U.S. Department of the Interior

National Park Service

NPS Intermountain Region

Valles Caldera National Preserve

Valles Caldera National Preserve Fire Management Plan Environmental Assessment

September 2024

Land Acknowledgement Statement

Valles Caldera is of spiritual and ceremonial importance to numerous American Indian peoples in the greater Southwest region. We recognize this is a regionally significant geographic and cultural focal point and a pivotal sacred place for numerous tribal groups. These cultural connections are both contemporary and of great antiquity, and we respectfully seek to uphold the values and prioritize the voices of the tribes and pueblos for whom this special place continues to be part of their practices, beliefs, identity, and history.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to assure that their development is in the best interests of all. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

Public Comment

Public comments on Valles Caldera National Preserve's Fire Management Plan Environmental Assessment are welcomed by the National Park Service during the 30-day public review period. Comments may be made electronically through the National Park Service Planning, Environment, and Public Comment (PEPC) website at http://parkplanning.nps.gov by retrieving "Valles Caldera National Preserve Fire Management Plan Environmental Assessment 2024." Written comments may be addressed to the individual listed below:

Laura Trader
Ecologist
Fire Management Program
15 Entrance Road
Los Alamos, New Mexico 87544

Please note it is our practice to make entire comments, including names, addresses, phone numbers, and email addresses, publicly available. Individuals may request that we withhold this information, but we cannot guarantee we will be able to do so. If you would like us to consider withholding this information, please state your request prominently at the beginning of your comments and present a rationale for withholding it. The rationale must demonstrate that disclosure would constitute a clearly unwarranted invasion of privacy. In the absence of documentable circumstances, this information will be released. We will always make comments from businesses or organizations, and from individuals identifying themselves as representatives of or officials from businesses or organizations, available in their entirety for public inspection.

ON THE COVER: Naturally ignited fire in Valles Caldera National Preserve, New Mexico.
Photo: Katherine Brinkman, 2022

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1. Purpose and Need for Action

1.1 Introduction

The United States (U.S.) Department of the Interior (DOI), National Park Service (NPS) is proposing to develop and implement a programmatic fire management plan (FMP) for Valles Caldera National Preserve ("Valles Caldera," or "park").

This Environmental Assessment (EA) evaluates potential effects of two FMP alternatives on the natural, biological, physical, cultural, social, and economic environments related to Valles Caldera and provides an opportunity for public comment, pursuant to the National Environmental Policy Act of 1969 (NEPA), Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] 1500–1508), and other applicable laws, regulations, and policies. The two Alternatives, Alternative A (no action)-a suppression-oriented wildland fire management program and Alternative B (preferred action)-a multiple strategy wildland fire management program, are described in section 2, Alternatives.

Upon completion of this EA and programmatic FMP, project-specific planning (e.g., prescribed burn and manual and mechanical thinning plans) would be formulated with greater specificity and attention to unique features associated with each project area. Threatened and endangered species consultation, cultural resource consultation, and unique habitat and wetland assessments would be conducted as needed as site-specific fire management actions are determined. Unplanned ignitions would be consulted upon on an emergency basis. All responses to wildland fire in the park would include Minimum Impact Strategy and Tactics (MIST) to avoid adverse impacts to natural, biological, and cultural resources (Appendix C). Response to wildland fire in the park would be coordinated extensively with local partners, associated tribes and pueblos, and land management agencies.

The term "wildland fire" is used throughout this EA, and is defined in NPS Directors Order #18, Wildland Fire Management (2008). Wildland fire is any non-structure fire that occurs in the wildland in vegetation or natural fuels. There are two types of wildland fire: 1) Planned ignitions, including broadcast prescribed fire and pile burning, where fire is intentionally ignited by management under an approved plan to meet specific objectives, and 2) Unplanned ignitions, including unplanned human-caused fire and naturally ignited (lightning) fire, also referred to as wildfire. A prescribed fire that has expanded beyond or escaped the predetermined prescribed fire area may be designated a wildfire.

1.2 Purpose and Need for the Proposal

As part of its mission, the NPS Wildland Fire Program manages wildland fire to protect the public, park communities, and infrastructure; conserve natural and cultural resources; and maintain and restore natural ecosystem processes (NPS, 2024e). An FMP is needed to fulfill this mission and meet the requirement that each NPS unit with burnable vegetation, including Valles Caldera, must have an approved FMP that aligns with the Department of Interior (DOI) FMP Framework and NPS fire management planning guidance as described in NPS Reference Manual (RM)-18, Fire Planning, Chapter 4. In addition, an FMP must align with existing park planning documents, such as a general management plan and resource stewardship plan. The purpose of Valles Caldera's FMP is to describe policy, goals, and objectives; establish strategies and tactics for managing wildland fire; provide for firefighter and public safety; and address the need for adequate funding and staffing to support the fire management program.

1.3 Background

Valles Caldera was designated a national preserve on July 25, 2000, when the federal government acquired the land. The Valles Caldera Trust was established to provide management of the park while being overseen by a board of trustees appointed by the president of the United States.

In 2010, as part of a U.S. Forest Service initiative, the Valles Caldera Trust, Jemez Ranger District of the Santa Fe National Forest, and 30 additional agencies and organizations collaborated to submit a proposal titled *Southwestern Jemez Mountains Landscape Restoration Strategy*. The proposal detailed an approach for restoration of more than 200,000 acres in the southwestern region of the Jemez Mountains. The proposal was submitted for funding through the Collaborative Forest Landscape Restoration Program (CFLRP) established by Congress to encourage collaborative, science-based ecosystem restoration of priority forest landscapes in the U.S. The proposal was subsequently awarded ten years of funding for restoration, with an additional five years of monitoring, in Valles Caldera and surrounding Santa Fe National Forest.

In 2012, Valles Caldera Trust completed the draft of Valles Caldera's Landscape Restoration and Stewardship Plan (LRSP), a long-term restoration and integrated stewardship strategy designed to "restore the resilience and adaptive capacity of the preserve's forest and grassland systems; protect and improve wildlife habitats; increase soil, riparian, and wetland resilience; reduce soil erosion; and restore watershed function." The actions described in the plan are grouped into five categories: forest management, wildland fire management, road management and erosion control, riparian and wetland restoration, and burned area rehabilitation. Planned (prescribed) fire, naturally ignited (lightning) fire, and forest thinning are described as essential tools for the restoration and stewardship of park ecosystems and for achieving management objectives.

In May of 2014, Valles Caldera Trust completed and submitted a draft Biological Assessment (BA) to the U.S. Fish and Wildlife Service (USFWS) to evaluate potential direct, indirect, and cumulative impacts of implementation of the LRSP on federally listed threatened, endangered, and proposed species and their critical habitats.

In 2014, Valles Caldera Trust completed an Environmental Impact Statement (EIS) for the LRSP to analyze potential short-term (1-3 year), mid-term (3-10 year), and long-term (>10 year) direct, indirect, and cumulative impacts resulting from plan implementation. The analysis considered actions and impacts at the project and landscape level. The EIS and Record of Decision for the LRSP were finalized in September of 2014.

