southern half of the state as attainment/unclassifiable. The EPA also plans to concur with the recommendation for the Wasatch Front. In the Uinta Basin the state recommended that areas less than 6,000 feet be designated nonattainment. In December 2017, the EPA proposed that the elevation be raised to 6,250 feet so that it would include the Whiterocks monitor that is operated by the Ute Tribe. The UDAQ expects the proposed designations to be finalized by the end of April 2018 (UDAQ 2017).

Colorado Air Quality Monitoring

In 2016, the Colorado Air Pollution Control Division (CAPCD) conducted air quality and meteorological monitoring operations at 56 locations statewide throughout 2016. During 2016 there were about 92 daily exceedances of the ozone standard and about 4 daily exceedances of the PM2.5 standard in the Denver area. There was one daily exceedance of the PM2.5 standard near the Manti La Sal NF at Grand Junction. An exceedance of a NAAQS is defined in 40 CFR 50.1 as "one occurrence of a measured or modeled concentration that exceeds the specified concentration level of such standard for the averaging period specified by the standard." A violation of the NAAQS consists of one or more exceedances of a NAAQS. The precise number of exceedances necessary to cause a violation depend on the form of the standard and other factors, including data quality, defined in federal rules such as 40 CFR 50 (CAPCD 2016).The available data from the Colorado Western Slope region shows that air quality in the forest area for particulates and ozone have been well below exceedances from 2006-2016. The Western Slope Region, along with the central mountains, are projected to be the fastest growing areas of Colorado through 2020 with greater than two percent annual population increases, according to the Colorado Department of Local Affairs. All of the areas currently comply with federal air quality standards (CAPCD 2016).

Hazardous Air Pollutants

The Dark Canyon Wilderness is exposed to smaller quantities of hazardous air than other wilderness areas in Region 4, when comparing emission sources and wilderness proximity as shown in Figure 19.

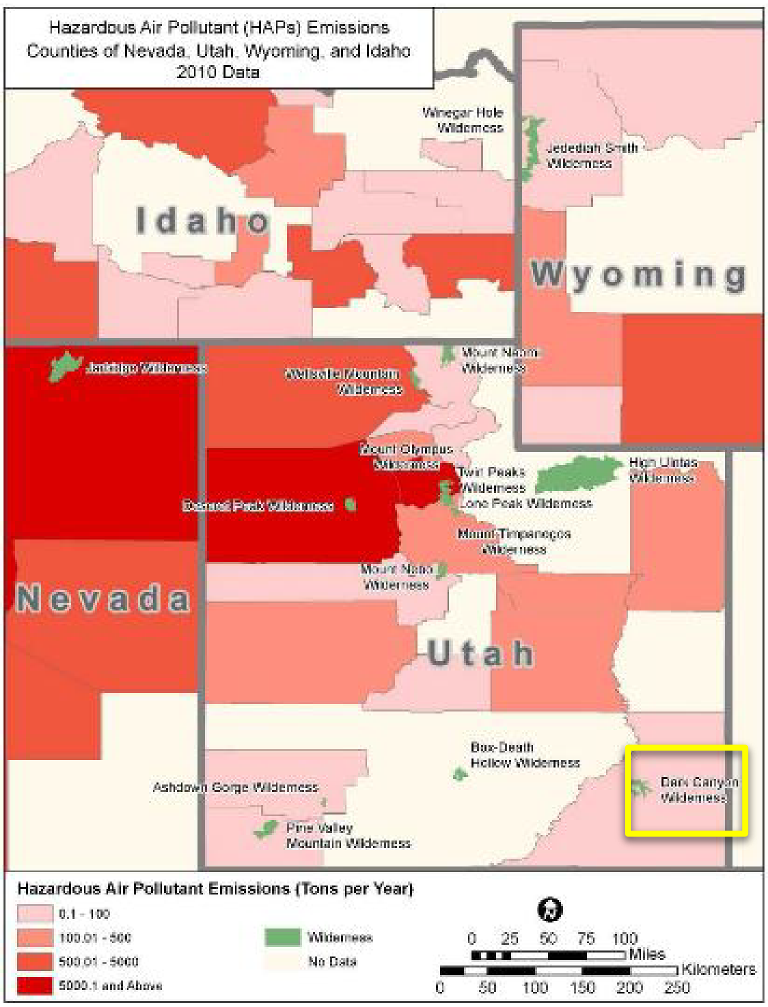


Figure 19. Hazardous air pollution emissions with wilderness locations overlaid. Dark Canyon Wilderness is highlighted with a yellow outlined box.

Air Pollution Emissions

Currently there are no comprehensive Forest emissions inventories that estimate emissions exclusively from Forest administrative operations and permitted operations. The Forest considers prescribed burning, wildfires and fugitive road dust as producing the most emissions and fossil fuels development and production, and other forest operations, as producing lesser amounts of air pollution (Nick and McCorison). The states develop emissions inventory for counties and airshed areas within their jurisdictions.

Utah Emissions Inventory

The 2014 triennial inventory is the most recent statewide inventory available. The triennial inventory covers over 360 individual point sources, 194 area categories, and 12 mobile on road and off road categories. Table 23 shows total emissions, by county, of the criteria pollutants, CO, NO_x, PM_{10}, $PM_{2.5}$, SO_2, and VOCs. Utah County produces the greatest amount of pollutants and is in nonattainment or maintenance for several criteria pollutants described above (UDAQ 2017).

Table 23. Estimated emissions inventory in Utah counties for 2014 measured in tons per year.

County	CO	NOx	PM_{10}	$PM_{2.5}$	SO2	VOC
Carbon	8,119	6,332	4,930	867	10,333	16,502
Emery	17,837	20,402	5,146	1,249	6,427	36,041
Grand	14,414	3,166	1,632	371	23	42,417
Juab	10,975	2,460	3,108	745	17	26,542
San Juan	19,987	2,057	4,750	713	512	85,704
Sanpete	6,846	1,175	5,429	812	13	14,835
Sevier	9,057	2,011	7,511	1,091	35	16,843
Utah	52,088	12,687	15,374	3,039	228	28,840

CO = Carbon Monoxide; NO_X = Nitrous Oxide; PM_{10} = Particulate Matter <10; $PM_{2.5}$ = Particulate Matter <2.5; PMC = Particulate Materials Center; VOC = Volatile Organic Compound; SO_2 = Sulfur Dioxide

The nearest ozone monitoring station to Dark Canyon Wilderness is in Palisade, Mesa County, Colorado and in Utah the stations nearest the Forest are located at Hurricane, Price, Roosevelt, Spanish Fork and Vernal (Nick and McCorison).

Colorado Emissions Inventory

For Colorado, emissions inventory data is available from the Intermountain West Data Warehouse, Western Air Quality Study for 2011 for the two counties that overlap the Manti La Sal National Forest. Emissions inventories are shown for 2014 in Table 24. The Forest local emissions and air pollution that is transported into the Forest area by prevailing winds are the primary sources of air pollutants. Weather conditions are a major driver of ozone creation described in detail below (IWDW 2018).

Table 24. Estimated emissions inventory in Colorado counties for 2014 measured in tons per year.

County	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Mesa	29,010	6,767	5,331	1,473	99	8,342
Montrose	12,573	2,694	2,041	834	1,295	2,742

CO = Carbon Monoxide; NO_X = Nitrous Oxide; PM_{10} = Particulate Matter <10; $PM_{2.5}$ = Particulate Matter <2.5; PMC = Particulate Materials Center; VOC = Volatile Organic Compound; SO_2 = Sulfur Dioxide

Sensitive Receptors

Lichens

During 2014, 26 lichens, which included 6 genera and 6 different species, known to be pollution sensitive and common to each of the 15 air quality biomonitoring sites were collected for elemental analysis on the Forest. Also, the lichen growth substrate on which the lichens were growing was collected for elemental analysis to compare to that in the lichen. The average number of pollution sensitive species collected at each site was 6.2. This number compares to the 2000 study done by Dr. St. Clair with an average of 10.1, and with an average of 6.3 along the Wasatch Front; 8.0 in the Bridger Wilderness Area; and 10.3 in the High Uintas Wilderness Area (St. Clair 2000). Sites 5, 9, and 13 with the least number of pollution sensitive species identified could be attributed to their proximity to urban areas of Manti and Moab. Good species diversity at each monitoring site along with the healthy look of most all of the lichen populations and relatively moderate average of pollution sensitive species (6.2) would indicate that the lichen are not being heavily impacted by air pollution on the Forest. According to the data developed by ICP-OES2 many sites have somewhat elevated levels of sulfur as compared with the data of the St. Clair 2000 elemental analysis. However, the visual health and wellbeing of the lichens showed no necrosis or death that could be attributed directly to the elevated levels of sulfur (Gatherum 2014).

Critical Loads

Atmospheric Deposition includes nutrients in several forms. The primary gases involved with inorganic nitrogen deposition include ammonia (NH3), nitrogen oxides (NOx), and nitric acid (HNO3), while the primary particles are nitrate (NO3-), and ammonium (NH4+). Ammonium (NH4+) are most often from agricultural sources. Sulfur dioxide (SO_2) and HNO_3 are emitted as a result of high temperature combustion (e.g. power plants, cars, industrial facilities), while ammonia (NH3), and nitrate (NO_3) is the dominant sulfurous pollutant emitted by anthropogenic sources, including fossil fuel combustion and industrial processes. Sulfur is transferred to ecosystems through wet deposition of sulfate (SO_4), as well as dry deposition of sulfate particles and gaseous SO_2 (Nick and McCorison). The indicators for excessive nitrogen and sulfur deposition are displayed in Table 25.

Table 25. Indicators for excess nitrogen and sulfur deposition. Adapted from Federal Land Managers' Air Quality Related Values Working Group (FLAG).

Ecosystem	Indicators for Sulfur Deposition	Indicators for Nitrogen Deposition
Freshwater	Chemical change (ANC depression), changes in phytoplankton and benthic community composition, species diversity, biomass	Chemical change (ANC depression), changes in phytoplankton and benthic community composition, species diversity, biomass
Terrestrial	Leaching of soil cations, soil acidification, mobilization of aluminum ions; Lichen species and vitality	Changes in: litter and soil carbon and N dynamics; biomass; soil N processes; litter decomposition rates; soil microbe functional groups; soil organic matter quality and quantity; soil water chemistry; Lichen species and vitality

Nitrogen and Sulfur

Nitrogen, Ammonium and Sulfur wet deposition rates are monitored by the National Atmospheric Deposition Program (NADP). This precipitation chemistry network began in 1978 with the goal of providing data on the amounts, trends, and geographic distributions of acids, nutrients, and base cations in precipitation. While a variety of nutrients are monitored, for the purposes of this document only sulfur and nitrogen are shown. Results from sampling sites where spatially extrapolated to cover the continental US. 2014 was chosen for being the most recent published results. The Dark Canyon Wilderness is modeled as receiving low to moderate levels of nitrogen, ammonium and sulfur. Thus, when monitoring for nitrogen, ammonium and sulfur exposure of a sensitive receptor within the wilderness, it should exhibit characteristics of low exposure (Nick and McCorison).

Mercury

Mercury has a long atmospheric lifetime and accumulates in the food chain. Anthropogenic (human-caused) increases in deposition are harmful to ecosystems and humans. The Mercury Deposition Network (MDN) is the only network providing a long-term record of total mercury (Hg) concentration and deposition in precipitation in the United States and Canada. However, spatial coverage and record length are short for the area covered in this document compared to nitrogen and sulfate deposition. The nearest mercury deposition monitoring station is located at Mesa Verde National Park and it showed an annual average of 0.15 mg/m2 in 2014 and 0.10 mg/m2 in 2015 (NADP 2016).

Visibility

Visibility is expressed in deciview (dv), a metric which is calculated using the light extinction coefficient. A one-deciview increase (or decrease) represents a change in conditions just perceptible to most human observers. The currently accepted estimate for natural visibility in the west is between 4.5-5 dv (110-115 miles). The lower the deciview value, the greater a distance can be seen - less haze present. The IMPROVE program is a multi- agency cooperative monitoring effort. The goals of the program are to establish the baseline conditions in Class I wilderness; to identify the pollutants and emission sources responsible for any man-made visibility impairment; document long term trends; and to provide regional haze monitoring for all Class I wilderness areas (IMPROVE). The network takes aerosol, optical, and scene measurements, although only aerosol measurements are taken at all sites. These include particulate matter mass and key constituents such as sulfate, nitrate, organic and elemental carbon, soil dust, and sea salt (Nick and McCorison).

The entire Manti-La Sal National Forest is classified as a Class II aireshed area. The Dark Canyon Wilderness is not a Class I wildernesses thus, no IMPROVE site has been established to monitor its condition. The Canyonlands, Capital Reef and Mesa Verde National Parks are the closest Class I areas with IMPROVE monitoring sites to the Manti La Sal National Forest. The most recent 5-year average indicates that visibility at Utah's Class I areas is improving on both the 20% worst and 20% best days and has already achieved better visibility improvement than the preliminary reasonable progress (PRP) projections for 2018 (UDAQ 2015).

Trends

Colorado and Utah National Ambient Air Quality Monitoring

The Air Pollution Control Division of the Colorado Department of Public Health and Environment conducted air quality and meteorological monitoring operations at 46 locations statewide throughout 2015. The monitoring shows an overall reduction in air pollution. In Utah, emissions for criteria air pollutants either stayed the same or continued their downward trends in 2015. The Utah Division of Air Quality states that with an increasing population, industrial base, and more stringent federal air quality standards, it has been a challenge to meet air quality objectives, and that 2015 proved to be a year in which Division of Air Quality made great strides to ensure cleaner air in the years to come. The monitoring shows an overall reduction in air pollution.

Wilderness Air Quality Values Monitoring and Sensitive Receptors

The Dark Canyon Wilderness is exposed to some of the highest ambient ozone concentrations within Region 4. Multiple sensitive receptors may exist for air pollution monitoring within the Dark Canyon Wilderness such as streams for water chemistry monitoring, ozone sensitive plant species, and lichen. These options were determined by examining river/stream millage, acreage of surface waters and vegetation composition of each wilderness. Lichen study plots have already been established in and around the Dark Canyon Wilderness and more may be available through the Forest Health Monitoring (FHM) network. Data from these studies could be used as a baseline for future research (Nick and McCorison).

The Clean Air Status and Trends Network (CASTNET) is a long-term monitoring network designed to measure acidic pollutants and ambient ozone concentrations in rural areas. CASTNET monitors measure ambient O3 concentrations for the entire year, which extends beyond the required ozone season for most states (CASTNET 2016). The nearest monitors to the Manti La Sal National Forest are located at Canyonlands National Park (CAN407) and Mesa Verde National Park (MEV405) Both stations reported annual hour average ranging from about 40 to 50 ppb from 1995-2016.

Future Air Quality Estimates

National Ambient Air Quality Standards

Overall, present and future reductions in air pollution in and around the Manti-La Sal National Forest are mostly expected to result from increasing motor vehicle/internal combustion engine fuel efficiency and improving motor vehicle and industrial pollution control systems (CAPCD 2016, UDAQ 2017).

Utah County is a nonattainment area for PM10 and PM2.5 and will probably stay in nonattainment for many years due do the difficulty with controlling fugitive dust in the greater Salt Lake area.

As shown above, in October of 2016, the EPA strengthened the ozone NAAQS. Ozone monitors operated by the UDAQ along the Wasatch Front show exceedances of the new standard in Weber, Davis, Salt Lake, and Utah Counties. The EPA concurred with part of the Governor’s area designation recommendation and designated the counties in the southern half of the state as attainment/unclassifiable. The EPA also plans to concur with the recommendation for the Wasatch Front. In the Uinta Basin the state recommended that areas less than 6,000 feet be designated nonattainment. In December 2017, the EPA proposed that the elevation be raised to 6,250 feet so that it would include the Whiterocks monitor that is operated by the Ute Tribe. The UDAQ expects the proposed designations to be finalized by the end of April 2018.

Wilderness Air Quality Values

Visibility is expected to improve throughout the Manti La Sal National Forest area for the next several years and the states of Colorado and Utah forecast meeting regional haze goals set for 2064.While overall sources of air pollution have been declining for many years in the Manti-La Sal National Forest region, there is concern about increasing W126 ozone exposure values and the potential for critical load exceedances.W126 ozone exposure appears to be increasing at the IMPROVE sites nearest the Forest at Canyonlands and Mesa Verde National Parks.

Mitigating Management Actions

State and Regional Air Pollution Emissions Control

The Colorado Department of Public Health and Environment, Air Pollution Control Division, and the Utah Department of Environmental Quality, Division of Air Quality, oversees the development and adoption of the state’s air quality regulation program. The Divisions can set its own Ambient Air Quality Standards that are equally or more stringent than the Federal air quality standards. The Divisions implements the air management programs adopted by the states air quality commissions and enforces compliance with the NAAQS, PSD increments, and regulates smoke emissions from prescribed burning in accordance with state regulation. Under the CAA the Forest Service and its permitted operations are required to comply with all applicable state air quality regulations.

Of special concern are any Forest activities within Utah County (nonattainment/maintenance for PM10, PM2.5 and ozone) for which the Forest Service as a federal agency is required by law to do an emissions estimate to determine that the emissions are either below the minimum level (100 tons per year) or do a conformity determination in accordance with the Utah State Implementation Plans.

The Forest is required to comply with prescribed burning regulations administered by the states of Colorado and Utah and in so doing complies with the CAA smoke management requirements.

Prevention of Significant Deterioration in Dark Canyon Wilderness and Nearby By Class I Air Sheds
The PSD Program is a CAA requirement that sets emission limitations for major new or modified stationary sources of air pollution such as coal fired electrical power generation plants and sets limits to an increase of pollutants in Class I and Class II areas. A permittee wishing to build new (or significantly modify existing) facilities in a clean air region must obtain a prevention of significant deterioration (PSD) permit from the state. Where emissions from new or modified facilities might affect Class I areas, the Federal land manager (FLM) must be notified. The manager reviews the PSD permit to ensure that AQRVs are not adversely affected, that National Ambient Air Quality Standards (NAAQS) and PSD increments are not violated, and that best available control technology (BACT) is used to minimize facility emissions. If the land manager determines that the facility's emissions will "adversely impact" AQRVs, the FLM will recommend that the permit not be issued or that mitigations be adopted. It is important to remember that notification of permit applications is not required for facilities that may affect Class II areas. However, the land manager may provide input regarding any anticipated impacts on AQRVs to the permitting authority during the public comment process. Additional methods of protecting wilderness values in Class II areas include participation in regional assessments and State Implementation Plan (SIP) revisions. In nonattainment areas, FLMs can also provide feedback to the permitting authority during the facility permitting and air quality planning processes (Nick and McCorison).

State Smoke Management Programs
Both states of Colorado and Utah developed and maintain Smoke Management Programs. The EPA approved Colorado and Utah's Smoke Management Programs, which is a key element of the Regional Haze State Implementation Plans that was required under the CAA. The states are required, under the approved plans, to manage planned burning in a manner that protects air quality and ascertains air quality impacts locally and regionally. Currently, state and federal land managers must complete multiple forms, depending on the type of planned burn. That information and subsequent planned burn data must then be transformed into a form suitable for modeling to ascertain air quality (CAPCD 2016, UDAQ 2017).In 2017, the Utah Smoke Management Program oversaw 90 large burn projects throughout the state.

3.2.7 Soil

Indicators

There are two soil indicators. Soil productivity and soil quality, and soil stability.

Soil Productivity and Soil Quality

Within this indicator there are four soil functions described below.

Soil Biology
Ability to provide habitat for a wide variety of organisms, including plants, fungi, microorganisms and macro-organisms in the upper sections of the soil to promote root growth, control moisture and temperature within the soil profile, and provide for nutrients available to plants.

Soil Hydrology
Ability of the soil to absorb, store, and transmit water, both vertically and horizontally. Soil hydrology is extremely important on the Forest because ecosystem productivity is typically limited by water. Soil can regulate the drainage, flow, and storage of water and solutes, including nitrogen, phosphorus, pesticides, and other nutrients and compounds dissolved in the water. With proper functioning, soil partitions water for groundwater recharge and use by plants and animals. Soil optimizes infiltration, reducing surface runoff and reducing erosion and sedimentation to streams and waterways.

Nutrient Cycling

Nutrient cycling is the movement and exchange of organic and inorganic matter back into the production of living matter. Soil stores, moderates the release of, and cycles nutrients and other elements. In contrast to the annual harvests associated with agriculture, forest harvest, and hence nutrient removal, typically occurs only once per rotation or every 40 to 120 years. This not only reduces the rate of removal, but the long-time interval makes natural additions of nutrients by atmospheric deposition and by weathering of soil minerals very important in maintaining nutrient status. Soil organic matter and carbon storage are extremely important for maintaining nutrient cycling especially on sensitive soils with coarse textures that contain low amounts of inherent nutrients.

Carbon Storage

Ability of the soil to store carbon. The carbon cycle illustrates the role of soil in cycling nutrients through the environment. More carbon is stored in soil than in the atmosphere and above-ground biomass combined. Compaction and loss of organic matter and topsoil can be assumed to affect carbon storage. Both the soil cation exchange capacity and soil aggregate stability are directly dependent on soil carbon storage.

Soil Stability

Within this indicator there are two soil functions described below.

Soil Stability and Support

Soil stability and support is necessary to anchor plants and buildings. Inherent soil properties, like soil texture and particle size distribution, play a major role in physical stability. The main forest impacts to structure and stability are mass wasting, erosion, and loss of organic matter.

Filtering and Buffering

By filtering and buffering, soil protects the quality of water, air, and other resources. Toxic compounds or excess nutrients can be degraded or otherwise made unavailable to plants and animals. Microorganisms in the soil degrade some of these compounds; others are held safely in place in the soil, preventing contamination of air and water. Wetlands soils especially function as nature's filters. Main impacts to the filtering and buffering function include those impacts to soil hydrology and biology.

Physiography and Soils

The diverse soils of the Forest are described, characterized, and classified in seven different soil surveys.

- UT-608 (NRCS SSURGO soil database) covers most of the San Pitch Mountains (Gunnison Plateau).
- UT-627 (NRCS SSURGO soil database) covers the very southeastern portion of the San Pitch Mountains (Gunnison Plateau).
- UT-633 (NRCS SSURGO soil database) covers most of the La Sal Mountains.
- CO-675 and CO-680 (NRCS SSURGO soil databases) covers the far eastern portion of the La Sal Mountains.
- UT-645 (Forest Soil Survey, completed by Daniel Larsen, Forest Soil Scientist) covers the Wasatch Plateau and the Abajo Mountains/Elk Ridge.

Soils on the Manti-La Sal National Forest vary considerably in relationship to the geologic, climatic, and topographic characteristics for the area. Most of the soils have formed from sedimentary rocks including sandstone, shale, and limestone.

In the South Zone, quartz diorite porphyry is a major rock type from which the soils have formed. The texture may range from loamy sand to clay. Soil depths are shallow to moderately deep with the exception of those soils developed on transported materials such as alluvium, colluvium, and glacial deposits. Stony or cobbly soils are common on most of the steep mountain slopes. Most of the soils, except for those on some pinyon-juniper and spruce-fir sites, have dark colored surface horizons of eight inches or more in thickness. In addition to the good topsoil development, there is commonly an increase in clay content in the subsoil compared to the surface texture (Argillic horizon). The soils are moderately productive but are limited by short growing seasons due to cold temperatures at the high elevations and limited available moisture at the lower elevations. Between these extremes is a zone typified by the aspen vegetative type, which generally has the most productive soils.

The North Zone is renowned for land instability and flooding. Landslides, debris avalanches, and mudflows are most prevalent on soils of the North Horn Geologic Formation, particularly where the land and bedrock slopes in the same direction. The soils typically have textures of very fine sandy loam to silty clay and loam at the surface. The subsoils are generally finer textured and less permeable, which contributes to soil instability and landslides on the North Horn developed soils. The abundance of steep slopes and occurrence of intense summer thunderstorms are prime factors which relate to high erosion potentials when surface cover is removed.

Soil Erosion Hazard

The susceptibility of soil to erosion, or the relative loss of exposed soil to erosional forces, is expressed by soil erosion hazard ratings. These hazard ratings consider slope, soil type and texture and is considered to be soil lost through sheet and rill erosion where 50 to 75 percent of the surface has been exposed through some type of disturbance including logging, fire, grazing or mining. A rating of “slight” indicates that erosion is not likely if soils are bared; whereas, a rating of severe or very severe, indicate a high likelihood of sheet and/or rill erosion if soils are bared and a loss of soil productivity will likely result from the loss of soil. The abundance of steep slopes and occurrence of intense summer thunderstorms are prime factors which relate to high erosion potentials when surface cover is removed. Also, large scale destructive change has occurred across the Forest since the turn of the century.

The normal existence of a soil mantle on practically all terrain that is suitable for grazing is the basis for all indicators of range condition and trend that relate to soil. The soil mantle itself is an indicator of a long period of essential stability. In view of this stability, signs of recent disturbance such as active gullies, wind scoured depressions, and topsoil remnants indicate that the slow constructive process of soil development has been superseded by rapid, destructive process of accelerated erosion. Over time, as grazing has decreased and restoration projects have occurred across the Forest, soil cover has increased and likely reduced the soil erosion on the Forest (Goodrich 2012), but much of the destructive change that has occurred is still evident (Dulfon 2016). Table 26 displays the general soil erosion hazard ratings across the Forest.

Table 26. Erosion hazard ratings across the Forest by acres and percent.

Erosion Hazard Rating	Acres	Percent
Slight	61,338	4
Moderate	433,946	32
Severe	778,184	57
Very Severe	17,233	1
Not Rated	79,302	6

Landslide Hazards

Areas mapped with high landslide risk are located within the Wasatch Plateau and the San Pitch Mountains on slopes greater than 35 percent on the North Horn Formation as shown in Table 27. These areas do not have any active landslides currently, but this landform is known to have active landslides and has had a lot of landslide activity in the past. Areas mapped with moderate to high risk are located on slopes greater than 35 percent on formations known to contain landslides. Areas mapped with moderate risk are located on slopes 20 to 35 percent on formations known to contain landslides.

Table 27. Landslide risk on the Forest in acres.

Risk	La Sal Mountains	Abajo Mountains and Elk Ridge	Wasatch Plateau and San Pitch Mountains	Total
Extreme	0	650	32,726	33,376
High	0	0	169,607	169,607
Moderate to High	18,384	52,770	173,602	244,756
Moderate	12,397	29,445	190,072	231,914

Soil Quality and Productivity

Soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation and ecosystem health. Soil productivity is the inherent capacity of a soil to support the growth of specified plants and plant communities, or sequence of plant communities. Plant growth is generally dependent on available soil moisture, nutrients, texture, structure, organic matter, and the length of the growing season.

Grazing

Currently, there are 119 allotments on the Forest with 169 permits. Cattle, sheep, and/or horse grazing covers almost the entire Forest. In the past heavy grazing led to soil loss, sheet erosion, head cutting, rills and a reduction in soil organic matter that can still be seen in places today where site quality and productivity have been lowered overall. Soil monitoring of Forest rangelands was conducted in 2015. Soil compaction was found at 7 of the 45 sites surveyed with percent area of compaction ranging from 10 to 30 percent. All sites were rated as stable or very stable except one, which was rated at risk with moderate stability due to compaction, loss of organic matter at the site, and reduced carbon storage.

Harvesting

Since 1992, approximately 11,182 acres of the Forest have been harvested through commercial thinning and salvage treatments. These treatments likely led to local areas of compaction, soil loss, and erosion especially where skid trails and temporary roads have been used. Practices have evolved to be more conscious of the impacts to soils; logging practices have shifted to less impact causing equipment, and soil restoration is included in the majority of projects to meet the desired conditions for the land.

Prescribed Fire and Wildland Fire

Historically, there have been several landscape scale fires throughout the Forest on approximately 129,389 acres. Prescribed fire and wildland use fire have also occurred. Within prescribed burn areas, litter layers and organic matter were generally kept intact and nutrient losses were likely minimal due to low to moderate burn severity in a controlled environment (Certini 2005). Wildland fires, however, are more unpredictable and burn severities tend to be higher, loss of organic matter, soil cover and soil microbial changes are more likely to occur (Certini 2005) along with increased erosion (Wondzell and King 2003; Larson et al. 2009) that further reducing the nutrient pool available (Megahan 1990; Certini 2005).

Soil Water Balance

The USGS has recorded at least seven multiyear droughts occurring in Utah since 1896 (Wilkowuske et al. 2003), and droughts are becoming increasingly common and more severe than in the past (Littell et al. 2016; Seager et al. 2007). Trees have evolved protective mechanisms to deal with water stress, but there are many external factors that determine the effects of drought, including soil composition, topography, and tree species mix, age, and density. Specific soils across the Forest are more susceptible to drought and water stress overall. Trends in the soil water balance over time have shown that there is a greater water deficit within the soil in edge environments within badlands or mesa lands and are generally associated with pinyon/juniper or shrub land vegetation especially within the Abajo Mountains and Elk Ridge areas of the Forest.

Carbon Storage

Soil stores carbon and globally, more carbon is stored in soil than in the atmosphere and above-ground biomass combined. Limiting factors of soil carbon storage are soil depth and rockiness. Carbon compounds are inherently unstable and owe their abundance in soil to biological and physical environmental influences that protect carbon and limit the rate of decomposition (Schmidt et al. 2011).

On the Manti-La Sal National Forest and within the Intermountain Region of the Forest Service, most of the drier soils contain approximately 0.5 percent soil organic carbon and cooler/moister soils contain approximately 8 percent soil organic carbon (Reeves et al. 2016; Brady 2002). Approximately 29 percent of the carbon stored on the Manti-La Sal is soil organic carbon. NFS land within the Intermountain Region has approximately 135 milligrams of carbon per hectare of which approximately 75 milligrams of carbon per hectare is soil organic carbon and forest floor carbon stocks (Heath et al. 2011). On the Forest, approximately 12,700,000 metric tons of carbon are stored in the soil (measured in 2014); this amount has dropped since 2008 when approximately 13,000,000 metric tons of carbon were stored in the soil on the Forest (Scottorn and Anderson 2016). Soil organic carbon amounts overall have been increasing over time (USDA 2015a).

Soil Stability

Soil stability and support is necessary to anchor plants and structures. Inherent soil properties, like soil texture and particle size distribution, play a major role in physical stability.

Past Flooding and Erosional Actions

Erosion and flooding have shaped much of the Forest. Historic catastrophic flooding occurred throughout the late 1880s and early to mid-1900s depositing material on the valley floors (Reynolds 1911; USDA 1935, 1947, 1948, 1957, 1983a, 1986 and 2016a and b). This was partly due to overgrazing in the hillslopes leading to cover loss and exposed soil on slopes that are very prone to erosion when bared (Reynolds 1911; Stewart and Forsling 1931). Erosional events have been well documented on the Forest (USDA 1927, 1928, 1946, 1948, 1950; Ellison 1954), and much of the Wasatch Plateau has formed due to erosional processes. Past erosion has been surveyed on approximately 51,431 acres across the Forest. Most of the erosion monitored was moderate in severity with gullying, bare soil, cattle trailing, and sheet erosion as shown in Table 28. The severe to very severe erosion was found mostly on steeper slopes ranging from 80 to100 percent slope in concave landscape positions. The implementation of grazing management, best management practices, and erosion control measures has reduced the erosional occurrences on the Forest, but erosion has been noted in recent years as well following wildland fires and flooding events (Vanderbilt 2006).

Table 28. Acres of each erosion type on the Forest.

Erosion Type	Acres
Bare Ground	26
Barrens and Trail Disturbance	2,032

Gulley	37,643
Outcrop	389
Outcrop and Trail Disturbance	42
Sheet	12
Trail Disturbance	806
Unspecified	10,480

Past Landslides

Approximately 241,379 acres of past/active landslides have been mapped across the Manti La Sal National Forest. Most of these acres exist on the Wasatch Plateau within the Flagstaff Limestone, North Horn, and Price River geologic formations. The Wasatch Plateau, especially the western portion are very susceptible to landslides due to the higher amount of precipitation and the westward dip of the rocks which coincides with the direction of the slope making sliding more prevalent. Many the landslides on the Forest occurred following flooding and wildfires (USDA 1986; USDA 2016a), but there are still large active landslides and unstable areas present.

Restoration Efforts

Watershed restoration efforts have been ongoing since the 1950s, and have included soil erosion restoration through reseeding, reduction in livestock grazing, and implementation of range management. Following the flooding, erosional, and landslide events of the 1980s, restoration efforts ramped up and included erosion control measures to reduce sediment production, revegetating riparian and hillslope areas, road restoration, and road reconstruction and decommissioning. In recent years, restoration has been focused on prescribed burning, invasive plant control, and watershed improvement projects, which have occurred on approximately 29,668 acres.

Trends

Shifts in climate are expected to primarily impact mid elevation forests where winter moisture comes as rain rather than snow, and where a decrease in snowpack could result in prolonged periods of soil moisture deficit. The interactions of increased soil temperature and changes in type and amount of precipitation will also affect soil functions differently across different soil types. Finer soil textures are expected to buffer changes in climate more readily than coarse soil textures and those areas with finer soil textures will experience change more slowly (IAP 2016). Soil carbon changes could lead to changes in soil structure, soil bulk density, and soil porosity (Singh et al. 2011; IAP 2016), potentially changing water infiltration rates and rooting depth. Warmer soil temperatures will likely lead to increased losses of soil carbon (IAP 2016).

3.3 Carbon Stocks

Carbon dioxide is removed from the atmosphere, or sequestered, when it is absorbed by plants as part of the biological carbon cycle. In 2014 U.S. greenhouse gas emissions totaled 6,870 million metric tonnes and continue rising. Within the same year land use and forestry were responsible for offsetting 11.5 percent of those emissions (EPA 2016a). The NFS holds 24 percent of the total carbon stocks in the United States (USDA 2015b). The ability of forestland to absorb and store carbon from the atmosphere can play a significant role in managing current levels of atmospheric carbon dioxide.

3.3.1 Indicators

There are four indicators for carbon stocks. They are described by measure and rationale below.

Carbon Pools

The measure for carbon pools is metric tons. The rationale for carbon pools as an indicator is that they are the Forest's capacity to store carbon. Pools are live above ground, live below ground, dead wood, Litter, soil organic.

Most of the earth's carbon is stored in rocks (Ajani et al. 2013). Coal is one of the biggest carbon stocks on the Forest. Coal mining has occurred on the Wasatch Plateau for well over 100 years. From the late 1800s to 2015, 722.3 million short tons of coal have been removed from the Plateau (UGS 2016). In 2015, 78 percent of Utah's coal production came from Carbon and Sevier Counties. Beginning in 2008 coal production began to decline. In 2015 the Deer Creek Mine closed. Based on the current and projected stores, there is still 1.2 billion short tons of coal reserves on the Wasatch Plateau (UGS 2016). However, we do not currently have the data to account for coal moving in and out of carbon pools and were unable to determine carbon storage related to carbon stocks.

Figure 20 shows the proportions of surface carbon stocks found on the Forest, except for coal. The USDA Forest Inventory and Analysis Program has collected data categorized in five different surface ecosystem pools: live above ground, live below ground, dead wood, litter, and soil.

Carbon by Vegetation Community

The measure for carbon by vegetation community is metric tons. The rationale for carbon pools as an indicator is that it is the amount of carbon stored as carbon pools in the five vegetation communities.

Pinyon/Juniper/Woodlands

Contain the highest acreage of any vegetation type and holds 43 percent of the Forest's carbon because of the large pinyon pine, juniper and gamble oak populations.

Forested

Fifty-five percent of the Forest's carbon stocks are in forested vegetation, which includes aspen, spruce fir and mixed conifer vegetation types. This forested group contains the largest trees on the Forest and consequently larger volumes of carbon storage, even though the collective acreage is less than woodlands.

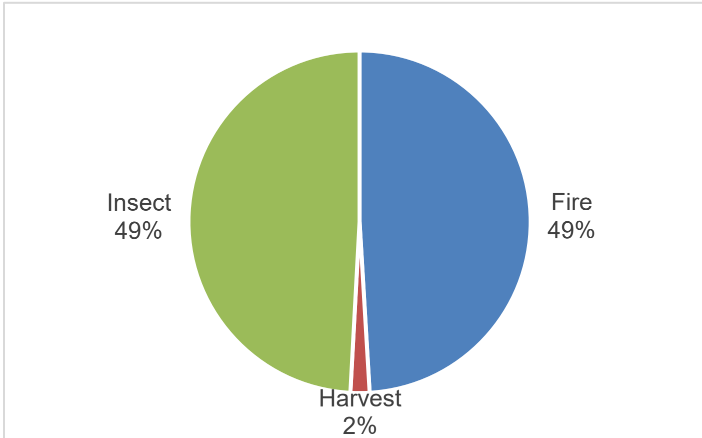
Non-stocked

Figure 20. Carbon stocks on the forest by five carbon pools. (USDA 2016b FIA data 2014).

The combination of perennial forbs, grasslands, sagebrush, and alpine vegetation types. The non-stocked vegetation types are widespread across the Forest; however, this type stores a relatively small amount of carbon.

Figure 21 shows the proportion of disturbances on the Forest. Insects and fire have the biggest effects to vegetation. Generally, as precipitation decreases vegetation growth declines and therefore affects the ability of a forest to sequester carbon. Increasing temperature combined with decreasing precipitation can have substantial effects to vegetation growth. As a result, reduced vegetation production decreases the Forest's ability to sequester and store carbon.

Figure 21. Proportion of disturbances to carbon storage on the Forest (USDA 2015b).



Sequestration and Net Primary Productivity

The measure for sequestration and net primary productivity is metric tons of carbon per acre per year. The rationale for this as an indicator is that it measures the Forest's ability to absorb carbon from the atmosphere.

Net Forest Carbon and Carbon Stock Change

The measure for net forest carbon and carbon stock change is teragrams of carbon per year. The rationale for this as an indicator is assesses the movement of Forest carbon between stocks.

Trends

A forest's rate of sequestering carbon is higher when vegetation is relatively young (10 to 50 years) because of its need for nutrients to support growth. Some large-scale high-severity fires and insects and disease disturbances occurring in the late 1990s resulted in carbon emissions. Over the past 60 years (this dataset), the Forest has been a carbon sink (Figure 23). Positive values represent carbon sinks from the atmosphere or enhancement effects, whereas negative values represent carbon sources to the atmosphere, or detraction effects.

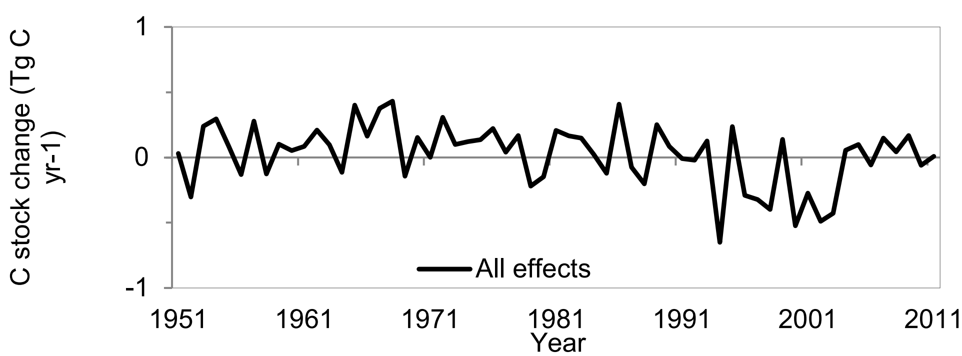


Figure 22. Carbon stock change due to all effects in teragrams of carbon per year (USDA2015b).

The Forest is overall sequestering more carbon than it emits. The Forest's greatest emissions of carbon were approximately the same time as the spruce bark beetle epidemic, carbon emissions may be tied to the effects of the epidemic (Scottorn 2016) and large-scale stand-replacing fires. Basically, when vegetation is removed, a forest's ability to sequester and store carbon is reduced. Accumulated nitrogen deposition and C02 results in increased forest vegetation growth, which improves sequestration. Even though all disturbance and climate effects reduce a forests ability to sequester carbon, live vegetation are using increased C02 and nitrogen to grow faster and sequester more carbon than emission.

3.4 At-risk Species

At-risk species consist of all Forest designated Species of Conservation Concern (SCC) (Appendix 4) as well as all federally threatened, endangered (T&E), and proposed and candidate species. The full list of at-risk species is shown in Table 29. Per the 2012 Planning Rule, SCC are defined as "…*a species other than federally recognized, threatened, endangered, proposed or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the best scientific information indicates substantial concern about the species capability to persist over the long-term in the plan area*."

The SCC review process is a multi-step, iterative process that includes ongoing communication between the Regional Office (RO), the public and the Forest (Appendix 3). The Forest solicited SCC-specific input from the public during 10 public workshops throughout communities near the Forest between September and November 2016. The public was invited to submit their input at the meetings, online, or via email. SCC related public comments and responses were compiled in the Manti-La Sal National Forest Species of Conservation Concern Public Comment Report. Additional information on the evaluation process and the individual species evaluation sheets can be found in the MLNF Potential SCC Review Final Procedural Report and the Final Species Evaluation Report.

Species included here are those recommended for consideration by the Forest at the time this report was completed and is still evolving. The Forest will continue to keep the public updated regarding any changes. The Regional Forester will identify the SCC species that will be taken forward into the development of the draft Revised Forest Plan that will be submitted for public review.

3.4.1 Indicators

- Ecological conditions/habitat (terrestrial wildlife)
- Population information, where available

Table 29. List of all at-risk species on the Forest.

Type	Status	Common Name	Species
Plant	Threatened	Heliotrope milkvetch	*Astragalus montii Welsh*
Plant	SCC	Isley's Milkvetch	*Astragalus isleyi* Welsh
Plant	SCC	La Sal Daisy	*Erigeron mancus* Rydberg
Plant	SCC	Baker's Oreoxis	*Oreoxis bakerii* Coulter & Rose
Plant	SCC	La Sal Mountains' Groundsel	*Senecio fremontii var. inexpectans* Cronquist
Plant	SCC	Geyer's onion	*Allium geyeri var. chatterleyi*
Plant	SCC	Link Trail Columbine	*Aquilegia flavescens var. rubicunda*
Plant	SCC	Pinnate Spring-parsley	*Cymopterus beckii*
Plant	SCC	Kachina Daisy	*Erigeron kachinensis*
Plant	SCC	Canyon Sweetvetch	*Hedysarum occidentale var. canone*
Plant	SCC	Navajo Beardtongue	*Penstemon navajoa*
Plant	SCC	Eastwood's Podistera	*Podistera eastwoodiae*
Plant	SCC	Arizona Willow	*Salix arizonica*
Non-plant	Endangered	Southwestern Willow Flycatcher	*Empidonax trailii extimus*
Non-plant	Threatened	Mexican Spotted Owl	*Strix occidentalis*
Non-plant	Threatened	Yellow-billed Cuckoo	*Coccyzus americanus*
Non-plant	Threatened	Canada Lynx	*Lynx canadensis*

Non-plant	Threatened	Greenback Cutthroat Trout	*Oncorhynchus clarkii stomias*
Non-plant	SCC	American Pika	*Ochotona princeps*
Non-plant	SCC	Black-rosy Finch	*Leucosticte atrata*
Non-plant	SCC	Townsend's Big-eared Bat	*Corynorhinus townsendii*
Non-plant	SCC	Fringed Myotis	*Myotis thysanodes*
Non-plant	SCC	Greater Sage-grouse	*Centrocercus urophasianus*
Non-plant	SCC	Bluehead Sucker	*Catostomus discobolus*
Non-plant	SCC	Bonneville Cutthroat Trout	*Oncorhynchus clarki utah*
Non-plant	SCC	Colorado River Cutthroat Trout	*Oncorhynchus clarki pleuriticus*
Non-plant	SCC	Utah Sallfly	*Sweltsa cristata*
Non-plant	SCC	Boreal Toad	*Anaxyrus boreas*
Non-plant	SCC	Southern Leatherside Chub	*Lepidomeda aliciae*

3.4.2 Terrestrial Wildlife

Threatened, Endangered, Proposed, Candidate Species

There are county lists that include all federally threatened and endangered species recorded within that county. The Forest boundary crosses 10 counties within Utah and Colorado. Within those counties, federally listed species that are recorded within at least one of the counties, but not known to occur on the Forest include:

- Utah prairie dog (*Cynomys parvidens*)
- Gunnison sage-grouse (*Centrocercus minimus*)
- North American wolverine (*Gulo gulo luscus*)
- California condor (*Gymnogyps californianus*)

There are four federally listed threatened and endangered species that are known to occur on the Forest or species for which the US Fish and Wildlife Service has identified suitable habitat for a threatened and endangered species within the Forest boundary. These species are discussed in greater detail below.

Mexican Spotted Owl

Mexican spotted owls (MSO), a federally listed threatened species, and are known to occur on the Monticello District of the Forest. This large, dark-eyed owl is found in mature, mixed conifer forests with dense, uneven-aged stands. Breeding owls in southern Utah primarily use deep, steep-walled canyons with mature coniferous or deciduous trees in the bottoms. They are relatively intolerant of high temperatures, and roost and nest in shady forests or in the cracks of deep slot canyons. Nest sites are generally found on cliff ledges in Douglas fir and to a lesser extent ponderosa pine/Gambel oak vegetation types. They forage in mature forests of mixed conifers and Gambel oak, possibly due to the availability of preferred prey (woodrats) and avoidance of great horned owls. Predators include great horned owls, northern goshawks, red-tailed hawks, and golden eagles.

On the Monticello District, MSO and suitable habitat are found in all the mixed conifer LTAs, most notably in MC_LTAG2, MC_LTAG3 and MC_LTAG4. Important components in their habitat in mixed conifer/pinyon-juniper woodland and riparian vegetation types in canyon habitats are the presence of water, clumps or stringers of trees, steep canyon walls, and a high percentage of ground cover and woody debris.

The MSO was federally listed in 1993. A Recovery Plan for the MSO was completed in December 1995 and revised in 2012 (USFWS 2012). The critical habitat designation was finalized in 2004 and includes the western half of the Monticello district. Habitat models have been developed for use in Utah; the 1997 general habitat model and a potential breeding/roosting habitat model (Willey-Spotskey 2000). Information from these sources, including the primary constituent elements (habitat requirements) and canyon habitat described in the recovery plan, the critical habitat breeding/roosting habitat model and professional knowledge of the site-specific area are used in determining potential MSO habitat.

Most habitat deemed appropriate for the MSO was surveyed on the Moab/Monticello Ranger District. To date, all nests located have been within canyon country, and Protected Activity Centers (PACs) were designated. There are seven designated PACs on the Monticello District. Surveys in the 1990s and in 2002-2010 on the district (MLNF 2010) have not detected breeding owls on the Moab district, or on adjacent BLM land which has also been extensively surveyed. Recent surveys have confirmed the continued occupancy of the existing owl territories/PACs on the Monticello District, and one new territory was documented in 2012 surveys.

Trends

Current range-wide population trend is uncertain, and apparently varies among different regions occupied by the metapopulation (NatureServe 2015). A status review (USFWS 2013) noted that the increased number of areas occupied since 1995 does not indicate an increase in abundance but is a positive indicator. Occupancy in known territories has been stable on the Forest.

The limiting factors to the population are the availability of nesting/roosting habitat, prey availability and competition for nest habitat from other raptors. Specific threats to the population in the Colorado Plateau area are high levels of recreation in canyon habitat, overgrazing, road development in canyons, oil/gas/mining development and catastrophic fire and timber harvest in upland forests (USFWS 2012).

Designated Critical Habitat

Within the Four Corners states, there is 8.6 million-acres of federal land designated as critical habitat for the MSO as shown in Table 30. The Forest contains 202,825-acres accounting for about 9 percent of MSO designated critical habitat within Utah. There are seven Protected Activity Centers (PACs) around known breeding territories designated on the Forest, totaling 6,865 acres with additional management restrictions.

Table 30. Acres of designated critical habitat for Mexican spotted owl on Federal lands within Arizona, Colorado, New Mexico and Utah.

Area	Acres designated critical habitat
Federal land in AZ, CO, NM, and UT	8,600,000
Utah	2,252,857
MLNF[1]	202, 825
Protected/restricted habitat within designated critical habitat on the Forest	115,573

[1]There is additional suitable habitat on the Forest meeting the primary constituent elements outside of the designated critical habitat.

Southwestern Willow Flycatcher

One of four subspecies of willow flycatcher, the migratory southwestern willow flycatcher (SWWF) occurs in New Mexico, Arizona, southern California, and the southern parts of Utah and Colorado. The SWWF is a riparian obligate species, nesting in dense clumps of willow or shrubs with similar structure (alder, some tamarisk) along low-gradient streams, wetlands, beaver ponds, wet meadows and rivers. Dense bunchy multi-stemmed shrubs appear to be a crucial habitat element, although continuous dense acreage is not required because openings often present. Thickets of trees and shrubs approximately 4-7 m tall, with a high percentage of canopy cover and dense foliage from 0 to 4 meters off ground, form preferred nest sites for this bird.

The US Fish and Wildlife Service listed the SWWF as an endangered species in 1995 (USFWS 1995b). This migratory bird is endangered by extensive loss and alteration of riparian habitat, and by brood parasitism in some areas. River and stream impoundments, groundwater pumping, and overuse of riparian areas have altered up to 90 percent of the flycatcher's historical habitat (USFWS 2004).

Range maps for SWWF often include southeastern Utah, and the 2002 Recovery Plan (USFWS) included the Monticello district of the Forest in the Upper Colorado Recovery Unit. Critical habitat designated in 2013 included portions of the Virgin River, Paria River and San Juan River in Utah (USFWS 2013). Identification to subspecies may be problematic near the limits of SWWF range, for example, in southern Utah. Research on distribution by song differentiation indicates that pure strains of *Empidonax traillii extimus* may occur at low elevations (less than 4500') as far north as 37° N latitude (the Utah-Arizona State line) (Sedgwick 2001). DWR surveys (Wright 2009) did not find any breeding willow flycatchers south of 38˚N or identify any suitable habitat on NFS lands. Some conflict exists as to whether the range of this subspecies extends any farther north than 20 miles into Utah. However, the USFWS Utah Field Office still considers the Colorado and Green River drainages through San Juan, Grand and Emery counties as potential habitat.

Trends

The trend in resident populations in areas monitored in AZ, NV and CA has shown an annual decline (McLeod and Pellegrini 2013).

Surveys to date have not located any SWWF on the Forest, though not all potential habitat was surveyed according to protocol. Suitable and potential habitat as described by the USFWS does occur, in willow patches along waterways or near small lakes or wet meadows. The amount of suitable habitat is limited along the predominantly intermittent streams and narrow canyon systems on the Monticello District.

Yellow-billed Cuckoo

The yellow-billed cuckoo is a riparian obligate bird that feeds in cottonwood groves and nests in willow thickets. It migrates to South America for the winter and arrives in the US in late May or early June. It migrates south in August. These birds have the shortest combined incubation/nestling period of any bird species. It nests in open-cup structures that are small, flat, shallow and flimsy made of twigs, vines and rootlets. Nest sites have been correlated with large and relatively large willow-cottonwood patches, dense understories, high local humidity, low local temperature, and in proximity to slow or standing water. Their habitat requirements include low dense understories with branches 3-5 m (9-15 feet) above the ground, typically willow. They are rarely found in forest patches less than 24 ha (59 acres) in size. They feed on insects, primarily caterpillars and grasshoppers.

In addition to outright destruction of riparian habitat, the yellow-billed cuckoo is intolerant of forest fragmentation. Both wildlife and domestic grazing is thought to be a significant threat to the yellow-billed cuckoo range wide (USFWS 2001). Grazing may reduce or eliminate the willow understory and the recruitment of cottonwoods by trampling and grazing of young shoots. The invasion of tamarisk generally means extirpation of willow-cottonwood complexes. Water diversions, damming and conversion to agriculture have also diminished willow-cottonwood complexes.

The yellow-billed cuckoo was listed as a threatened species on October 3, 2014. Critical habitat was proposed in November 2014, and the current maps do not include any lands on the Forest. Since 1990 there have been several casual observations of yellow-billed cuckoos in southeastern Utah, including breeding along the Colorado River in Moab and birds located along the San Juan and Dolores Rivers (USFWS 2011). No birds have been observed on the Moab/Monticello District. No observations have been made on the North Zone of the Forest. The required dense, deciduous, multi-storied, low-elevation riparian forest is not available on any of the districts.

Trends

Yellow–billed cuckoos are rare west of the Rocky Mountains and populations in Utah have experienced significant declines (Utah Wildlife Action Plan Joint Team 2015) and the distribution and habitat use in the state is poorly understood. This species is not well monitored by the Breeding Bird Survey for any part of its range (Utah Wildlife Action Plan Joint Team 2015).

Little work had been consistently done on this elusive bird, and no effort had been made to define potential breeding areas, derive a population estimate for the state, or to establish breeding habitat associations for Utah-specific habitat conditions (Utah Wildlife Action Plan Joint Team 2015).

The UDWR has surveyed for yellow-billed over the last several years. One of the survey areas is in Huntington Canyon beginning approximately 1.5 mi NW of Huntington City on SR 31 to Deer Creek. Those surveys have resulted in 3 observations of yellow-billed cuckoo within the Huntington area, occurring in June 2003, July 2012, and August 2012. All three observations were adjacent to irrigated farmlands in the lower part of the canyon. The DWR's predictive model indicates that habitat for the yellow-billed cuckoo only occurs along Huntington Creek and does not go any further up Huntington Canyon than approximately 3 miles past the junction of SR 10 and SR 31.

Canada lynx

The Canada lynx is a medium-sized wild cat with a large home range based largely on the availability of their primary prey, snowshoe hare. The cyclic nature of lynx population numbers can be directly tied to cycles in hare populations. Lynx will feed on other small mammals and birds such as squirrel, beaver and grouse in the summer or when hare numbers are low. Canada lynx primarily occupy alpine, conifer and mixed conifer forests in boreal and montane regions, with a key element of cold winters with deep snow. They typically den in hollow trees, under stumps or in thick brush. Dens are found in old growth forests with a high density of logs. Three primary habitat components for lynx include foraging habitat that supports snowshoe hare and provides for hunting cover, denning habitat of old spruce/fir forests and dispersal habitat with varied vegetative composition and structure.

The primary factor that caused the lynx to be listed in 2000 was the lack of guidance for the conservation of lynx and snowshoe hare habitat in federal land management plans. Conservation agreements are now in place, but a final recovery plan has been delayed by challenges over listing status, distinct population segments and critical habitat designation.

The primary concern for Canada lynx is habitat loss/fragmentation and loss of connectivity between populations. In the contiguous U.S., overall numbers and range are substantially reduced from historic levels. Other factors impacting their existence include road system expansion, urbanization, agriculture, trapping, recreational development (ski areas) and fire suppression effects to forest structure. There is also concern over competition with bobcats and coyotes in some areas.

Lynx have been transplanted into southwestern Colorado. Several individuals have dispersed into Utah, but no known breeding populations have been established in the state. The USFWS Utah Field Office does not recognize the Moab and Monticello District of the Forest as potential lynx habitat. Lynx are on the list for Montrose County in Colorado due to potential habitat on the Uncompahgre Plateau. There is no snowshoe hare population on the La Sal Mountains in Utah or Colorado. In addition, the portion of the Moab District that falls within Colorado is predominantly ponderosa pine, pinyon/juniper and mountain brush. These vegetation types do not contain the fundamental elements considered necessary for lynx habitat (USFWS 2009b). Lynx are well-known long-distance dispersers. Any individuals on the La Sal or Abajo Mountains would be dispersing/transient lynx, which may be found in completely unsuitable habitats.

Trends

No local trend data available.

Species of Conservation Concern

Using best available scientific information (BASI), the Regional Office identified 76 species for review by Forest specialists including 23 non-plant species. Of these, 6 non-plant terrestrial species were recommended for further consideration: American pika, black rosy-finch, boreal toad, Townsend’s big-eared bat, fringed myotis, and greater sage-grouse.

American Pika

American pikas are small montane mammals related to rabbits. Populations are widely distributed across the mountains of western North American. On the Forest, the pika are found on the Wasatch Plateau and La Sal Mountains in high elevation, alpine habitats above 9000 ft. in association with talus slopes. They are restricted to rocky talus slopes, especially the talus/alpine vegetation interface. Their den sites are under the rocks. They do not hibernate, but harvest grasses and forbs which are stored in hay piles for winter consumption, which is important for surviving long, severe winters.

Climate change is the primary threat to the species (USFWS 2010). Alpine ecosystems are considered one of the most sensitive habitat types to adverse impacts from climate change related stressors (IAP 2016). This threat may be direct (pikas are highly temperature-sensitive; increased ambient temperatures can result in death and reduce the area they can occupy) or indirect through changes in treeline, forage production and snowpack. Recent research has documented the loss of several pika populations in the state and region over the last 5 years due to climate related factors (Beever et al. 2016). Grazing by domestic livestock and native or introduced ungulates may impact populations on a local level, particularly from impacts on forage availability and trampling of soil and vegetation at talus habitat margins (USFWS 2010).

Trends

Limited survey data indicate a well-distributed and stable population, with high occupancy rates in suitable habitat on the La Sal Mountains, but on the Wasatch Plateau there is reduced distribution since 1985, with small isolated populations subject to elimination (UDWR 2009).

Black-rosy finch

The black rosy-finch breeds in alpine areas, usually near rocky slopes and cliffs. Their nests are placed in cracks or holes of cliffs, on small cliff ledge under overhanging rocks, or under rocks in talus slides. The black rosy-finch feeds on seeds and insects. This species is mainly an altitudinal migrant, going to lower elevations if adverse weather occurs during winter. It winters in open country, including mountain meadows, high deserts and valleys.

Impacts from recreation activity are thought to be minor, as the species seems tolerant of human presence (Johnson 2002). Grazing (domestic livestock and/or introduced ungulates) would have a negative impact if it reduced food supply or resulted in an increase in brown-headed cowbirds (nest parasite) in alpine habitat (Johnson 2002). Climate change and resulting changes to snowpack (drought), treeline elevation, or breeding habitat quality, is considered to be a potential threat/risk (WAP 2015). The Partners in Flight Landbird Conservation Plan (Rosenberg et al. 2016) includes the black rosy-finch as a Watch List species with extremely high vulnerability due to small population and range, high threats and range-wide declines.

Other considerations for local conservation concern are limited range, specificity of habitat requirements and apparently low population numbers in the plan area. A resumption of hard rock mining in breeding habitat, or large-scale mining, development or habitat conversion in winter habitat may have negative impacts in some areas of its range.

Trends

Although not well-sampled by Breeding Bird Surveys due to its remote alpine habitat, trends are believed to be declining range wide, and in combination with an overall small population size, it was considered a species of continental concern with extremely high vulnerability in 2016 Partners in Flight Landbird Conservation Plan (Rosenberg et al. 2016). Trends specific to the Forest have not been determined.

Boreal Toad

Habitats in the Southern Rocky Mountains include mainly subalpine lakes, reservoirs, ponds, creek pools, marshy areas, wet meadows, and adjacent terrestrial habitats. Individuals seeks shelter under logs or rocks or in rodent burrows or other below-ground spaces. Eggs and larvae develop in shallow areas of ponds, lakes, or reservoirs, or in pools of slow-moving streams (NatureServe 2015, UDNR 2003).

Genetic work indicates that the Utah population, along with those in Colorado and Wyoming form a clade, with one genetically unique population on one southern mountain range in Utah (WAP 2015). Populations are declining throughout their range (NatureServe 2015, IUCN 2007). Both Utah and Colorado have documented long-term declines in the populations for these species (WAP 2015, UDNR 2003).

The species is rare on the Forest, one breeding population found in 2015 on East Mountain. Additional survey work was completed in the 2016 field season for several locations on the Forest. Habitat management actions are planned for 2017.

Trends

This species is experiencing both short (10 to 30 percent) and long-term declines (less than 50 percent) across its range (2015). Trend is unknown on Forest.

Townsend’s Big-eared Bat

The Townsend’s big-eared bat uses caves and mines year-round for maternity colonies and hibernacula. The greatest threats include disturbance and closure of abandoned mines and from white nose syndrome (WAP 2015). White-nose syndrome has not yet been documented as afflicting Townsend's big-eared bats, but this fungal disease of bats now occurs throughout much of the eastern portion of the range of *C. townsendii*

(NatureServe 2015). Mortality associated with wind turbines is a potential threat (NatureServe 2015). This species is also particularly vulnerable to human disturbance at roost sites (UDNR 2003). Climate change-related impacts to pinyon-juniper, big sagebrush and riparian habitats from warming temperatures, drought, lower summer stream flows and increased wildfire (IAP 2016) may also adversely impact the species.

Trends
Generally rare, although they may be locally common near appropriate roosting habitat (WAP 2015). Found throughout Utah in a wide variety of habitats but closely tied to caves and abandoned mines (UDNR 2003). Populations are thought to be declining over the long-term. Abundance and trend in the plan area are unknown.

Fringed Myotis

The fringed myotis, a bat, is widely distributed in the western US, but the species is uncommon in Utah (Oliver 2000; UCDC 2016). It occurs primarily at middle elevations (2,400 to 8,900 feet) in desert, riparian, grassland, and woodland habitats. Caves, mines and rock crevices are important habitat components for roosting. This species forages primarily near the tree canopy, and its diet includes beetles and moths.

There is a very high threat severity from invasive species including disease (white-nose syndrome) (WAP 2015). Habitat modification and human disturbance are also high risks (NatureServe 2015, UDNR 2000). The lower and mid-elevation habitats occupied by this species are vulnerable to changes from increased temperatures and severe or multiyear drought. This species relies on water sources and riparian areas; threats to these habitat types from climate-change related warming temperatures, decreased snowpack, shifting timing of snowmelt and lower summer stream flows could also impact this species (UDNR 2003, CNHP 2015).

Trends
Fringed myotis abundance varies locally (WAP 2015, UDNR 2000). Abundance and trend in the plan area are unknown (UDNR 2003), but the species is regularly detected during acoustic and mist-net surveys.

Greater Sage-grouse

Scattered populations occur throughout UT, primarily in habitat dominated by sagebrush, excluding the southeastern quarter of the state (UDNR 2003). The Utah Wildlife Action Plan (WAP 2015) estimates that within the state, current populations only cover 41 percent of historic habitat. State-wide, the UT greater sage-grouse population has declined since 1967, with the 2001 population estimated at 12,999 birds (UDNR 2002).

For the Forest, the USDA, Forest Service, greater sage-grouse record of decision (2015), defines the desired habitat conditions as, "…large contiguous areas of native vegetation, approximately 6-to-62 square miles in area…" There are two distinct populations of greater sage-grouse that breed, nest, brood, and winter within the planning area. These two populations are the Wildcat Knolls and Horn Mountain populations located on the south end of the Wasatch Plateau in Emery and Sevier Counties, Utah. These two populations are within the Parker Mountain-Emery Sage Grouse Management Area (SGMA). A third population (Emma Park) is located on the north part of the plateau near Scofield Reservoir; however, this population breeds and nests outside the planning area and limited data suggests that they may potentially spend part of their life cycle (late-brood rearing) on or near the planning area. This population is part of the Carbon SGMA.

The elevations at Wildcat Knolls and Horn Mountain range from 8,200 – 9,500 ft. in elevation, are characterized by sagebrush-steppe habitat, surrounded by escarpments with 500 – 1,000 feet vertical cliffs on the eastern side of the plateau, deep canyons, and mountain habitats.

Sagebrush vegetation is comprised of Mountain big sagebrush and black sagebrush types. Other species in the plant community include: serviceberry, birch leaf mountain mahogany, and curl-leaf mountain mahogany. Serviceberry occurs in areas with wetter and deeper soils. Mountain big sagebrush is primarily found in the drainage corridors, while black sagebrush, dwarf rabbit brush, and low rabbit brush occur on drier areas. Ponderosa pines are located around the edge of the escarpment and canyon slopes and aspen/conifer is located on the mountain slopes above these sites. Herbaceous vegetation is diverse with dominate grass species including mutton bluegrass, letterman needlegrass, and Salina wildrye. Historic range seedings with smooth brome and crested wheatgrass has created monocultures in some areas that lack species diversity. These areas were treated at Wildcat Knolls in 2008 to try and restore forbs and grasses, important for sage grouse brood rearing. Plant community structure on the Horn Mountain is like Wildcat Knolls, except that mountain brush communities are more abundant, including mountain mahogany and scattered pinyon pine (Perkins 2010).

Trends

The sage grouse populations on Horn Mountain have been monitored since the late 1970s by USFS and UDWR Biologists. In 1987, UDWR biologists began translocating sage-grouse to the Wildcat Knolls area. Over a four-year period, 53 sage-grouse were moved to the Wildcat Knolls site from various parts of the state. Prior to monitoring efforts that began in 1990, UDWR biologists did not record any sage grouse activity on the Wildcat Knolls area (Perkins 2010). In 2016, peak male lek attendance for Wildcat Knolls was 47, which was the highest ever recorded. A winter count for both cocks and hens was conducted in 2006, with an estimated count of 100 birds.

On Horn Mountain, four leks have been monitored since 1990, with the highest number of birds coming from the South Horn lek. Peak male lek attendance in 2016 was 15, the highest ever recorded was 18 in 2006. Sage grouse have never been translocated to the Horn Mountain study area (Perkins 2010).

Trend within the planning area seems to be stable to slightly increasing; however, these populations will never increase by more than 100-200 birds based on habitat and geographic restrictions

3.4.3 Aquatic Wildlife

Threatened, Endangered, Proposed, Candidate Species

There are county lists that include all Federally Threatened and Endangered (T&E) species recorded within that county. The Forest boundary crosses 10 counties within Utah and Colorado. Within those counties, federally listed T&E that are recorded within one (or more) of the counties, but not known to occur on the Forest include:

- Bonytail (Gila elegans)
- Humpback chub (*Gila cypha*)
- Pikeminnow (Ptychocheilus oregonensis)
- Razorback sucker (*Xyrauchen texanus*)

It is important to note that although these four species do not occur within the plan area, actions such as water withdrawals that may be taken on within the Forest boundary have the potential to impact these species and must be considered.

Currently, there is one identified population of threated fish species on the Forest; the greenback cutthroat trout (*Oncorhynchus clarkii stomias*) within the Forest boundary. Recent DNA analysis indicates that the greenback cutthroat trout population are a lineage of Colorado River Cutthroat trout. Recent DNA analysis indicates that the greenback cutthroat trout population currently identified on the Forest maybe a sub-species of the Colorado Cutthroat trout. This species is discussed in further detail below. Until additional genetic work has been conducted to clarify this population's status, it will be managed as a population of Greenback Cutthroat Trout.

Greenback Cutthroat Trout

Beaver Creek on the southern slope of the La Sal Mountains contains a population of fish currently identified as greenback cutthroat trout. The original population was surveyed in 1994 and because of its location was thought to be Colorado River cutthroat (*O. c. pleuriticus*). In 2011 the genetics of the Beaver Creek cutthroat were reexamined, and it was determined that the population was the greenback subspecies. Ongoing genetic and fish distribution research on the native cutthroat trout assemblage of the western U.S. may result in changes to the identification of the fish in Beaver Creek.

Cutthroat trout inhabit cold water streams and cold-water lakes with adequate stream spawning habitat present in the spring of the year. Limiting factors to greenback cutthroat trout may include other trout species that hybridize with greenbacks and fall spawning species that compete with greenbacks for food and space, combined with over-harvest of greenbacks. Declines in greenback cutthroat trout from historic distributions was caused by diversion of water for irrigation, water pollution and sedimentation caused by mining and logging, and especially displacement by introduced non-native trout. The fish are negatively impacted or eliminated when brook trout are present (juvenile brook trout drive young greenbacks into open waters of larger streams, exposing the greenbacks to predation). Other impacts to this population of trout is from livestock grazing and water diversions.

Trends

In general, populations of several cutthroat trout species have been declining throughout their ranges. This includes the Bonneville cutthroat trout which are found on the Forest as well as the Colorado River, Yellowstone and Westslope cutthroat trout which are not. Overall, their populations have declined more than 50 percent (IAP 2016). The population of cutthroat trout in Beaver Creek is may be adversely impacted by low snowpacks and droughty summers, which reduce flows in the creek and limit the amount of suitable habitat available.

Species of Conservation Concern

The Regional Office initially identified 76 species for review by Forest specialists including 23 non-plant species. Of these, 5 non-plant aquatic non-plant species were recommended for further consideration: bluehead sucker, Bonneville cutthroat trout, Colorado River cutthroat trout, Southern Leatherside Chub and the Utah Sallfly (*Sweltsa cristata*).

Bluehead Sucker

Bluehead suckers are found in most historical habitats although declines have been noted in the White River and in the upper Green River into Wyoming (UDWR 2006). The International Union for the Conservation of Nature (IUCN) lists the status of the entire bluehead sucker population as ‘stable’ (IUCN 2007). The species is locally abundant in all of the three major sub-drainages of the San Rafael River. In the Bonneville Basin, Weber River, blueheads were found in 2003 and 2004; but not in streams surveyed in 2005 (UDWR, 2005).

Bluehead sucker are found in the mainstream Green, Colorado, and San Juan River, including the Duchesne, White, Strawberry, Price, San Rafael, Fremont, and Escalante River and Muddy Creek tributaries. They are also found in the Weber, Ogden, and Bear Rivers in the Bonneville basin (UDWR 2005). Within the planning area, surveys conducted by Forest Service biologists in 2012 and 2014 found bluehead suckers in both Ferron and Lowry creeks. There are no other populations that have been found within the planning area.

Trends

There is no data available to establish a trend for the Forest’s populations of this species.

Bonneville Cutthroat Trout

This species occurs within the Bonneville Basin streams and lakes and also occurs within a limited portion of the Virgin River Drainage (UDNR 2003). Most are found in the headwater streams and high-elevation river reaches, but a few populations occur in perennial streams located in the Deep Creek Mountains.

Trends

There is no data available to establish a trend for the Forest's populations of this species.

Colorado River Cutthroat Trout

This species requires cool, clear water and well-vegetated streambanks for cover and bank stability; instream cover in the form of deep pools, boulders and logs; and is adapted to relatively cold water, thriving at high elevations (NatureServe 2015). The Utah Wildlife Action Plan (2015) estimates that this species currently inhabits approximately 1/3 of its available habitat.

Historically, natural system modification from mining, agriculture, water and other development contributed to the extirpation or reduction of large numbers of populations of Colorado River cutthroat trout. Currently, the introductions and invasions of nonnative trout probably represent the greatest cause of recent declines and the major impediment to restoration of this fish in much of its historical range. Many populations appear to remain vulnerable to this threat either because barriers to ongoing invasions are absent or because existing barriers may be temporary or have nonnative fish passed over them illegally. Ironically, the barriers themselves pose a threat because most populations of Colorado River cutthroat trout are restricted to short, headwater stream segments (SWAP 2015, Young 2008).

Climate change is an additional threat to cutthroat trout species. Potential impacts from a changing climate include warming air temperatures and potential changes in the amount, timing, and type (snow versus rain) of precipitation (IAP 2016). The scale and location of these changes will generally combine to cause warmer water temperatures, earlier snowmelt runoff and declines to lower summer base flows, and downstream contraction of perennial flow initiation from headwaters. Warming water temperatures are expected to result in habitats for trout to continue to shift upstream; over the last four decades, this has been occurring at a recently estimated rate of 1000-1600 feet/decade. Additionally, smaller snowpacks and earlier runoff are projected to continue reducing habitat volume and size while potentially increasing fragmentation.

Lack of connectivity to other populations renders them vulnerable in the short term to extirpation from natural disturbances such as fire, post-fire debris torrents, or floods and in the long term to loss of genetic variability and the potential for evolving in response to changing environmental conditions. This lack of connectivity also contributes to the greatest future threat to the persistence of this subspecies—climate change (WAP 2015, SWAP 2015, Young 2008, IAP 2016).

Additional threats include incompatible agriculture, energy production, transportation and service corridors (SWAP 2015).

Trends

In general, populations of several cutthroat trout species have been declining throughout their ranges. This includes the Bonneville cutthroat trout which are found on the Forest as well as the Colorado River, Yellowstone and Westslope cutthroat trout which are not. Overall, their populations have declined more than 50 percent (IAP 2016). Common where populations have been located within the planning area, mostly in headwaters, the local trend is stable, moving slightly upward with conservation efforts.

Southern Leatherside Chub

Southern leatherside have been documented in three 4th level hydrologic unit codes (HUC) in the Utah Lake drainage and six 4th level HUCs in the Sevier River drainage. Introduced populations of leatherside chub have been observed in six 4th level HUCs in the Colorado River Basin and are still persisting in the Fremont River, Pleasant Creek, Dirty Devil River, and Quitchupah Creek (southern three HUCs). It is not known if these populations are southern or northern leatherside. If these populations are southern leatherside, they may have management implications (UDNR 2010).

Habitat fragmentation is a substantial threat to southern leatherside populations. Southern leatherside that once occupied contiguous drainages, such as the Sevier River system, are now divided into smaller subpopulations with limited opportunity for genetic exchange. Nonnative fish predators appear to ecologically fragment southern leatherside into patchy peripheral stream habitats, potentially impacting local demographic processes such as growth rate, fecundity, and survivorship (UDNR 2010).

Trends
Southern leatherside distributions have become increasingly fragmented over time, resulting in the loss of populations as well as individuals within populations.

Utah Sallfly

The Utah Sallfy (*Sweltsa cristata)* is known to occur in 3 locations in the La Sal and Abajo Mountains (Baumann 2006). The aquatic nymphal stage occurs only in springs, brooks and small headwater streams with low flow and cold, clean water with high dissolved oxygen content. The adults are weak flyers, and thus poor dispersers, and need a water connection to link habitats.

The species has a very limited known range (Call and Baumann 2002). It is extremely sensitive to pollution and sedimentation, including from livestock and other uses (Baumann 2006). Water diversions and a continually increasing demand on freshwater resources in Utah contribute to habitat alteration and fragmentation (Call and Baumann 2002, Baumann 2006). Drought and changing climate conditions also pose a threat to this species.

Trends
There is not enough information to determine population trend.

3.4.4 Terrestrial Vegetation

Threatened, Endangered, Proposed, Candidate Species

Heliotrope milkvetch

Heliotrope milkvetch was discovered by M. Lewis and R. Thompson in 1976 (Welsh 2015). In 1988, Tuhy submitted a report to the MLNF regarding the status of ASMO11. His report considered the three known locations where the plant occurs. Tuhy (1988) reported that Heliotrope Mtn site had an estimated 1,500-2,000 plants the Ferron Mtn site-conceivably 400,000 plants, and White Mtn site-conservatively estimated at 460,000 plants. The number of plants were recorded at the Heliotrope Mountain study plot for seven years. At that time Tuhy (1988) felt that precipitation (too much) may be a factor in the decline of plant numbers in 1984 and 1985. He also argued that livestock grazing is of little consequence and may reduce competition from other species growing near ASMO11.