In December of 2014, the National Defense Authorization Act for Fiscal Year 2015 (Public Law 113-291, Sec. 3043) transferred administration of the park from Valles Caldera Trust to the NPS and the NPS assumed management on October 1, 2015. Although the LRSP and EIS were developed prior to NPS management of Valles Caldera, the 2014 enabling legislation (Public Law 113-291, Sec. 3043) allows for administering management plans and activities adopted by Valles Caldera Trust. Therefore, the LRSP and EIS were used to support and direct fire management actions and treatments from 2015 to 2022. Later in 2022, it was determined that under NPS fire management policy, including NPS RM-18 (NPS, 2023b) and the 2009 Guidance for Implementation of Federal Wildland Fire Management Policy (DOI, 2009), the LRSP did not meet standards to serve as an operational FMP. It could, however, continue to provide the foundation for restoration and stewardship actions in the park in conjunction with a new FMP and NEPA compliance. Since 2022, Valles Caldera and Pueblo Parks Fire have not implemented new thinning or prescribed fire projects.

In February of 2022, Valles Caldera and Pueblo Parks Fire created an FMP Interdisciplinary Team (IDT) that would be responsible for writing and reviewing a new FMP for Valles Caldera. The FMP IDT consisted of the following NPS staff: Superintendent, Chief of Science and Resource Stewardship, Chief of Interpretation, Chief Ranger, Fire Management Officer, Integrated Resources Program Manager, Fire Ecologist, Assistant Fire Management Officer, Cultural Resources Program Manager, Environmental Protection Specialist, Hydrologist, Biological Science Technician (Wildlife), Botanist, Archaeologist, and Geographic Information System Specialist. The FMP IDT held its first meeting on March 10, 2022, with a final meeting on September 20, 2022, and a draft FMP was completed on November 11, 2022. On April 4, 2023, the park was granted permission to begin the NEPA process.

1.4 Project Area Description

Valles Caldera is located at the southern edge of the Rocky Mountains, in the Jemez Mountains of north-central New Mexico. It is approximately 18 miles west of Los Alamos and 22 miles northeast of Jemez Springs, along New Mexico Highway 4 (Figure 1). Most of the park is in Sandoval County, with a small portion in Rio Arriba County. It is surrounded by Santa Fe National Forest, except where it shares boundaries with the Pueblo of Santa Clara to the northeast and Bandelier National Monument to the southeast. Refer to Appendix A for a more detailed park description.

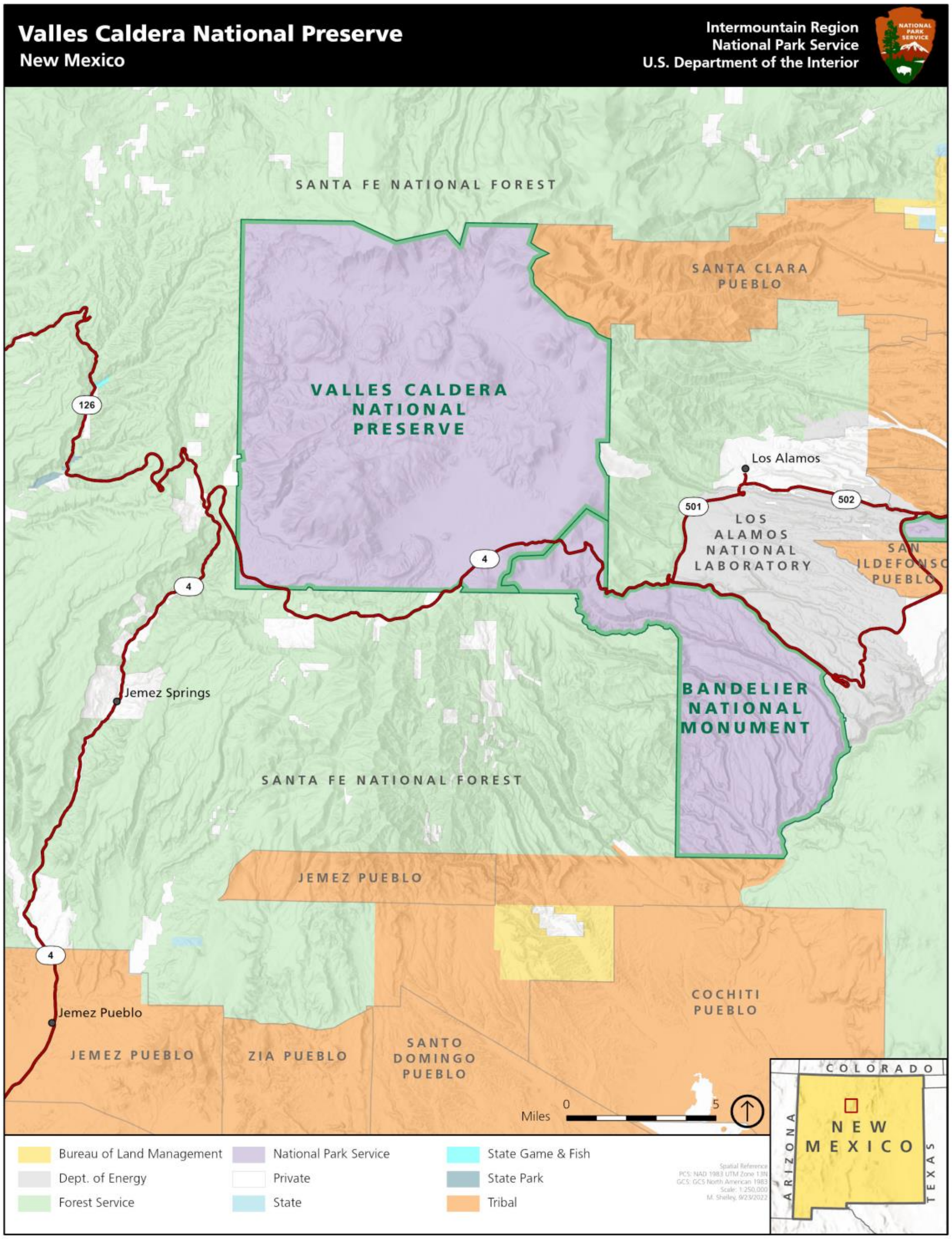


Figure 1. Valles Caldera National Preserve and Vicinity

1.5 Impact Topics

This section identifies resources and other values (impact topics) that could be affected by implementation of Alternative A, a fire suppression-oriented wildland fire management program, and Alternative B, a multiple strategy wildland fire management program. Impact topics and associated issues were identified, discussed, and refined by Valles Caldera's FMP IDT. The FMP IDT identified 23 potential impact topics; 16 impact topics were retained for detailed analysis (Table 1), and seven impact topics were dismissed from further consideration. Each impact topic retained for analysis is further discussed and analyzed in detail in Chapter 3: Affected Environment and Environmental Consequences. Appendix B (Impact Topics Dismissed from Further Analysis) provides a justification for each impact topic that was dismissed from further analysis.

1.5.1 Impact Topics Retained for Detailed Analysis

Table 1. Impact Topics Retained for Detailed Analysis

	Impact Topic		Impact Topic
1	Air Resources: Air Quality	9	Cultural Resources: Prehistoric and Historic Structures
2	Biological Resources: Vegetation	10	Geological Features: Obsidian
3	Biological Resources: Wildlife	11	Soil Resources and Geological Processes
4	Biological Resources: Special Status Species (Wildlife)	12	Water Resources: Floodplains
5	Biological Resources: Special Status Species (Plants)	13	Water Resources: Water Quality or Quantity
6	Cultural Resources: Archaeological Resources	14	Human Health and Safety
7	Cultural Resources: Cultural Landscapes	15	Visitor Use, Experience, and Recreation
8	Cultural Resources: Ethnographic Resources	16	Viewsheds

2. Alternatives

2.1 Introduction

This EA considers two alternatives, Alternative A (no action) and Alternative B (preferred action).

Alternative A (no action): a suppression-oriented wildland fire management program where suppression-oriented goals and objectives would prioritize safety and manage risk to people, natural, biological, and cultural resources, and infrastructure; and enhance relationships and collaboration for fire suppression.

Alternative B (preferred action): a multiple strategy wildland fire management program where goals and objectives would prioritize safety and manage risk to people, natural, biological, and cultural resources, and infrastructure; enhance relationships and collaboration in all fire management actions and activities, including wildfire, prescribed fire, and forest thinning; prioritize ecosystem stewardship; allow naturally ignited fire to function; employ monitoring, research, and adaptive management; and incorporate adaptation to changing environmental conditions.

2.2 Alternatives Carried Forward for Analysis

2.2.1 Features Common to Both Alternatives

Fire Management Unit
Under both Alternative A and B, one Fire Management Unit (FMU) would be established for Valles Caldera (Figure 2). Under Alternative A, the unit would be designated a Fire Suppression FMU. Under Alternative B, the unit would be designated a Multiple Strategy FMU.

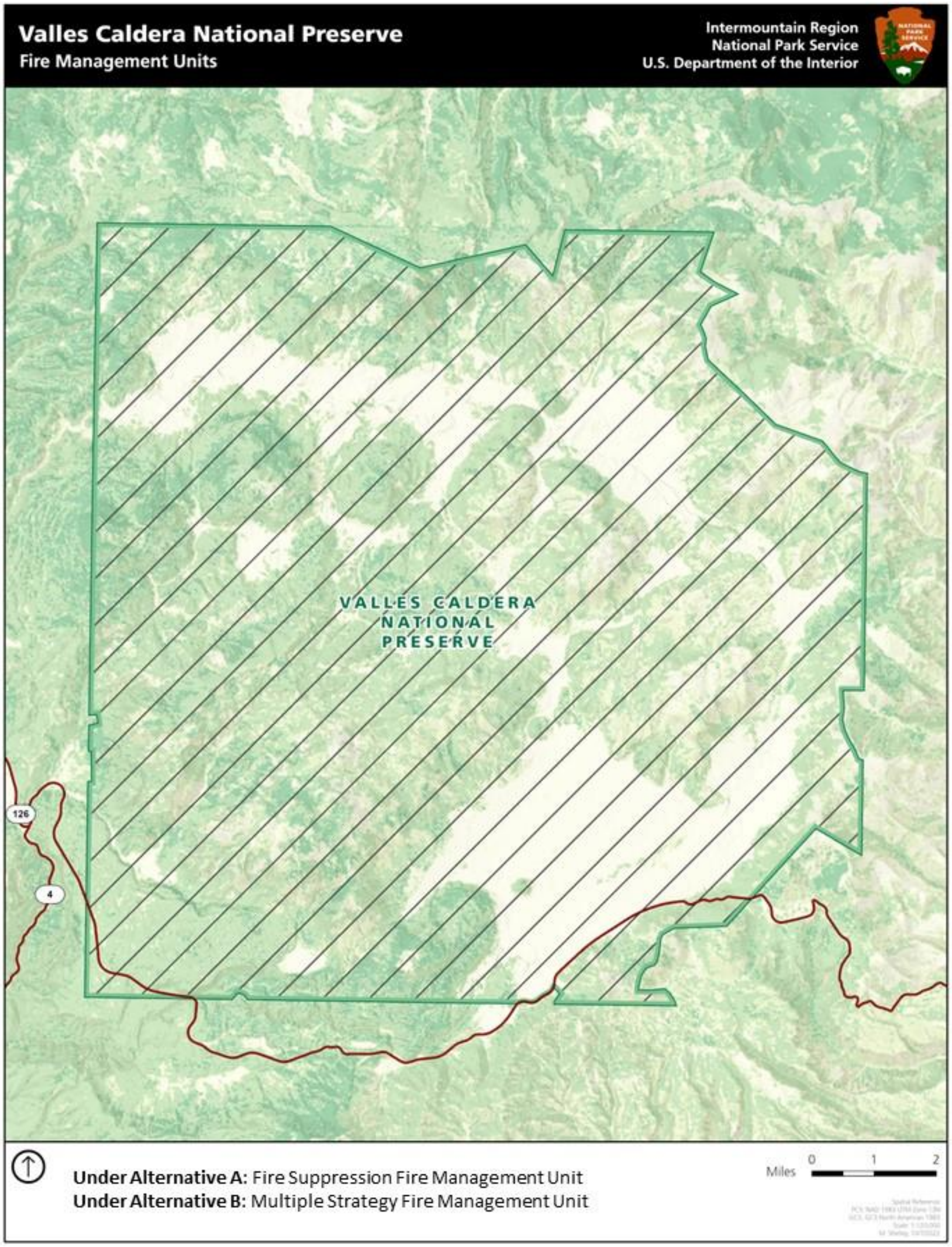


Figure 2. Valles Caldera National Preserve Fire Management Unit

Unplanned Fire: Management of Wildfires

Response to unplanned wildland fire would be based on safety, fire location, time of year, weather, climate, resource availability, values at risk, the environmental, ecological, and social consequences of fire, and costs. The circumstances under which a fire occurs, and the likely consequences to firefighter and public safety and welfare; natural, biological, and cultural resources; and values to be protected would dictate the management response. All human-caused wildfires would be suppressed.

Under both Alternative A and B, the range of fire management strategies that can be employed in any combination to manage unplanned fire in Valles Caldera include monitor, confine, point or zone protection, and full suppression (Table 2).

However, under Alternative A the objective for response to unplanned wildland fire would be full fire suppression. Under Alternative B, unplanned wildland fire may be managed for one or more objectives and the objectives may change as fire moves across the landscape. Objectives could range from full fire suppression to allowing a naturally ignited (lightning) fire to burn in a defined geographic area, under specific prescription parameters, to accomplish fire and resource management goals and objectives.

Table 2. Wildfire Management Strategies

Wildfire Management Strategy	Definition
Monitor	The systematic process of observing, collecting, and recording of fire-related data, particularly regarding fuels, topography, weather, fire behavior, fire effects, smoke, and fire location. This may be done on-site from a nearby or distant vantage point, or off-site using a sensor or through remote sensing (aircraft or satellite).
Confine	The process of restricting a wildfire to a defined area using a combination of natural and constructed barriers to stop the spread of fire under the prevailing and forecasted weather conditions. Actions to suppress portions of the fire perimeter may include handline construction, water and retardant drops from aircraft, and/or ignitions by fire crews to create boundary or internal blacklines.
Point or Zone Protection	A variety of suppression actions taken to protect a specific area from fire while not actively lining the entire fire perimeter, usually with tactics that contain progressive fire encroachment away from values at risk such as homes, communities, and areas of high resource value.
Full Suppression	Extinguishing a fire as efficiently and effectively as possible and addressing all “hot spots” that are an immediate threat to control lines or are outside the fire perimeter. Synonymous with “Full Perimeter Containment” and “Control.” Full suppression can include a fire that is burning outside of prescription parameters, is not meeting fire and resource objectives, or may pose an immediate threat to life or property. All human caused wildfires will be fully suppressed. Tactics for suppression are varied and depend on the situation (e.g., location, weather, safety considerations.) for each individual fire. Suppression actions can include hand crews cutting a line around a fire perimeter to halt fire spread; water and retardant drops from aircraft; manual and mechanical thinning; “burn out” situations in which fire is used to remove live and dead vegetation to stop the fire; and “cold trailing” in areas of low fuel loads, where crews physically feel the ground and put out “hot spots.”