Stressors have reported to be livestock grazing, ATVs, and mining. However, Tuhy (1988) argued that livestock grazing is of little consequence and may reduce competition from other species. In 2015 the Forest installed a log fence to prevent ATV access across White Mountain.

Trends

In 2015 a group from the Forest, Region, and the USFWS surveyed for the plant on Heliotrope Mtn. The plant was relocated in previously known locations and in two unrecorded locations with an estimated population of 65 plants in one of the new locations.

Species of Conservation Concern

The Forest is currently recommending 12 plant species to the Regional Forester for further consideration as SCC. Several of these species are located within the same community type and share similar threats. The plant species being considered for the SCC list are: Isely's milkvetch, La Sal Daisy, Baker's Oreoxis, La Sal Mountains Groundsel, Geyer's onion, Link trail columbine, pinnate spring-parsley, Kachina daisy, Canyon sweetvetch, Navajo beardtongue, Eastwood's podistera, Arizona willow.

Isely's Milkvetch

This spring-blooming milkvetch is endemic to the western slopes and foothills of the La Sal Mountains in Grand and San Juan Counties (Franklin 2005). It is found only in desert shrub and pinyon-juniper communities at 5000 to 6600 feet in elevation on sandy to gravelly clay, saline and selenium soils derived from the Mancos and Morrison formations. The species has a narrow range, and a small population on BLM and USFS lands. Mining, recreational use, especially off-road motorized use, are the biggest threats to the species and its habitat. Other impacts in occupied habitat are from powerline maintenance, dispersed camping, and unauthorized roads. The potential effects of severe drought, increased wildfire and other climate change related impacts are unknown. It is also a BLM sensitive plant species and a UNPS (2016) Rare Plant List "Extremely High Priority Species".

Trends

While population numbers may be highly variable between years depending on spring precipitation, the overall population appears stable as all currently known habitat areas have remained occupied.

La Sal Daisy

Increasing recreational activity was identified as a potential threat by Franklin (2005). The narrow alpine habitat of the La Sal Mountains is experiencing increased traffic by recreational users and introduced mountain goats (Wild Utah Project 2015). Trampling, excessive grazing and other localized site disturbance could have adverse impacts to the population. The combination of the effects of climate change could compound with the effects of other threats (NatureServe 2015). A portion of the habitat on the northern portion of the peaks has patented mining claims with a potential for exploratory activities in the future.

Trends

A study in 2008 did not find evidence for widespread impacts on the alpine turf habitat in the middle group of the La Sals (Smith 2008). The impact study plots were re-sampled in 2015, and while some localized impacts were recorded, there was no evidence of widespread adverse effects (Wild Utah Project 2015). Monitoring of alpine vegetation, focused on La Sal daisy and associated cushion plant species, was initiated in 2014 in response to the introduction of non-indigenous mountain goats. Additional research on the elevational distribution of La Sal daisy and associated species was conducted to establish baseline information on the population and identify potential climate change impacts (Fowler and Smith 2010). The elevational transect was resampled in 2015, and preliminary analysis of the data shows no change in population density or elevational centroid (Fowler et al 2018).

Baker's Oreoxis

In Utah, this spring-parsley species is found only in the La Sal Mountains in alpine grass-forb communities above 11,500 feet. No specific threats to the species have been identified, however increasing recreational activity has been identified as a potential threat to other alpine plant species (NatureServe 2015 and Franklin

2005). The narrow alpine habitat of the La Sal Mountains is experiencing increased traffic by recreational users and introduced mountain goats (Wild Utah Project 2015). Trampling, excessive grazing and other localized site disturbance could have adverse impacts to the population.

Trends
No trend data has been reported. The species has been recorded during 2015-2016 alpine vegetation monitoring and occurred on about 25 percent of the alpine cushion plant monitoring sites (n = 68). It has been noted that the species is very difficult to distinguish in the field from the sympatric and nearly identical Oreoxis alpina.

La Sal Mountains' Groundsel

This species inhabits alpine ridge crests and talus slopes and is endemic to the La Sal Mountains (Franklin 2005). It is highly associated with snow cornices, swales and drainage bottoms where snow lingers into June. Modeling of La Sal Mountains groundsel habitat indicated approximately 500 acres of potential habitat in the La Sal Mountains. Surveys to date have documented 20 acres of occupied habitat.

Increased recreation activity within the limited alpine habitat on the La Sal Mountains has been noted as a potential threat to the species (NatureServe 2015, Franklin 2005). The narrow alpine habitat of the La Sal Mountains is experiencing increased traffic by recreational users and introduced mountain goats. Trampling, excessive grazing and other localized site disturbance could have adverse impacts to the population. The barren areas where this species tends to grow, in steep, loose and rocky soils, are especially susceptible to disturbance and erosion.

Recent monitoring noted fall grazing, on La Sal Mountains groundsel by introduced mountain goats, which could pose a threat for a species which relies solely on seeds for reproduction (Utah Wild Project 2015). The combination of the effects of climate change could compound with the effects of other threats, especially for species which is closely tied to persistent snowbanks.

Trends
No population trend data is available.

Geyer's onion

This wild onion is found in pinyon/juniper and ponderosa pine/manzanita community types where there is open, shallow, fine-textured sandy loam soil and rock outcrops. It occurs between 6,600 and 8,200 feet in elevation. The subspecies is a narrow endemic occurring in scattered locations on the Abajo Mountains and Elk Ridge.

It has been found in the Chippean Rocks, Little Dry Mesa, Harts Draw and White Rim areas on the Monticello district. While it is not a preferred forage species and not sought out and consumed by livestock, it may be impacted by trampling. It appears to be grazed by wildlife, and showed no adverse population impacts from light-moderate fire. Off-road vehicle use threatens to impact the species in some areas. Geyer’s onion is reportedly impacted by livestock trampling, water trough developments, and road maintenance.

Link Trail Columbine

Link Trail Columbine occurs in spring seeps and perennial wet sites at the bases of the Mesa Verde group sandstone. It was first collected in 1908 west of the town of Emery. Since then it has been found in four other areas including Straight Canyon, where a persistent population exists despite continued disturbance (rock and mud slides). Current population estimates range from 1,300 to over 1,700 plants.

Trends
The global short-term trend for the species is stable (NatureServe 2015).

Pinnate Spring-parsley

A perennial herb in the carrot family up to 3 feet tall, pinnate spring-parsley produces bright yellow flowers in compact clusters in the spring. The habitat for this plant is characterized as sandy soils weathered from Navajo sandstone and on slickrock ledges and cracks. Occurrence includes crevices, and ledges from gradual to shear slickrock slopes from 6,880 to 8,200 feet (Franklin 1992). It is generally in association with ponderosa pine/manzanita and oak brush/snowberry community types.

In the plan area, populations have been located on the Monticello district on Elk Ridge in the Cliff Dwellers Pasture, Causeway and Chippean Rocks areas. There are eight element occurrences on the Forest totaling less than 5,000 plants (Franklin 1992). Franklin (1992) states that this plant is generally isolated and not subject to any evident threats. However, this species could be impacted by trampling/trailing by livestock and recreationists.

Trends
The Utah Natural History Programs' GIS data reported 45 collections from the plan area (Franklin 1992). NatureServe (2015) cites a 2012 report from the Utah Native Plant Society (UNPS) that states that the number of individuals has "greatly increased" across its range, which includes two widely scattered locations in Utah on the Abajo Mountains/Elk Ridge and in Capital Reef National Park and into Arizona and the Navajo Nation.

Kachina Daisy

This Colorado Plateau endemic is known from a few sites in southeastern Utah and adjacent Colorado. It has been found in widely scattered locations on the Monticello district and adjacent BLM land. It grows in seeps and hanging gardens on Mossback and Navajo sandstone formations and in moist pockets on open slickrock in ponderosa pine habitat types at elevations of 7,000 to 8,000 feet (Welsh 2015, Atwood et al. 1991).

This plant's habitat is specific to seeps and cracks within the fins and rock ledges of sandstone walls. Livestock grazing rarely disturbs this inaccessible habitat type within the canyons. Known populations in the plan area have not been adversely affected by fire. Identified threats include recreation (rock climbing) and drought (NatureServe 2015).

Severe drought or climate-related drying of springs and seeps may impact portions of this species habitat (UNHP 2015). In many areas on the Forest, the sandstone bedrock is very effective at collecting and channeling the limited precipitation to the cracks where this plant grows.

Trends
There are eighteen occurrences documented on the Forest with an estimated 2500-3000 plants, and numbers on adjacent BLM lands may be as high as 10,000 (Franklin 1992). The records (62) in the Utah Natural Heritage database are all from the early 1990s, and no further inventory has been done by the state. Known populations on the Forest appear stable. The known occurrences in the plan area are protected by inaccessibility of habitat and are not threatened by management activities.

Canyon Sweetvetch

Cronquist et al. (1981) place this species under synonymy with *H. occidentale*, along with *H. lancifolium*, *H. marginatum*, and *H. uintahense*. Their rationale for combining the five species is that leaflet, raceme, and calyx characteristics "…occur separately elsewhere in the whole range of *H. occidentale* and do not form a convincing diagnostic syndrome." Welsh et al. (2015) cite the differences between var. *canone* and var. *occidentale* as; leaflet size, flower size, and locality, all of which have potential for overlap, or uncertainty when keying out the species.

Trends
Trend is stable to upward. 2016 vegetation surveys indicated the plant to be common in the known locations

in the plan area and moving into disturbed sites (road to Anderson Mine) (Fugal et al. 2016). In 2016 it was also located on BLM administered lands, in Cottonwood Canyon.

Navajo Beardtongue

This species is endemic in extreme southeast Utah, San Juan County. Long known from only the upper elevations of Navajo Mountain on the Navajo Nation, recent collections place it at the head of Dark Canyon, on Chippean Ridge and in the Abajo Mountains on the Manti-La Sal National Forest. It is found at high elevations in ponderosa pine-mixed conifer, ponderosa pine-Gambel's oak, grassland meadow-ponderosa pine, and, at one of the newer locations, aspen-Gambel's oak communities" (Franklin 2005).

Potential climate change-related effects such as increased wildfire are not known to be a threat to this understory forb in the diverse fire-adapted habitats occupied by this species. There are no identified threats on NFS lands where this species occurs.

Trends
There is no information on the status of the Dark Canyon or Abajo Mountain locations, i.e., estimates of population size, habitat condition or potential threats (Franklin 2005).

Eastwood's Podistera

This carrot-family species has been recorded during recent work in the La Sal Mountains, growing at the base of talus rockslides in open subalpine and treeline ecotone habitats (Fowler et al. 2018, Smith et al. 2014). It has not been found in La Sal alpine habitats during recent surveys but has been found in Colorado and New Mexico (NatureServe 2015).

No specific threats to the species have been identified. Increasing recreational activity has been identified as a potential threat to true alpine plant species (NatureServe 2015 and Franklin 2005), however recreation does not have as much impact on the subalpine areas where this species is found. A small percentage of these areas are accessible and grazed by livestock. These areas are also used by pika (Smith et al. 2014). Trampling, excessive grazing and other localized site disturbance could have adverse impacts to the population. However, there is currently no evidence to indicate substantial concern for this subalpine species.

Trends
No abundance or trend data is available.

Arizona Willow

Many more populations are known today compared to the mid-1990s when it was nearly listed under the Endangered Species Act. Some new population reports should be confirmed, however. Found mostly in riparian areas on volcanic soils, where threatened by livestock grazing. At least two small populations protected in Cedar Breaks NM. Can hybridize with *Salix brachycarpa* and not all populations may be genetically pure. Tends to form thickets which may represent few distinct genets (Alexander 2016). Only one population of 17 plants occurs on the Manti-La Sal NF (Thompson 1997). The majority of the populations (59) occur in Arizona (Thompson 1997).

Trends
Upward trend. Based on 2004 data, total SAAR14 plant cover (feet2) on the Forest increased 540 percent between the years 2001 and 2004.

3.4.5 Aquatic Vegetation

No aquatic vegetation within the plan area have identified for as an at-risk species at this time.

4. SOCIAL AND ECONOMIC ASSESSMENT

4.1 Introduction

This chapter presents socioeconomic and land use information for the Forest area of influence. The area of influence is defined as "an area influenced by the management of the plan area that is used during the land management planning process to evaluate social, cultural, and economic conditions. The area is usually a grouping of counties" (FSH 1909.12, zero code). The Forest's area of influence includes 10 counties: six in the North Zone in central Utah—Carbon, Emery, Juab, Sanpete, Sevier, and Utah counties; two counties in the South Zone in southeastern Utah—Grand and San Juan counties; and two counties also in the South Zone in southwestern Colorado—Mesa and Montrose counties. These 10 counties are considered the Forest's area of influence because there are social and economic ties between residents of these counties and Forest Service land management. The economic contributions of Forest uses, such as grazing, forest products, outdoor recreation, and mineral and energy production occur primarily in these counties. Assessment topics from Table 1 covered in this chapter include 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15.

4.2 Cultural, Social, and Economic Conditions, Benefits People Obtain from the Forest, and Contributions of Multiple Uses

4.2.1 Indicators

Measuring the human relationship with the ecological environment requires two types of indicators: those that help to understand social and economic conditions in communities near the Forest and those that measure human uses of the Forest's lands and resources.

Social and Economic

- Population size
- Age structure
- Racial and ethnic composition
- Income and poverty
- Economic diversity

Benefits to People

- Recreation visits
- Timber cut and sold
- Mineral removal
- Authorized animal unit months
- Payment to states and counties
- Forest service expenditures

4.2.2 Demographic Conditions

Urban-Rural Designation

The U.S. Department of Agriculture's Economic Research Service classifies all counties along a rural-urban continuum, which describes the degree of urbanization in a county. This is one measure of the degree to which human populations may act as a stressor on Forest lands and resources. Most of the counties in the Forest's two functional economic areas are rural. However, Juab and Utah counties in the North Zone make up the

Provo-Orem Metropolitan Statistical Area (U.S. Census Bureau 2016). The Grand Junction Metropolitan Statistical Area in Mesa County is also an identified metro area, but the population centers in Mesa County are not immediately adjacent to the NFS lands in the county. All counties and their designations are displayed in Table 31.

Table 31. Forest rural-urban designations.

County	Rural to Urban Population Designation
Carbon, UT	Non-metro, urban population of 2,500 to 19,999, not adjacent to a metro area
Emery, UT	Non-metro, urban population of 2,500 to 19,999, not adjacent to a metro area
Juab, UT	Metro, metro areas of 250,000 to 1 million population
Sanpete, UT	Non-metro, urban population of 2,500 to 19,999, adjacent to a metro area
Sevier, UT	Non-metro, urban population of 2,500 to 19,999, not adjacent to a metro area
Utah, UT	Metro, metro areas of 250,000 to 1 million population
Grand, UT	Non-metro, urban population of 2,500 to 19,999, not adjacent to a metro area
San Juan, UT	Non-metro, urban population of 2,500 to 19,999, not adjacent to a metro area
Mesa, CO	Metro, metro areas of fewer than 250,000 population
Montrose, CO	Non-metro, urban population of 20,000 or more, adjacent to a metro area

Source: USDA ERS 2013

This data suggests that urbanization is not a stressor in most of the areas immediately surrounding the Forest. However, urbanization outside the immediate planning area, such as along the Wasatch Front, can drive demand for Forest resources and uses. Most of Utah's population lives along the Wasatch Front (U.S. Census Bureau 2014). Given the proximity of the planning area to the Wasatch Front, growth in this area can cause, stressors to the Forest such as increased demand for recreational opportunities.

Age Structure

The 2012 planning rule directs the Forest Service to consider and engage youth in Forest planning. The typical visitor to a national forest or grassland is more likely to be white, male, and older than the population overall. Population structure in communities near the Forest is relevant for understanding local stakeholders. For instance, communities with large numbers of retirees are likely to have different recreational preferences than those populated with young families.

Like Utah, North Zone counties have a median age well below the national average. In addition, nearly 40 percent of the North Zone's population is 19 years of age or younger. In contrast, this age group accounts for just over a quarter of the national population. The share of the population over the age of 65 in North Zone counties is small relative to the state and nation. These data suggest that engaging youth in national forest programs is an essential element of ensuring that national forests continue to provide benefits to the public on the North Zone.

Youth account for a much smaller share of the population in South Zone counties. The population in Grand County, UT and Mesa County, CO have age distributions that are like the United States as a whole. San Juan County, UT has a much younger median age and Montrose County, CO has a much older median age. One-fifth of the population in Montrose County, CO is 65 and older. Due to the prevalence of older residents in South Zone counties, recreational preferences of local Forest visitors are likely to differ from the North Zone. The age structures for both the North Zone and South Zone counties are displayed in Table 32.

Table 32. Age structure by county as well as by state and across the United States.

Location	Median Age	% Population 0-19	% Population 9-65	% Population 65 and Older
Carbon County, UT	34	31	55	14
Emery County, UT	34	33	53	13
Juab County, UT	30	39	50	11
Sanpete County, UT	30	35	53	12
Sevier County, UT	34	34	51	15
Utah County, UT	25	39	54	7
Grand County, UT	39	24	62	14
San Juan County, UT	31	40	52	11
Mesa County, CO	38	26	58	16
Montrose County, CO	44	25	55	20
North Zone	31	38	54	8
South Zone	38	27	57	16
Colorado	36	27	62	12
Utah	30	34	56	10
United States	37	26	60	14

Source: U.S. Census Bureau 2014

4.2.3 Economic Conditions

Median Household Income

Household income and poverty rates can influence how nearby residents and visitors relate to NFS lands. Low household incomes and high poverty rates can make people more vulnerable to changes in resource availability and forest management. Low median household incomes and high rates of poverty can indicate that communities have fewer resources to adapt to change. These are two indicators of an area's vulnerability to ecological change. Communities and households with fewer resources will have fewer opportunities to engage in substitute behavior (for example, travel to another recreation site or replace lost forage for livestock). The smaller and more rural counties of Carbon, Sanpete, and Sevier have below average incomes and higher poverty rates, however, only Sanpete has a poverty rate above the national average.

Median household income is below the national and state averages in all South Zone counties. Additionally, poverty rates exceed national and state averages in all four counties. These data indicate that communities surrounding the Forest, particularly the communities near the southeastern portion of the Forest, experience relatively high rates of economic insecurity. This suggests that these communities may be more dependent on Forest resources and more vulnerable to changes in resource availability (Lynn et al. 2011). The median household incomes and percent of the population below the poverty line for all counties, states and the United States are shown in Table 33.

Table 33. Median household income in dollars and percent of the population below to the poverty line associated with Forest.

Location	Median Household Income in Dollars	Percent Population Below Poverty Line
Carbon County, UT	46,366	14
Emery County, UT	50,653	11

Location	Median Household Income in Dollars	Percent Population Below Poverty Line
Juab County, UT	56,976	14[a]
Sanpete County, UT	48,305	16
Sevier County, UT	46,327	15
Utah County, UT	60,830	14
Grand County, UT	44,239	16 [a]
San Juan County, UT	41,411	28
Mesa County, CO	48,610	16
Montrose County, CO	44,885	17
Colorado	59,448	13
Utah	59,846	13
United States	53,482	16

Source: U.S. Census Bureau 2014

[a] Indicates data that are less reliable and should be interpreted with caution.

Payments to States and Counties

The Department of the Interior and the USDA Forest Service, in coordination with the Treasury Department, make payments to states and local governments through several programs based on population, receipt sharing, and the amount of federal land within an affected county. The Payments-in-lieu-of-taxes (PILT) program compensates local governments for the lack of property taxes on federal lands. Local governments provide a variety of services that support the use and enjoyment of the Forest, including road maintenance and emergency services. The Secure Rural Schools (SRS) program also provides funding to local governments to support schools, roads, and ecosystem restoration. However, as of April 2017 the SRS program has not been reauthorized. In the absence of SRS reauthorization, counties receive a share of Forest revenues through 25 percent payments. For all counties in the area of influence, 25 percent payments are substantially lower than SRS payments, ranging from a reduction of about 50 percent to 95 percent. Table 34 display the Forest Service's SRS and PILT payments to the counties the forest lies within.

Table 34. Payments to states and counties, forest wide 2015.

County	Forest Acres	SRS Dollars	PILT Dollars	Total Dollars
Carbon, UT	30,236	30,315	75,983	106,298
Emery, UT	212,299	238,270	119,312	357,582
Juab, UT	369,335	603,397	901,916	1,505,313
Sanpete, UT	30,409	36,528	59,662	96,190
Sevier, UT	93,323	98,920	230,694	329,615
Utah, UT	57,235	39,380	37,718	77,098
Grand, UT	450,122	879,787	216,959	1,096,746
San Juan, UT	4,512	3,613	9,602	13,214
Mesa, CO	22,513	21,523	50,789	72,312

Source: DOI 2016 and USFS 2016t

Note: Juab County does not receive payments from the Manti-La Sal National Forest because all National Forest System lands in this county are administered by other national forests (Fishlake, Uinta, and Wasatch NFs).

Payments to states and local government support public services in communities near the Forest and contribute to employment and labor income in the counties that surround the Forest. Some of the least affluent areas, San Juan and Sanpete counties, in Utah, receive the largest payments. Department of the Interior and USDA Forest Service payments to local governments in sparsely populated and low-income areas are likely to be particularly meaningful, since these areas typically get less revenue from property, sales, and income taxes to fund local government operations.

The employment and labor income contributions of PILT and SRS payments are estimated in the economic contribution analysis section of this report. The environmental impact statement for the Forest Plan Revision will include 25 percent payments in the economic analysis if SRS is not reauthorized at that time.

4.2.4 Environmental Justice

In 1994, President Clinton issued Executive Order 12898. This order directs federal agencies to focus attention on the human health and environmental conditions in minority and low-income communities. The purpose of Executive Order 12898 is to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations.

Environmental justice is the fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The goal of environmental justice is for federal agency decision-makers to identify impacts that are disproportionately high and adverse with respect to minority and low-income populations and identify alternatives that will avoid or mitigate those impacts.

The emphasis of environmental justice is on health effects and/or the benefits of a healthy environment. The Council on Environmental Quality (CEQ) has interpreted health effects with a broad definition: “Such effects may include ecological, cultural, human health, economic or social impacts on minority communities, low-income communities or Indian tribes …when those impacts are interrelated to impacts on the natural or physical environment” (CEQ 1997).

Minority Population

Overall, the North Zone counties are less diverse than both the state and nation. Table 35 displays the share of the population in each racial/ethnic group. All North Zone counties have a larger share of non-Hispanic white residents than either Utah or the United States. Furthermore, Utah is more racially and ethnically homogenous than the nation. This finding suggests that North Zone counties do not contain environmental justice populations. However, this does not preclude the possibility that Forest management actions could have disproportionate and adverse effects on specific groups. For instance, although the American Indian population is small in all six North Zone counties, Forest Plan decisions may have the potential to affect resources and uses that are of value to American Indian populations.

Table 35. Percent race and ethnicity by county, North Zone, 2014.

Race/Ethnicity	Carbon	Emery	Juab	Sanpete	Sevier	Utah	State of Utah	USA
White	84	92	93	86	92	84	80	63
Hispanic or Latino (any race)	13	6	4	10	5	11	13	17
Black or African American	0.6 [a]	0.7 [a]	0.2 [a]	1	0.5 [a]	0.5	1	12
American Indian	0.5 [a]	0.9 [a]	0.8 [a]	1 [a]	1.0 [a]	0.4 [a]	1	0.7
Asian	0.7 [a]	0.2 [a]	0.3 [a]	0.4 [a]	0.2 [a]	1.4 [a]	2	5

Race/Ethnicity	Carbon	Emery	Juab	Sanpete	Sevier	Utah	State of Utah	USA
Hawaiian of Pacific Islander	0.1 [a]	0 [a]	0.3 [a]	0.6	0.2	0.8	0.9	0.2
Other	0.1 [a]	0 [a]	0	0 [a]	0 [a]	0.2 [a]	0.2 [a]	0.2
Two or More Races	1.7 [a]	0.4 [a]	1 [a]	1 [a]	0.9 [a]	2	1.8	2

Source: U.S. Census Bureau 2014

[a] Indicates data that are less reliable and should be interpreted with caution.

Grand County, Utah and Mesa County, Colorado are like the North Zone counties as shown in Table 36. They have less racial and ethnic diversity than either state or the nation. In contrast, San Juan County, UT and Montrose County, CO have relatively high shares of minority residents. Most residents of San Juan County identify as American Indian. This share is approximately 50 times greater than the share of American Indians in Utah and the United States. While Montrose County, CO is overall less diverse than Colorado and the United States and has a similar share of Hispanic/Latino residents as Colorado, the proportion of Hispanic/Latino residents is greater than the national share. Therefore, the South Zone contains environmental justice populations based on minority status. shows the racial and ethnic percentages by counties for the South Zone of the Forest.

Table 36. Percent race and ethnicity by county, South Zone, 2014.

Race/Ethnicity	Grand, UT	San Juan, UT	Mesa, CO	Montrose, CO	Colorado	Utah	USA
White	84	46	82	77	69	80	63
Hispanic or Latino (any race)	10	5	14	20	21	13	17
Black or African American	0.2 [a]	0.2 [a]	0.7 [a]	0.5 [a]	4	1	12
American Indian	5 [a]	48	0.4 [a]	0.4 [a]	0.5	1	0.7
Asian	0.7 [a]	0.6	0.6	0.5	3	2	5
Hawaiian of Pacific Islander	0.2 [a]	0.2 [a]	0.1 [a]	0.2 [a]	0.1 [a]	0.9	0.2
Other	0 [a]	0.2 [a]	0.2 [a]	0.1 [a]	0.2 [a]	0.2 [a]	0.2
Two or More Races	0.5 [a]	1 [a]	2	*1	2	2	2

Source: U.S. Census Bureau 2014

[a] Indicates data that are less reliable and should be interpreted with caution.

Low Income Population

The highest poverty rates across all 10 counties in the planning area are in San Juan County, UT, and Montrose County, CO. These data reveal the overlap between minority status and poverty. San Juan County, UT, in which minority residents make up the majority of the population, has by far the highest poverty rate in the planning area. Nearly 30 percent of San Juan County residents live in poverty. This is approximately double the poverty rate in the state and nation (U.S. Census Bureau 2014). While the poverty rate in Montrose County, CO is somewhat elevated relative to the state and nation, the difference is small.

These data suggest the existence of environmental justice populations in the South Zone of the Forest, based on both minority and low-income status.

4.2.5 Benefits to People

This section addresses the social and economic dimensions of forest resources, uses, and management. Based on the planning rule's definition of ecosystem services, benefits to people from national forests, ecosystem services may be an umbrella that includes multiple uses. Multiple uses are among the benefits people obtain from national forests. Multiple uses include outdoor recreation, range, water, timber, and wildlife and fish. Separation of ecosystem services from multiple uses in the assessment is not required. Given the overlap between the two topics, they are addressed together in this report. Providing multiple uses and other ecosystem services from forest lands is essential to the Forest Service's mission. The necessity of multiple use management is enshrined in law and regulation, including the Multiple-Use Sustained-Yield Act of 1960 and the National Forest Management Act of 1976.

The 2012 planning rule directives define key ecosystem services as those that are (1) important in the area of influence and broader landscape and (2) likely to be influenced by plan decisions. The Forest Plan Revision interdisciplinary team identified key ecosystem services to include: the five multiple uses (outdoor recreation, range, timber, water, and wildlife and fish) as well as carbon sequestration and storage.

Additionally, this section also addresses the contribution of mining, forest operations, and forest infrastructure to economic activity and quality of life. Forest operations and infrastructure include, for example, the benefits to people of access, recreation facilities, and fuel treatments.

Livestock Grazing

Permittees graze cattle, horses, sheep and goats on the Forest. Livestock grazing has both social and economic dimensions. Ranching provides an income for some individuals, but it also has sociocultural value. In the West, ranching cannot be entirely understood through a commercial agriculture, economic impact lens. Indeed, in the western U.S. most ranchers have an off-ranch job. Ranching provides noneconomic benefits, such as support for tradition and heritage (Smith and Martin 1972, Raish and McSweeney 2003).

Historic Conditions of Range Resources

The stocking rates for sheep and cattle on most if not all of the Forest allotments were much higher prior to the establishment of the Manti Forest Reserve in 1903 and the La Sal National Forest Reserve in 1906. Historical records estimate that there may have been as many as 100,000 animals (cattle, sheep and horses) grazing the Moab and Monticello districts in the late 1800s, though an accurate number has proven difficult to determine (U.S. Research Inc. 2000). On the Wasatch Plateau, there are estimates of nearly 1 million sheep grazing the area. After the establishment of the Manti Forest Reserve, there are records that indicate the Forest issued permits for 300,000 sheep and about 15,000 head of cattle. After complaints from the cattle ranchers that sheep were given preference the permitted numbers were record as 200,000 sheep and 28,000 head of cattle (Prevedel et al. 2005). The lands that make up the Forest today were severely overgrazed during the 1800s and into the 1900s resulting in depleted rangelands and loss of soils due to erosion. The resulting floods and landslides in the communities below the mountain ranges prompted citizens to petition the Federal Government to establish reserves (Prevedel et al. 2005, Hindley et al. 2000, U.S. Research Inc, 2000).

It took several years for the Forest Service to gain control of the grazing practices which had prevailed for decades. The seasons of use were also much more liberal than they are today. In a broader context, in the territory of Utah, it is estimated that at the turn of the century there were over 400,000 head of cattle and 3.8 million sheep (Hindley et al. 2000).

The 1986 Forest Plan identified 144 grazing allotments, 482 permits, and 175,334 permitted animal unit months (AUMs). This was about 20,700 head of cattle and close to 85,000 sheep. Permit obligation was estimated to be 20 percent higher than carrying capacity at the time of Forest Plan implementation (USFS 1986).

Current Conditions

The Forest has implemented the Rescissions Act (1995) allotment management plan process (P.L. 104-19 1995). Currently, permit obligations and estimated grazing capacity are close to balancing. As part of this process, range conditions in key areas on all allotments are monitored. The information is used to identify use patterns, species composition and ground cover. This information has contributed to aligning permitted numbers to carrying capacity. Annual monitoring data and reports on most allotments show that livestock grazing is ecologically sustainable at current levels (USFS 2011a). The Forest manages allotments under an adaptive management philosophy that allows for modification of the intensity (stocking level), duration, or timing of grazing in response to variations in forage production, water availability, and precipitation patterns. Adaptive management is used to respond to extended drought conditions and wildfires.

Structural range improvements (fences and water developments) are key to successful implementation of allotment management plans and annual operating instructions. Throughout the Forest, there are improvements that no longer function due to age, weathering, falling trees and fires. The Forest has prioritized these improvements for reconstruction or replacement as funding allows.

There are also many areas on the Forest that are decreasing in forage production due the encroachment of pinyon-juniper into sage/grass areas and increases in shrub density in many other areas due to lack of fire or some poor grazing management practices. There have been projects implemented to improve forage for both wildlife and livestock on the Forest but it continues to be a need in many areas.

Water has always been a limiting factor, but has appeared to become more so in recent years as springs go dry and streams run for a shorter period of time. The development of water on some allotments have helped in improving management but also continues to be a need for range management on the Forest.

Rangeland health condition is discussed in the Terrestrial Ecosystem portion of the assessment in length. Briefly here, many conditions that exist today are the remaining impacts of the severe overgrazing that occurred prior to the establishment of the Forest Reserves in the early 1900s. However, Forest Service range trend studies, photos, and other published documents comparing historical conditions on the Forest to more recent conditions (USFS 1993, Prevedel et al. 2005, Hindley 2000) have shown immense improvements and that most areas are continuing to show upward trends in ground cover and in species composition (USFS 2011a). Noxious weeds are a growing threat to rangeland conditions as uses continues to expand and increase (see Invasive stressor/driver report).

Rangeland Capability and Suitability

Rangeland capability addresses the ability of the land to support livestock; suitability addresses whether or not livestock grazing should occur and whether other uses should take precedence.

Rangeland capability is defined by the Forest Service as the physical attributes or characteristics of the landscape that are conducive to livestock grazing under an assumed set of management practices and at a given level of management intensity. Capability depends upon current conditions and site conditions such as climate, slope, landform, soils, and geology, as well as the application of management practices. The landscape level capability determination is based on physical/biological attributes to support long-term sustained grazing. This definition varies from those traditionally used by the Forest Service in managing the rangeland resource. In past planning activities, capability was usually combined with the term suitability.

Rangeland suitability is established either to provide prescriptive management direction for project-level analysis and subsequent NEPA decisions, or as a decision to not graze specific designated areas. Typically, areas are reviewed for the purpose to see if livestock grazing is compatible with management area emphasis, uses, and values identified. Suitability also looks at what uses are foregone with livestock grazing. Landscape scale suitability is a management determination that is based upon on Forest Plan prescriptions where grazing is compatible with other uses/activities and resource management objectives (i.e., land exchanges, ESA restrictions, conflict with other uses). Suitable lands may contain areas that do not meet capability criteria. In other words, it can include both capable and non-capable lands.

The 1986 Forest Plan established 15 Management units (MU) all of which contains management prescriptions that include livestock grazing as being a suitable and compatible use under certain conditions. Livestock may still be and have been excluded under certain conditions in each MU. The establishment of the Dark Canyon Wilderness in 1989 included an exclusion of grazing from 33,000 acres from the wilderness and about 11,600 are excluded from grazing as part of the Blanding/Monticello Municipal watershed. The Forest has identified approximately 1,294,700 acres on the Forest as suitable for livestock grazing. This does not mean that livestock grazing occurs on 1.3 million acres, it simply means that there is not a landscape scale decision to specifically exclude grazing on these 1.3 million acres. As mentioned above, this doesn't include areas that have been closed to grazing on a site-specific basis such as campgrounds, RNAs, areas closed for watershed protection, study enclosures, etc.).

The 1986 Forest Plan did not differentiate between capable and suitable rangeland acres or between capable rangeland acres for cattle and capable rangeland acres for sheep as per current classification systems of Forest Service manuals and handbooks. In addition, the original suitability analysis did not have the data and analytical capability now available in the Forest's geographic information system. Also, they limited suitable as only including capable acres. This explains why the 1986 Forest Plan gives 651,481 as suitable/capable acres, while currently 1,294,700 acres is described as suitable and about 714,500 acres as capable rangeland acres for cattle and 878,700 capable rangeland acres for sheep (USDA 2016c).

Current Levels of Grazing

Annual authorized livestock numbers can vary substantially due to precipitation patterns and yearly forage production. Currently, the grazing program consists of 119 allotments, 169 permits, and 137,986 permitted AUMs (USFS 2016b). Table 37 shows that the number of permitted AUMs declined by 37,348 AUMs between 1986 and 2016. This reduction occurred as capacities were adjusted through evaluation of long-term trend and use studies, range improvement efforts, adjustments of livestock permits, and overall improved range management systems and practices. Several factors contribute to the reduction in permitted numbers; extended period of drought (7 to 10 years), and multiple resources competing for public land use (USFS 2011a). The reduction in the number of allotments and permits since 1986 has resulted from the consolidation of allotments or consolidation of permits per allotment.

Table 37. Trend in permitted and authorized AUMs, 1986-2015.

Fiscal Year	Permitted AUMs	Authorized AUMs
1986	175,334	151,686
2004	146,606	108,616 [a]
2010	143,138	140,219
2013-2015 Average	137,986	124,697

Source: U.S. Forest Service 2016b

[a] Authorized numbers were reduced largely due to prolonged drought conditions from 1999-2003 (USGS 2003)

The Forest provides forage for approximately 70,000 cattle and horse animal unit months (AUMs) and 50,000 sheep and goat AUMs. Table 38 displays authorized AUMs by animal type in fiscal years 2013, 2014, and 2015. Livestock grazing on the Forest during this period has been stable.

Table 38. Authorized livestock grazing on the Forest.

Fiscal Year	Cattle and Horse AUMs	Sheep and Goat AUMs
2013	70,691	52,869
2014	73,015	54,830
2015	72,162	50,525
2013-2015 Average	71,956	52,741

Source: U.S. Forest Service 2016b

Trends in Agriculture Sectors

In both the North and South Zone counties, farm-related employment, including ranching has been flat while non-farm employment grew rapidly between 1970 and 2015 as shown in Figure 23.

In the North Zone, farm employment added only 300 jobs between 1970 and 2015. Although only 300 jobs, the agricultural employment in Sanpete County has remained stable and is an important part of the local economy. In contrast, non-farm employment grew by approximately 287,000 jobs. As a result, the relative importance of agriculture to the economy declined dramatically over this period. In 1970, farming/ranching accounted for approximately 9 percent of employment in the North Zone. By 2015, its share of total employment had declined to less than 2 percent.

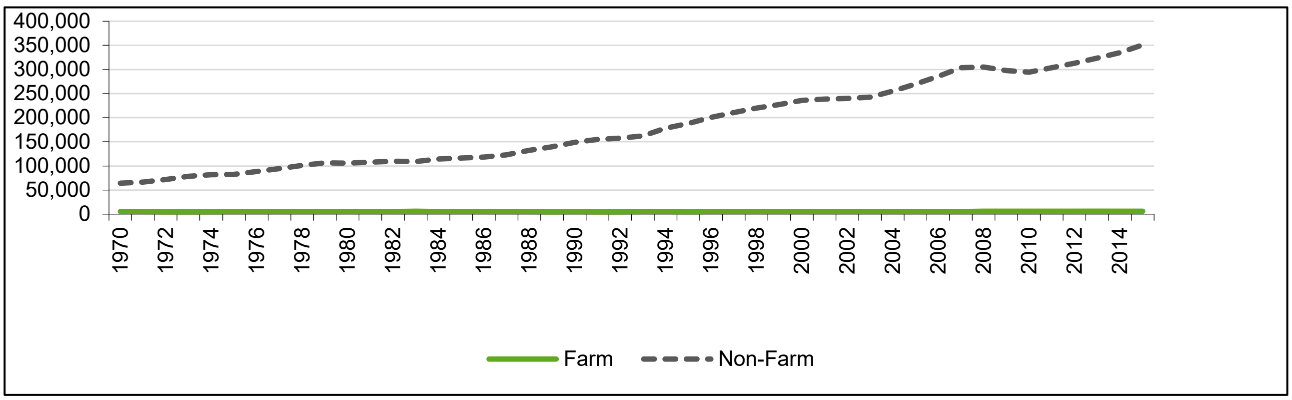


Figure 23. Change in farm and non-farm employment for the North Zone (U.S. Census Bureau 2016).

However, there is a great deal of variation among counties in the North Zone in terms of the share of farm employment. Nearly 12 percent of jobs in Emery County are in agriculture, while only 1 percent of jobs in Utah County are in agriculture. Figure 24 reveals the economic variation among North Zone counties.

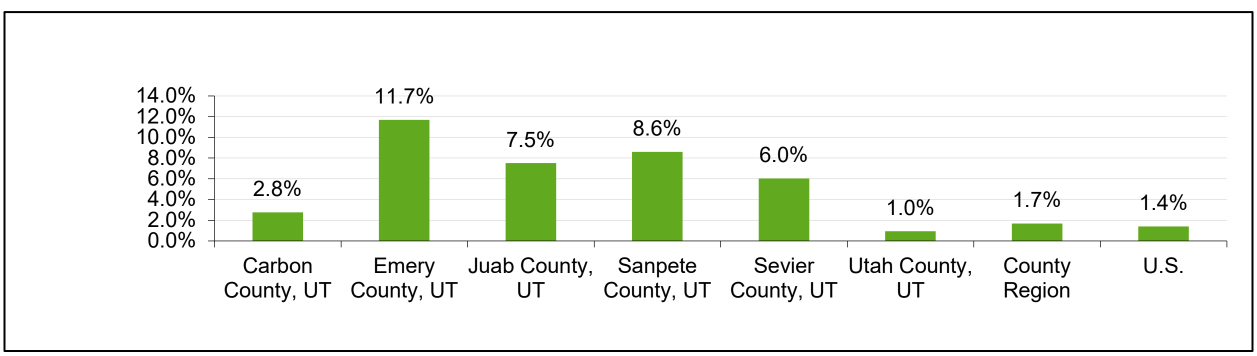


Figure 24. Farm jobs as a percent of total employment, North Zone in 2015 (U.S. Census Bureau 2016).

While farm employment grew by approximately 1,400 in the South Zone over this period, non-farm employment grew by approximately 86,000 as shown in Figure 25. In other words, farm employment accounted for 10 percent of South Zone employment in 1970 and less than 4 percent in 2015 (U.S. Census Bureau 2016).

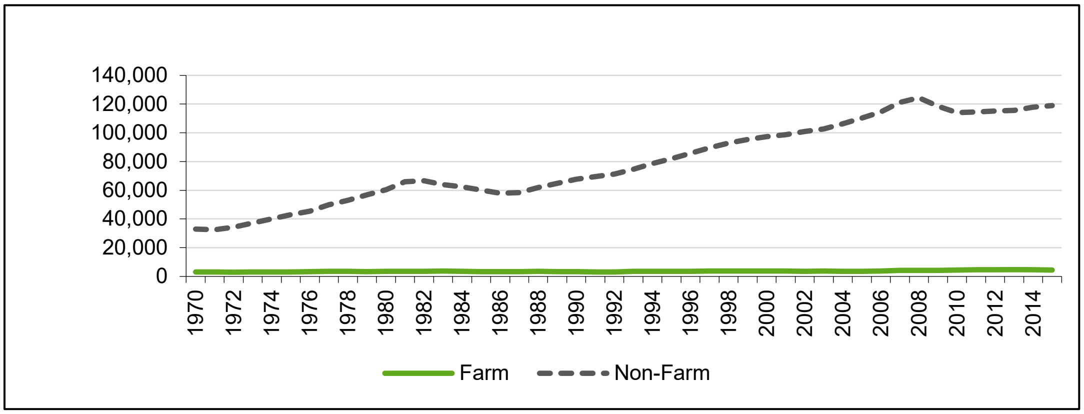


Figure 25. Change in farm and non-farm employment, South Zone in 2015 (U.S. Census Bureau 2016).

Overall, farm/ranching employment remains relatively more important to economic activity in the South Zone compared to the North Zone. Figure 26 shows the percent of farm jobs on the South Zone. San Juan County has a high share of farm employment. The employment and labor income associated with livestock grazing on the Forest is estimated in the economic contribution analysis section of this report.

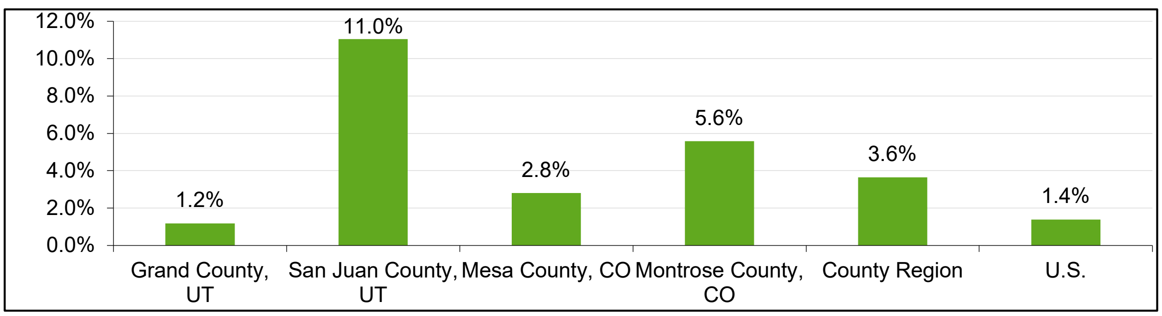


Figure 26. Farm jobs as a percent of total employment, South Zone in 2015 (U.S. Census Bureau 2016).

Value of Ranching

As mentioned above, noneconomic factors influence the persistence of ranching in the West. Over the past 20 years, academic literature has addressed the shift from the "Old West" – a rural economy based on extractive natural resources – to the "New West, which is characterized by tourism development and amenity migration (Winkler et al. 2007). This change has contributed to economic diversification (discussed in a subsequent section) but has also led to cultural conflict (Ooi et al. 2015).

Ranch ownership can strengthen ties to the community, fellow ranchers, and families. Research has found that many ranchers identify the value of ranching as being closer to the earth, providing a desirable place to raise a family, and providing a satisfying way of life (Smith and Martin 1972). Interaction with other ranchers builds networks and social capital (Ooi et al. 2015). Such interpersonal relationships contribute to a sense of belonging and quality of life.

The maintenance of ranches in the planning area contributes to the preservation of open space. Without access to allotments on the Forest, some ranches may no longer be economically viable. The sale of ranches often leads to conversion of ranchland to sub-divided developments that reduce the availability of open space (Brunson and Huntsinger 2008).

Livestock grazing has been an important part of the local economy and culture for over a century. Grazing was directly related to the establishment of the Forest. The establishment of the Forest has led to many changes to grazing over the years (Prevedel et al. 2005, Hindley et al. 2000, U.S. Research Inc. 2000). Ecological integrity and sustainability are important parts of the grazing program today. Livestock grazing is likely to be sustained within the planning area over the next 20 years based on recent past site-specific range analyses. Projects have been successful in improving livestock management. Additionally, the emphasis of ecological restoration at the watershed scale will contribute to the direct and indirect sustainability of grazing on the Forest. Managing grazing for intensity, duration and timing of grazing should continue to improve overall rangeland conditions. (Reed et al. 1999). These principles will allow for productive lands which are capable of sustaining grazing and other multi-use activities into the future and will continue to be an important part of the local economy and culture.

Forest Products

Current Levels of Harvesting

Softwood saw timber, poles and posts, fuel wood, and a variety of special forest products are harvested from the Forest. Table 39 displays the quantity of various forest products harvested between fiscal years 2013 and 2016. Annual saw timber harvests varied substantially between 2013 and 2016. Ranging from no saw timber harvesting in 2013 to approximately 44,000 hundred cubic feet in 2016.

Table 39. Forest product harvesting in the past four years.

Fiscal Year	Sawtimber (ccf)	Christmas Trees (#)	Fuelwood (cords)	Poles (#)	Posts (#)	Ornamentals (#)	Nuts/Seeds (lbs.)
2013	0	3,487	7,036	1,425	872	15	31,270
2014	9,460	3,311	5,820	1,110	839	0	18,910
2015	13,226	3,489	5,922	1,000	1,360	10	13,520
2016	44,070	4,107	6,055	1,100	1,280	21	10,180
Average	16,689	3,599	6,208	1,159	1,088	12	18,470

Source: U.S. Forest Service 2016b

Trends

Figure 27 displays the trend in the share of employment in timber-related sectors in the North Zone. Employment in these sectors was erratic between 1998 and 2014. It grew between 1998 until the start of the Great Recession, at which point it decline again to the 1998 level. Nationally, the housing crash associated with the recession collapsed housing starts and dramatically decreased demand from the construction industry for timber (Keegan et al. 2012). Post-recession recovery saw growth in the sector, but it again lost most of those gains in 2014 (U.S. Census Bureau 2016). Timber accounts for a very small share of private employment in the North Zone—approximately half of one percent at its peak in 2006. Therefore, the erratic trends in this sector do not indicate substantial changes in the economic fortunes of the region overall.

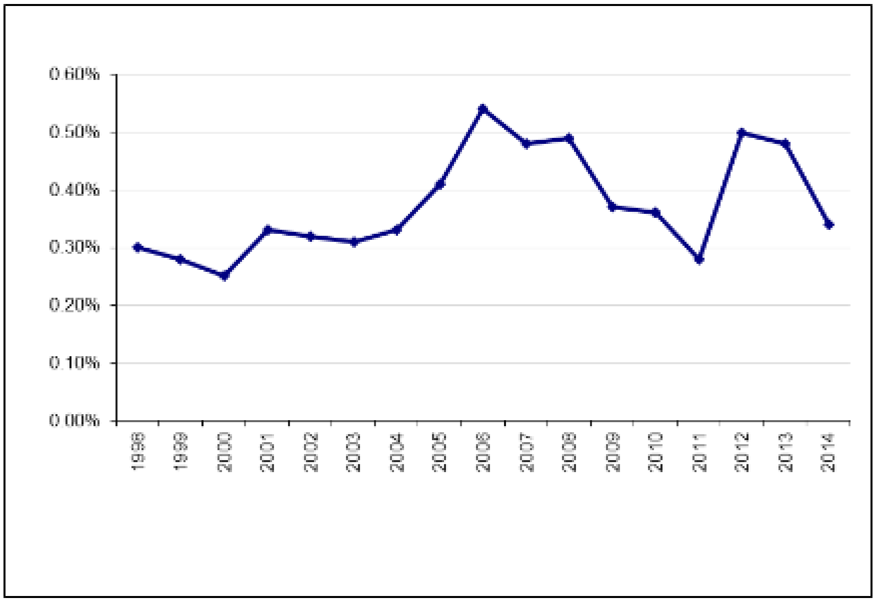


Figure 27. Percent of total private employment in timber sectors, North Zone (U.S. Census Bureau 2016).

Employment in timber sectors declined by nearly two-thirds between 1998 and 2014 in the South Zone as shown in Figure 28. However, at no point during this period was timber a sizeable sector. At the peak in 1998, less than 1 percent of private employment was in timber-related industries (U.S. Census Bureau 2016). Unlike the North Zone, the Great Recession and subsequent recovery in the housing market did not appear to affect the steady downward trend of the timber sector in the South Zone.

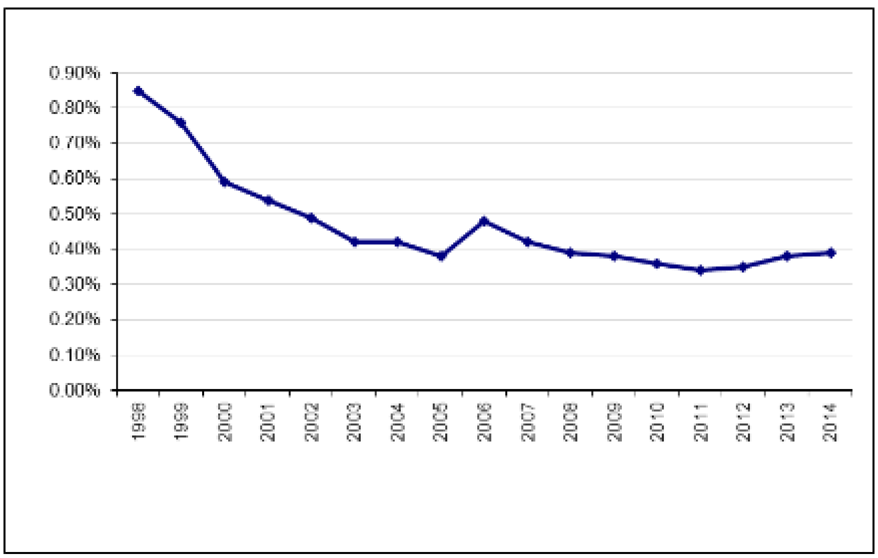


Figure 28. Percent of total private employment in the timber sector on the South Zone (U.S. Census Bureau 2016).

The employment and labor income associated with timber harvested from the Forest is estimated in the economic contribution analysis section of this report.

Value of Forest Products

The previous section provided data on the contribution of timber to economic activity in the counties surrounding the Forest. These contributions arise chiefly from commercial logging and wood processing facilities. Therefore, this section focuses on the values of other forest products such as fuelwood, Christmas trees, and food and seeds.

Households may use wood for home heating for both cultural and economic reasons. When gas prices are high, wood offers an affordable fuel source. Low-cost or free fuelwood collection permits from the Forest provide affordable home heating for households near the Forest. As shown in Table 39, approximately 6,200 cords of fuelwood are removed from the Forest annually. Assuming a typical household reliant on wood heating uses five cords a winter, fuelwood removed from the Forest enables approximately 1,200 households to affordably heat their homes (Bonislawski 2014). Table 40 shows the proportion of households, which use wood as their primary home heating source.

Table 40. Percent of households within counties and states where wood is the primary home heating source, 2015.

Location	Primary Home Heating Source Percent
Carbon County, UT	2
Emery County, UT	8
Juab County, UT	7
Sanpete County, UT	5
Sevier County, UT	5
Utah County, UT	0.5
Grand County, UT	5
San Juan County, UT	35
Mesa County, CO	3
Montrose County, Co	11
Colorado	2
Utah	1

Source: U.S. Census Bureau 2015

Except for the urban Utah County, all counties in the North Zone are more reliant on wood for home heating than residents of the state overall. Emery and Juab counties have the highest share of households using wood as their primary heating source. According to that data in Table 33, these counties have median incomes like the nation overall and do not experience elevated rates of poverty. This suggests that wood heating in these areas may be more tied to culture and preference, rather than economic necessity.

Wood heating is more dominant in the South Zone, particularly in San Juan County, UT. More than one-third of households in San Juan County rely on wood as their primary home heating source.San Juan County also has the lowest median household income and highest poverty rate among all ten counties in the planning area. This indicates that affordable and available fuelwood is important to well-being in San Juan County. Montrose County, CO is also much more reliant on wood heating than the state or planning area average. More than one-tenth of households in Montrose County use wood as their primary home heating source. Montrose County has the second lowest median household income and second highest poverty rate among the ten planning area counties (U.S. Census Bureau 2014).

Other non-timber forest products gathered on the Forest, such as nuts, seeds, and Christmas trees support livelihoods and traditions in the communities near the Forest. In the South Zone, gathering piñon nuts is culturally and economically valuable. Cutting Christmas trees provides a family activity that preserves tradition. Local seed companies benefit from ecological diversity on the Forest. Farmers and ranchers use poles and posts from the Forest for range improvements. Many of these activities are not captured in market transactions or are captured in non-timber sectors. Therefore, the employment shares do not provide a complete picture of the importance of forest products to communities that surround the Forest.

Outdoor Recreation

Current Recreation Visitor Use

There are approximately 350,000 visits to the Forest annually (USFS 2016r). Most visitors to the Forest are white (97 percent), male (64 percent), from Utah (87 percent), with annual household income between $50,000 and $74,999 (33 percent). Youth (under 16) make up the largest share of visitation (25 percent) among any age class (USFS 2016r).

Hunting and fishing are among the most common motivations for people to visit the Forest. Only “viewing natural features” has a higher share of participants reporting it as their main activity during their visit (17.5 percent). Hunting is identified as the main activity by 11.2 percent of visitors and fishing by 8.6 percent of visitors. Motorized trail activity, developed camping, and driving for pleasure are other highly reported main activities, with more than 7 percent of visitors selecting each as the primary purpose of their visit (USFS 2016r). Cultural resource tourism on the South Zone makes up a small but growing percentage of recreation activity (USFS 2016r).

Detail on recreational settings, opportunities, and access are contained in the report for topic 9.

Trends in Recreation Sectors

Figure 29 displays the trend in the share of employment in travel and tourism-related sectors in the North Zone. Since 1998, the share of employment in travel and tourism sectors has been relatively flat, around 12 percent of private employment (U.S. Census Bureau 2016).

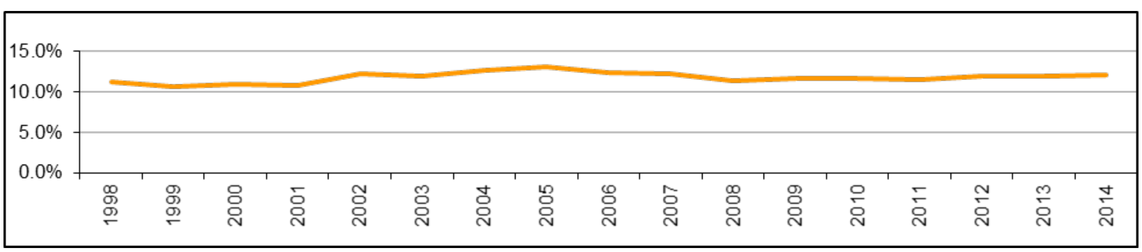


Figure 29. Percent of total private employment in travel and tourism sectors, North Zone (U.S. Census Bureau 2016).

Travel and tourism are dominant economic drivers in the South Zone, with approximately 20 percent of jobs in these sectors. Figure 30 shows the trends in travel and tourism-related employment in the South Zone. The share of employment in these sectors increased steadily between 1998 and 2014 (U.S. Census Bureau 2016).

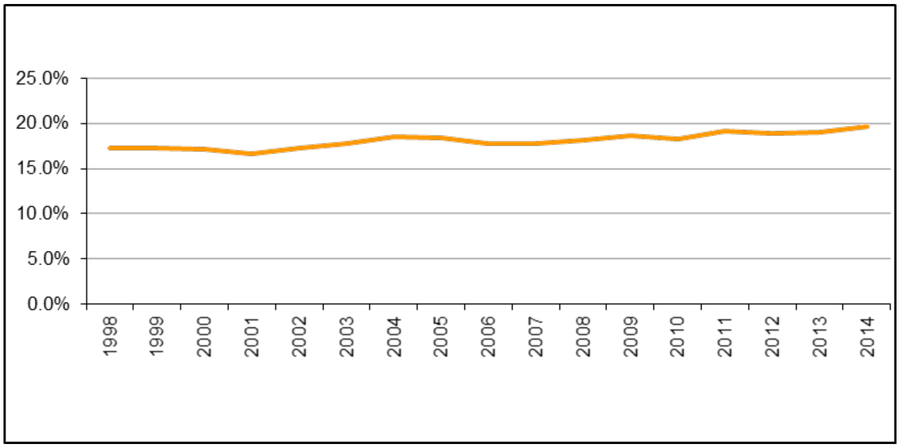


Figure 30. Percent of total private employment in travel and tourism sectors, South Zone (U.S. Census Bureau 2016).

Recreation on the Forest contributes to employment in travel and tourism sectors, however, much of the employment in these sectors is attributable to other outdoor recreation opportunities and tourist attractions in the region. For example, Arches and Canyonlands national parks are in the South Zone and receive nearly 2 million visits each year (compared to 350,000 to the Forest) (NPS 2016b). The concentration of outdoor recreation opportunities in the South Zone, particularly near Moab, Utah, makes travel and tourism industries major economic drivers. In Grand County, Utah (which contains Moab), nearly half of private sector employment in the county is in travel and tourism sectors (Headwaters Economics 2015). Therefore, the Forest recreation management actions have the potential to influence a key economic sector, particularly in the South Zone.

Value of Recreation

Outdoor recreation visitors spend money on food, fuel, lodging, and souvenirs during their trips to the Forest. Average visitor spending ranges from $33 for local day visitors to $514 for non-local overnight visitors staying off the national forest (White et al. 2013). These visitor expenditures support employment and labor income in recreation-related sectors in the communities that surround the Forest. The economic contribution of visitor expenditures is estimated in the economic contribution analysis section of this report.

Visitor expenditures are only one measure of the economic aspects of outdoor recreation. Visitors to public lands benefit from free or low-cost recreation opportunities. The value of an outdoor recreation experience to a visitor is not typically captured in market transactions. In other words, while some recreation visitors pay fees to access a site or purchase hunting licenses, the values of those experiences often exceed the amount that is spent for the experience. The difference between what visitors spend and what they would be willing to spend in order to access outdoor recreation opportunities is called consumer surplus. Consumer surplus is not captured in an economic contribution analysis and the survey data necessary to accurately estimate consumer surplus are not available. However, the inability to quantify consumer surplus associated with recreation does not indicate that these values do not exist.

Outdoor recreation opportunities on the Forest contribute to visitors' quality of life. The Forest provides an area for friends and family to gather, to pass on traditions, and to strengthen relationships. Some activities, such as hunting and fishing, serve a dual purpose of recreation/leisure and supporting household well-being through the provision of food.

Mineral and Energy Production

Multiple uses and ecosystem services refer to renewable natural resources. Therefore, these categories do not typically include minerals. However, due to the economic importance of mining in the counties surrounding the Forest, it is addressed as part of the "benefits to people" analysis in this report.

Current Mineral Removal

Coal is the largest source of mining activity on the Forest. Approximately 8 million short tons of coal are removed from the Forest annually (Salow 2016). In Utah, the average sales price per short ton of coal is $35 (EIA 2016a). Therefore, approximately $280 million worth of coal are removed from the Forest annually.

Natural gas wells on the Forest also contribute to economic activity in the region. Approximately 450,000 mcf (thousand cubic feet) of natural gas is produced from 13 wells on the Forest (Salow 2016). The wellhead price of natural gas is approximately $3 per mcf. Therefore, natural gas production from the Forest is worth approximately $1.4 million annually.

Trends in Mining Industry

Figure 31 displays the trend in mining employment in North Zone counties. Since 1998, employment in the mineral extraction industry has declined from approximately 1.5 percent to approximately 0.8 percent of total private employment in 2014 (U.S. Census Bureau 2016).

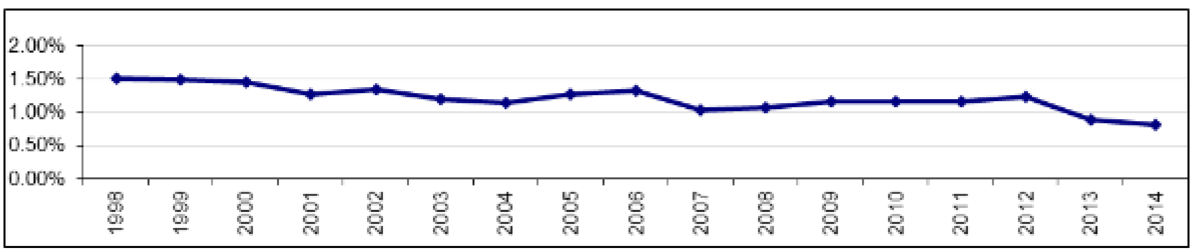


Figure *31. Percent of total private employment in mining, North Zone (U.S. Census Bureau 2016).*

In contrast, the share of mining employment in South Zone counties grew substantially between 1998 and 2014, from approximately 1 percent to nearly 5 percent as shown in Figure 32. However, the growth in mineral extraction employment in the South Zone is driven by Mesa County, Colorado, where the oil and gas industry grew substantially over the period. The boom in oil and gas production in Mesa County did not occur on the Forest's lands in the county.

Since 2014, oil and gas prices have declined dramatically (US EIA 2016a and US EIA 2016b). In 2013, crude oil prices in Utah and Colorado were approximately $90 per barrel. By 2015, the price of a barrel of oil had more than halved, to approximately $40 (US EIA 2016b). Unfortunately, employment data beyond 2014 are not available. However, the decline in oil and gas prices has likely reduced the share of mining-related employment in the South Zone.

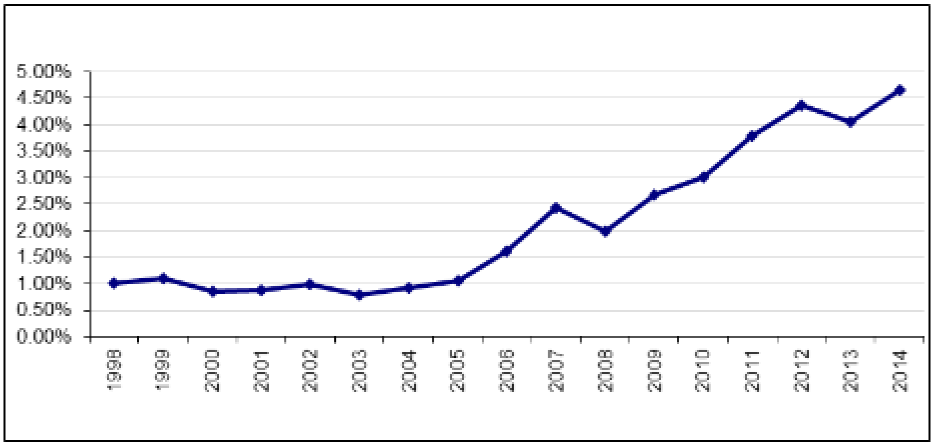


Figure 32. Percent of total private employment in mining, South Zone (U.S. Census Bureau 2016).

These figures provide insight into the mining sector throughout the 10-county area. However, they do not reveal how mines on NFS lands in the planning area contribute to economic activity. The contributions of mineral extraction on the Forest are addressed in the subsequent economic analysis section.

Water Provision

The Forest contributes to the supply of clean water for a variety of human uses. Since water is not traded in markets the way that other multiple uses are (for example, timber), this section is organized to qualitatively address who benefits from water, how they benefit, and changes in demand for water provision. The hydrology and watersheds section in the topics 1 and 2 report describe conditions and trends in water quality, water quantity, watershed function, and stressors that are affecting watersheds in the planning area. Water is an essential input to nearly all human activities. Human health, agriculture, and industrial production are reliant on clean and plentiful water.

Clean water provided by the Forest is essential for agricultural producers in the planning area. Agriculture is a major source of employment in some of the North and South Zone counties. Agriculture is of particular economic importance in Emery, Juab, Sanpete, Sevier, and San Juan counties in Utah and Montrose County, Colorado (U.S. Census Bureau 2016). Utah is among the driest states in the nation. Therefore, irrigation is essential for agricultural production. Reservoirs on the Forest store snowmelt for irrigation.

Municipalities and individual households also rely on the Forest for clean drinking water. Both municipalities and individual wells withdraw water from watersheds that overlap with the Forest. Forest uses and management actions, such as grazing, mining, and recreational use, have the potential to affect drinking water quality. The hydrology and watershed section of the topics 1 and 2 report describes threats to drinking water quality in detail.

Surface water on the Forest contributes to recreational use and enjoyment of the Forest. Boaters, anglers, and other water-based recreation users are heavily affected by water quantity and quality on the Forest. Nearly 10 percent of visitors to the Forest report fishing as their primary trip purpose and nearly 25 percent report fishing as one of their activities during their visit to the Forest. Smaller shares of visitors' report participating in other motorized and non-motorized water activities during their visit to the Forest (USFS 2016r).

The value of water is not captured in market transactions, therefore, the type of economic contribution analysis done for other multiple uses (range, recreation, and timber) cannot be done for water. However, the absence of water as an independent category in the economic contribution analysis does not reflect a lack of economic importance, rather that water is an input to all economic activity.

Wildlife and Fish

The Forest provides habitat for a diverse range of wildlife and fish. The protection of wildlife and fish habitat contributes to social and economic well-being in the planning area counties and in the broader landscape. The reports for topics 1, 2, and 5 address wildlife and fish habitat in detail.

People benefit from wildlife and fish in myriad ways. Anglers and hunters rely on wildlife and fish for recreational enjoyment, sustenance, and to preserve heritage. Rainbow trout draw anglers to the Forest. Big game habitat on the Manti-La Sal National Forest draws hunters to the Forest. According to the Forest's National Visitor Use Monitoring survey, approximately 20 percent of recreational visitors' report hunting or fishing as their primary trip purpose and about 40 percent report hunting or fishing as part of their trip. Furthermore, 28 percent of visitors' report wildlife viewing during their trip to the Forest (USFS 2016a). These survey results indicate that the protection of fish and wildlife habitat on the Forest is essential to recreational use and enjoyment.

Recreation visitors to the Forest are a source of economic activity in communities near the Forest. Local communities that provide goods and services to hunters and anglers rely on their spending. Recreation visitor expenditures support employment and labor income in communities near the Forest. Furthermore, State governments rely on hunting and fishing license and permit revenue to fund State Government operations. The contributions of wildlife and fish-related recreation to economic activity are captured in the economic contribution analysis in this report.

People also value wildlife and fish on the Forest for non-recreational purposes such as the value of knowing that wildlife and fish are present on the Forest even if no future use, such as hunting or wildlife viewing, is intended. These sorts of values for wildlife and fish are not captured in market transactions. Although these values are difficult to fully capture and monetize, they are a real source of social and economic contributions from the Forest to people in the planning area counties and across the United States.

Carbon Sequestration and Storage

Climate change threatens human well-being across the world. Costs to humans associated with climate change influence infrastructure damage due to sea level rise, increased frequency and intensity of wildfire, increased building cooling costs, and effects to agricultural productivity and human health. These costs are global in nature. Therefore, carbon emissions and carbon storage associated with the Forest has costs and benefits that extend far beyond the 10-county analysis area used in this report.

Forest Operations and Infrastructure

Forest operations and infrastructure include personnel, program activities, roads, and facilities that contribute to the use and enjoyment of the Forest.

Salary and Non-salary Expenditures

In fiscal year 2014, the Forest's annual budget was approximately $11 million. Two-thirds of this was spent on salaries. One-third was spent on equipment and other non-salary expenditures that contribute to forest management. The Forest's operational expenditures contribute to economic activity in the communities that surround the Forest. Forest Service employees live in these communities and spend their income on housing, food, and a variety of other local goods and services. The Forest's non-salary expenditures generate economic activity in businesses that supply goods and services to support Forest Service programs. The economic contributions of the Forest's expenditures are captured in the economic contribution analysis in this report.

Decisions regarding national forest budgets are not made in the forest plan revision process. The federal appropriations process determines the funding available to national forests to implement forest management actions. Overall, National Forest System budgets declined between fiscal years 2012 and 2016 (Hoover 2016). Meanwhile, an increasing share of the Forest Service's budget is spent on wildland firefighting.

Forest Infrastructure

Infrastructure on the Forest includes NFS roads, trails, bridges, public utilities, private infrastructure, recreation facilities, drinking water systems, dams, and administrative facilities. Forest infrastructure is an essential input in economic activity in the region. Recreational use of the Forest relies on accessible roads, trails, and developed sites. Households and industries rely on cellular towers, water developments, pipelines, and transmission lines to conduct their business. Like water, forest infrastructure is not a separate category in the economic contribution analysis because it is embedded in nearly all market transactions associated with forest uses. Timber cannot be removed from the Forest for processing without NFS roads. Recreational visitors will not spend money in communities near the Forest if they cannot access preferred recreational sites. New families and businesses will not move to the communities surrounding the Forest if they lack access to infrastructure essential to modern life.

Cultural Resources

Cultural and historic resources may make an important contribution to the social, economic, and ecological sustainability of the local communities intimately connected to the Forest. Cultural and historical resources found on the Forest provide excellent opportunities for contributing benefits to the public including expanded knowledge and understanding of history, cultural, spiritual connections to heritage, scientific data about past cultures or historical conditions, human adaptation to past climatic events, and tourism that benefit rural economies. Cultural and historical resources provide opportunities to foster connection between people and cultural/historic resources and landscapes locally and beyond plan area. Public participation in the current program is high and provides public programs to youth and adults enhancing public knowledge, opportunities for volunteerism and partnerships, and promoting stewardship for cultural resources.

4.2.6 Economic Contribution Analysis from Multiple Uses

The economic contribution analysis estimates the role of Forest Service resources, uses, and management activities on employment and income in the communities that surround the Forest.

The role of the Forest in the regional economy was modeled with IMPLAN Professional 3.1 software using 2014 data. IMPLAN is an input-output model, which estimates the economic consequences of activities, projects, and policies on a region. Input-output analysis represents linkages between sectors in an economy. For example, forest visitors spend money on accommodation and food. Accommodation and food service businesses buy supplies from other businesses. The employees of these firms spend their earnings on a variety of goods and services. These transactions result in direct, indirect, and induced effects in the regional economy, respectively. IMPLAN uses Forest Service data on expenditures and resource uses to estimate the economic consequences of Forest management.

Employment by Program Area

Table 41 shows the number of jobs attributable to various Forest Service programs. Livestock grazing, mining, Forest Service expenditures contribute the most to employment in the regional economy, each contributing approximately 300 jobs on an average annual basis. The Forest Service expenditures category captures both salary and non-salary expenditures. Therefore, this category includes Forest employees, Forest contractors and suppliers, as well as employees of businesses where Forest employees spend their household income.

Table 41. Numbers of jobs attributed to Forest programs by program area.

Program Area	Total Employment	Direct Employment Effect	Indirect and Induced Employment Effect
Forest Service expenditures	284	219	66
Grazing	337	179	158
Minerals	321	12	219
Payments to states and counties	88	65	24
Recreation not related to wildlife and fish	60	43	17
Recreation related to wildlife and fish	30	22	8
Timber	71	47	24
Total Forest Management	**1,192**	**677**	**515**

Source: Forest Service estimates using IMPLAN 2014

Labor Income by Program Area

Table 42 displays labor income attributable to various Forest Service programs. The jobs estimates, presented above, offer an incomplete picture of the Forest's contributions to the 10-county economy. Not all jobs are equivalent. Labor income estimates help to clarify the role of forest management in supporting livelihoods in communities near the Forest.

Table 42. Labor income in dollars attributed to Forest programs by program area.

Program Area	Total Labor Income	Direct Labor Income Effect	Indirect and Induced Labor Effect
Forest Service expenditures	10,778	8,496	2,283
Grazing	6,435	1,029	5,405
Minerals	18,624	8,562	10,062
Payments to states and counties	3,590	2,743	847
Recreation not related to wildlife and fish	1,803	1,249	554
Recreation related to wildlife and fish	949	657	292
Timber	3,009	1,954	1,054
Total Forest Management	**45,189**	**24,690**	**20,498**

Source: Forest Service estimates using IMPLAN 2014

Whereas, Table 41 indicated that livestock grazing, mining, and Forest Service expenditures were roughly equivalent in terms of their contributions to regional employment, Table 42 shows that mining on the Forest contributes substantially more to labor income than livestock grazing and Forest Service expenditures. This finding reveals that jobs associated with mining on the Forest pay more than jobs associated with livestock grazing or Forest Service expenditures.

Economic Importance of the Manti-La Sal National Forest

Table 43 displays the contribution of activities on the Forest to regional employment and labor income. These sectors do not align with the program area categories in Table 41 and Table 42 because the employment and income associated with each program area occur in a variety of sectors. For example, the mining program on the Forest supports 321 jobs and $18.6 million in labor income on an average annual basis. Table 43 shows that the Forest supports 130 jobs and $10.7 million in labor income in the mining sector. This discrepancy is because mining activity on the Forest supports jobs and labor income in several non-mining sectors, particularly construction, retail trade, finance and insurance, professional, scientific, and technical services, and health care.

Table 43. Current contribution of the Forest to the regional economy by number of jobs contributed and labor income in 2014 dollars contributed.