Minimum Impact Strategy and Tactics
To avoid adverse impacts to natural, biological, and cultural resources when managing wildland fire in Valles Caldera, MIST would be employed as described by NPS policy in Exhibit 1 of RM-18, Managing Wildland Fire, Chapter 2 and as detailed in Appendix C. MIST is a framework for identifying and applying strategies and tactics to manage wildland fire while minimizing long-term effects of management actions. The aim is to help identify the minimum tools to accomplish tasks safely and effectively and to meet suppression and resource objectives while causing the least environmental, cultural, and social impacts.

Post-fire Programs and Response
Prompt action to minimize threats to life or property and prevent unacceptable degradation to natural and cultural resources would be taken after wildfires. Damages resulting from wildfires would be addressed through four actions: Suppression Repair, Emergency Stabilization, Rehabilitation, and Restoration (Table 3).

Table 3. Post-fire Programs and Response

Postfire Programs and Response	Definition
Suppression Repair	The Incident Commander or assigned representative is responsible for ensuring the assessment and implementation of suppression repair work.
Emergency Stabilization	Emergency Stabilization (ES) activities intend to protect life and property and critical resource values from additional damage by post-fire events such as flooding or tree fall. An ES plan must be developed and proposed for funding. These actions are the responsibility of the Superintendent, who may designate a team of specialists to evaluate, propose, and carry out the ES plan.
Rehabilitation	The intent of rehabilitation is to repair wildfire-damaged lands that are unlikely to recover naturally to management approved conditions, or to repair or replace minor facilities damaged by wildfire. This activity must be proposed in a Burned Area Rehabilitation (BAR) plan.
Restoration	The intent of restoration is to continue the rehabilitation efforts started in the BAR process beyond the time-period limitation set by the DOI.

Defensible Space and the Wildland Urban Interface
Defensible space and structure protection in Valles Caldera's FMU (Figure 3) would generally include manual and mechanical thinning treatments such as mowing, trimming, limbing, and removal or redistribution of vegetation and hazardous fuels. Thinning treatments would occur where needed for defensible space, but would focus on the Cabin District, entrance station, road corridors, utility corridors, Banco Bonito primitive campground, backcountry cabins, scientific instrument installations (e.g., RAWS sites, flux towers, SNOTEL sites, seismograph stations), radio repeaters, and other historic assets such as San Antonio Cabin. Defensible space actions would be the same under Alternative A and Alternative B. However, there may increases in frequency and area treated under Alternative A due to a lack of thinning, prescribed fire, and allowing naturally ignited fire to burn.

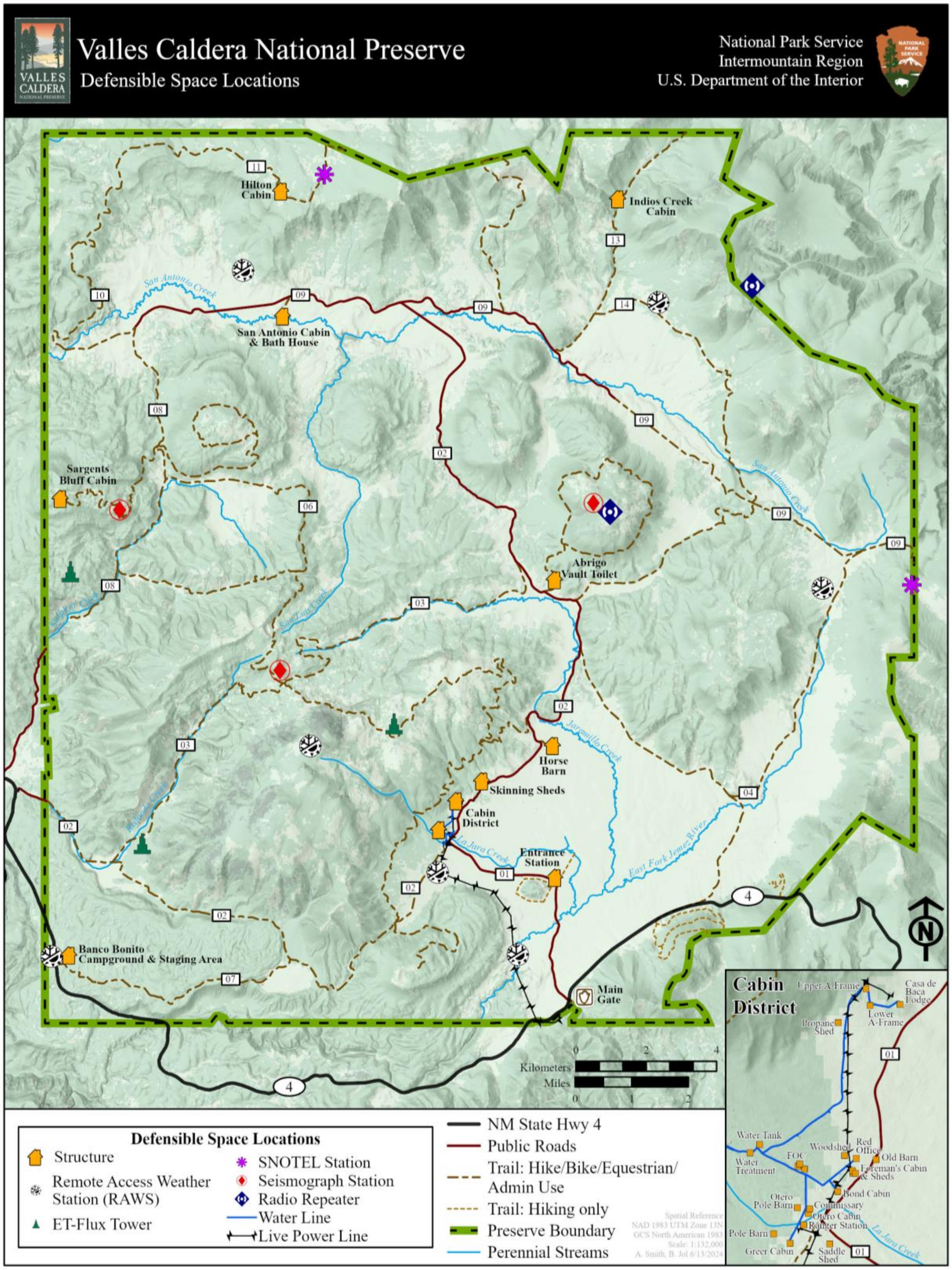


Figure 3. Defensible Space Locations in Valles Caldera's Fire Management Unit

2.2.2 Alternative A: No Action (Suppression-oriented wildland fire management program)

This section describes features unique to Alternative A. Refer to section 2.2.1 for features common to both alternatives.

Goals and Objectives

Alternative A would include suppression-oriented goals and objectives (Table 4) to prioritize safety and manage risk to people, natural, biological, and cultural resources, and infrastructure, and to enhance relationships and collaboration for fire suppression.