Industry	Total Regional Jobs	Forest Related Jobs	Total Labor Income	Forest Related Labor Income
Agriculture	10,807	309	215,278	4,731
Mining	8,128	130	667,523	10,743
Utilities	1,438	2	163,415	236
Construction	33,526	25	1,533,504	1,178
Manufacturing	27,546	20	1,679,845	798
Wholesale Trade	12,385	28	836,607	2,037
Transportation and Warehousing	50,282	19	1,412,761	1,493
Retail Trade	9,136	90	531,512	2,599
Information	13,681	9	1,068,445	599
Finance and Insurance	23,867	41	663,698	1,108
Real Estate, Rental and Leasing	22,198	34	361,146	845
Professional, Scientific, and Technical Services	36,813	57	1,978,581	2,426
Management of Companies	3,441	5	107,987	174
Administration, Waste Management and Remedial Services	22,428	28	665,278	838
Educational Services	17,101	11	761,125	532
Health Care and Social Assistance	44,192	58	1,998,723	2,864
Arts, Entertainment, and Recreation	8,952	15	101,320	195
Accommodation and Food Services	31,100	67	606,731	1,291
Other Services	17,287	24	729,290	1,084
Government	53,282	220	2,718,713	9,419
Total	**447,591**	**1,192**	**18,801,480**	**45,189**
Forest Service as Percent of Total	**0**	**0.27**	**0**	**0.24**

Source: Forest Service estimates using IMPLAN 2014

Market transactions attributable to activities on the Forest support an estimated 1,192 jobs and $45 million in labor income in the regional economy. Forest Service activities on the Forest are responsible for approximately 0.27 percent of total employment and 0.24 percent of labor income in the ten-county area. The Forest contributes the most employment and labor income to the (1) agriculture, (2) government, and (3) mining sectors. All these sectors are linked to the Forest, including forest product removal, mining, livestock grazing, and payments to states and counties. The agriculture sector is the most reliant on Forest Service activities. Approximately 2.9 percent of employment and 2.2 percent of labor income in the agriculture sector is attributable to activities on the Forest.

Other studies assessing the economic impacts of forest management may result in differing estimates of economic contribution due to differing underlying assumptions, inputs and analysis areas. There is flexibility and specialist judgement when building these models even within a standard, technically sound approach.

Utah State University's Economic Research Institute produced estimates of the economic contribution of grazing on the Manti-La Sal NF (Ward et al, 2017). Their modeling effort resulted in a lower estimate of total employment and a higher estimated labor income than those reported above Table 44. These differences stem from the use of a different analysis area—the USU study uses a 3-county study area, while this report uses a 10-county study area. Therefore, the USU model has more "leakage", (i.e., if ranchers buy goods or services in a county outside the analysis area, those impacts are not captured). Second, this assessment reports more AUMs than the USU study. The assessment uses 2013-2015 average authorized AUMs of about 72,000 cattle and 53,000 sheep. Finally, the two studies develop unique expenditure profiles for sheep farming and cattle ranching. This assessment uses methodology developed jointly by the Forest Service and Bureau of Land Management, and not alarmingly, will likely differ than that developed by USU researchers. These different profiles, combined with the different AUMs and analysis areas resulted in different estimates of employment, labor income.

Table 44. Economic contribution of grazing comparing Forest estimates to Utah State University's estimates.

Industry	Total Effect of Grazing
Forest Service Employment Estimate	337
Forest Service Labor Income Estimate in thousands of dollars	6,435
Forest Service Value Added Estimate in thousands of dollars	12,222
Utah State University's Employment Estimate	163
Utah State University's Labor Income Estimate in thousands of dollars	9,012
Utah State University's Value-Added Estimate in thousands of dollars	12,052

Source: Forest Service estimates using IMPLAN 2014 and University of Utah's estimates from Ward et al, 2017.

The above analysis considers only the market transactions that result from activities on the Forest. Numerous non-market social and economic values are associated with the Forest. The value of ecosystem services, such as, clean air and water, are not captured in the economic contribution analysis. Therefore, this analysis should not be conflated with a representation of the total economic value of the Forest.

4.2.7 Social and Economic Sustainability

The Forest provides opportunities to use and enjoy natural resources. Reports for topics 1 and 2 address the ecological sustainability of Forest Service resources and uses. This report addresses the Forest's relationship to social and economic sustainability in the counties that surround the Forest.

Social and Economic Sustainability Measures

Diversified economies – those with employment in a variety of industries – are more resilient to changes in a single sector. While some individuals will still experience periods of unemployment, economic diversification helps to lessen the potential of economic collapse due to the decline of one industry. One measure of economic diversity is the Shannon-Weaver index, which is based on the number of sectors present in an economy and the size of those sectors. In the 10-county economic area, the diversity index is 0.76 out of 1. For comparison, Utah's economic diversity index is 0.77 (IMPLAN 2014). Therefore, the planning area is approximately as economically diverse as the state overall. The county-level diversity indices reveal a substantial amount of variation within the planning area counties. Economic diversity is strongly correlated with population size. The three largest counties in the planning area – Utah County, UT in the North Zone and Mesa and Montrose counties, CO in the South Zone – are the most economically diverse. Table 45 display the economic diversity indices for counties in the North and South Zones.

Table 45. Economic diversity index, across the Forest by counties.

County	Shannon-Weaver Diversity Index
Carbon, UT	0.69
Emery, UT	0.62
Juab, UT	0.66
Sanpete, UT	0.68
Sevier, UT	0.67
Utah, UT	0.74
Grand, UT	0.66
San Juan, UT	0.64
Mesa, CO	0.73
Montrose, CO	0.72

Source: IMPLAN 2014

Contribution of Forest Programs, Resources, and Uses to Social and Economic Sustainability

Extractive natural resource-based economies are often subject to boom and bust cycles. Boom and bust cycles threaten social and economic sustainability. As described above in the mining and energy section, oil and gas prices have declined dramatically in recent years (US EIA 2016a and US EIA 2016b). During a boom period, population typically grows rapidly, which strains public services (for example, policing and schools) and causes housing prices to increase. A bust period then leads to a dramatic decline in public revenues, out-migration, and high unemployment. Natural resource-based economies that are not diversified in other industries are particularly affected by boom and bust cycles.

The economic contribution analysis reveals that the Forest makes the largest contributions (in terms of employment and labor income) to the agriculture, mining, and government sectors. Mining and agriculture sectors, including, for example, commercial logging and cattle ranching, are susceptible to boom and bust cycles. For example, a fall in energy prices or a slow-down in housing starts will affect employment in these sectors. The 2007-2009 recession and the recent drop in energy prices affected these sectors. The Forest Service does not control business cycles or other macroeconomic conditions. However, Forest Service management does interact with the broader economy. Sustainable management is at the core of the Forest Service's mission. The Multiple-Use Sustained-Yield Act of 1960 enshrined in law a requirement to manage national forests to provide benefits to present and future generations.

The *benefits to people* section, above, describes the channels through which the Forest Service contributes to social and economic well-being through the provision of outdoor recreation opportunities, forage for livestock, a sustainable flow of timber, watershed services, and fish and wildlife habitat. Additionally, the Forest serves as a carbon sink. The Forest's operations and infrastructure ensure that people have access to the goods and services that they value.

4.2.8 Trends

Population Change

From 2000 to 2010 North Zone counties saw significant population growth, especially for the more metropolitan Utah County. From 2010 to 2014 growth slowed across the North Zone, Utah, and the United States as a whole, however, Utah County continued to grow at an above average pace as shown in Table 46.

The rural counties of Carbon, Emery, and Sevier saw much less population growth from 2000 to 2010, and zero to negative growth between 2010 and 2014.

South Zone counties also experienced rapid population growth from 2000 to 2010 as shown in Table 46. Growth was led by the two Colorado counties, Mesa and Montrose, which saw growth at twice the national rate. Population growth slowed significantly for South Zone counties between 2010 and 2014. Montrose County's population declined slightly over this period.

Table 46. Population change, by county across Forest.

Location	Population 2000	Population 2010	Percent Change 2000-2010	Population 2014	Percent Change 2010-2014
Carbon County, UT	20,422	21,403	5	21,118	-1
Emery County, UT	10,860	10,976	1	10,834	-1
Juab County, UT	8,238	10,246	24	10,349	1
Sanpete County, UT	22,763	27,822	22	28,129	1
Sevier County, UT	18,842	20,802	10	20,812	0
Utah County, UT	368,536	516,564	40	540,425	5
Grand County, UT	8,485	9,225	9	9,348	1
San Juan County, UT	14,413	14,746	2	14,944	1
Mesa County, CO	116,255	146,723	26	147,509	0.5
Montrose County, CO	33,432	41,276	24	40,885	-0.9
North Zone	449,661	607,813	35	631,667	10
South Zone	172,585	211,970	23	212,686	0.3
Colorado	4,301,261	5,029,196	17	5,197,580	3
Utah	2,233,169	2,763,885	24	2,858,111	3
United States	281,421,906	308,746,065	10	314,107,084	2

Source: Table DP-1, 2000 Census; 2010 Census; 2014 from EPS, calculated from ACS and represents average characteristics

These data indicate that human population pressure on Forest's lands and resources have increased considerably since the Manti-La Sal Forest National Forest Land and Resource Management Plan was published in 1986.

Unemployment

Unemployment trends are a measure of economic resilience. All counties in the planning area had similar unemployment trends between 2000 and 2015.

In the North Zone, Utah County, UT had the lowest unemployment rate – below even the statewide unemployment trend Figure 34. Utah County is an urban and economically diverse area with a variety of employment opportunities. In contrast, the more rural and natural resource-dependent counties of Carbon and Emery had above-average unemployment rates in the North Zone. Agriculture is a major economic driver in Emery County and mining is in Carbon County. These are commodity industries, which are susceptible to dramatic changes in price due to global supply and demand forces.

Overall, the North Zone is currently at or near full-employment, which economists define as a five percent unemployment rate. However, the trend data indicate the potential for sizeable changes in employment prospects due to business cycles.

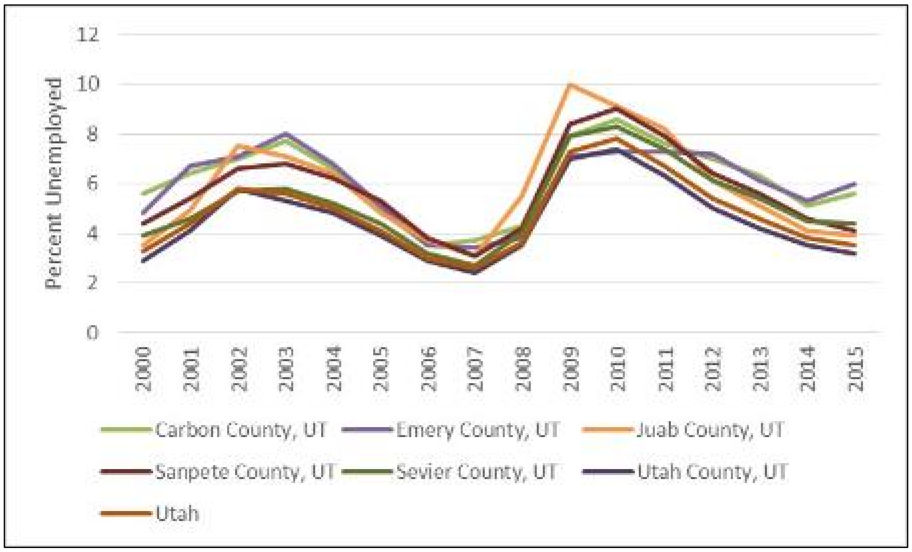


Figure 34. Unemployment trends on the North Zone (BLS 2016).

The South Zone counties have had higher unemployment rates than their respective states throughout most of the 2000 to 2015 period as shown in Figure 33. San Juan County, UT, which has the highest share of minority residents and the highest poverty rate among all 10 counties in the planning area has also experienced very high unemployment. Unemployment in San Juan County, UT peaked in 2009 near 12 percent and remains elevated at approximately 8 percent. Mesa County, CO experienced a high degree of volatility in unemployment rates over this period. In some periods, the unemployment rate was below the Colorado average, but it spiked dramatically during the Great Recession and remains elevated. Mesa County, CO has a large oil and gas industry, where production has slowed due to the recent drop in prices.

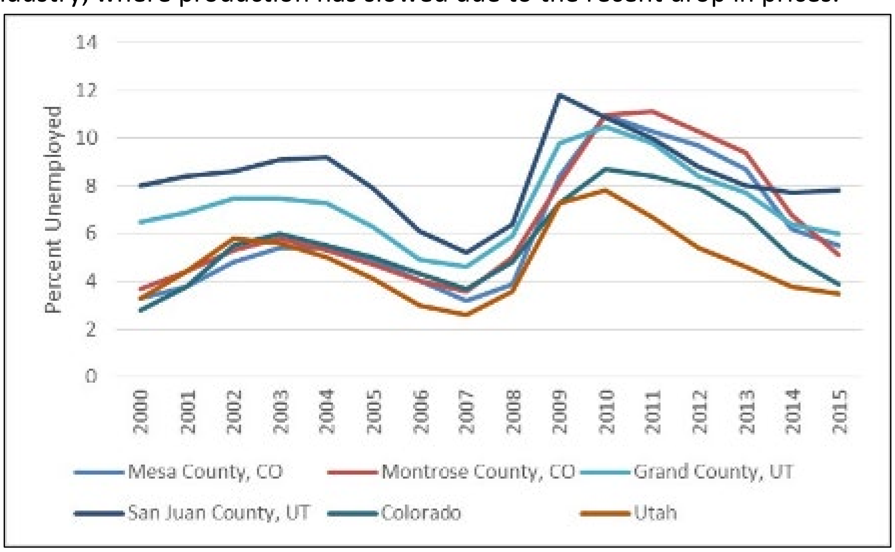


Figure 33. Unemployment trends on South Zone (BLS 2016).

Land Use and Wildland-urban Interface

Land ownership patterns in the North Zone are like Utah overall. In all counties, a minority of lands are privately owned. Federally managed lands, primary Bureau of Land Management or NFS lands, account for two-thirds of all lands in the North Zone. BLM-managed lands are more prevalent across North Zone counties, with approximately 4.4 million acres compared to 2 million acres of NFS lands (not just the Forest) in North Zone counties as shown in Figure 35.

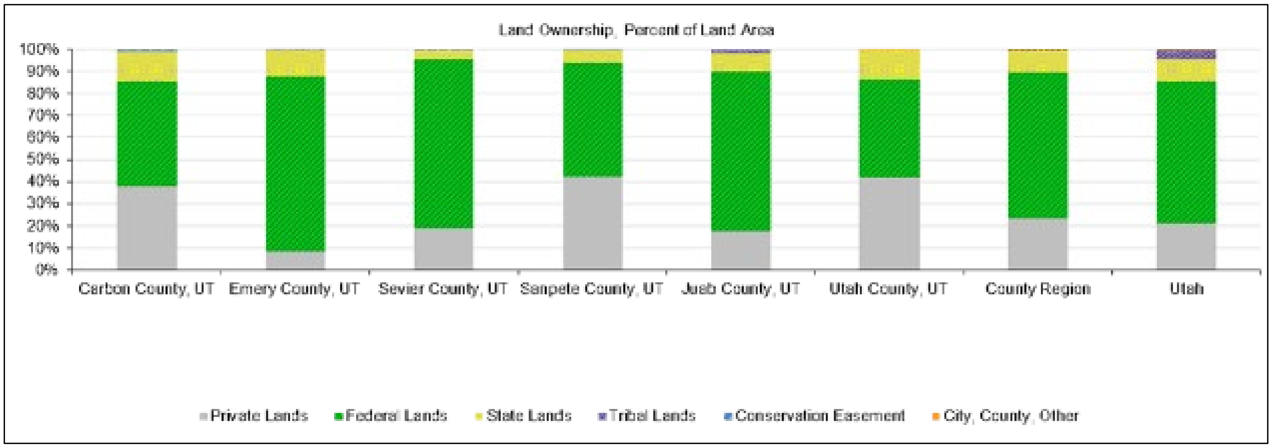


Figure 35. Land ownership by percent on the North Zone (USGS 2012).

In the South Zone, tribal lands account for a larger share of the land base, particularly in San Juan County, Utah. Privately owned lands are even less prevalent in the South Zone than the North Zone. In particular, the two Utah counties in the South Zone have less than 10 percent private land ownership. Like the North Zone, BLM-managed lands are more prevalent than NFS lands across South Zone counties, with approximately 5.2 million acres compared to 1.4 million acres of NFS lands (not just the Forest) in South Zone counties as shown in Figure 36.

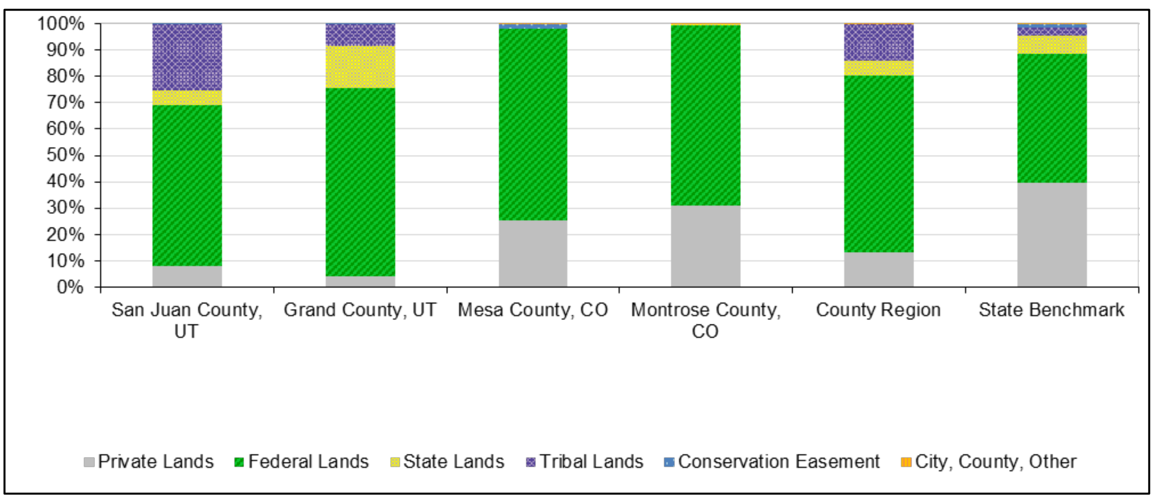


Figure 36. Land ownership by percent on the South Zone (USGS 2012).

Note: Column titled “State Benchmark” is the aggregate of Colorado and Utah.

Federal land management actions are more likely to influence social and economic conditions in places with large shares of public lands.

The conversion of land for residential development contributes to habitat fragmentation and the loss of open space. As noted above, the North Zone population has grown rapidly since 2000. Population growth increases demand for residential development. In the North Zone, most of the residential development between 2000 and 2010 occurred in exurban areas, where lot sizes are relatively large (Theobald 2013). Exurban residential development is more likely to contribute to habitat fragmentation and the loss of open space compared to residential development in urban and suburban areas. Although the population in the South Zone has grown less rapidly, the counties have experienced similar trends in residential development. Most of the residential development in South Zone counties has occurred in exurban areas (Theobald 2013).

Exurban residential development increases the size of the wildland-urban interface. Residential development adjacent to wildlands increases the cost and complexity of national forest management due to the need for fire suppression to protect human life and property. Residents who live near forest lands are also more likely to be affected by smoke emissions associated with forest restoration activities.

In the South Zone, residential development in the wildland-urban interface is minimal. In 2010, less than 2 percent of the wildland-urban interface in South Zone counties contained homes (Gude et al. 2008, U.S. Census Bureau 2010, and U.S. Census Bureau 2011). The North Zone has slightly higher residential development in the wildland-urban interface: 2.5 percent of the wildland-urban interface contained homes in 2010. This is driven by Sevier and Utah counties, where 5 percent and 8 percent, respectively, of the wildland-urban interface had residential development (Gude et al. 2008, U.S. Census Bureau 2010, and U.S. Census Bureau 2011). Overall, these trends suggest that residential development in the wildland-urban interface in both North Zone and South Zone counties is modest and not driving increased fire suppression costs.

4.3 Recreation Settings, Opportunities, Access, and Scenic Character

Indicators

- Recreation opportunity spectrum
- Recreation access
- Developed recreation
- Dispersed recreation
- Recreation special use permits
- Scenic characteristics
- Recreation facilities

4.3.1 Recreation Opportunity Spectrum

The Forest Service uses the Recreation Opportunity Spectrum (ROS) to define recreation settings and categorize them into six distinct classes: primitive, semi-primitive non-motorized, semi-primitive motorized, roaded natural, rural, and urban (36 CFR 219.19). The Forest's current ROS classes are shown in Table 47.

Table 47. Acres and percent in each recreation opportunity spectrum class.

ROS Class	Acres	Percent of Plan Area
Primitive	48,082	3
Semi-Primitive Non-Motorized	117,891	8
Semi-Primitive Motorized	831,807	59
Roaded Natural	413,672	29
Rural	1,484	0.1
Total	**1,412,936**	**100**

Winter Recreation Opportunity Spectrum

The 1991 Forest Travel Map, as amended, provides a framework for winter recreation opportunities. It designates those areas open and closed to motorized over snow use. Closure areas were designated primarily to protect wildlife on winter range or the integrity of semi-primitive non-motorized (SPNM) areas. A winter ROS has not yet been developed for the Forest.

4.3.2 Recreation Access

The Forest Motor Vehicle Use Map (MVUM) provides guidance within the plan area for where motorized recreation activities can take place. This map is reviewed and amended annually as needed before reprinting.

Motorized and Non-motorized Trails

There are approximately 930 total miles of existing NFS trails within the plan area. Approximately 296 miles of this total is open to motorized use. The largest percentage of the trail system within the plan area is non-motorized trails outside of wilderness, with approximately 562 miles. Additionally, there are 47 miles of wilderness trail located within Dark Canyon Wilderness.

4.3.3 Developed Recreation

The most common developed site types within the plan area are campgrounds, picnic areas, trailheads, cabin rentals, interpretive sites, fishing sites, and boating sites. Of the 40 campgrounds and picnic areas within the planning area, 27 accept reservations. Most of the developed recreation sites are located along main roads and travel ways. Water based recreation sites are located adjacent to lakes and reservoirs.

One of the most popular developed recreation opportunities offered within the plan area is cabin rentals. Currently, there are five cabins available to rent within the plan area with two additional cabins scheduled to come online in 2017. These cabins offer a range of visitor conveniences ranging from rustic (no water, pit toilet facility) to more modern (water, flush toilet, showers, refrigerator, etc.).

The Stuart Guard Station Interpretive Center located along Utah Highway 31 provides another developed recreation opportunity during the summer season. This site interprets civilian conservation corps (CCC) and early Forest Service history and is staffed by host volunteers during summer weekends. All developed sites are Forest Service operated and maintained. There are no facilities operated by concessionaires within the plan area.

While there is a wide variety of developed recreation opportunities offered across the plan area, aging of developed sites remains a concern. This issue is influenced by flat or declining appropriated budgets and the ability of fee collections to finance annual and deferred maintenance needs. Tools such as the 2013 Recreation Facilities Analysis have helped with the prioritization of sites and maintenance needs; however, depreciation of sites often exceeds the ability to address needs.

An additional concern is the need for facilities that are designed and maintained to be fully accessible. As the population ages, there continues to be a need to design facilities that accommodate wheelchairs, walkers, and help those with sight and hearing impairments. Facilities within the plan area are in marginal compliance with accessibility standards.

4.3.4 Dispersed Recreation

Dispersed recreation includes a wide variety of recreation opportunities that take place outside of developed recreation sites. Dispersed recreation activities generally do not have fees associated with them and offer minimal facilities, although there are several toilet facilities and/or kiosks located at popular fisheries, trailheads, and winter staging areas. Most Forest visitors come to the plan area to engage in dispersed recreation activities and most visitors choose to camp in dispersed areas rather than within developed campgrounds.

Dispersed Camping

Most of these dispersed campsites have been established over many years by reoccurring recreational use and tend to be in areas with desirable characteristics, such as easy access from Forest system roads, relatively flat topography, nearby fisheries/streams, and shade. Forest recreation personnel have observed that dispersed campers are often seeking a more secluded camping experience, with the opportunity to arrange their vehicles, camp trailers, tents, and fire rings as they desire without the regimentation and fees typically associated with developed sites. Many of these dispersed sites hold an important value for families and friends who return year after year for family gatherings and associated activities.

Areas of concentrated use have resulted in large and expanding site footprints in some locations, with resulting bare soil and vegetation loss. Many campsites within the Miller Flat/Joes Valley/Huntington Canyon recreation zone exhibiting concentrated use have had impacts addressed with a blend of developed/dispersed management. In these sites, some combination of improvements such as site containment, toilet facilities, designated fire rings, and road access improvements have been constructed to protect adjacent resources while still maintaining a dispersed experience.

Approximately 3,000 dispersed campsites have been inventoried across the Forest.

Of the 716 sites inventoried on the North Zone, 365 (51 percent) of the sites were identified as low impact, 342 (48 percent) were identified as moderate impact, and 9 (0.1 percent) were identified as high impact. Dispersed site inventories have helped prioritize management actions.

Compatibility Issues and User Conflict

Increasing population growth and demand for recreation opportunities may lead to more crowding and conflict among Forest users. Despite the many options currently available for recreation access on the Forest, there is a desire for more. Local groups have expressed interest in expanding motorized recreation opportunities. UTV riders expect trails wide enough for their specific vehicles. Mountain bikers expect single track mountain bike trails designed specifically for their use. Winter users are expecting motorized and non-motorized uses to be separated to reduce conflicts with their chosen recreation pursuit. Innovations and changes in technologies have and will continue to foster more specific expectations. The Forest will need to consider strategies that effectively minimize crowding or conflicts between competing uses while still preserving visitor experiences.

4.3.5 Recreation Special Use Permits

One-Time Special Use Permits

The types of permits that are issued on a short-term, generally one-time basis are: non-commercial group use, still photography and motion picture permits. An average of 15 to 20 of these permits are issued annually.

Annually Recurring Special Use Permits

Outfitting and Guiding and Recreation Event permits are recurring permits that, after being initially issued for 1 to 2 years, are issued for up to 10 years. There are currently 88 annually recurring permits covering a variety of different recreation activities.

Recreation Residences

Recreation residences are in designated tracts and neighborhoods or as individual cabins. There are 33 recreation residences under 20-year special use permits within the plan area. Although the permit is non-transferrable, the cabin facility can be deeded/willed, handed down to the next generation, or sold. All new owners apply for a new term special use permit.

Resorts and Organizational Camps

There is one resort located in the Miller’s Flat/Joes Valley/Huntington Canyon Recreation Zone known as the Joe’s Valley Resort/Marina. The marina is authorized for the purposes of operating and maintaining a resort/marina, including food service and retail sales. The marina is permitted under a 20-year term special use permit and expires at the end of calendar year 2026.

There is one organization camp located in the Abajos Recreation Zone. The term special use permit authorizes the Boy Scouts of America-Utah National Parks Council annual camp-out event held annually during the month of June at the Blue Mountain (Dry Wash) Scout Camp.

4.3.6 Scenic Character

The Forest serves as the visual backdrop to most of both Arches and Canyonlands National Parks, Natural Bridges National Monument and is a component of their key observation points (KOP). The Gateway, Moab Front and Elk Ridge Recreation Zones all have areas where high numbers of KOPs are viewing the Forest. Both parks’ foundational documents specifically identify the importance of the La Sal and Abajo Mountains to park service visitors and the scenic iconography of the parks (Arches National Park, 2013 and Canyonlands National Park, 2013).

The Forest is also the visual backdrop to much of the surrounding Bureau of Land Management managed lands. The high elevation and often snowcapped mountains are critical elements of the iconic western landscapes that surround them.

The aesthetics of the Forest are valuable enough that they are noted in County plans as well as in adjacent public land agencies’ land management planning documents. For example Arches National Park’s significance statement says Arches National Park will provide visitors opportunities to experience majestic natural settings emblematic of the Colorado Plateau and including the La Sal Mountains (Arches National Park, 2013). Carbon County’s General Plan notes that the County wishes to preserve the prized vistas provided by large undeveloped parcels of public lands whenever possible and visual impacts should be minimized to the greatest degree possible (Carbon County 1997).

National Visitor Use Management (NVUM) statistics from 2001 to 2011 consistently show that *viewing natural features* ranks 1st or 2nd when visitors are asked to select activities they engaged in while visiting the Forest (USDA Forest Service, 2001, 2006c, 2011b). Viewing wildlife and driving for pleasure also consistently rank in the top 5 as shown in Table 48. The high percentage of people visiting the Forest for scenery reasons demonstrates the importance of evaluating and maintaining Forest landscapes to meet these expectations. Scenery is cherished by visitors and non-visitors alike and plays strongly into their perceptions of the Forest, often eliciting emotional responses (Ribe, 2003). This perception may contribute to their feelings about any and all Forest policy regardless of whether the policy is directly tied to scenery or not (Ribe, Armstrong, & Gobster, 2002).

Table 48. Top five activities visitors participated in by percentage of estimated visitors per year in 2001, 2006, and 2011.

Activity	2001
Viewing Natural Features	71

Activity	2006
Viewing Natural Features	64

Activity	2011
Hiking / Walking	41

Activity	2001
Viewing Wildlife	57
Relaxing	56
Hiking / Walking	47
Driving for Pleasure	33

Activity	2006
Relaxing	36
Viewing Wildlife	34
Hiking / Walking	33
Driving for Pleasure	33

Activity	2011
Viewing Natural Features	38
Relaxing	32
Driving for Pleasure	32
Viewing Wildlife	27

Note: 28 activities could be chosen from on the survey forms, only the top five are shown here.

The Forest currently uses the Visual Management System (VMS) in all planning efforts. The VMS is no longer considered to be best available science and therefore all future planning efforts including the Forest Plan should use the Scenery Management System (SMS) analysis.

4.3.7 Adjacent Land Influences

The South Zone of the Forest abuts Bureau of Land Management and National Park Service lands on many of its boundaries. Recent state tourism campaigns promote the amazing scenery of Utah's National Parks bring many visitors seeking spectacular vistas to the Forest area. Arches National Park's peak visitation is during the summer which coincides with the dominant period of Forest use as well. Visitor data from the park service indicates 10,000+ cars a week during the summer and 1.2 million plus visitors annually (USDOI NOS 2016). The Forest serves as the visual backdrop to most of both Arches and Canyonlands National Parks and is a component of their key observation points. Both parks foundational documents specifically identify the importance of the La Sal and Abajo Mountains to park service visitors and the scenic iconography of the parks (Arches National Park, 2013 and Canyonlands National Park, 2013).

4.3.8 Trends

Recreation Use

NVUM data provide the most relevant, reliable, and accurate data available on national forest visitation. NVUM data are collected using a random sampling method that yields statistically valid results at the national forest level. However, results for any single year or season may under or over-represent some groups of visitors.

Average daily traffic (ADT) counts from counters placed on selected forest roads also provide insight to forest visitation. Nine years of data collection show weekday and weekend ADT has experienced modest growth with the following exceptions:

- Ferron Canyon shows a 25 percent increase in weekday and weekend ADT.
- North Skyline Drive at the head of Fairview Canyon shows a 57 percent increase in weekday ADT and a 29 percent increase in weekend ADT.
- 12-Mile Canyon shows a 32 percent decrease in weekday ADT and a 29 percent decrease in weekend ADT.

Recreation Activities

Since adoption of the 1986 plan, recreation activities within the plan area have changed, especially related to motorized recreation activities. The use and availability of OHVs and over-snow vehicles, coupled with the power and advanced technology for each has provided visitors with greater ability to go places within the plan area that had previously been unavailable to them. The open, rolling terrain present in much of the plan area has made motorized travel management a big challenge for the Forest Service. Providing for quiet non-motorized activities separated from motorized uses has become increasingly difficult.

At the same time, there has been growth in the amount of dispersed camping across the plan area. Not only is there an increase in dispersed camping but the size and scale of the recreation vehicles used by campers has grown exponentially. Many trailers and RVs are now much longer and, with slide outs, much wider than were originally conceived of and planned for. The increase in dispersed camping coupled with the size of recreation vehicle impacts not only the natural resources at dispersed campsites but has also affected developed campgrounds. Many campgrounds that were constructed in the 1960s and 1970s are not designed to accommodate recreation vehicles of this size, so campers either squeeze their equipment into limited spaces or choose to disperse camp instead.

There has been a tremendous increase in the amount and interest in mountain bike use particularly in the La Sal Mountains and greater Moab area. Cyclists are concerned about keeping available trails open to them, adding additional trails, and designing single track trails specifically for mountain biking.

Bouldering in lower Straight and Cottonwood Canyons on both Forest Service and BLM administered lands, rock climbing in Mill Creek, Brumley Creek, and Maple Canyons, and kiteboarding at Big Drift have emerged as unique activities tied to specific geographic locations in the plan area.

New technology is fueling recreational activities that are changing the outdoor recreation scene across the Forest. These include side by side OHVs, snow kites, e-mountain bikes, fat-tire bikes designed for use in the snow, and ski and track conversions for motorcycle and ATV snow travel. These new uses can have unanticipated impacts and are often difficult for managers to address.

Social media and other web-based applications have provided coverage and often time directions to sensitive areas and cultural sites on the Forest that have been protected by their anonymity in the past. Strategies for dealing with increased use to these areas is needed.

As the American public ages, but at the same time remains active, there is an increased interest and need to provide adequate accommodations for many forms of recreation activities and infrastructure. Developed campgrounds designed for universal accessibility, as well as improved and new innovations for assistive technology will become increasingly important as the population ages and will influence the recreation activities that visitor choose to participate in (Sperazza, 2010).

As described above, advances in technology have had a great impact on the recreation resource in the past 20 years. Whole industries have been created around the new technologies that have arisen. Visitors can now GPS their locations from their smart phones, reach home computers through the cloud network, find an OHV that is as comfortable to ride in as a car, and set up camp in recreational vehicles that are self-contained and include microwaves and big screen TVs. Paying active attention to these emerging trends in technology is challenging but will help resource managers ensure that recreation users continue to have ample opportunity to enjoy their national forests.

Recreations Settings and Scenic Character

Climate Change

Much like wildfire, insect infestations, fungal outbreaks and other ecologic influences, climate change may also alter the existing biophysical landscape and the recreation and aesthetic opportunities available on the Forest. Some potentially influencing characteristics include but are not limited to: vegetation composition and ecosystem habitat health and locations, water quantity, fish and wildlife habitats, snow quantity and length of stay, seasons of use and patterns of recreation activities present and available across the landscapes, and aesthetic expectations and characters across the landscape. Winter recreation and wildlife dependent activities (hunting, fishing and bird/wildlife viewing) may be the most vulnerable recreational opportunities although other activities may see reductions due to temperature and season shifts that make them no longer appealing to visitors. For more details see chapter 4, Carbon Stocks and Climate Change.

Infrastructure

The condition of infrastructure within the plan area is largely based on two factors: the current age of the infrastructure and the ability of the Forest Service to maintain the infrastructure effectively. Most of the developed recreation infrastructure within the plan area was designed and constructed in the 1960s and 1970s. Some high use areas, such as Joes Valley, Lake Canyon Recreation Area, Maple Canyon, Huntington Canyon, and Buckeye Reservoir received significant capital improvements in the mid-1990s into the mid-2000s. Most sites have had toilet facilities replaced over the last 10 to 15 years. However, other campground infrastructure has seen only annual maintenance for many years with more expensive maintenance items such as picnic table and fire ring replacement being deferred. Many interior campground roads and parking areas are also in need of gravel lifts or repaving. Use of YCC, Canyon Country Youth Corps (CCYC), AmeriCorps personnel, and volunteers has been very helpful in addressing many annual maintenance needs. These resources will continue to be used in the future.

Development of strong partner relationships with the State of Utah, Emery, Carbon, Grand, San Juan, and Sanpete Counties have been instrumental in providing for maintenance of motorized trails. Many non-motorized and wilderness trails also see periodic maintenance through the efforts of Backcountry Horsemen, dedicated hunters, and other volunteers. YCC, CCYC, and AmeriCorps crews also help achieve trail maintenance and improvement projects each year. However, many non-motorized trails continue to receive little or no maintenance due to budget limitations.

Trends in the Broader Landscape

The Forest is located among a much larger landscape of federal public lands, state lands and private lands that provide world class outdoor recreation opportunities. The Forest is adjacent to Bureau of Land Management (BLM) on many of its boundaries and is within 25 miles or less of three National Park Service units (Arches and Canyonlands National Parks and Natural Bridges National Monument). Recent Utah State tourism campaigns have promoted the stunning scenery of the National Parks (The Mighty 5 campaign) and the adjacent lands/access points (The Road to the Mighty 5 campaign). As a result of these campaigns and increasing visitation to the NPS and BLM sites, there has been spillover of recreationists onto the Forest.

National Park Service

Arches National Park provides primarily front country recreation experiences including scenic drives and short-day hikes and one developed campground. Technical climbing and canyoneering opportunities exist in the park as well. During peak seasons (spring through fall) visiting the park can be a crowded experience, with high levels of use occurring on park roads and popular trails and at the campground.

Arches National Park’s peak visitation is during the summer, which coincides with the dominant period of Forest use as well. Visitor data from the park service indicates 10,000+ cars a week during the summer and 1.2 million plus visitors annually (USDOI NPS 2016).

Canyonlands National Park provides for more backcountry type recreational experiences including backpacking, multi-day river trips on the Green and Colorado Rivers, rock climbing, jeeping, and mountain biking on the White Rim Road. Front country experiences are also available with scenic drives and short hikes.

Natural Bridges National Monument is the closest NPS unit to the Forest and provides short hikes to its three namesake natural bridges. The park has one campground.

The higher elevation landscapes associated with the La Sal and Abajo mountain ranges on the South Zone serve as a refuge from the heat for National Park visitors. More and more visitors to southeastern Utah National Parks are also using the Forest for camping and other forms of recreation, during their trips.

Bureau of Land Management

The Bureau of Land Management (BLM) also provides numerous recreation opportunities ranging from OHV riding, and jeeping to rafting, backpacking and climbing within the broader landscape. The mission of the BLM is to manage and conserve public lands for the use and enjoyment of present and future generations under the mandate of multiple use and sustained yield.