Table 4. Alternative A Goals and Objectives

Goal 1: Manage risk to employees and the public and ensure safety is the highest priority in all fire suppression actions
Objectives
• Utilize the most current risk management techniques in all fire suppression actions.
• Suppress all wildland fires.
• Communicate to the public the goals and objectives related to all fire suppression actions.
• Cooperate extensively with tribes and pueblos, adjacent landowners, and land management agencies regarding all wildfires.
• Conduct post-fire reviews to evaluate firefighter and public safety.
Goal 2: Manage fire risk to sensitive natural, biological, and cultural resources and infrastructure
Objectives
• Reduce hazardous fuels and create defensible space zones in developed areas, including the Cabin District, entrance station, road corridors, utility corridors, Banco Bonito primitive campground, backcountry cabins, scientific instrument installations, radio repeaters, other historic assets such as San Antonio Cabin, and the Wildland Urban Interface.
• Develop and implement preservation and protection measures for natural, biological, and cultural resources.
• Employ Minimum Impact Strategy and Tactics (MIST) to avoid adverse impacts to natural, biological, cultural resources, and wilderness values and character.
• Ensure a Resource Advisor is present and consulted on all major fire suppression actions.
Goal 3: Enhance internal and external relationships for fire suppression through collaboration, communication, and education
Objectives
• Cultivate and maintain inclusive, authentic, and durable partnerships with Native American communities, supporting cultural practices and honoring the sacredness of the land in all fire suppression actions.
• Emphasize interagency communications and cross-boundary collaboration for fire suppression, training, sharing of resources, and evaluation of fire suppression actions.
• Communicate Firewise information in local communities, working in collaboration with tribes and pueblos, and county, state, and federal agencies.

Collaboration, Communication, and Education
Alternative A would prioritize both internal and external collaboration, communication, and education for fire suppression. Interagency communications and cross-boundary collaboration for fire suppression would be emphasized. Firewise information would be shared locally.

Valles Caldera's Public Information Officer (PIO) or interpretative staff would be responsible for providing timely and accurate information to visitors, neighbors, and the public regarding fire suppression actions. This would include press releases related to initial responses to unplanned fire, fire suppression actions, situational updates, fire danger ratings, fire restrictions, smoke, closures, and other impacts to the public. Information would also be posted on information boards in Valles Caldera and on Valles Caldera's website and social media accounts. During a large or complex wildfire, public information and guidance would be delegated by the Superintendent to the Incident Management Team.

Response to Unplanned Wildland Fire (Wildfire)
The objective for response to unplanned wildland fire would be full fire suppression. The range of strategies that would be employed to meet objectives would include monitor, confine, point or zone protection, and full suppression (as described in Table 2).

Fuel Treatments
Fuel treatments, such as manual and mechanical thinning and prescribed fire, would not be implemented under Alternative A except for defensible space and fire suppression actions.

Monitoring, Research, and Partnerships
There may be opportunity for monitoring, research, and partnering related to defensible space actions and unplanned, suppressed fires in Valles Caldera.

Science-based Adaptive Management and the Resist, Accept, and Direct Decision Framework
Because the science-based adaptive management concept in the fire management program is primarily focused on ecosystem stewardship and implementation of treatments such as prescribed fire and thinning, the opportunity for this concept to be fully implemented under a fire suppression only objective is limited. The Resist-Accept-Direct (RAD) framework may be limited to "Accept" (accepting ecosystem transformations by not intervening and accepting the ecosystem conditions that result) in a fire suppression only program.

Tribal Partnerships and Indigenous Knowledge
Alternative A would focus on cultivating and maintaining inclusive, authentic, and durable partnerships with Native American communities, supporting cultural practices, and honoring the sacredness of the land in all fire suppression actions. Alternative A would engage tribal forestry and fire crews in fire suppression operations.

Conservation and Protection Measures, Performance Requirements, Best Management Practices, and Mitigations for Threatened and Endangered Species and Cultural Resources
Under Alternative A, the fire management program would consult with USFWS regarding potential impacts to federally listed species and the State Historic Preservation Office (SHPO) and Tribal Nations regarding cultural resources as related to fire suppression actions and post-fire response.

2.2.3 Alternative B: Preferred Action (multiple strategy wildland fire management program)
This section describes features unique to Alternative B. Refer to section 2.2.1 for features common to both alternatives.

Goals and Objectives
Under Alternative B, goals and objectives (Table 5) would prioritize safety and manage risk to people, natural, biological, and cultural resources, and infrastructure; enhance relationships and collaboration in all fire management actions and activities, including wildfire, prescribed fire, and forest thinning; prioritize ecosystem

stewardship; allow naturally ignited fire to function in fire-dependent ecosystems; employ monitoring, research, and adaptive management; and incorporate adaptation to changing environmental conditions.

Table 5. Alternative B Goals and Objectives

Goal 1: Manage risk to employees and the public and ensure safety is the highest priority in all fire management actions and activities
Objectives
• Utilize the most current risk management techniques in all fire management actions and activities.
• Suppress all wildland fires with a high probability of undesired outcomes.
• Communicate to the public the goals and objectives related to all fire management actions and activities.
• Cooperate extensively with tribes and pueblos, adjacent landowners, and land management agencies regarding all wildland fires.
• Conduct post-fire reviews to evaluate firefighter and public safety.
Goal 2: Utilize the full range of fire management actions and activities in the stewardship of ecosystems
Objectives
• Restore or modify forest structure and composition to reduce the risk of uncharacteristically severe fire.
• Use thinning and fire to create and maintain a diversity of meadow, grassland, shrubland, and forest vegetation communities that represent a spectrum of successional stages at the landscape scale.
• Use fire to mimic beneficial fire regimes.
• Use fire to promote native vegetation and implement post-fire actions to discourage non-native invasive species.
• Use thinning and fire to increase landscape resilience and resistance to pests and pathogens.
• Use thinning and fire to maintain or improve characteristics of terrestrial and aquatic wildlife habitat, water quality, and watershed function.
Goal 3: Promote cultural, social, and ecological conditions that allow naturally ignited fires to function in fire dependent ecosystems
Objectives
• Maintain vegetative structure and composition that allows naturally ignited (lightning) fire to function in fire-adapted ecosystems to the maximum extent possible.
• Allow naturally ignited fire to function when possible and in a safe manner, in collaboration with tribes and pueblos, adjacent landowners, and land management agencies.
• Foster fire-adapted human communities.
• Promote monitoring, science, and Indigenous Knowledge and encourage employees, associated tribes and pueblos, and visitors to learn and engage in the process of land stewardship.
• Share success stories and outcomes of fire and resource management treatments and projects.
Goal 4: Manage fire risk to sensitive natural, biological, and cultural resources and infrastructure
Objectives
• Reduce hazardous fuels and create defensible space zones in developed areas, including the Cabin District, entrance station, road corridors, utility corridors, Banco Bonito primitive campground, backcountry cabins, scientific instrument installations, radio repeaters, other historic assets such as San Antonio Cabin, and the Wildland Urban Interface.

• Implement fire and resource management treatments in forest refugia and in buffers surrounding fire-sensitive areas and species.
• Develop and implement preservation and protection measures for natural, biological, and cultural resources.
• Adhere to conservation and protection measures, performance requirements, best management practices, and mitigations for threatened and endangered species as described in the U.S. Fish and Wildlife Service Biological Opinion and for cultural resources as described in National Historic Preservation Act Section 106 agreement documents.
• Employ Minimum Impact Strategy and Tactics (MIST) to avoid adverse impacts to natural, biological, cultural resources, and wilderness values and character.
• Ensure a Resource Advisor is present and consulted on all major fire management program actions and activities.
Goal 5: Enhance internal and external relationships through collaboration, communication, and education
Objectives
• Foster understanding and support among employees, visitors, neighbors, and partners for wildland fire, fuels management, fire ecology, and aviation programs.
• Cultivate and maintain inclusive, authentic, and durable partnerships with Native American communities, supporting cultural practices and honoring the sacredness of the land in all fire management actions and activities.
• Emphasize interagency communications and cross-boundary collaboration for fire management activities, training, sharing of resources, and evaluation of fire management actions and activities.
• Communicate both Firewise and fire ecology information in local communities, working in collaboration with tribes and pueblos, and county, state, and federal agencies.
• Facilitate the integration of Indigenous Knowledge and fire science to improve understanding of the role of fire in ecosystem stewardship.
Goal 6: Use monitoring, research, and partnerships to advance science-based wildland fire management decision-making and facilitate adaptation to changing environmental conditions
Objectives
• Promote inquiry and flexibility in fire and ecosystem stewardship, considering historic ranges of variation, a changing climate, and a future range of variability.
• Use available environmental, natural, and cultural resource datasets to develop site-specific fire and resource management objectives for each treatment plan.
• Engage in adaptive management by collectively evaluating pre- and post-treatment datasets and consider using fire and fuel treatments in innovative ways.
• Consider future and changing ecological, climate, and fuel conditions, and fire regimes during the planning process and adaptive management cycle.
• Consider the Resist-Accept-Direct framework for ecosystem and land stewardship, particularly in ecosystems facing rapid ecological change.
• Develop wildland fire strategies in altered or novel ecosystems where fire can play a beneficial role.
• Engage and utilize the collective knowledge base of the Southwest Jemez Mountains Collaborative and the Jemez Mountains Research Learning Center.

Collaboration, Communication, and Education

Alternative B would prioritize both internal and external collaboration, communication, and education. Internal collaborative planning for all fire management actions and activities, including planned and unplanned fire, thinning, and fire monitoring and research would be enhanced by establishing an internal Fire Interdisciplinary Team (Fire IDT). Interagency communications and cross-boundary collaboration for fire management actions and activities would be emphasized. The fire program would focus on fostering fire-adapted human communities, as well as understanding and support among employees, visitors, neighbors, and partners for wildland fire, fuels management, and aviation programs. Firewise and fire ecology information, fire success stories, and outcomes of fire and resource management treatments and projects would be shared nationally and locally.

Valles Caldera's PIO or interpretive staff would be responsible for providing timely and accurate information to visitors, neighbors, and the public regarding all fire management actions and activities. This would include press releases related to initial responses to unplanned fire, fire suppression actions, situational updates, prescribed fire, thinning, treatment goals and objectives, fire danger ratings, fire restrictions, smoke, closures, and other impacts to the public. Information would also be posted on information boards in Valles Caldera and on Valles Caldera's website and social media accounts. During a large or complex wildfire, public information and guidance would be delegated by the Superintendent to the Incident Management Team.

Unplanned Fire: Management of Wildfire

Under Alternative B, unplanned fire may be managed for one or more objectives and the objectives may change as fire moves across the landscape. Objectives could range from full fire suppression to allowing a naturally ignited (lightning) fire to burn in a defined geographic area, under specific prescription parameters, to accomplish fire and resource management goals and objectives. The range of strategies that would be employed to meet objectives would include monitor, confine, point or zone protection, and full suppression (as described in Table 2).

Fuel Treatments

Under Alternative B, fuel treatments including planned (prescribed) fire (Table 6) and manual and mechanical thinning and removal or redistribution of thinned materials (Table 8) would be used in Valles Caldera to minimize risk to life, property, and resources; achieve structural protection and safety objectives; reduce hazardous fuels; create and maintain defensible space; mimic beneficial fire regimes, and facilitate ecosystem stewardship. Treated areas would function as a fuel break to facilitate management of future wildland fires and may create conditions that allow naturally ignited (lightning) fires to function in Valles Caldera's fire dependent ecosystems.

Thinning and prescribed fire treatments in Valles Caldera would move the structure, composition, and function of the park's ecosystems toward more resilient conditions that have the adaptive capacity to recover from wildfire, insect and disease outbreaks, and climate change. Treatments would reintroduce fire as a natural disturbance and beneficial process on the landscape, resulting in reduced risk of unusually severe or extensive wildfire that could adversely impact human communities and damage water, soil, wildlife, scenery, heritage resources, recreation opportunities, tourism, and other values. Treatments would also repair and rehabilitate areas adversely affected by past wildfire and post-fire flooding and erosion.

Thinning and prescribed fire treatments would play a critical role in addressing a multitude of ecosystem stewardship needs for Valles Caldera. Treatments are expected to reduce the over-abundance of smaller diameter trees and closed-canopy forest that dominates the landscape; increase the amount of mature and old-growth forest characteristics including the number of large trees, snags, and downed logs; reduce inter-tree competition for water, nutrients, and light; increase tree water balance, growth rates, and carbon sequestration; increase the abundance and diversity of herbaceous vegetation; increase regeneration of ponderosa pine seedlings and aspen; increase the relative abundance of thick-barked fire-resistant tree species; reestablish or expand historic meadow and grassland ecosystems; improve wildlife habitat quality and diversity for native species; reduce soil erosion and increase soil productivity; and improve hydrologic function and soil moisture recharge. Thinning and burning to achieve these conditions would increase biological diversity and species richness for flora and fauna.

Locations for fuel treatments in Valles Caldera would be identified and prioritized based on risk to life, property, and resources, including areas where: defensible space is needed to facilitate management of wildland fire; hazardous fuel reduction is needed for structure protection; fire behavior potential is high; natural, biological, and cultural resources are at risk; forests have a high degree of ecological and fire return interval departure. Forests in the southwest corner of Valles Caldera would be a priority for fuel treatments due to a high incidence of fire occurrence in areas south and west of the park. Predominant winds are from the west and southwest and the area is characterized by west and south facing slopes. The alignment of forest, wind, slope, and high fire occurrence create high fire risk. Fuel treatments have occurred in the southwest corner, would continue to the north and east, and would be maintained over time.

Fuel treatment planning, including project prioritization, design, and description, goal and objective development, implementation, and monitoring, would be collaborative, through Valles Caldera's Fire IDT. Fuel treatment planning would follow the adaptive management framework established in Appendix D, the National Park Service Fuel Treatment Flow Diagram. Data collected by Pueblo and Four Winds Fire Ecology Program and Valles Caldera's Science and Resource Stewardship Program would be used as a baseline to guide fuel treatment planning. Fuel treatment planning would also consider the Resist-Accept-Direct (RAD) framework.

Treatment plans would include site-specific, measurable objectives created by Valles Caldera's Fire IDT through examination of site-specific data collected by Pueblo and Four Winds Fire Ecology Program and Valles Caldera's Science and Resource Stewardship Program. After a treatment is implemented, post-treatment data would be collected and used to evaluate if objectives were met, to measure the effectiveness of prescriptions, and to determine if additional research is needed.

Planned (Prescribed) Fire

A prescribed fire is intentionally lit under predetermined conditions to meet fire and resource management goals and objectives. Under Alternative B, prescribed fire would include slash and wood pile burning, jackpot burning, and broadcast burning (Table 6). Refer to Table 7 for target vegetation communities and general prescription guidelines for prescribed fire.