There are several BLM administered recreation opportunities either adjacent to or near the planning area. On the North Zone, these include the Price Canyon Recreation Area, Cleveland-Lloyd Dinosaur Quarry, Cedar Mountain, and the San Rafael Swell located east of the Wasatch Plateau.

On the South Zone, the NFS lands that comprise the La Sal and Abajo Mountains are almost surrounded by BLM administered lands. The La Sal Mountains are bordered by the Negro Bill Canyon, Mill Creek Canyon, and Sewemup Mesa Wilderness Study Areas (WSA), along with the Canyon Rims Recreation Area. The Abajo's are bordered by the Dark Canyon, Cheesebox Canyon, Mule Canyon, Bridger Jack Mesa, Butler Wash, and Fish Creek Canyon WSA's.

The Price Field Office, east of the North Zone, report displacement of visitors from the Moab area due to overcrowding. Trends observed by BLM personnel in these areas include increasing motorized use by full size vehicles and OHV's, increasing levels of dispersed camping, and a tremendous increase in the amount and interest in mountain bike use, particularly in the San Rafael Desert and San Rafael Swell.

The BLM Field Offices (Moab and Monticello) surrounding the South Zone completed an update to their Resource Management Plans in 2008 and in doing so have designated campgrounds and no camping areas. This has moved some visitors interested in dispersed camping onto the Forest since they can no longer find campsites on BLM lands during busy weekends. Recreation events that occur on BLM lands also bring large numbers of visitors to the Forest. For example, during the large mountain bike industry event known as *Outerbike* which occurs on BLM managed lands, the Forest has recorded the highest levels of mountain bike use of Forest trails.

BLM and Forest Service recreation staff have a close working relationship as many trails and other recreation opportunities are shared between the agencies such as the Whole Enchilada and Kokopelli bike trails. Numerous authorized outfitter and guides and recreation events operate on both Forest Service and BLM lands, which requires close coordination.

Visitation to lands managed by the Moab Field Office was just under 2.5 million in 2001 and growing (USDOI BLM 2008b). Currently the Field Office estimates their visitation is 2.7 times the visitation of Arches National Park. This indicates that the number of recreationists in the vicinity of the Moab District of the Forest is quite high. Similarly, the Monticello Office has recorded steady increases in all activities recorded within the field office, especially in camping, hiking, OHV use, driving for pleasure and mountain biking (USDOI BLM 2008c).

State of Utah

The Utah Division of State Parks and Recreation operates several state parks bordering the plan area. Millsite, Palisade, Scofield, and Huntington Lake State Parks closely border the Wasatch Plateau on the North Zone. On the South Zone, Dead horse Point State Park is located southwest of Moab near Canyonlands National Park.

Newspaper Rock Historic Site is located just north of the Abajo Mountains while the Edge of the Cedars State Park is located just south of the Abajo Mountains near Blanding, Utah.

Average annual visitation from 2007-2011 for the four state parks bordering the Wasatch Plateau is approximately 405,000 people. Average annual visitation to Dead horse Point and Edge of the Cedars State Parks is approximately 191,500 (Utah State Parks 2014).

The State of Utah manages several wildlife management areas surrounding the Wasatch Plateau. These were primarily designated to protect key winter range for deer and elk. The state also manages the La Sal Mountain State Forest which occupies two large blocks of land immediately east of the La Sal peaks. These state forest parcels provide designated OHV and motorcycle trails, hunting, and camping opportunities.

Utah Recreation Trends

The 2014 Utah State Comprehensive Outdoor Recreation Plan (SCORP) produced by Utah State Parks concluded that recreation in Utah is extremely important throughout the state. Public opinion surveys showed that about 50 percent or more of residents in each area of the state rate recreation as “Extremely Important.” Most residents travel more than 25 miles to participate in recreational activities, indicating that it’s worth the drive.

Walking for pleasure or exercise, hiking or backpacking, and camping were consistently mentioned as recreational activities that residents participate in most regularly. Pools or aquatic centers, motorized trail areas for ATVs and snowmobiles, and improved camping areas are the most needed facilities or facility improvements throughout the State of Utah (Utah State Parks, 2014).

Two of the seven districts delineated under SCORP are included in the Forest planning area. Sanpete County is part of the Six County Planning District, which includes approximately 366,000 acres of NFS land on the North Zone of the Forest. Most of the remaining NFS lands in the planning area are part of the Southeastern Planning District which encompasses Carbon, Emery, Grand, and San Juan Counties.

The most popular activities in the Six County District were picnicking, camping, and OHV riding. Of the seven districts, the Six County District had the highest proportion of respondents participating in OHV riding at nearly 78 percent. There were also high proportions of participants in fishing (74 percent), wildlife or bird watching (64 percent), and hunting (57 percent). Compared with other districts, there were also a higher proportion of horseback riding participants (26 percent compared with about 16 percent statewide).

The top activities in terms of participation in the Southeastern District were picnicking, camping, and hiking or backpacking. There were also high proportions of respondents indicating participation in OHV riding (69 percent), fishing (64 percent), and wildlife or bird watching (61percent).

There was a broad range of facility needs indicated in the resident survey, including OHV riding areas, camping areas, and hiking trails. Other needs identified in the question regarding the top two facility needs included improved fishing access, urban fisheries, golf courses, courts, hunting access, and, in general, more facilities for youth.

National Recreation Trends

National research on outdoor recreation trends by Ken Cordell has concluded that there has been considerable “growth in the first decade of the 21st century in nature-based recreation. Between 2000 and 2009, the number of people who participated in nature-based recreation grew by 7.1 percent and the number of activity days grew by about 40 percent.” (Cordell, 2012) The nature-based activity that has grown the most in the past ten years has been viewing and photographing nature. National projections show that there will continue to be growth in nature-based recreation out to the year 2060.

Some important trends especially relevant to recreation on public lands include:

- Between 2000 and 2009, the total number of people who participated in one or more of 60 outdoor activities grew by 7.5 percent, and the total number of activity days of participation increased over 32 percent.
- There is substantial growth in both participants and annual days for five nature-based viewing and photography activities: viewing birds, other wildlife (besides birds), fish, wildflowers/trees and other vegetation, and natural scenery.
- Public lands continue to be highly important for the recreation opportunities they offer. In the West, recreation on public lands account for 69 percent of annual recreation days, slightly more than 60 percent of viewing and photographing nature activity, around three-fourths of backcountry activity, 57 percent of hunting, and 67 percent of cross-country skiing.
- Recreation resources will likely become less available as more people compete to use them.
- Trends towards more flexible work scheduling and telecommuting may well allow recreationists to allocate their leisure time more evenly across the seasons and through the week, thus facilitating less concentrated peak demands.
- Technological innovations will allow more people to find and get to places more easily and quickly, perhaps leading to over-use pressure not previously considered a threat.

Projected trends in outdoor recreation up to the year 2060 were also highlighted in the report. The five activities projected to grow fastest in number of participants are:

- Developed skiing (68 to 147 percent increase);
- Undeveloped skiing (55 to 106 percent increase);
- Challenge activities (50 to 86 percent increase);
- Equestrian activities (44 to 87 percent increase); and
- Motorized water activities (41 to 81 percent increase).

The activities with the lowest projected growth in participant numbers are:

- Visiting primitive areas (33 to 65 percent increase);
- Motorized off-road activities (29 to 56 percent increase);
- Motorized snow activities (25 to 61 percent increase);
- Hunting (8 to 23 percent), fishing (27 to 56 percent increase); and
- Floating activities (30 to 62 percent increase).

Social, Cultural, and Economic

One study addressing why people do and do not participate in outdoor recreation (*Outdoor Recreation Constraints: An Examination of Race, Gender and Rural Dwelling* based on a National Survey on Recreation and the Environment completed in 1996) looked at three segments of people, who are typically marginalized groups in American Society: Blacks, women and rural dwellers. The study looked at 12 constraints people in these groups might perceive in participating in outdoor recreation activities. It also looked at per capita income, age, and favorite activities that included winter, water, dispersed, or developed recreation.

Of the three groups, women were most likely to feel constrained. Race was not a significant predictor of constraints for participants in outdoor recreation, but non-participants were more likely than whites to feel personal safety concerns that inhibited their outdoor recreation opportunities. Rural residence does not appear to be an important factor among either participants or nonparticipants. The only significant factor for rural residents was that they are seven probability points *less likely* to be constrained by not having enough time than non-rural residents.

Not enough money and inadequate transportation was a constraint for those with lower per capita income. Older participants were less likely to say insufficient time, no companions and inadequate information hindered their participation in outdoor recreation activities.

Nonparticipating women were more likely than men to feel constrained by lack of funds, inadequate information and outdoor pests.

Counties with the largest male to female wage gaps include a notable number of natural-resource-heavy economies: Uintah, Carbon, Emery, Rich and Duchesne County. Carbon and Emery counties are within the planning area.

Counties with relatively small or nonexistent wage gaps include Grand, Kane, Wayne and San Juan counties. These counties tend to have large, low-paying, leisure and hospitality services sectors. Grand and San Juan Counties are within the planning area.

Older non-participants were more likely than younger people to feel constrained by health and personal safety concerns but were less likely to say they were constrained by insufficient time, money, no companions, or inadequate information.

Overall, the most prevalent constraints to both participants and non-participants were time, money, outdoor pests, and lack of companions. The major difference came with the health constraint where participants were far less constrained than non-participants.

Women in Utah marry younger, on average at 24 instead of 27 nationally, have more children than the U.S. average at 2.3 per women versus 1.9 nationally. Many Utah women also work outside the home. 61 percent of women over the age of 16 work in Utah. Women make less than men in Utah, and as a result single mothers are economically challenged to provide for their families. Data from the 2012 American Community Survey for Utah shows the median earnings for year-round, full-time male workers at $48,540. The comparable figure for female workers measures $34,062. Any of these issues could constrain Utah women’s participation in outdoor recreation.

With 31 percent of its population under the age of 18, Utah has the youngest population in the nation (2012). Utah’s birthrate of 18 births per thousand population far outstripped the national average of 12.6 births per thousand population in 2011. Utah’s birth rate has remained higher than the national average for decades and ranks as one of the highest in the nation. Young parents with young children may feel they have insufficient time and/or money to participate in outdoor activities.

4.4 Mineral Resources and Renewable and Nonrenewable Energy

The authority to manage and regulate the exploration and development of mineral and energy resources within NFS lands is jointly shared between the Secretary of Agriculture and the Secretary of the Interior. The administration of the mining laws and the mineral leasing acts is primarily the responsibility of the Bureau of land Management (BLM), Department of the Interior. Certain mineral leasing acts require the consent of the Secretary of Agriculture and are subject to such conditions prescribed to ensure the adequate utilization of the lands for the purposes for which they were acquired or are being administered. The BLM has jurisdiction over management of federal oil and gas resources underlying both BLM-administered and NFS lands. The BLM may also lease certain solid minerals on certain private lands, provided the mineral rights are owned by the Federal Government. The BLM sells mineral materials/salable minerals at fair market value and grants free use permits to government agencies, and issues free use permits for a limited amount of material to nonprofit organizations. The Forest Service also sells mineral materials and issues free use permit.

Most mineral exploration on the Forest is for coal (underground), oil, and natural gas (nonrenewable energy and minerals). Lesser exploration occurs for gypsum and uranium (locatable minerals). Commodity prices, which are dependent on both regional and global geo-political issues and supply and demand, are the principle factors that drive mineral exploration efforts.

Indicators

- Acres of oil and gas leased
- Potential acres of oil and gas lease
- Number of locatable mineral mines
- Number of pending non-energy leasable mineral applications
- Number of saleable mineral permits
- Number of inactive or abandoned mines

4.4.1 Renewable energy

There are no developed renewable energy resources (wind, hydropower, solar, biomass, geothermal resources) on the Forest.

4.4.2 Nonrenewable Energy and Minerals

The Mineral Leasing Act of 1920, as amended, provides that deposits of laterally extensive minerals such as coal, oil, natural gas, oil shale, and tar sands can be acquired through competitive leasing systems. The Bureau of Land Management has jurisdiction over management of federal oil and gas resources underlying both Bureau of Land Management lands and NFS lands. New oil and gas leasing on the Forest has been suspended at this time because current management direction, based on documents developed in 1986 and 1992, does not adequately address existing concerns. Coal exploration on the northern portion of the Forest is now primarily associated with known coal reserves that are located on or near existing coal leases.

Oil and Natural Gas

According to the Utah Division of Oil Gas and Mining (UDOGM) oil and gas production data, 16 CBM wells are currently in production on the Forest. Their annual and cumulative production is described in Figure 37. As of December, 2016, nine wells are in production and seven wells are in shut-in status on the Forest. Wells in shut-in status may be undergoing maintenance, or are intermittently operated, low producing wells commonly referred to as stripper gas wells. According to UDOGM “a gas well that has an average daily production of 60 MCF or less per day over a 12-month period is considered a stripper well.”

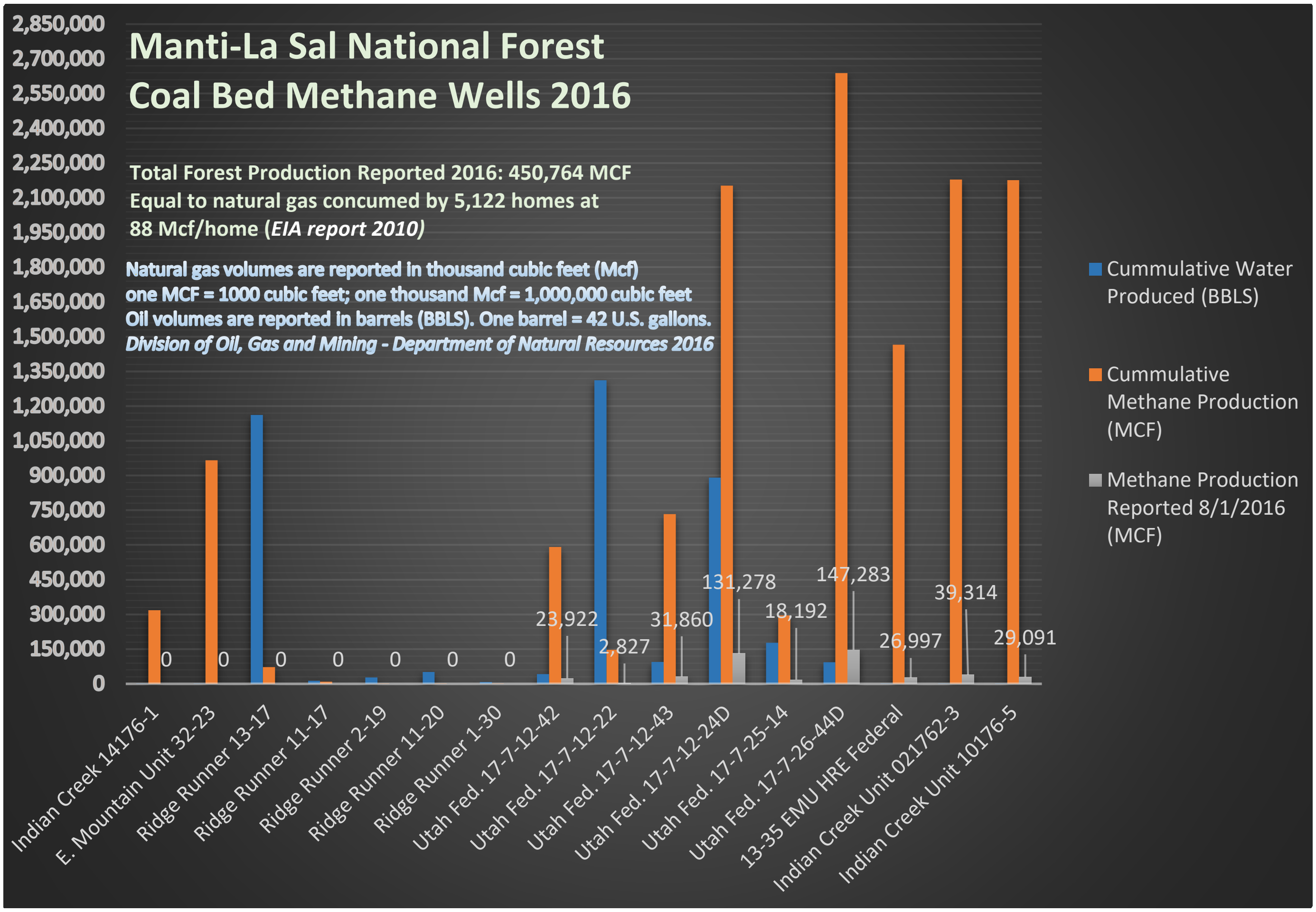


Figure 37. Annual and cumulative coal bed methane production, and cumulative water production levels for the sixteen active wells on the Forest.

The CBM wells in the Clear Creek, Buzzard Bench and Flat Canyon Fields on the NZ are completed in the Cretaceous Ferron Sandstone coal beds of the Mancos Shale. Depth to the top of the approximately 660 foot thick Ferron Sandstone, on the Wasatch Plateau, ranges from approximately 5000 to 7000 feet, depending on the surface elevation (Tabet, 1995). CBM wells are often associated with groundwater, which is pumped from the well and re-injected into wells completed in deeper geologic formations (Boysen 2002). Pumping the water from the well reduces the hydraulic pressure head, releasing the coal sourced methane from solution. In 2016, 450,764 Mcf of natural gas was produced on the Forest, enough to supply 5,122 homes at 88 Mcf per home in the mountain west (UDOGM oil and gas reporting and US EIA report 2010) (Fig. 6). According to UDOGM, over 22 million Mcf of CBM gas has been produced in 2016. The 1400 to 1600 foot thick Emery Sandstone Member of the Mancos Shale Formation, which lies approximately 2100 feet above the Ferron Sanstone, also shows potential as a source of recoverable CBM as evidenced by a few oil and gas test wells (Tabet, 2004). At present, no oil is produced from the North Zone of the Forest. However, Carbon County produced 51,975 barrels of oil in 2016.

In the South Zone of the Forest, exploration efforts prior to the early 2000s were interested in both the deeper Mississippian limestones as well as the shallower Pennsylvanian Hermosa Group and the Permian Cutler Group. Eleven exploration wells have been drilled in the Abajo Mountains, and another six wells in the La Sal Mountains, with no recorded production. Well records from the early 2000s onward indicate that exploration has been focused on the Hermosa Group shale gas reservoirs. There are no producing oil and gas wells on the SZ of the Forest at present.

Coal

Total reported coal production on the Wasatch Plateau (North Zone), from the inception of commercial mining in 1870 through 2015, is 722.3 million tons (Utah Geological Survey, Utah Energy and Mineral Statistics, 2016). Most of the coal, 555.9 million tons, has been mined since 1982, with peak coal production occurring from the mid-1990s to early 2000s. From 1987 to 1999, coal production doubled to 23.57 tons/year (Gloyn et al., 2003). By 2009, the number of active underground mines had decreased from ten in 1999 to four, with a commensurate decrease in production to approximately 11.4 million tons/year (Boden et al., 2015). Coal production continued to decreased to approximately 8 million tons/year in 2016 (MSHA data) due in part, to the shutdown of the Deer Creek Mine in January, 2015. Currently, there are three companies actively mining coal underground on the North Zone of the Forest, with a combined total production for 2016 of nearly eight million tons. On the North Zone, underground coal mining has taken place on the Wasatch Plateau for well over 100 years. Currently, the Forest is one of the few national forests that contain significant deposits of potentially leasable coal.

The Wasatch Plateau coalfield accounts for the largest annual and cumulative coal production in Utah. From the late nineteenth century to 2015, cumulative coal production totaled 722.3 million short tons (Utah Geological Survey, Utah Energy and Mineral Statistics, 2016). In 1972, the Utah Geological Survey estimated the total coal resource in the Wasatch Plateau coalfield at approximately 6.4 billion tons, with the majority, 4.8 billion tons, located in Carbon and Emery Counties (Gloyn et al., 2003).

In 2015, Bowie Resources LLC, located in Carbon and Sevier Counties, accounted for 78 percent of Utah's coal production. Coal production began declining during the 2008 recession and has continued to decline as coal has dropped out of favor for electric generation and industrial needs due to environmental concerns. The Deer Creek Mine closed in January 2015 (Vanden Berg, 2016). The largest, highest quality, and most economically recoverable coal reserves on the northern Wasatch Plateau are estimated to be depleted by the year 2040 (Kirschbaum, 2000).

Estimates for the Skyline Mine (Bowie Resources LLC) are that nearly 12 million tons of coal may be recoverable from current operations. Future production at the Skyline Mine will come from the Flat Canyon Lease, estimated to have approximately 25-30 million tons of recoverable coal. Skyline expects to begin mining the Flat Canyon Lease in 2017 (Boden et al., 2015).

The Sufco Mine (Bowie Resources LLC) is the largest coal producer in Utah and the 11th largest producing underground coal mine in the United States. Sufco Mine has approximately 25.5 million tons of coal reserves under lease (Boden et al., 2015). The Fossil Rock Mine (Bowie Resources LLC) has plans to begin coal mining operations and is currently conducting exploration drilling to better delineate coal reserves currently estimated at 49 million tons (Boden et al., 2015). The South Crandall (Princess) Mine (Murray Energy Corporation) has blocked its portals, but has tentative plans to reopen.

On the South Zone, available data on the La Sal-San Juan region show no known coal reserves occurring in beds 4 feet or greater in thickness. Neither field has significant past production or established reserves. Coal exploration in San Juan County has never proceeded beyond the prospect stage.

4.4.3 Non-energy Leasable Minerals

The Bureau of Land Management will lease certain solid minerals such as: phosphate, sodium, potassium, sulphur, Gilsonite, or a hardrock mineral on public and other federal lands. No economically recoverable non-energy leasable mineral resources have been identified on the Wasatch Plateau on the North Zone. On the

South Zone, large potash (source of potassium) zones hosted in the Paradox Formation have been identified on the southern end of the La Sal District (Hite, 1978). Locally, potash exploration drill holes have also encountered salt (sodium) (Massoth, 2012).

4.4.4 Salable minerals/mineral materials

The Materials Act of 1947 and the Mining Act of July 23, 1955 provide for the disposal of mineral materials (also known as common variety minerals or salable minerals) through bidding, negotiated contracts, and free use. The Bureau of Land Management sells mineral materials at fair market value, grants free use permits to government agencies, and issues free use permits for a limited amount of material to nonprofit organizations.

Salable minerals are generally low value deposits/sources of sand, gravel, and stone suitable for building and construction materials, and road surfacing. There are numerous sources of aggregate (sand, gravel, boulders) and sandstone on the North and South Zones, comprising both developed and undeveloped sites. Large deposits of Flagstaff Limestone are also present on the Wasatch Plateau, with numerous abandoned borrow sites being located throughout the Ferron/Price Ranger District. There are no current special use permits or free use permits for salable minerals on the North or South Zone. The FS also sells mineral materials and issues free use permits.

4.4.5 Locatable Minerals

Locatable minerals are minerals that may be located with a mining claim and developed under the General Mining Law of 1872 (17. Stat. 92; 30 U.S.C. 28), as amended. Locatable minerals include such minerals as precious metals (gold, silver, platinum, etc.), base metals (iron, copper, lead, zinc, manganese, etc.), strategic minerals (uranium, minerals containing rare earth elements, etc.), precious gems, gypsum, bentonite, and high quality limestone as shown in Table 49.

Table 49. Number of mining claims on the North and South Zones of the Forest.

Mining Claim	North Zone	South Zone
Active unpatented	2	323[a]
Closed unpatented	0	0
Patented	2	14[b]

[a] 262 are uranium, 59 gold, and 2 gypsum claims.

[b] 9 are gold and 5 are uranium claims.

On the North Zone, there are two operating gypsum mines on lands managed by the Forest. Both are owned by Sunroc Corporation and are in Juab County near Levan, Utah on the west side of the San Pitch Mountains. Minor gold and silver occurrences have been recorded in the San Pitch Mountains, but none have been profitable operations. The Birdseye Marble Quarry has two active unpatented locatable mineral mining claims on the north end of the Ferron/Price Ranger District (BLM LR2000 database). The limestone has been used as decorative facing stone on buildings.

On the South Zone, placer gold, derived from weathered stock work veinlets, has been recovered from glacial and alluvial gravels in the northern La Sal Mountains (Johnson, 1973; Tabet, 2005). The UGS Mineral Occurrences data base lists several gold discovery sites of both placer and vein type deposits in the northern part of the La Sal Mountains, but none are known to be currently operating or producing any gold. The UGS Mineral Occurrences data base reports minor silver as occurring with gold in the northern part of the La Sal Mountains. Most uranium and vanadium production in the area has been from the late Jurassic Morrison Formation. The lower Salt Wash member of the Morrison is the main uranium producer, while locally, the upper Brushy Basin member also hosts uranium-vanadium deposits (Peters, 2014). There are numerous active unpatented lode mining claims on the south end of the La Sal Mountains (BLM, LR2000 database). Minor base metals, primarily copper, have been associated with the gold/silver and uranium/vanadium deposits. The La Sal Mine complex is a dormant uranium/vanadium mine partially on the Forest currently in the permitting process. It is expected that when market conditions are right, this company will proceed with its operation.

4.4.6 Abandoned mines

Numerous abandoned mine sites are located on the South Zone in both the Abajo and La Sal Mountains. These sites are comprised primarily of underground mines and prospects exploring uranium/vanadium deposits hosted in sedimentary rock formations.

Many of the uranium mine and prospect adits remain open and accessible and consequently, may pose a danger to the general public. Others have collapsed naturally or been permanently closed by the BLM. Residual radioactivity associated with abandoned ore stockpiles and/or mine waste rock dumps also may pose a health risk to the general public.

A field inventory, conducted by Forest Service personnel and Bio West Inc., of all inactive or abandoned mines on the Manti-La Sal National Forest was completed in 1989. Approximately 100 uranium mines within the Monticello (Abajo Mountains) and Moab (La Sal Mountains) Ranger Districts were identified. These mines were then ranked by their safety and environmental hazard potential and evaluated for potential CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act – Superfund Act) violations. Of the 100 mines, it was deemed that nine mines were posed a high risk to the public and/or environment, and additional 17 mines posed a more moderate risk. The primary safety hazard criteria include physical risk of bodily injury posed by open adits and shafts, overly steep waste piles and unstable structures. The primary radiological hazard criteria include radiation exposure due to prolonged proximity to radioactive (hot) waste piles while camping, the ingestion of contaminated water, or the inhalation of radon gas or dust containing radioactive particles. The primary environmental hazard criteria include, contamination of down gradient streams or springs, uptake of radioactive particles by plants that may be grazed on, and airborne transport of radioactive particles such as radon and dust.

4.4.7 Transmission corridors

Currently there are no renewable energy corridors on the Forest. However, on the North Zone there are two non-renewable energy corridors —the Questar Gas Pipeline and the PacifiCorp Electrical Powerline. On the Forest’s South Zone there is the Rocky Mountain Power Electrical Powerline non-renewable energy corridor.

4.4.8 Trends

Renewable Energy Projections and Potential

Utah’s identified renewable energy zones for solar, wind, and geothermal total approximately 13,262 square miles and an estimated 837 gigawatts of electrical generating capacity (Berry et al., 2009). While significant quantities of these three resources are found co-located in southwest Utah, they far from the Forest boundary. There is low potential within the Forest boundary to provide renewable energy (Berry et al, 2009; Black & Veatch, 2010; Blackett 2004; Blackett 2009; UGS, 2004).

On the Forest the following projections and potential exist.

- Two small areas on the west side of the Abajo Mountains, within the Forest boundary, have been designated as having potential for solar resource development (Black & Veatch, 2010).
- Small area on the north end of the Ferron/Price Ranger District was identified as having potential for wind generated power (Berry et al., 2009). The site is rated as having a medium level of confidence for future development.

- A large area with wind power generating potential lies to the east of the Abajo Mountains. This area is largely outside of the Forest boundary, with only a small area of encroachment onto the northeast corner of the Forest. The area is rated as having a high level of confidence for future development.
- Several geothermal boreholes have been drilled within the Forest boundary, and others in close proximity to it on all three ranger districts. The geothermal gradient recorded at the sites were consistent with the average geothermal gradient for the United States (25°C/km ≤ Geothermal Grad. less than 45°C/km). There is low potential for development of geothermal resources within the Forest.
- There are no hydroelectric power generating stations on the Forest and no references were found regarding their future development on the Forest.
- The Bears Ears National Monument designation in December 2016, withdrew the lands from new mineral leases, mining claims, prospecting, and oil, gas and geothermal leases.

Non-renewable Energy and Locatable, Salable, and Non-Energy Mineral and Geothermal Energy Potential and Trends

Leasable Minerals

Coal and oil and gas are known to be present in economically recoverable deposits; there is a high occurrence potential. Deeper oil and gas resources may be discovered. Coal is slowly being depleted but several decades of recoverable reserves are present. There is high potential for development of oil and gas resources of known reservoirs within the Forest once a new Oil and Gas Analysis is adopted. Exploration and production of oil and natural gas resources are partly dependent on whether new reservoir discoveries within the Forest were lithologically and structurally able to supply an increased demand.

Locatable Minerals

Gypsum is present and is being actively mined; there are additional known resources on the Sanpete Ranger District. Uranium is present although mining is presently on hold. There is high potential for future development. Precious and base metals are present in grades and quantities that are non-economical for development; low development potential.

Non-energy Leasable Minerals

Potash is present in the Paradox Basin, mainly in the form of sylvite. There is a high potential for occurrence and development of potash deposits on the south side of the La Sal Mountains within the Forest boundary.

Geothermal Energy Resources

There is no known potential on the Forest for geothermal resource development.

Salable Minerals

There are many sources of salable minerals on the Forest, with a high occurrence and development potential.

4.5 Infrastructure - Transportation, Utility Corridors, Facilities

Indicators

- Presence and types of facilities/infrastructure
- Condition of facilities
- Miles of roads

4.5.1 Forest Transportation System

The regulations at 36 CFR 212 require all Forest Service units to designate a system of NFS roads. The current Motor Vehicle Use maps for the Forests were published in 2010 and are republished each year. Fundamental to travel management of NFS roads is the Travel Analysis Process, which is used to inform decisions related to the designation of roads, trail and areas for motor vehicle use. The analysis also identifies issues and assesses benefits, problems, and risks of the Forest transportation system. The Travel Analysis Process for the Forest was completed in 2015, with the following key findings:

- Funding inadequate for maintaining the current transportation system to standard;
- Some roads are causing adverse impacts to soil productivity, water quality, wildlife habitat, and cultural resources;
- Resources are being damaged as a result of motor vehicle travel off system roads; and
- There are many roads that are likely not needed or that present a greater risk of causing adverse impacts to the surrounding environment than they are a benefit in providing access opportunities.

Approximately 615 miles were identified as *likely not needed* in the Travel Analysis Report.

NFS roads are assigned a maintenance level (ML) between 1 and 5, which defines the level of service provided by and the maintenance required for a specific road. Maintenance level 1 roads are closed to motor vehicle use. Maintenance level 2 roads are maintained for high-clearance vehicles. Maintenance level 3, 4, and 5 roads are maintained for passage by standard passenger cars during the normal season of use. Table 50 displays miles of road by the maintenance level and location of each. It breaks the locations down by county as well as by North and South Zones. Currently, the Forest manages about 2,300 miles of road.

Table 50. Miles or road in each county and Forest District by maintenance level.

Location	Level 1	Level 2	Level 3	Level 4	Total
Sanpete County	62	598	104	2	**766**
Utah County	5	45	28	0	**78**
Juab County	1	45	6	0	**52**
Emery County	15	173	77	2	**267**
Carbon County	3	26	9	0	**38**
Sevier County	0	45	0	0	**45**
North Zone	**86**	**932**	**224**	**4**	**1,246**
Grand County	12	72	16	0	**100**
San Juan County	219	617	39	0	**875**
Mesa County	1	4	0	0	**5**
Montrose County	13	52	12	0	**76**
South Zone	**245**	**745**	**67**	**0**	**1,057**
Forest-wide	**331**	**1,677**	**291**	**4**	**2,303**

There are 30 road bridges on the Forest constructed mainly of timber. Condition surveys of a percentage of road bridges are performed every 2 years. Almost half of the bridges have not be reconstructed in the past 20 years. Four bridges are in poor or serious condition.

4.5.2 Public Utilities

Public utilities on the Forest include cable TV, telephone, internet service, cellular service, radio, water lines, gas lines and powerlines. The number of each type of corridor is shown in Table 51. The miles of each linear utility are displayed in Table 52.

Table 51. Number of utility corridors on the Forest by North and South Zones.

Utility Corridor Type	North Zone	South Zone
Irrigation Water Trans Pipeline	7	1
Water Trans Pipeline	24	15
Oil and Gas Pipeline	4	0
Powerline	18	10
Telephone Line	3	0
Telephone and Telegraph Line	2	6
Cellular	0	2
Commercial Mobile Radio Service	0	3
Fiber Optic	0	4

Table 52. Miles of public utilities on the Forest.

Public Utilities	Miles
Power lines	72
Gas lines	56
Canals/Ditches	34
Water pipelines	73
Telecommunications	42

4.5.3 Private Infrastructure

Private infrastructure refers to facilities developed under private ownership that are used in conjunction with special use authorization. Such facilities include buildings and other kinds of structures representing a broad range of permitted recreation and land use activities as shown in Table 53.

Table 53. Special use building on the Forest by Zone.

Special Use Type	North Zone	South Zone
Private Camp	1	0
Recreation Resident	33	0
Residences, Government Building	1	0
Education Center	2	0
Isolated Cabin	1	1
Marina	1	0
Warehouse and Storage Yard	3	0
Agriculture Residence	1	0

4.5.4 Recreation Facilities

Forest-owned recreation facilities on the NFS include toilet buildings, rental cabins, visitor centers, etc. There are a total of 176 recreation facilities on the Forest.

Drinking Water Systems

The Forest has 17 open drinking water systems with 15 serving recreational facilities and the remainder serving administrative sites.

Dams

The Forest has 17 forest-owned dams. Most dams are low hazard earth dams.

4.5.5 Administrative Facilities

There are 27 Forest-owned administrative facilities, which include fire buildings, offices, warehouses, shops, visitor centers, and living quarters. Specifically, there are seven guard stations, six administrative buildings, four district offices, and 10 repeater/ communication sites. The Forest manages 83 FA&O buildings.

The condition rating of a building is called the facility condition index (FCI). To meet national standards, the FCI must be greater than 90 percent. A rating of 90 percent equates to fair condition. As of 2016, about 50 percent of the administrative facilities met the national standard. The Forest maintains a facilities master plan that indicates the status of the FA&O buildings and Forest's intention into the future. Since the inception of the 2003 Facility Master Plan, 19 unneeded buildings were decommissioned, seven buildings were developed for an alternative use, and two buildings were acquired. In 2009, five Forest-owned buildings and 20 acres of land were conveyed. The conveyed dwellings and land were not on Forest land.

4.5.6 Range Infrastructure

Rangeland improvements are designed to improve production of forage, change vegetative composition, control patterns of use, provide water, stabilize soil and water conditions, and provide habitat for livestock and wildlife. There are many rangeland improvement structures located on the Forest. Examples are range fences, corrals, and water troughs. For more information, see the Rangeland Systems in the Terrestrial and Aquatic Ecosystems section of this report.

4.5.7 Trends

Road maintenance funding has been decreasing for the past 15 years, while recreation uses of the road system have increased. It is expected that the Forest transportation system will begin to deteriorate at a faster pace as road maintenance funding has been decreasing for over 10 years, while recreation uses of the road system has increased. It is expected that the facility maintenance budgets will continue to decrease, so it is likely that Forest administrative facilities will continue to deteriorate. The Forest will continue to decommission unneeded buildings. The Forest is considering decommissioning select drinking water systems due to declining budgets and more stringent requirements by the US Environmental Protection Agency. There is an increase in buildings that qualify as historic resources. There has been a trend over the past 18 years to convert buildings to an alternate use. For example, buildings that have been used as guard stations in the past have been converted to rec rental buildings or visitor centers. The Forest Service is making efforts to reduce the carbon footprint by making more buildings energy efficient and sustainable. For example, enough insulation is being placed in buildings, energy-efficient windows are being installed, on demand type water heaters are being installed and solar systems are used to replace propane powered light fixtures in remote cabins.

4.6 Areas of Tribal Importance

Tribes have identified different types of areas of importance on the Forest. These include ancient archaeological sites and archaeological landscapes, specific landforms, landscape features, and plant communities. These places have importance both to tribal history and identity as well as to the ritual, social, and economic life individual tribal members. More areas of importance will be identified in the future, as deemed appropriate by tribes and in relationship to projects or activities on the Forest.

4.6.1 Cultural Resources

The South Zone contains some of the most important ancient American Indian cultural resources and landscapes in the Four Corners Region. The Northern portion of the Forest also contains significant ancient sites.

Cultural resource sites are among the areas of importance that have been identified by Tribes. These include individual sites as well as landscapes made up of sites, landforms and natural resources that form the world of ancient as well as modern Indian people. The most notable concentration of these resources are located within the South Cottonwood basin on the Monticello Ranger District. These include villages, farmsteads, agricultural features, look-out structures, ceramic kilns, and resource extraction locales.

Another important ancient cultural landscape is found on the Ferron/Price Ranger District on the Manti Division. This landscape consists of a concentration of alcove or rock shelter sites in the southern end of the district. These sites occur in the outcropping Castlegate Sandstone formation and frequently possess well-preserved cultural deposits, potentially dating back to the earliest periods of human occupation in the Intermountain Region (ca. 10,000 B.P.). Because of this potential, the rock shelter sites have high research, interpretive and cultural values.