Table 6. Types and Definitions of Planned (Prescribed) Fire

Types of Planned (Prescribed) Fire:	Definitions
Slash and wood pile burning	Vegetation is cut and/or moved to a central location (a pile) and burned.
Jackpot burning	Naturally existing accumulations of fuels and/or vegetation are targeted for ignition.
Broadcast burning	Fire is ignited within a predefined area and allowed to move through the vegetation and fuel within those boundaries.

Table 7. Target Vegetation Communities and General Prescription Guidelines for Prescribed Fire

Target Vegetation Community	General Prescription Guidelines for Prescribed Fire
Ponderosa Pine Forest and Savanna, Xeric Mixed-conifer Forest	Prescribed fire would be used in these vegetation communities alone or following thinning treatments. Prescription parameters would emphasize a mosaic of low- to moderate-severity fire interspersed with unburned patches to reduce hazardous fuels, restore composition and structure, and dispose of biomass from thinning treatments.
Montane Grassland and Forest Meadow	Prescribed fire would be used in these vegetation communities alone or with thinning treatments along grassland and forest boundaries. Prescriptions would promote low- to moderate-severity

Target Vegetation Community	General Prescription Guidelines for Prescribed Fire
	fire with patchy continuity to reduce tree encroachment, initiate nutrient cycling, and restore species composition, cover, and richness.
Aspen Forest and Mesic Mixed-conifer Forest	Prescribed fire would be used in these forest types alone or following thinning treatments. Prescriptions would promote low- to mixed-severity fire with patchy continuity to reduce hazardous fuels, restore structure and composition, and dispose of biomass from thinning treatments.
Gambel Oak/Mixed Montane Shrubland	Prescribed fire would be used to enhance structural diversity and wildlife habitat improvements initiated by thinning treatments. Prescriptions would promote low-intensity fire with patchy and discontinuous burning to restore structure and composition and dispose of biomass from thinning treatments.
Mesic and Xeric Spruce-fir Forests	Prescribed fire would be used in these forest types alone or following thinning treatments. Prescriptions will promote low- to mixed-severity fire with patchy continuity to reduce hazardous fuels, restore structure and composition, and dispose of biomass from thinning treatments.

Manual and Mechanical Thinning and Removal or Redistribution of Thinned Materials
Non-fire fuel treatments, such as manual and mechanical thinning and removal or redistribution of thinned materials, involve removing live and dead vegetation according to a prescribed plan to meet specific objectives (Table 8). Thinning would be used as a pre-treatment for prescribed fire to remove smaller diameter trees, shrubs, and snags to keep fire within a designated area or to protect specific resources. Thinning would also be used in suppression actions and as an effective treatment for defensible space and in the Wildland Urban Interface. Thinning treatments at Valles Caldera would be designed to retain large trees, logs, and snags, and emphasize retention of fire-resistant species like thick-barked ponderosa pine and Douglas-fir species. Refer to Table 9 for target vegetation communities and general prescription guidelines for thinning.

Table 8. Types and Definitions of Thinning and Removal or Redistribution of Fuels

Types of Thinning	Definition
Manual Thinning	A method used to trim limbs from trees as well as cut down individual trees and other vegetation using a chainsaw, crosscut saw, or axe.
Mechanical Thinning	A method used to cut down trees and other vegetation using vehicles, equipment, and other specialized apparatus.
Types of Removal or Redistribution of Fuels	**Definition**
Piling	Moving thinned or downed vegetation and logs to a central location (a pile).
Haul Out	The disposal of thinned forest vegetation by removing (or hauling) it from the site. Removal may include yarding or skidding (transporting trees or parts of trees by trailing or dragging them to a road or landing site).
Lop and Scatter	A method of forest treatment where thinned trees and other vegetation (slash) are manually lopped and limbed into smaller pieces (so the materials lay flatter to the ground) and distributed across the site. Lop and scatter can increase surface fuel

	loading; however, benefits can include breaking up concentrations of fuel, reducing soil erosion, and retaining water and nutrients on-site.
Mechanical Scattering	Using mechanized equipment to chunk or chop (not shred or chip) thinned trees and other vegetation into smaller pieces and distributing the materials across the site.

Table 9. Target Vegetation Communities and General Prescription Guidelines for Thinning

Target Vegetation Communities	General Prescription Guidelines for Thinning
Ponderosa Pine Forest and Savanna, Xeric Mixed-conifer Forest	These vegetation communities would be assigned a "Restoration" prescription, where the largest and healthiest trees would be left in groups with 10-20 feet between tree canopies and 25-50 feet between groups of trees. The largest and most vigorous ponderosa pine and Douglas-fir, as well as aspen, would be favored for retention. Small diameter white fir, Douglas-fir, and ponderosa pine would be targeted for removal.
Montane Grassland and Forest Meadow	This vegetation community would be assigned a "Restoration" prescription, where small, well-spaced groups of large diameter trees would be retained and encroaching smaller diameter trees would be thinned.
Aspen Forest and Mesic Mixed-conifer Forest	This vegetation community would be assigned a "Forest Health, "Aspen Regeneration", and "Hazardous Fuels Reduction" prescription, where the focus would be to remove ladder fuels, trees impacted by insects, trees with signs of damage or disease, and fire-intolerant species. Small diameter conifers would be targeted for removal. Large diameter aspen, Douglas-fir, ponderosa pine, and Southwestern white pine would be retained.
Gambel Oak/Mixed Montane Shrubland	This vegetation community would be assigned a "Forest Health" and "Hazardous Fuels Reduction" prescription, where small diameter conifers would be targeted for removal and mature conifers, oak trees, and shrubs would be retained.
Mesic and Xeric Spruce-fir Forests	This vegetation community would be assigned a "Hazardous Fuels Reduction" prescription, where small, diseased, or damaged trees would be removed, targeting white fir, corkbark fir, and Engelmann spruce. Larger and healthier trees of all species would be retained. Fuel breaks would be strategically located to create a patchy landscape of forest stands and meadows, improving safety and effectiveness for wildland fire management.

Monitoring, Research, and Partnerships

Under Alternative B, monitoring, research, and partnerships to advance science-based wildland fire decision-making and facilitate adaptation to changing environmental conditions would be implemented in a combined approach by Pueblo and Four Winds Fire Ecology Program and Valles Caldera's Science and Resource Stewardship Program. Monitoring and research would be focused on treatment effects, fire effects, fire science, and climate change, and in direct support of threatened and endangered species as it relates to fire management actions and activities, in consultation with USFWS. External partnerships for science and monitoring would be enhanced.

Science-based Adaptive Management and the Resist, Accept, and Direct Decision Framework

Valles Caldera and Pueblo Parks Fire would implement deliberate and measurable treatment actions monitored through Pueblo and Four Winds Fire Ecology Program and Valles Caldera's Science and Resource Stewardship

Program. Data collected by both programs would be used as a baseline to guide fire management planning and to create site-specific objectives for prescribed fire and thinning plans. After a treatment is implemented, the data would be used to evaluate if objectives are met, to measure the effectiveness of fire and thinning prescriptions, and to determine if additional monitoring or research is needed.

As part of the science-based adaptive management process, Alternative B would implement the Resist-Accept-Direct (RAD) framework (Table 10) when making decisions regarding ecosystem and land stewardship, particularly in ecosystems facing rapid ecological change as a result of a changing climate or other drivers of change.