The Hopi have identified all ancestral sites on the Forest as Traditional Cultural Properties (TCPs), considering these sites as “footprints” of the tribe. In addition, oral histories for the Forest indicate that sites are being used for activities by members of other tribes as well, particularly on the Monticello Ranger District.

The Navajo also claim cultural affiliation with all Ancestral Puebloan (Anasazi) peoples based on both oral and ceremonial tradition.

4.6.2 Landforms and Landscape Features

Tribes have identified a number of places of importance through past consultation efforts. These include specific locales as well as general landscape features and plant communities. These are part of larger landscapes of sacred geography that are all inter-related and linked to tribal stories and history. They embody critical aspects of cultural beliefs and practices and still play important roles in living these beliefs today.

Tribes have emphasized the importance of the association between plant communities, landforms, and landscape features. The plant community can have greater significance than the landform itself because of the power that the landform gives it. In addition, each area, along with its associated plants, are endowed with particular blessings. As a result, tribal members will travel long distances in order to acquire the right plant for a singular need (McPherson 1992:53-55). Plants, rocks, and minerals are also important for traditional and economic activities, such as basket making, pottery making, and jewelry making.

4.6.3 Bears Ears

The Bears Ears are a pair of small mesas on the southern end of South Elk Ridge on the Monticello Ranger District. They strongly resemble a pair of bear’s ears when viewed from the south, and can be seen from south of the San Juan River. The Bears Ears National Monument was designated in 2016, encompassing the Bears Ears mesas. The Navajo Nation has formally identified the Bears Ears (*Shash Bijaa*) as a TCP. It is associated with five ceremonies and plant medicines are currently gathered in the area. Certain plants are collected at the Bears Ears in order to relieve particular ailments or for particular ceremonial practices. In addition, Chanters conduct ceremonies there on behalf of individual Navajos as well as the Navajo people.

The Bears Ears are identified as a Navajo sacred place in Indian Claims Commission documentation from 1954. Important oral histories also describe particular old Navajo sites in the area (Van Valkenburgh 1974). Important aspects of more recent Navajo history are associated with the Bears Ears and nearby areas on Elk Ridge.

Manuelito, a prominent Navajo leader during the Long Walk era, was born near the Bears Ears around 1820 (McPherson 2011).

The Ute also ascribe tremendous importance to the Bears Ears. It is the first place where bears came out of hibernation in the spring and the place where the Ute held the first Bear Dance (McPherson 2011).

The area is also very important to the Hopi. For example, the Flute Clan migrated to the Hopi Mesas from this area and includes references to the Bears Ears in ceremonial songs. In addition, there are Hopi shrines near the Bears Ears that have traditionally been visited every other year (Ross and Thompson 1986).

A trail that may have been part of the Old Spanish Trail system passed up Comb Wash, between or past the Bears Ears, and then ran north up Elk Ridge (McPherson 2011). This was undoubtedly a much older trail that continued to be used during the early-mid 1800s and its presence helps confirm the importance of this landform to ancient and historic Indian people.

4.6.4 Elk Ridge

The Navajo Nation has formally identified Elk Ridge on the Monticello District as a TCP and it is associated with five ceremonies. In addition, plant medicines are gathered in the area today. Chanters also conduct ceremonies there on behalf of individuals and the Navajo people.

This area has long been of importance to Navajo families, and additionally served as a refuge during the mid-1800s (known as the "Fearing Time). This included the family of K'aa Yelii, brother of Manuelito, and others who hid from Federal soldiers in this area (McPherson 2009).

Navajos gather a wide variety of plants in this area, including salt berry, three-leaf sumac, sacaton, sand grass, pinyon nuts, juniper berries, wild cherries, wild potatoes, and yucca fruit (McPherson 2009). Again, the association of these plants with this sacred location contributes to their importance and efficacy in healing and other ceremonies.

Ute peoples also consider this high mesa to be of considerable importance. It was a place to hunt, graze livestock, and was an extension of the community life at the mouth of Allen Canyon (McPherson 2011).

4.6.5 Abajo Mountains

The Navajo Nation has formally identified the Abajo Mountains on the Monticello Ranger District as a TCP. It is associated with three ceremonies, is within the Navajo Nations aboriginal territory, and serves as an outer boundary marker for Navajoland. It is also a source of medicinal plants (McPherson 1992)

The Zuni also identify the Abajos (or Blue Mountain) as a one of a series of mountains that are held sacred and help mark the outside boundaries of Zuni land. They are also part of their traditional hunting area (Ferguson and Hart 1985).

The Ute identify the Abajos as another sacred high place and call it Blue Mountain. Utes identify themselves as people of the mountains and used this place for worship and refuge in the past (McPherson 2011) and for worship today.

4.6.6 La Sal Mountains

The Ute consider the La Sals, on the Moab Ranger District, a sacred mountain and have a long history of using these mountains for summertime camps, worship, and refuge. They are associated with rain today and served repeatedly in the past as a stronghold during periods of conflict (McPherson 2011).

In addition, Navajo families frequented the La Sals (Correll 1971). These mountains provided a resource rich summer camp location and a refuge during the difficult mid-1800s (McPherson 2009).

4.6.7 Allen / South Cottonwood / Hammond Canyons

The area encompassing Allen, South Cottonwood, Dry, and Hammond Canyons on the Monticello District is central to the history of the White Mesa Utes. It is known as Avikan or The Homeland and was used for generations as a farming area and base of operations for other activities that extended up each of these canyons (McPherson 2011). This established relationship was one reason that lands at the confluence of these canyons were allotted to White Mesa Ute families in 1923.

4.6.8 Landscape Features

A broad range of additional landscape features are important to the tribes associated with the Manti-La Sal National Forest. These locations are important as places where ancestral or modern ceremonies are known to have occurred, or are places linked to tribal stories. For example, past consultation efforts with the Ute Indian Tribe have identified rock shelters and mountain peaks to be of particular importance to the Tribe.

Culturally modified Ponderosa Pine trees are also of considerable importance to the Ute Tribe. The cambium of these trees was used for both medicine and food. A number of trees on the Forest bear large distinct scars from the harvest of cambium during the mid to late 1800s through the early 1900s. These trees are living connections with the ancestors who used them and are sacred. Concentrations of these trees occur on the Ferron Ranger District, with additional trees on the Moab and Monticello Ranger Districts.

The health and availability of plant communities are of critical importance to all tribes, across all Ranger Districts. These are seen as important sources of material for traditional ceremonial and economic activities. They also serve as a way for modern tribal members to remember traditional knowledge, reconnect with traditional lands, and to and practice traditional ways.

The Southern Paiutes have expressed a particular concern with maintaining habitat for groups of animals, including eagles. The well-being of animal populations as a whole is also of concern to other tribal groups.

4.6.9 Trends

Trend data indicates areas of Tribal importance are under greater threat than at any time in the past thirty years. Chief among these threats is a significant increase in the number of visitors, which is associated with an uptick in looting, vandalism, and wear and tear on sensitive sites. The impacts of global warming, including drought and higher temperatures, has increased the threat of catastrophic wildfire near sites, a trend that is likely to worsen over the next thirty years.

Increased Forest Visitation

Visitation of areas of Tribal importance within the Forest boundaries has more than doubled over the past thirty years, with the steepest incline of visitation occurring over the past five to ten years. Recent technological advances—such as the Internet and social media—are driving this trend, making it easier to find cultural Tribal sites. This trend is likely to continue, leading to increased foot traffic at Tribal sites.

Looting and Vandalism

Data from the Forest Service and other sources indicate looting and vandalism of tribal sites are on a rise in recent years, though resource constraints limit the ability to determine the extent of the problem. Much of this has been driven by increased visitation, as previously mentioned. As visitation numbers continue to rise, the Tribal sites on the Forest will be increasingly vulnerable to looting and vandalism. Continued resource constraints will to limit the ability to accurately assess the extent of the problem, making cooperating monitoring with outside entities a key component of protecting sites.

Recreation

For the past thirty years, motorized recreation vehicles have made it easier for visitors to probe farther into the Forest, near some of the most sensitive tribal sites. This has increased the threat to areas of tribal importance, and we expect this trend to continue, as visitors push for additional motorized trails in sensitive areas. We also expect that, as new recreational opportunities and technologies arise, the threat to isolated cultural sites may become even greater. An example of this is the advent of drones, which can fly over severely restricted terrain to uncover untouched cultural resource and tribal use sites. Once such information is broadcasted on social media, it is likely these sites will be heavily trafficked. Recreational trends, such as increased interest in rock climbing also pose a great threat to the most sensitive archaeological sites on the Forest. Increased visitation may also affect solitude for tribal ceremonies and may disrupt plant collection by tribal members.

Mineral Exploration

Many areas of Tribal importance are near areas rich with coal, gas, uranium, and oil resources. Some Tribes have expressed a general dislike for energy development and its effect on landscapes. Efforts have been made in recent years to open some of these areas up to mineral exploration, most recently the Public Lands Initiative (PLI), which would present risks to Tribal sites in these areas. The shift away from coal exploration in favor of cleaner burning fuels, such as gas and uranium, makes areas with such resources more vulnerable to exploration and subsequent damage. One such area with a high concentration of Tribal sites and uranium is the Monticello Ranger District. On the other hand, continued long wall coal mining on the Ferron/Price Ranger District can potentially adversely affect cultural resource sites as a result of ground subsidence and the development of facilities such as roads and powerlines.

Fire

Fire suppression over the past 100 hundred years has increased the fuel loads in areas with a large concentration of tribal cultural resource sites, increasing the likelihood of catastrophic fire. While stone artifacts are less prone to fire damage, many sites have wood components, other perishable materials, and rock art that are highly vulnerable to wildfire. Of greater consequence is the removal of vegetation and damage to soils that results in catastrophic increases in the erosion of buried site features. This also makes sites more visible and subject to increased visitation.

A rise in temperatures over the past thirty years, mixed with decreased precipitation and higher fuel loads, increases the likelihood of fire near sites of importance to tribes, including catastrophic wildfire. This can also lead to temporary loss of plants and potential changes in the types and abundance of important plants, including the introduction of invasive plants. This could affect the ability of tribal members to collect plants for ceremonial use that are associated with sacred landforms.

Technological advances and national attention resulting from the BENM likely will cause a spike in visitation at sensitive Tribal sites within the monument, portending an uptick in looting and vandalism to archaeological sites and the overall condition of areas of importance to tribes. This, mixed with the impacts of climate change (higher temperatures and less precipitation) and fire vulnerability almost certainly will present increased threats to the areas of Tribal importance everywhere on the Forest in the near and long term.

4.7 Cultural and Historical Resources and Uses

Cultural resource types, densities, and time periods vary on the Forest based on local historical trends and topography. These trends vary widely based in part on the very wide distances between the four geographic units on which the districts occur. The Forest includes four separate landforms, including the San Pitch Mountains, the Wasatch Plateau, the La Sal Mountains and the Abajo Mountains/Elk Ridge. The San Pitch Mountains and Wasatch Plateau are close enough together that their cultural resources can be discussed together as part of the overview of the three northern ranger districts. The cultural resources of both the Moab and Monticello ranger districts are distinct and are discussed separately.

4.7.1 Indicators

Number of Sites

There are 4,832 documented sites on the Forest, with the majority, about 80 percent, located on the South Zone as shown in Table 54. Forest sites include a wide range of site types that date from both ancient American Indian and historic European American eras. Ancient American Indian site types include villages, single- and multiple-residential sites, agricultural terraces and check dams, kilns, isolated storage sites (granaries and slab-lined cists), rock art, rock shelters, low stone observation rooms, and artifact scatters. Historic sites include sawmills, mines, livestock camps and cabins, Civilian Conservation Corp camps, roads and trails, culinary water systems, trans-basin canal systems, and artifact scatters. Most of the historic period sites are European American in origin, but there are important historic period American Indian sites on the Forest, including culturally modified ponderosa pines, hogans, and sweat lodges. See the "Overview" map in Appendix 1 for the locations for the districts.

Table 54. Total number of documented sites on the Forest in 2016.

District	Sanpete	Ferron	Price	Moab	Monticello	Total
Number of Sites	137	708	141	636	3210	4832

The Monticello District stands out from the other four districts on the Forest in the relative percentage of sites determined to be eligible for the National Register of Historic Places as shown in Table 55. This is largely due to the nature of much of the archaeological record on that district, which consists of Ancestral Puebloan habitation or limited use sites that contain buried deposits that are of considerable archaeological value. This is one of the sites' characteristics that make them eligible for the NRHP.

Table 55.Total number of National Register eligible and listed sites on the Forest by district.

National Register Status	Sanpete	Ferron	Price	Moab	Monticello
Eligible	56	297	47	306	1853
Listed	1	0	0	1	0

Site Condition

A variety of processes affect site condition, including natural weathering erosion, wildfire, and trampling by game. Other effects have increased in the past roughly 130 years due to increases in population and use of what is now the Forest. Intensive livestock grazing before and immediately after formation of the Forest and the associated loss of topsoil due to this overgrazing are both effects that probably damaged many sites to a large degree. Early Forest Service vegetation treatment and erosion control projects also degraded site condition.

Data on the condition of Forest sites is incomplete and based on relatively subjective site condition data from more than 40 years' worth of site forms. The site conditions of the sites are shown as percentages in Table 56 by each district. The most recent version of site form used in Utah since 1982 is the Intermountain Antiquities Computer System (IMACS). IMACS uses categories to describe site condition, as follows: excellent (virtually undisturbed); good (75 percent undisturbed); fair (50 to 75 percent undisturbed); and poor (more than 50 percent disturbed) (IMACS User's Guide 1992). The "excellent" category is rarely used, since most sites have at least some level of disturbance due to natural weathering. Overall, the system is difficult to apply, in part due to the inability to accurately assess the condition of buried or subsurface deposits. In general, 25 percent of the sites on the Forest are described as being in good condition, 18 percent in fair condition, and 12 percent in poor condition. There is no condition data in INFRA for 46 percent of the sites on the Forest.

Table 56. Percent of the Forest in each site condition class by district.

Site Condition	Sanpete	Ferron	Price	Moab	Monticello	Forest Average
Good	20	25	34	23	24	25
Fair	16	15	26	14	19	18
Poor	7	12	16	8	18	12
No Data	65	48	24	55	39	46

4.7.2 Cultural Resources of the Ferron, Price and Sanpete Ranger Districts

The Sanpete, Ferron, and Price Ranger Districts occur primarily on the Wasatch Plateau, with a portion of the Sanpete District on the much smaller San Pitch Mountains located west of the Wasatch Plateau. This area shares a common culture history; however, local history and topography influenced the ways in which past people used these landforms, and this created slightly different cultural resource records. The general distribution of documented sites is shown in Figure 38.

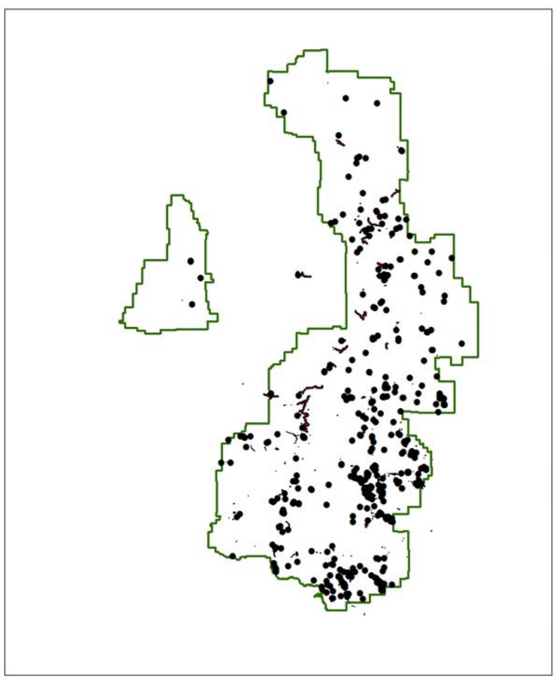


Figure 38. Distribution of documented sites on the North Zone or Sanpete, Ferron, and Price districts.

Synopsis Through Time

The Wasatch Plateau has been used by ancient peoples since early Paleoindian times (12,000 – 1,700 BP), as isolated Clovis spear points have been recovered in two different locations. Late Paleoindian projectile points have also been found in larger numbers on the Plateau, indicating that the mountain was particularly important to big game hunters during that era. As the climate dried and warmed around 8,500 BP, Archaic hunters and plant gatherers used the Plateau extensively. Little ground stone has been found on exclusively Archaic period sites, suggesting that hunting was the prime activity for them. Another common type of Archaic site on the Plateau is the chipped stone quarry, located in areas where abundant Flagstaff chert erodes out of Flagstaff Limestone.

Farming populations began to occupy central Utah around 1,700 BP (or AD 300) (Fremont period 1,700 – 550 BP). They built year-round habitations in areas along perennial streams, at elevations low enough to support the growing of corn and other cultigens. Fremont period artifacts also occur at chert quarry sites, indicating that tool stone was also an important Plateau resource for them. Most alcove sites on the Plateau contain Fremont era artifacts, suggesting that these locales were particularly favored by Fremont peoples. The suite of Fremont sites on the Wasatch Plateau, in particular, are important to the understanding of central Utah archaeology because they represent upland resource use by two Fremont populations, those from Sanpete and Castle Valleys.

Following the general abandonment of farming around 550 BP (AD 1250), area residents returned to a hunting and gathering way of life. Evidence of the earliest of these people (called Late Prehistoric, 550 – 150 BP) consists primarily of Desert Side Notched projectile points. Open air sites containing these points are relatively widespread on the Plateau.

Settlement of central Utah by new emigrants from Europe/Africa/Asia began in Utah Valley in 1849, Sanpete and Juab Valleys in 1851, Sevier Valley in 1864, and Carbon and Emery counties in the late 1870s. Ute and Paiute Indians were forced onto reservations or out of the area by the late 1860s, clearing the way for final emigrant expansion in central Utah. By the 1870s, cattle and sheep herds were being moved onto the Forest, and logging had begun in its canyons. Both of these activities would accelerate into the early 1900s. Coal mining began in the area in the San Pitch Mountains in 1859, but commercial development there did not begin to rival the developments that would soon follow on the Wasatch Plateau. Logging for both buildings and mine props accompanied the mining, as did other industries such as dairying and livestock production. Water diversions that captured water for irrigation and culinary use began in the late 1800’ on the Wasatch Plateau. By about 1936, there were more than 30 tunnels, ditches, and diversions moving water from the spine of the plateau and its tributary canyons into nearby communities.

Other important historic uses of the Plateau include hunting, recreation, and travel (connecting Sanpete and Castle Valleys). The development of Forest recreation facilities, roads and trails was accelerated in the 1930s by the Civilian Conservation Corps.

Site Distribution and Type on the Wasatch Plateau and San Pitch Mountains

The archaeological record on the Wasatch Plateau and San Pitch Mountains has been affected by topography and natural resource abundance. As a result, sites are unevenly distributed and almost all the documented sites occur on the Wasatch Plateau. Table 57 indicates that most Wasatch Plateau cultural resources occur on the Ferron District.

Table 57. Prehistoric site components on the Wasatch Plateau and San Pitch Mountains, by Forest district.

Prehistoric Site Components	Sanpete	Ferron	Price
Lithic Scatter	55	480	62

Prehistoric Site Components	Sanpete	Ferron	Price
Artifact Scatter	0	25	3
Rock Art	2	17	1
Rock Shelter	1	69	4
Habitation Site	0	9	0
Total	**58**	**600**	**70**

Although historic period components are also more common on the Ferron District, there is relatively more even distribution of historic period sites across the three districts as shown in Table 58.

Table 58. Historic site components on the Wasatch Plateaus and San Pitch Mountains, by Forest district.

Historic Site Components	Sanpete	Ferron	Price
Artifact Scatters	15	23	8
Water Diversion / Development	16	17	8
FS Admin / Research / Recreation	37	6	4
Sawmills	0	11	9
Coal Mines	0	8	5
Livestock Management	2	4	4
Arborglyphs	3	11	7
Cabins / Dugouts	0	3	7
Roads / Trails	5	10	6
Peeled Ponderosas	0	9	0
Misc. Historic Sites	4	4	3
Total	**82**	**106**	**61**

The most common historic site types on all three districts are artifact scatters and arborglyphs. Artifact scatters (consisting of cans, broken bottles, and/or other miscellaneous artifacts) generally represent camping associated with livestock management, hunting, logging/firewood cutting, or general recreation. Arborglyphs are almost always on aspen trees, and generally consist of names and/or dates, with few figures. Many historic period sites are eligible for the National Register of Historic Places for their archaeological research potential and for their association with important aspects of local history. All historic period sites reflect the strong and living connection between the Forest and local communities and families.

Site Condition on the Wasatch Plateau and San Pitch Mountains

All sites on the Sanpete, Ferron, and Price Ranger Districts have been affected to some degree by natural processes, including erosion and weathering. However, because of the highly erosive nature of the area's soils, this effect is more pronounced at many ancient American Indian sites, particularly those that were overgrazed by livestock just before and after creation of the Manti National Forest in 1903. Historic period sites have also been subject to weathering and to illegal artifact collecting. Some of them have also been damaged by removal of buildings or scavenging for old wood (or firewood). Almost all of the known rock shelter sites have been damaged by looting of buried artifacts, which has significantly reduced the sites' potential to provide information about past human use of the plateau. The relatively high density of roads and trails on the Wasatch Plateau has both directly and indirectly affected archaeological sites. Observation is that sites closer to roads are more likely to have evidence of illegal surface artifact collection and rock shelters that are either close to roads or relatively easy to hike into have more evidence of looting. Past vegetation or watershed treatment projects on the Wasatch Plateau/Sanpitch Mountains conducted before agency implementation of NHPA in the 1970s affected a number of sites, particularly on the Ferron District.

4.7.3 Cultural Resources of the Moab Ranger District

Human use of the Moab District was seasonal and by many different groups (Figure 40). In the early prehistoric period, most use is from the Northern Colorado Plateau although rock art and stone tools documented on the district indicates groups from the western Colorado area and the San Juan Basin also used the area. During the Puebloan era, people from the Ancestral Puebloan and Fremont cultural areas used the district. Later, Hopi ceramics can be found indicating continued short-term use by Puebloan peoples. Historically, the district was also important to Ute people who preceded Hispanic peoples from New Mexico and other European Americans who migrated into the area from western Colorado and northern Utah.

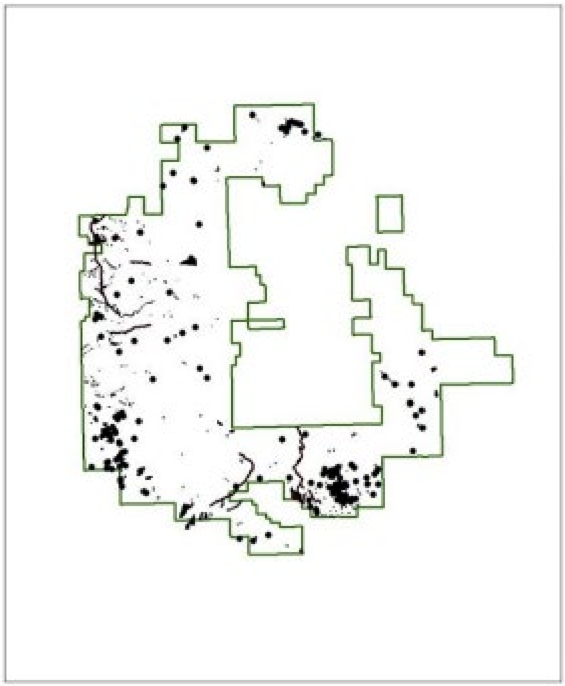


Figure 39. Distribution of documented sites on the Moab District.

Synopsis Through Time

Little is yet known about Paleoindian (12,000 – 1,700 BP) use of the Moab District. At least one Late Paleoindian projectile points has been found at a site near Buckeye Reservoir. Regionally, this continues to be a poorly documented and understood era of human history in SE Utah. Archaic hunting and gathering groups used the Moab District and sites are found in a variety of settings. Sites are primarily open lithic scatters although rock shelter settings have also been documented.

Ancestral Puebloan and Fremont farming groups used the La Sals area from roughly 1500 - 900 BP (AD 500 – 1100). Ancestral Puebloan/Fremont sites are primarily associated with open air sites and contain artifacts indicative of plant and animal resource extraction and processing, tool stone procurement, and tool production. Polar Mesa Cave and some other rock shelter sites also exhibit use during this period.

Following the Puebloan era, Ute Numic speaking people seasonally used the Forest from about 550 – 150 BP (AD 1450 – 1850). Few Protohistoric/Historic (post-1850) Native American resources are clearly identified in the database. These sites are primarily open air lithic and sherd scatters that represent temporary camps and resource extraction and processing locales.

In the late 1800s, European American use of the Moab District began. Historic sites and components at multicomponent sites on the Moab District include a variety of different site types. Historic sites include uranium mines, Forest Service administrative facilities, sawmill, roads, irrigation ditches, cabins, camps, grazing related facilities (fences, corrals, other), battlefield, aspen carvings, and others types. Gold was discovered in the La Sal Mountains during the late 1800s and gold mines were established in the La Sals by 1898 the Miners Basin town associated with this early gold mining was founded and was occupied until 1907. Uranium mining occurred throughout the District and these resources represent episodic use from the 1940s through the 1980s. Grazing on the Moab District was initiated during the late 1800s and continues today. Initially small cattle outfits began grazing in the 1870s followed by the entrada of large cattle companies in the 1880s. Sheep grazing on the Moab District began on the La Sals in the late 1890s. The timber industry focused primarily on ponderosa pine forests. These activities left a variety of landscape and cultural sites including logging roads, loading areas, sawmills, camps, and other evidence. Irrigation and water developments are found in the La Sal Mountains as well as the western and southern flanks of the mountains. Irrigation continues to be an important aspect in the communities surrounding the La Sals and several irrigation systems have historic roots.

Site Conditions

Impacts to sites on the Moab District include natural and human caused disturbance. As with other Districts, erosion is constantly affecting sites. Structural decay of buildings is also a natural process that is affecting sites, principally historic structures. Since 2002, the trend in wildfire size and intensity has affected the condition of sites on the District. To a large extent direct impacts were not severe and catastrophic, but damage to surface artifacts was extensive. Impacts to sites on the Moab District also include a history of human alteration to sites including vandalism and looting. All the known rock shelters have been looted.

4.7.4 Cultural Resources of the Monticello Ranger District

The archaeology of the Monticello District is complex and abundant as shown in Figure 40. It reflects the changing history of human use of the uplands and complex development of tribal society. Prehistorically, early use was by hunting and gathering people followed by settlement by Ancestral Puebloan farmers. Later, but prior to European-American contact, Numic, Navajo, and Puebloan use is documented on the District. Historic sites include the remnants of extractive activities such as mining, timber and ranching. Additionally, there are Civilian Conservation Corp and Forest Service administrative sites on the District.

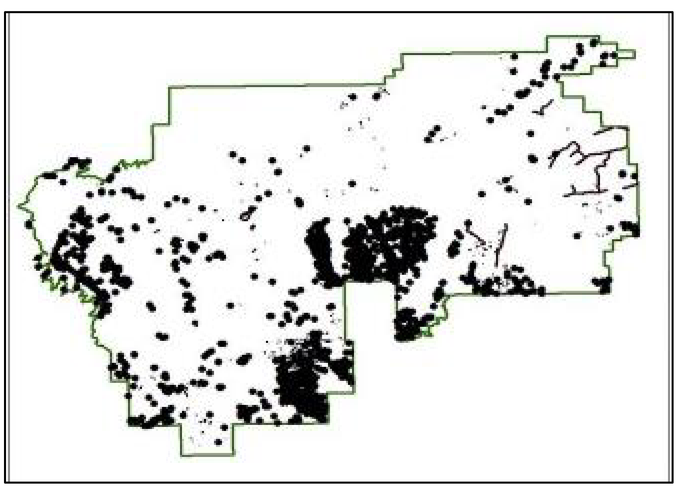


Figure 40. Distribution of documented sites on the Monticello District.

Synopsis Through Time

Little is yet known about Paleoindian use of the District. Small numbers of Late Paleoindian projectile points have been found at sites including scavenged points at Ancestral Puebloan sites and those occurring at open lithic scatter sites. Regionally, this continues to be a poorly documented and understood era of human history in SE Utah. Later Archaic sites are more common. They are primarily open lithic scatters, although a small number of cliff and alcove settings have been documented.

Heritage records indicate Ancestral Puebloan affiliated resources occur throughout the District; however, for centuries the south draining drainage networks, particularly the South Cottonwood Wash watershed, were the primary focus of these farming communities. Ancestral Puebloan occupation of the Forest becomes well-established by the AD 600s (1400s BP) and continues until the middle A.D. 1200s (BP 800s). Of the known sites, 2024 Ancestral Puebloan sites were identified as contributing elements to the proposed Upper South Cottonwood National Register Archaeological District. Diagnostic site features and artifacts found on these sites indicate many sites were either continuous occupied, or repeatedly re-occupied on and off throughout Ancestral Puebloan time.

Following the Ancestral Puebloan era, Ute, Navajo, and Paiute seasonally used the Forest from 550 - 150 BP (AD 1550 – 1850). Few Protohistoric/Historic (post-AD 1850) Native American resources are clearly identified in the database. These include wikiups, a Navajo hogan, sweat lodges, and lithic and pot sherd scatters.

In the late 1800s, New Mexico Hispanic and European American use began. Historic sites and components at multicomponent sites on the District include a variety of different site types. Historic sites include uranium mines, Forest Service administrative facilities, sawmills, roads, irrigation ditches, cabins, camps, graves, municipal water systems, grazing related facilities (fences, corrals, other), aspen carvings, cadastral markers, and inscriptions. Gold mines are limited to locations along Duckett Ridge and Gold Queen Basin. Uranium mining occurred throughout the District and these represent episodic use from the 1940s through the 1980s. Grazing was initiated during the late 1800s and continues today. Grazing and grazing management has resulted in a variety of landscape changes and constructed features. The timber industry focused primarily on ponderosa pine forests. These activities left a variety of landscape and cultural sites including logging roads, loading areas, sawmills, camps, and other evidence. Irrigation and water developments continue to be in-use and provide culinary water to local towns. Irrigation is an important aspect in the community and several irrigation systems have historic roots.

Site Conditions

Prehistorically, successive occupations at certain locales disturbed and altered both natural resources and earlier cultural resources. However, the effects of early historic use on the Monticello District are better documented and more extensive. For instance, large scale range improvement projects and intensive mining have resulted in damage to the cultural resources in areas of the Forest with the highest site densities. Uranium mining and related exploration activities during the 1940s through 1980s created an intense network of roads and mines through the dense South Cottonwood prehistoric cultural landscape. Mid-1900s era vegetation removal projects in other areas damaged hundreds of other archaeological sites. Many of the sites listed in poor condition on the Monticello District occur within these areas and were documented during the early 1970s. However, recent revisits to these sites listed in poor condition indicate that many of them retain enough physical integrity to continue to contribute to our understanding of prehistory.

Since 2002, the trend in wildfire size and intensity has affected the condition of sites on the Monticello District. Post-fire work with the sites indicated that direct impacts to buried features were not severe and catastrophic, but damage to surface artifacts and the stone used for building was extensive. Extensive erosion controls were installed at many of the sites and were effective in stabilizing sites until vegetation returned.

Illegal removal of surface artifacts or outright looting of sites has been particularly damaging on the Monticello District. Historic sites, such as mining areas and cabins, have seen the loss of many artifacts (bottles and other objects) to illegal artifact collection. This theft has been more widespread at prehistoric sites, with the loss of projectile points, ceramics, and perishable materials. Ancestral Puebloan sites found on the district have been a particular favorite of looters. This was particularly pronounced in the period of the 1970s-1980s, including much activity by professional looters. Looting continues today, but at a decreased intensity from those times.

Forest Priority Heritage Assets

Priority Heritage Assets are sites or collections of distinct public value that are or should be actively maintained. They include sites whose significance has been recognized through an official designation, such as listing on the National Register of Historic Places, or whose significance is recognized through agency investment in interpretation, preservation, or use. The Forest has identified 55 archaeological or historical sites as Priority Heritage Assets.

PHAs are also sites that have critical deferred maintenance needs with imminent threats to their significant resource values or whose condition poses safety risks. Treatments can stabilize these sites, and if on-going monitoring determines that they no longer have deferred maintenance needs, they no longer will be considered a PHA.

All heritage collections, which includes archaeological, archival, Heritage Program, and Forest Service history collections, are managed as Priority Heritage Assets. In total, the Manti-La Sal has over 658 square feet of artifacts, photos, and documents in 64 Priority Heritage Asset collections. Most of these collections are cataloged and in good condition; however, others need to be stabilized in archival storage containers and/or cataloged.

4.7.5 Trends

Site condition data begins in the 1970s, with implementation of the National Historic Preservation Act (NHPA) and the start of formal site documentation. Prior to that time, sites were intermittently damaged or destroyed at the landscape level, through chaining, disking, erosion control terracing, other management activities, or permitted activities. NHPA compliance has created a positive trend toward site protection. Other positive trends have occurred in cultural resource management since the first Forest Plan was completed in 1986. These include technological changes that aid in facilitating management and other tools allowing for improvements in documentation of current and changing site conditions. Some types of stressors have decreased since creation of the Forest, including impacts from the damage caused by overgrazing by domestic livestock. Additionally, wildfire has previously damaged sites. To prevent future fire damage, the Forest could use techniques such as hand-thinning and leaving contiguous untreated blocks of trees to create buffers around sites that protect archaeology without leaving obvious untreated areas that call attention to the fact that they harbor resources.

Other stressors increased after creation of the Forest, including road and trail construction and recreation demand. Damage from existing and a growing number of illegal motorized routes across sites are generally increasing, despite the fact that new trail construction projects avoid direct impacts to other sites. Sites have been the subject of illegal vandalism, artifact theft, and looting since before creation of the Forest; however, these impacts increased dramatically in the 1960s with increased motorized access. Damage from collapsing walls and defacing rock art are increasing as numbers of visitors increase. Similarly, the theft of surface artifacts is increasing. Finally, there is an increasing trend in the availability of site location information on web sites. This has led to an increase in visitation to the most sensitive and vulnerable of Forest sites, including Ancestral Puebloan sites with standing architecture and extensive middens.

Ancient American Indian sites have considerable traditional value as sources of connection for the modern descendants of ancestral Puebloan, Navajo and Ute peoples. There has been a trend in the last 20 years toward more tribal involvement in identifying and resolving project effects and in evaluating the value of sites.

4.8 Land Ownership, Status, and Use Patterns

4.8.1 Indicators

- Number, acres, and type of existing special use authorizations
- Number, acres, and type of existing landownership adjustments

4.8.2 Land Ownership

The Forest is in central and southeastern Utah and extreme western Colorado. The Forest lies within eight Utah counties (Carbon, Emery, Grand, Juab, San Juan, Sanpete, Sevier, and Utah) and two Colorado counties (Mesa and Montrose). It is surrounded, for the most part, both by public lands administered by the Bureau of Land Management (BLM) and private lands. The notable exceptions are lands adjacent to the San Pitch Division, the north and west sides of the Manti Division, and the block of land surrounding the Moab Ranger District. These lands are predominantly in private ownership with some intermixed state lands.

There are state and private inholdings on the North Zone of the Forest. On the North Zone, types of uses are for private cabins, hydroelectric power, agriculture, grazing, hunting, and coal mining. The majority of uses on the North Zone is for agricultural and private cabins. There are private inholdings on the South Zone of the Forest. Types of uses are mainly for houses, subdivisions, and cabins. In addition, uses include reservoirs, mining claims and agriculture uses as shown in Table 59.

Table 59. Summary of land ownership within the Forest boundary.

Land Ownership	Acreage on Forest Land	Percentage
Private Inholding	70,940	5
State Inholding	3,347	0.24
State Wildlife	1,223	0.09
Forest Service	1,291,434	95

Most existing formal withdrawals were made under authorities that predate the Federal Land Policy and Management Act. There are 45 existing withdrawals on the Forest. On the Forest, withdrawal types are for recreation sites, administrative sites, experimental forest sites, archaeological areas, power withdrawals, national wilderness, research natural areas, and reclamation withdrawals.

Adjacent Landowners

Most of the land that borders the Price/Ferron/Sanpete District is administered by the BLM. About 10 percent (52 mi) of the outside boundary of the Price/Ferron/Sanpete District borders BLM. There are 277 miles of state and private inholdings within the boundary of the Price/Ferron/Sanpete District. Most of the land that borders the Uinta Forest is private land. About 38 percent (36 mi) of the outside boundary of the Sanpitch Division borders private land. Most of the land that borders the Moab District is BLM and private land. Around 25 percent (52 mi) of the outside boundary of the Moab District is BLM and 26 percent (53mi) of the outside boundary of the Moab District is private land. There are 71 miles of private inholdings within the border of the Moab District. Most of the land that borders the Monticello District is BLM. Around 65 percent (123 mi) of the outside boundary of the Monticello District would be BLM. There are 32 miles of private inholdings that within the border of the Monticello District.

Administratively Managed Unit of the Uinta-Wasatch Cache National Forest

The Forest manages part of the Uinta National Forest, referred to as the Sanpitch Unit. This part of the Forest was original called the Nebo National Forest and was established in 1908. In order to facilitate better management of that land unit, it was transferred from the Nebo National Forest to the Manti National Forest in 1915. When the rest of the Nebo National Forest was dissolved and transferred to the Uinta National Forest in 1923, management of the Sanpitch Unit went to the Uinta. However, the fundamental problem of how to best manage this unit remained, as it is far from the Uinta National Forest headquarters in Provo, UT. So management of the Sanpitch Unit was moved back to the Manti National Forest in 1974, with management by the Sanpete Ranger District in nearby Ephraim. By the 1970s, the Forest Service had stopped changing the official name of land units like this whenever their administrative status changed.

4.8.3 Land Status

There are three main types of land transactions. Acquisition (purchases and donations), conveyance (sales) and land exchanges. There were land transactions on the Forest that occurred between 2009 and 2012. Land exchanges are performed to implement land use plans and management objectives; to acquire specific resources (T&E species, habitat, wildlife habitat, water rights, etc.); to consolidate ownership, block up lands for more efficient management, dispose of unmanageable/inaccessible lands, acquire inholdings, and allow for community expansion; to acquire access to specific areas (river, isolated parcels, etc.); to resolve trespass situations; to fulfill legislation (legislated land exchanges); and to consolidate surface and mineral estates as shown in Table 60.

Table 60. Acres and percent of Forest with a special land designation or withdrawal.

Land Status	Acres on Forest	Percentage
Withdrawals	56,644	4
Research Natural Areas	4,324	0.3
Inventories Roadless Areas	645,020	46
Wilderness	46,327	3

Completed Acquisitions (purchase/donation)

- Emery County Donation – Crandall Canyon Mine Memorial – 3.44 acres/2012

Pending Acquisitions

- Rocky Mountain Elk Foundation Donation – Candland Mountain Trailhead – 10.61 acres
- UMETCO Donation

Completed Conveyances (sales)

- Mt. Pleasant Administrative site (nonforest Land) – 19.45 acres/2011
- Monticello Lower Dwelling (nonforest land) – 0.16 acres/2010
- Monticello Upper Dwelling (nonforest land) – 0.29 acres/2010
- Manti Dwelling (nonforest land) – 0.48 acres/2009
- Ephraim Dwelling (nonforest land) – 0.26 acres/2009
- Castledale Townsite (nonforest land – 0.53 acres/2011

Land Exchanges

- McKay Matthews Interchange – The United States acquired 3.38 acres and conveyed 3.0 acres/2011
- Crandall Canyon Exchange – The United States acquired 2.24 acres and conveyed 2.5 acres/2012

4.8.4 Land Uses

Some uses of NFS lands are covered by special use authorizations, including permits, leases, and easements that allow occupancy, use, rights or privileges on the Forest. Special use authorizations are legal instruments whose terms and conditions are fully enforceable when reasonable and consistent with law, regulation, and policy. The mission of the Forest Service Special Use Program is to manage the use and occupancy of NFS lands in a manner that protects natural resource values, promotes public health and safety, and is consistent with forest land management plans. There are 279 miles of public utilities on the Forest. There are 22 miles of road use permits on the Forest to access private property. Land special uses include public utility lines (power, gas, water, telecommunications, road use permits). Other land uses under permits include communication towers, service buildings and others.

Right-of-way and easements affect both private and public lands throughout the plan area. The Forest has reserved or acquired rights-of-way needed for public access and has granted private or other public entities right-of-way for access across Forest lands as shown in Table 61.

Table 61. Permitted public utilities on the forest by miles and acres.

Public Utilities	Miles	Acres
Power Lines	72	383
Gas Lines	56	340
Canal and Ditches	34	55
Water Pipelines	73	194
Telecommunications	44	18

4.8.5 Access

Access refers to the legal rights-of-way acquired by the Forest Service, across non-NFS land for the management and use of NFS lands.

Large portions of the Forest are accessible by road. Visitors can use federal, state, county, and other public highways and roads to reach the Forest and its road system. Major highways in the plan area include:

- State Highway 31, which runs southeast-northwest providing access to the Ferron/Price Ranger District
- State Highway 29, which runs east-west providing access to the Ferron/Price Ranger District
- State Highway 264 and 96, which runs through the Forest as part of the Huntington/Eccles National Scenic Byway (Energy Loop)
- County Road 73, which runs south-north providing access to the La Sal Mountains on the Moab/Monticello Ranger District
- County Road B101, which runs east-north providing access to the Blue Mountains on the Moab/Monticello Ranger District

There are about 2,300 miles of Forest roads that are open at least part of the year to motorized vehicles, which allow visitor to drive to portions of the Forest and operate over-snow vehicles in the winter months. There are 1,076 miles of authorized motorized trails.

4.9 Wilderness and Other Designated Areas

4.9.1 Designated Wilderness

Dark Canyon is the only designated wilderness area on the Manti- La Sal National Forest.

The Wilderness Act of 1964 (Public Law 88-577) set up a system of wilderness areas across the United States and defined wilderness as a place "in contrast with those areas where man and his own works dominate the landscape… where Earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain… an area of undeveloped federal lands retaining its primeval character and influences, without permanent improvements or human habitation, which is protected and managed to preserve its natural condition". The 1964 Wilderness Act also set up a process by which new wilderness areas could become designated and managed under the Wilderness Act. Using this process, the Utah Wilderness Act (Public Law 98-428), was passed in 1984 which designated among others, the Dark Canyon Wilderness. Provides 46,353 acres of challenging terrain and opportunities for solitude.

The Dark Canyon Wilderness is managed to maintain or enhance the wilderness qualities of; naturalness, untrammeled character, undeveloped character, opportunities for solitude and /or primitive recreation and any special features found within the wilderness.

Naturalness

Dark Canyon generally remains in a natural state with very few impacts to its naturalness. Impacts to naturalness consist of impacts associated with livestock grazing, unauthorized motorized use associated with the Peavine Corridor, impacts associated with recreation use and exotic plant species.

Commercial Livestock grazing is authorized within the wilderness. The entire wilderness is located within the Twin Springs Cattle allotment but only the eastern portion of the wilderness is grazed. Woodenshoe Canyon and Dark Canyon below its junction with Rig Canyon are closed to grazing. Horses are also allowed in Horse Pasture Canyon in conjunction with the Twin Springs Cattle Allotment operations. Conflicts between wilderness users and livestock occur when cattle impact the quantity and quality of water located in the wilderness.

The "cherry stemmed" Peavine Corridor provides for motorized use within a 66-foot wide non-wilderness corridor. The motorized route is often washed out by flash floods and has caused motorized users to create their own routes outside of the cherry stem and within the wilderness, which has impacted riparian areas. The motorized use associated with the Peavine Corridor has become a challenge to maintaining wilderness character.

Several species of exotic invasive plants have been inventoried and treated in the wilderness including Canada thistle and tamarisk. Canada thistle is primarily located in the Horse Pasture Canyon drainage and tamarisk found throughout the wilderness near springs, seeps and riparian areas. Both species are treated annually with hand tools and minimal amounts of herbicide. The wilderness provides habitat for a wide variety of wildlife including the threatened Mexican spotted owl.

Untrammeled Character

The untrammeled character of Dark Canyon is primarily intact. The area experiences a few management actions that impact the untrammeled character of the area. These actions include livestock grazing and fire suppression in the wilderness and surrounding areas.

Undeveloped Character

Dark Canyon retains its undeveloped character. The only developments within the wilderness are fences, corrals and troughs associated with livestock grazing.

Opportunities for Solitude and/or Primitive Recreation

Six trailheads and approximately 56 miles of system trails provide access to the Dark Canyon Wilderness Current use levels within the wilderness remain relatively low when compared to similar public lands in the area. The National Visitor Use Monitoring done every five years estimates that the Dark Canyon Wilderness receives approximately 1,000 visitors per year. This estimate has remained stable over the last ten years. Solitude is easy to find in the wilderness.

As of 2016, there were six authorized Recreation Special Permits issued for outfitter and guides to operate within the wilderness. In 2013, a moratorium was placed on issuing new commercial outfitter and guide permits within the wilderness until a capacity study was prepared, this moratorium remains in place.

Special Features

The cultural and archaeological resources found in this wilderness are diverse in type and size and cover a wide variety of prehistoric and historic evidences of man. Cultural resources range from Paleolithic scatters to the remains of early 20th century Anglo livestock ranching. Ancestral Puebloan remains dot the canyon walls in the form of living structures, kivas and granaries, some of which still have intact roofs and walls. Damage to these sites from both intentional looting and from unintentional recreationists does occur.

4.9.2 National Monuments

Bears Ears National Monument

On December 28, 2016 President Obama used the Antiquities Act to designate 1.35 million acres as the Bears Ears National Monument. Approximately 289,000 acres of the monument are located on the Monticello portion of the Manti–La Sal National Forest.

The Proclamation designating the monument identified the values and objects that the monument was designated to protect which includes it's cultural, prehistoric, and historic legacy and maintaining its diverse array of natural and scientific resources, and ensuring that the prehistoric, historic, and scientific values of this area remain for the benefit of all Americans.

The Proclamation directs the BLM and USFS to prepare a management plan for the monument and set up a Bears Ears Coalition including members from the Hopi Nation, Navajo Nation, Ute Mountain Ute Tribe, Ute Indian Tribe of the Uintah Ouray, and Zuni Tribe to inform decisions on the management of the monument. The Proclamation also directed the BLM and Forest Service to set up an Advisory Committee to provide information and advice regarding the development of the management plan and, as appropriate, management of the monument.

4.9.3 Wild and Scenic Rivers

River and stream segments on the Forest were evaluated for their eligibility under the Wild and Scenic Rivers Act in 2003. Findings of the evaluation are in the "Manti-La Sal National Forest Final Determination of Eligibility for Wild and Scenic Rivers Report". The report was supplemented in 2007 with additional information regarding ephemeral streams. Streams found eligible through this process were then evaluated for their suitability. A Record of Decision (ROD) for the "Wild and Scenic River Suitability Study for NFS lands in the State of Utah" was issued in 2008. No rivers or streams on the Forest were determined to be suitable.

Currently, the Forest Service is determining if there are any stream segments that were missed during prior evaluations that need to be evaluated for eligibility and suitability. If there are stream segments that require evaluation the evaluation will be done in conjunction with this Forest Planning effort. See Appendix 4 for a description of the evaluation on the Forest.

4.9.4 Inventoried Roadless Areas

Inventoried roadless areas (IRAs) were first inventoried by the Forest Service in 1972, as part of the Roadless Area Review and Evaluation I (RARE I). The RARE I process initiated a review of NFS roadless areas, generally larger than 5,000 acres, to determine their suitability for inclusion in the National Wilderness Preservation System. RARE I received a fair amount of criticism and was never finalized. To supplement this original work, from 1977 to 1979, the Forest Service conducted a second review of these roadless lands. This second review was known as Roadless Area Review and Evaluation II (RARE II). The purpose of RARE II was to inventory all roadless and undeveloped areas in the NFS and recommend their allocations to "wilderness, further planning, or non-wilderness". Additional acres were added to the IRA inventory that was started in RARE I as a result of the RARE II.

The Forest inventory contained 40 roadless areas, totaling approximately 645,000 acres. The Utah Wilderness Act designated 706,736 acres of wilderness statewide, including the 45,000 acre Dark Canyon Wilderness on the Manti-La Sal National Forest. The current inventoried roadless areas of the Forest are mapped in the *Roadless and Undeveloped Area Evaluation RARE II Final Environmental Assessment*. Maps were updated as of October 1999, in response to the Roadless Area Conservation; Final Rule (36 CFR 294).

The IRAs are managed under the 2001 Roadless Rule to protect their roadless characteristics and generally limits road construction and reconstruction and commercial logging. All actions proposed within the IRAs are evaluated for their potential to impact the roadless and wilderness character of the areas. Overall the IRAs have maintained their roadless character and remain in relatively pristine condition. The IRAs do contain minor developments such as range developments (troughs, fences, etc.) and motorized trails as well as past vegetation treatments.

4.9.5 National Recreation Trails

Two National Recreation Trails (NRT) exist on the Forest. Both trails are located on the North Zone. The trails are the Left Fork Huntington Creek NRT and the Fish Creek NRT.

The Left Fork of Huntington Creek NRT #5131 is 5.8 miles long. It begins at Forest Road #50058 and ends at Forest Road #50014. The trail is located along the bottom and north side of Left Fork of Huntington Creek. It climbs 847 feet from the trailhead at Forks of Huntington Campground (7,696 feet) to Miller Flat Road (8,543 feet). The trailhead at Miller Flat begins in sagebrush/grass habitat and then continues the rest of the way through scenic stands of spruce and fir. The trail is normally hiked from Miller Flat Trailhead down to the Forks of Huntington; however, many people also hike and fish along the lower sections of the trail. The trail has been rerouted around debris jams resulting from post-fire flooding following the 2012 Seeley Wildfire. This trail is open to foot and equestrian use only.

The Fish Creek National Recreation Trail #5130 is 10.0 miles long. The lower trailhead is located at the end of Forest Road #50123 (Fish Creek Campground). The trail ends at the upper trailhead on North Skyline Drive (Forest Road #50150). The trail is located along the bottom of Fish Creek drainage and generally parallels the stream with two bridged crossings. It climbs 1,080 feet from Fish Creek Campground (7,696 feet) to Skyline Drive (8,776 feet). Vegetation ranges from willows and grass along the immediate stream course, to sagebrush-grass on the south exposures of the canyon. Aspen stands and mixed aspen-conifer are visible on the north facing slope.

4.9.6 Research Natural Areas

Research Natural Areas (RNAs) are lands within the NFS that are permanently protected as places to conduct research and monitoring, maintain biological diversity, and foster education.

36 CFR 219.10 (vi) states that the plan must include plan components to provide for "Appropriate management of other designated areas or recommended designated areas in the plan area, including research natural areas". Areas of important forest, scrubland, grassland, alpine, aquatic, and geologic types that have special or unique characteristics of scientific interest and importance will be identified and proposed as lands needed to complete the national research natural area network.

As part of the Forest Plan Revision, potential new RNAs identified through the planning process will be evaluated. Currently, Sinbad Ridge has been proposed by the Nature Conservancy for RNA designation.

Since implementation of the Forest Plan, the Forest has designated the following Research Natural Areas: Nelson Mountain, Mount Peale, Cliff Dweller's Pasture, Mill Creek Gorge, and Hideout Mesa. A Forest Plan amendment, approved in November 1998, established direction for and set aside Mill Creek Gorge and Hideout Mesa as RNAs. Since the Nelson Mountain, Mount Peale, and Cliff Dweller's Pasture RNAs were designated after the completion of the Forest Plan, applicable management direction needs to be incorporated for these areas during plan revision. Current Forest Plan direction calls for the prohibition of roads, prospecting, seismic activity, livestock grazing, and construction of utility corridors within RNAs. The six existing RNAs on the Forest are described in Table 62.

Table 62. Research Natural Areas on the Forest by name, establishment year, acres, and description.

RNA	Establishment Year	Acres	Description
Cliff Dwellers Pasture	1991	264	Water birch & Gambel oak-bigtooth maple bottomland communities; pinyon-juniper woodlands; Navajo sandstone cliffs; sandstone arch; packrat middens; rare plants
Elk Knoll	1957	40	Relatively level bench supporting subalpine tall forb vegetation, forests on adjacent slopes of subalpine fir & Engelmann spruce
Hideout Mesa	1998	360	Two-leaf pinyon & Utah juniper woodlands at upper elevational limits; patches of mountain brush and grassland; limited areas of ponderosa pine and big sagebrush
Mill Creek Gorge	1998	680	Deep gorge containing the steep-gradient Mill Creek; south exposures support pinyon-juniper woodlands; north exposures support mesic mountain brush communities with Gambel oak, Utah serviceberry & birchleaf mountain mahogany; Douglas-fir is associated with moist microsites; riparian
Mount Peale	1988	2380	Subalpine fir & Engelmann spruce forest & krummholz; cirque basins, rock glaciers & talus; alpine turf & boulder-field communities; rare plant
Nelson Mountain	1988	490	Diverse assemblage of woodland & shrublands including forests of white fir & Douglas-fir, and shrublands of curlleaf mountain mahogany, mountain big sagebrush & black sagebrush; rare plant

Both the Mount Peale and Mill Creek Gorge RNAs are closed to issuing any new Special Use Permits to protect the vegetation communities they were established to protect.

The Utah Division of Wildlife Resources (UDWR) introduced mountain goats into the La Sal Mountains including the Mount Peale RNA. The UDWR and USFS biologists are currently monitoring alpine vegetation to determine if any impacts are occurring within the RNA.

4.9.7 National Scenic Byway

The Forest hosts a portion of one nationally designated Scenic Byway; the Huntington and Eccles Canyons National Scenic Byway also known as the Energy Loop. This route follows Utah State Highways 31, 264, and 96 for 85 miles across the Wasatch Plateau and features three entry kiosks and fourteen interpretive stops along the way. Ten of the interpretive stops are located on the Forest. Visitors are introduced to the diversity of scenic, geologic, historic, cultural, and recreational resources found across the plateau.

Interpretive signing at the entry kiosks and at each of the fourteen interpretive stops was redesigned, fabricated, and installed in 2016. Emphasis on energy production was retained, recreational resources were more prominently featured, and interpretation of the 2012 Seeley Wildfire added. The recovery site of the 9,500 year-old mammoth skeleton remains a highlight of the byway experience.

4.9.8 Special Interest Areas

The purpose of special interest areas is to “protect and manage for public use and enjoyment special areas with scenic, geological, botanical, zoological, paleontological, archaeological, or other special interest characteristics or unique values” (FSM 2372.02). Current Forest Plan direction for special interest areas is to provide signing and protection, and to manage for long-term public enjoyment.

Existing Special Interest Areas

- The Great Basin Experimental Range (4,608 acres) was established for range and hydrological research.
- The Grove of Aspen Giants was established as a special scenic area (10 acres) containing some very large aspen trees. Most large aspens within this site have died and fallen over.
- The Pinhook Battleground is the historic site (1 acre) of a battle between early settlers and Americans Indians. The interpretive site was burned by the Porcupine Ranch Fires in 2008 but has since been replaced and a new trail was constructed to access the site.
- The Mont E. Lewis Botanical Area is a unique wet meadow containing plant species not normally found outside of artic and alpine habitats. This area was proposed in the 1986 Forest Plan as the “Scad Valley Botanical Area” and designated in 1995. The area presently consists of 20 acres, however, the Forest botanist has recommended the area be expanded by 80 acres to protect against impacts from livestock and people.

As part of the Forest Plan Revision process additional Special Interest Areas can be identified and evaluated. Below are several potential areas that have been identified in past planning efforts.

Potential Special Interest Areas

- Archeological site(s), Monticello Ranger District: The Forest possesses several outstanding ancient cultural landscapes. The most notable of these are located within the Cottonwood basin in San Juan County. These resources represent some of the most significant archaeological resources in the greater Southwest.
- White Mountain, Ferron Ranger District: The White Mountain area is subalpine to near alpine in elevation (10,900 feet). Seventy plant species have been collected and identified from this site, including three sensitive species.

- Maloy Park, Moab Ranger District: This area contains both unique landforms and vegetation. It is primarily used as a recreation area and for livestock grazing.
- Maple Canyon, San Pitch Division: This area contains unique geology featuring a non-typical arch formed from conglomerate. This area is also renowned for its rock climbing.
- Little Dry Mesa, Monticello Ranger District: This area contains three sensitive plant species, along with many other common and unique plants.

4.9.9 Trends

Wilderness

According to the NVUM, visitation to the Dark Canyon Wilderness has remained stable over the last 5 years. However, this may change as other areas in the region begin to experience crowding and with the increase in attention to the area due to the designation of the Bears Ears National Monument which includes the Dark Canyon Wilderness.

Campsite inventories were conducted in the early 1990s and then again in 2007.The inventories show a trend over time of less overall campsite sites but the ones that continue to exist being more heavily impacted. This may be due having less water available in the canyon as springs have dried up and backpackers are using the campsite near the remaining reliable water sources.

National Recreation Trails

Use of the Left Fork of Huntington Creek NRT has gone down dramatically since the 2012 Seeley Wildfire, as the trail and campground were closed for public safety. The fishery of the Left Fork of Huntington Creek was also decimated by post-fire flooding and has been slow to recover. Although now re-opened, use of the trail has been slow to rebound. It is expected that as the fishery improves, and visitors resume camping in the campground, that trail use will also increase.

Use of the Fish Creek NRT has remained consistent, with spikes in usage occurring during the opening of the fishing season in July and during the fall hunting seasons. During the fall hunts, equestrian use is the predominant use of the trail. Recreational hiking occurs primarily in the lower and upper 2 miles of the trail during the summer months, with minimal mountain biking taking place.

Research Natural Areas

Increased recreational use associated with climbing the high peaks of the La Sal Mountains is occurring in the Mount Peale Research Natural Area. A trail counter was placed on the Tuk Trail that leads to the Mount Peale Research Natural Area in 2016.

Scenic Byway-National

Use of the byway routes by commercial truck traffic related to energy production, timber sale operations, and commuter traffic to the coal mines and Huntington Power Plant is expected to increase by about 1 percent annually. Tourism traffic is heaviest during the Memorial Day and Labor Day time period with another traffic spike occurring during the fall hunting seasons.

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GLOSSARY

Airshed: A geographic area that, because of topography, meteorology, and/or climate is frequently affected by the same air mass.

Assessment: The identification and evaluation of existing information to support land management planning. Assessments are not decision-making documents but provide current information on select topics relevant to the plan area, in the context of the broader landscape.

Area of influence: An area influenced by the management of the plan area that is used during the land management planning process to evaluate social, cultural, and economic conditions. The area is usually a grouping of counties.

At-risk species: The set of at-risk species for planning purposes includes federally recognized threatened, endangered, proposed and candidate species, and species of conservation concern.

Carbon pool: Any natural region or zone, or any artificial holding area, containing an accumulation of carbon or carbon-bearing compounds or having the potential to accumulate such substances. Carbon pools may include live and dead above ground carbon, soil carbon including coarse roots, and harvested wood products.

Carbon stocks: The amount or quantity contained in the inventory of a carbon pool. For purposes of carbon assessment for NFS land management planning, carbon pools do not include carbon in fossil fuel resources, lakes or rivers, emissions from agency operations, or public use of NFS lands (such as emissions from vehicles and facilities).

Carbon storage: The ability of the soil to store carbon. More carbon is stored in soil than in the atmosphere and above-ground biomass combined.

Condition class: Depiction of the degree of departure from historical fire regimes, possibly resulting in alternations of key ecosystem components. These classes categorize and describe vegetation composition and structure conditions that currently exist inside the Fire Regime Groups. Based on the coarse-scale national data, they serve as generalized wildfire rankings. The risk of loss of key ecosystem components from wildfires increases from Condition Class 1 (lowest risk) to Condition Class 3 (highest risk).

Critical load: The concentration of air pollution or total deposition of pollutants above which specific deleterious effects may occur.

Crown Fire: A fire that advances from top to top of trees or shrubs more or less independent of a surface fire. Crown fires are sometimes classed as running or dependent to distinguish the degree of independence from the surface fire.

Drivers: Dominant ecological process that shape the ecosystem, such as natural disturbance regimes, predominant climatic regimes, broad scale system drivers, and natural vegetation succession.

Economic sustainability: The capability of society to produce and consume or otherwise benefit from goods and services including contributions to jobs and market and nonmarket benefits.

Ecosystem: A spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment (the non-living chemical and physical parts of the environment) within its boundaries.

Ecosystem/ecological integrity: The quality or condition of an ecosystem when its dominant ecological characteristics (for example, composition, structure, function, connectivity, and species composition and diversity) occur within the NRV and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence.

Ecosystem sustainability: The capability of an ecosystem to meet the needs of the present generation, without compromising the ability to meet their needs of future generations.

Energy Release Component (ERC): The computed total heat release per unit area (British thermal units per square foot) within the flaming front at the head of a moving fire.

Environmental justice: The fair treatment and meaningful involvement of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. (USDA DR5600-002, 1997)

Fire regime: A classification of vegetation types based on historic fire frequency and intensity.

Fire regime groups: A classification of fire regimes into a discrete number of categories based on frequency and severity. The national, coarse-scale classification of fire regime groups commonly used includes five groups: I - frequent (0-35 years), low severity; II - frequent (0-35 years), stand replacement severity; III - 35-100+ years, mixed severity; IV - 35-100+ years, stand replacement severity; and V - 200+ years, stand replacement severity.

Fire Behavior: The way a fire reacts to the influences of fuel, weather, and topography.

Fire Suppression: All work and activities connected with control and fire-extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

Forest boundary: The boundary that delineates NFS lands on the Manti La Sal National Forest.

Forest transportation system: Roads, trails, and areas designated for motor vehicle use that provide access to NFS lands for both motorized and non-motorized uses in a manner that is socially, environmentally, and economically sustainable over the long-term; enhances public enjoyment of NFS roads; and maintains other important values and uses.

Fuel Loading: The amount of fuel present expressed quantitatively in terms of weight of fuel per unit area. This may be available fuel (consumable fuel) or total fuel and is usually dry weight.

Fuel Model: Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

Hazardous air pollutants (toxic air pollutants, air toxics): Pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. Most air toxics originate from human-made sources, including mobile sources (e.g., cars, trucks, buses) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Some air toxics are also released from natural sources, such as volcanic eruptions and forest fires.

Human Health and/or Environmental Effects: Interrelated social and economic effects. (USDA DR5600-002, 1997)

Hydrological unit code (HUC): A sequence of numbers or letters that identify a hydrological feature like a river, river reach, lake, or area such as a drainage basin (also called watershed) or catchment in North America.

For example, a 5th level HUC is a watershed and a 6th level is a sub watershed. Forest level analysis primarily occurs at the HUC 5 level, with project-level analysis occurring at the HUC 6 level.

Indicator: A measure or measurement of aspect of sustainability. A quantitative or qualitative variable that can be measured or described and, when observed, shows trends. Quantifiable performance measures of outcomes or objectives for attaining criteria designed to assess progress toward desired conditions.

Land ownership adjustment: Land adjustments to NFS lands by purchase, exchange, interchange, or conveyance under authority delegated by law to the Secretary of Agriculture.

Land type associations (LTAs): Landscape-scale terrestrial ecosystems used in national forest planning as a framework for analysis and conservation design, and also used as a context for project planning. LTA units combine both physical ecological components, such as geology, soil, water, and climate, with biological components, including flora and fauna.

Landscape: A distinct association of land types that exhibit a unique combination of local climate, landform, topography, geomorphic process, surficial geology, soil, biota, and human influences. Landscapes are generally of a size that the eye can comprehend in a single view.

Land status: Ownership records of title to lands, withdrawals, rights, or privileges which affect or influence the use and management of NFS lands. It is the system of assembling, recording, and making landownership and related information available to field personnel.

Lease: A contract granting use or occupation of property during a specified period in exchange for a specified rent or other form of payment; a type of special-use authorization (usually granted for uses other than linear rights-of-way) that is used when substantial capital investment is required and when conveyance of a conditional and transferable interest in NFS lands is necessary or desirable to serve or facilitate authorized long-term uses and that may be revocable and compensable according to the terms.

Locatable minerals: Mineral disposable under the General Mining Act of 1872, as amended, that was not accepted in later legislation. These include hard rock, placer, and industrial minerals and uncommon varieties of rock found on public domain lands. Locatable projects are non-discretionary projects.

Low income population: Any readily identifiable group of low-income persons who live in geographic proximity to, and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who will be similarly affected by USDA programs or activities. Low-income populations may be identified using data collected, maintained and analyzed by an agency or from analytical tools such as the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty. (USDA DR5600-002, 1997)

Minority: A person who is a member of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. (USDA DR5600-002, 1997)

Minority population: Any readily identifiable group of minority persons who live in geographic proximity to, and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who will be similarly affected by USDA programs or activities. (USDA DR5600-002, 1997)

Mineral: Any naturally formed inorganic material; solid or fluid inorganic substance that can be extracted from the earth; any of various naturally occurring homogeneous substances (e.g., stone, coal, salt, sulfur, sand, petroleum, water, or natural gas) obtained usually from the ground. Under federal laws, considered as locatable (subject to the general mining laws), leasable (subject to the Mineral Leasing Act of 1920, as amended), and salable (subject to the Materials Act of 1947).

Multiple use: The management of all the various renewable surface resources of the NFS so that they are used in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output, consistent with the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528–531). (36 CFR 219.19)

National ambient air quality standards: Standards established by the United States Environmental Protection Agency under authority of the Clean Air Act (42 U.S.C. 7401 et seq.) that apply to outdoor air throughout the country. An exceedance "one occurrence of a measured or modeled concentration that exceeds the specified concentration level of such standard for the averaging period specified by the standard." 40 (CFR 50.1) A violation is of one or more exceedances.

National Fire Danger Rating System (NFDRS): A uniform fire danger rating system that focuses on the environmental factors that control the moisture content of fuels.

National forests: Areas formally reserved, designated, or proclaimed as National Forests.

National Forest System (NFS): All National Forest lands reserved or withdrawn from the public domain of the United States; all National Forest lands acquired through purchase, exchange, donation, or other means; the National Grasslands and Land Utilization Projects administered under Title III of the Bankhead-Jones Farm Tenant Act (7 U.S.C. 1010-1012); and other lands, waters, or interests therein which are administered by the Forest Service or are designated for administration through the Forest Service as a part of the system (Forest and Rangeland Renewable Resources Planning Act of 1974, 16 U.S.C. 1609).

Natural range of variation (NRV): Spatial and temporal variation in ecosystem characteristics under historic disturbance regimes during a reference period. The reference period considered should be sufficiently long to include the full range of variation produced by dominant natural disturbance regimes, often several centuries, for such disturbances as fire and flooding and should also include short-term variation and cycles in climate. NRV is a term used synonymously with historic range of variation or range of natural variation. The NRV is a tool for assessing ecological integrity and does not necessarily constitute a management target or desired condition. The NRV can help identify key structural, functional, compositional, and connectivity characteristics, for which plan components may be important for either maintenance or restoration of such ecological conditions.

Nonrenewable energy and minerals: Those minerals or materials designated as leasable under the Mineral Leasing Act of 1920, as amended, and the Mineral Leasing Act for Acquired Lands of 1947. These include energy-related mineral resources such as oil, natural gas, and coal, and some non-energy minerals, such as phosphate, sodium, potassium, and sulfur, and hard rock minerals on acquired NFS lands. Geothermal resources are also leasable under the Geothermal Steam Act of 1970. The Bureau of Land Management has jurisdiction over management of federal oil and gas resources underlying both Bureau of Land Management lands and NFS lands.

Non-energy leasable minerals: The Bureau of Land Management will lease certain solid minerals such as: phosphate, sodium, potassium, sulphur, gilsonite, or a hard rock mineral, on public and other federal lands. The Bureau of Land Management may also lease these minerals on certain private lands, provided the mineral rights are owned by the federal government.

Nutrient cycling: The movement and exchange of organic and inorganic matter back into the production of living matter.

Patented mining claim: A mining claim for which the federal government has passed its title to the claimant, making it private land. A person may mine and remove minerals from a mining claim without a mineral patent. However, a mineral patent gives the owner exclusive title to the locatable minerals.

Permit: A special use authorization that provides permission, without conveying an interest in land, to occupy and use NFS land or facilities for specified purposes, and which is both revocable and terminable.

Physiographic region: A region of similar geologic structure and climate that has had a unified geomorphic history.

Prescribed Fire: Any fire intentionally ignited by management actions in accordance with applicable laws, policies, and regulation to meet specific objectives.

Recreation landscape zones: Geographic landscape zones used by the Forest to describe recreation across the Forest. Specifically, Abajos, La Sal, Ferron, Price, and Sanpete zones.

Recreation Opportunity Spectrum (ROS): A system for classifying and managing recreation opportunities based on the following criteria: physical setting, social setting, and managerial setting. The combination of the three criteria results in six different ROS classes that are described below.

> **Primitive:** Describes large, remote, wild, and predominately unmodified landscapes. Areas with no motorized activity and little probability of seeing other people. Includes most wilderness areas.
>
> **Semi-Primitive Non-motorized:** Areas of the Forests managed for non-motorized use. Uses include hiking and equestrian trails, mountain bikes and other non-motor mechanized equipment. Rustic facilities and opportunity for exploration, challenge, and self-reliance.
>
> **Semi-Primitive Motorized:** Backcountry areas used primarily by motorized users on designated routes. Roads and trails designed for OHV's and high-clearance vehicles. Offers motorized opportunities for exploration, challenge, and self-reliance. Rustic facilities. Often provide portals into adjacent Primitive or Semi-Primitive Non-Motorized areas.
>
> **Roaded Natural (often referred to as front country recreation areas):** Accessed by open system roads that can accommodate sedan travel. Facilities are less rustic and more developed (campgrounds, trailheads, etc.). Often provide access points for adjacent Semi-Primitive Motorized, Semi-Primitive non-motorized, and Primitive settings.
>
> **Rural:** Highly developed recreation sites and modified natural settings. Easily accessed by major highway. Located within populated areas where private land and other land holdings are nearby and obvious. Facilities are designed for user comfort and convenience.

Renewable energy: Energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.

Right-of-way: Land authorized to be used or occupied for the construction, operation, maintenance, and termination of a project or facility passing over, upon, under, or through such land.

Road or trail: A road or trail wholly or partly within or adjacent to and serving the NFS that the Forest Service determines is necessary for the protection, administration, and utilization of the NFS and the use and development of its resources.

Road maintenance levels: The maintenance level (ML) of roads, measured between 1 and 5, in the Forest Transportation System between 1 and 5, indicating the level of service provided by and the maintenance required.

> **ML 1:** These are roads that have been placed in storage between intermittent uses. The period of storage must exceed one year. Basic custodial maintenance is performed to prevent damage to adjacent resources and to perpetuate the road for future resource management needs. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Roads managed at this maintenance level are described as being in basic custodial care.
>
> **ML 2:** Assigned to roads open for use by high clearance vehicles. Passenger car traffic, user comfort, and user convenience are not considerations. Warning signs and traffic control devices are generally not provided. Motorists should have no expectations of being alerted to potential hazards while driving these roads. Traffic is normally minor, usually consisting of one or more of a combination of administrative, permitted, are described as high clearance vehicles.
>
> **ML 3:** Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities. Roads in this maintenance level are typically low speed with single lanes and turnouts.
>
> **ML 4:** Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated.
>
> **ML 5:** Assigned to roads that provide a high level of user comfort and convenience. The roads are normally double lane, paved facilities. Some may be aggregate surfaced, and dust abated.

Salable mineral/mineral materials: Mineral commodities that are sold by contract from the Federal Government under the Materials Act of 1947, as amended. These are generally construction materials and aggregates, such as sand and gravel as well as pumice, pumicite, clay, rock, and petrified wood. The Bureau of Land Management sells mineral materials at fair market value, grants free use permits to government agencies, and issues free use permits for a limited amount of material to nonprofit organizations.

Sensitive receptors: Specific types of features or properties within a wilderness that can be negatively impacted by air pollutants (e.g., high-altitude lakes, lichens, and scenic vistas). Examples of indicators for sensitive receptors might be a population survey for a particular amphibian, a plankton count and water quality analysis in a sensitive lake or an assessment of the vista from a particular viewpoint.

Social sustainability: The capability of society to support the network of relationships, traditions, culture, and activities that connect people to the land and to one another and support vibrant communities.

Soil biology: The ability to provide habitat for a wide variety of organisms including plants, fungi, microorganisms and macro-organisms in the upper sections of the soil to promote root growth, control moisture, and temperature within the soil profile and provide for nutrients available to plants.

Soil filtering and buffering: The ability of soil to act as a filter to protect the quality of water, air, and other resources.

Soil hydrology: The ability of the soil to absorb, store, and transmit water, both vertically and horizontally.

Soil productivity: The inherent capacity of a soil to support the growth of specified plants and plant communities, or sequence of plant communities.

Soil stability and support: The ability of soil aggregates to resist disruption when outside forces (usually associated with water) are applied. Determined by soil texture and particle size distribution.

Spatial scale: The scale at which the Forest is using in the analysis for the assessment. They must be sufficiently large to adequately address the interrelationships between conditions of the Forest and the broader landscape, but not so large that the interrelationships lose relevance in guiding land management planning.

Special use authorization: A written permit, term permit, lease, or easement that authorizes use or occupancy of NFS lands and specifies the terms and conditions under which the use or occupancy may occur.

Stressors: Factors that may directly or indirectly degrade or impair ecosystem composition, structure, or ecological process in a manner that may impair its ecological integrity.

Surface Fire: Fire that burns loose debris on the surface, which includes dead branches, leaves, and low vegetation.

Surface Fuel: Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants.

Sustainability: The capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs.

Unpatented mining claim: A mining claim on a parcel of federal land, valuable for a specific mineral deposit or deposits. It is a parcel for which an individual has asserted a right of possession. The right is restricted to the extraction and development of a mineral deposit. The rights granted by a mining claim are valid against a challenge by the United States and other claimants only after the discovery of a valuable mineral deposit.

Vegetation condition class: A classification of the amount of departure from the natural regime that considers all vegetation characteristics including present and historic plant species, stocking amounts, and size and age of tree species.

Vegetation types: Forest vegetation GIS layers showing vegetation types in major categories.

Viewsheds: Foreground, middle ground, and background zones as measured in distances from a given point.

Watershed: A geographic area of land, water, and the animal and plant life within the confines of a drainage divide or line. The boundary between two watersheds is defined as the topographic dividing line from which water flows in two different directions.

Wildland fire: Any non-structure fire that occurs in vegetation or natural fuels. Wildland fire includes prescribed fire and wildfire.

Wildland urban interface: The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. Describes an area within or adjacent to private and public property where mitigation actions can prevent damage or loss from wildfire.