Table 10. Resist-Accept-Direct Framework Stewardship Options

RAD Option	Definition
Resist	Resisting ecosystem transformations by focusing actions on maintaining current or historical ecosystem conditions
Accept	Accepting ecosystem transformations by not intervening and accepting the ecosystem conditions that result
Direct	Directing ecosystem transformations toward a desired outcome by actively intervening to shape ecosystem change in the direction of new conditions

The RAD framework would provide managers and decision-makers a pathway to manage for change, not just persistence. It would encourage looking beyond traditional approaches of maintaining and restoring ecosystems based on historical conditions or snapshots in time to consider novel, forward-looking, and sustainable strategies that examine changing environmental conditions and future ranges of variability.

Tribal Partnerships and Indigenous Knowledge

Alternative B would focus on cultivating and maintaining inclusive, authentic, and durable partnerships with Native American communities, supporting cultural practices, and honoring the sacredness of the land in all fire management actions and activities, including planned (prescribed) and unplanned fire and thinning operations. Alternative B would engage tribal forestry and fire crews in planned and unplanned fire actions, thinning operations, and fire ecology data collection, helping to facilitate the integration of Indigenous Knowledge and fire science to improve understanding of the role of fire in ecosystem stewardship.

Conservation and Protection Measures, Performance Requirements, Best Management Practices, and Mitigations for Threatened and Endangered Species and Cultural Resources

Under Alternative B, the fire management program would consult with USFWS regarding impacts to federally listed species and the SHPO and Tribal Nations regarding cultural resources when developing all prescribed fire and thinning treatment plans. Implementation of treatments would adhere to all conservation and protection measures, performance requirements, best management practices, and mitigations as described in the USFWS Service Biological Opinion and in State Historic Preservation Act Section 106 agreement documents. (Appendix E).

3. Affected Environment and Environmental Consequences

3.1 Introduction

This chapter describes the Affected Environment and evaluates the potential Environmental Consequences on the natural, biological, physical, cultural, social, and economic environments related to Valles Caldera from implementation of Alternative A, a fire suppression-oriented wildland fire management program, and Alternative B, a multiple strategy wildland fire management program.

The Affected Environment section of this chapter describes the existing conditions of the resources and other values ("impact topics" as described in Chapter 1, section 1.5) that have the potential to be affected by implementation of Alternative A and Alternative B. The Affected Environment also describes trends or changes to the environment and other planned actions that can reasonably be estimated and are relevant to the implementation of an FMP.

The Environmental Consequences section describes the effects or potential impacts, including beneficial, adverse, and cumulative impacts to the resources and other values ("impact topics") from implementation of Alternative A and Alternative B. Cumulative impacts result from incremental impacts of the action (alternative) when added to other past, present, and reasonably foreseeable future actions, regardless of the agency or person that undertakes such actions. Cumulative impact analysis considers whether the action is related to other actions with individually insignificant but collectively significant impacts that may take place over time. Only the impact topics that were retained for detailed analysis (Table 1) are included in this section. Other impact topics that were considered but dismissed from detailed analysis are discussed Appendix B.

Impacts are described in terms of the *type* of impact, *duration* of impact, *intensity* of impact, and whether the impact is *direct or indirect* (Table 11).

Table 11. Impact Descriptions (Type, Duration, Intensity, Direct and Indirect)

Term	Description
Type	The *type* of impact describes a relative measure of beneficial or adverse effects. A significant impact may exist even if, on balance, the impact will be beneficial. For example, adverse impacts on ecosystems might be those that would degrade the size, integrity, or connectivity of a specific habitat. Conversely, beneficial impacts might enhance ecosystem processes or increase native species richness.
Duration	The *duration* (short-term or long-term) of the effect of an impact is important to consider, especially because some impacts could have short-term adverse impacts while having long-term beneficial impacts (and vice-versa). Impacts from fire management actions and activities are likely to occur within nested long- and short-term time scales. For example, after a fire, some burned areas are likely to show signs of restoration within one or two growing seasons, while, on a landscape scale, the benefits of restoring fire may take years.
Intensity	Measures of *intensity* consider whether an impact would be small or large, or in some cases irreversible. Measures of intensity are used to describe both beneficial and adverse impacts.
Direct	*Direct* impacts are caused by an action and occur at the same time and place as the action.
Indirect	*Indirect* impacts are not a direct result of an action and often occur later in time and/or further away from an area.

3.2 Air Resources: Air Quality

3.2.1 Affected Environment

The Clean Air Act (42 United States Code [USC] 7401 et seq.) gives federal land managers legal responsibility to protect and prevent significant deterioration of air quality in national parks (NPS, 2018). Specifically, Section 118 of the Clean Air Act requires parks to meet federal, state, and local air pollution standards. Valles Caldera is a Class II area under the Clean Air Act, which means moderate increases in new pollution may be allowed. The closest Class I area is Bandelier National Monument, which shares a common boundary on the southeast corner of Valles Caldera.

The Clean Air Act requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for six commonly occurring air pollutants to protect public health and welfare. The six criteria air pollutants are carbon monoxide (CO), lead, particulate matter (PM), ozone (O_3), nitrogen dioxide (NO2), and sulfur dioxide (SO2). Fine particulate matter, particulate matter measuring 2.5 micrometers or less in diameter ($PM_{2.5}$), is the primary constituent of wildland fire smoke that affects air quality and human health (Urbanski, 2014). Emissions of nitrogen oxides (NOx) and volatile organic compounds (VOCs) can contribute to the formation of ozone (Alvarado et al., 2015). Visibility is primarily impacted by particulate matter (EPA, 2021). The EPA designates areas that do not meet the NAAQS for a pollutant to be in "non-attainment" for that pollutant; Valles Caldera is in attainment (or is unclassifiable) for all pollutants.

The EPA has established an *Interim Air Quality Policy on Wildland and Prescribed Fires* to acknowledge need for the "use of wildland and prescribed fires to achieve resource benefits in the wildlands," and to provide guidance on mitigating air pollution impacts caused by smoke from fires (EPA, 1998). In November of 2023, the EPA entered a Memorandum of Understanding (MOU) between the U.S. Department of Agriculture Forest Service, the U.S. Department of the Interior, and the U.S. Centers for Disease Control and Prevention to address wildland fire and air quality coordination between agencies. The MOU is designed to, "enhance coordination and communication while aligning air quality and land management goals for wildfire risk mitigation, including strategic increase in prescribed fires, and to establish joint strategies for achieving those goals" (USDA, DOI, EPA, CDC, 2023).

On February 7, 2024, the EPA announced a final rule to strengthen NAAQS for $PM_{2.5}$, revise monitoring requirements for $PM_{2.5}$ to address environmental justice concerns, and to revise the $PM_{2.5}$ Air Quality Index. The final rule requires a 25% reduction in allowable $PM_{2.5}$, from 12.0 to 9.0 micrograms per cubic meter (https://www.epa.gov/criteria-air-pollutants/naaqs-table) (EPA, 2024).

The Clean Air Act also allows states to adopt additional ambient air quality standards. The New Mexico Environment Department's (NMED) Air Quality Bureau (AQB) and the EPA established a New Mexico State Implementation Plan to allow the state to assume powers and responsibilities for implementing the Clean Air Act. NMED's AQB developed the New Mexico Smoke Management Program to "protect the health and welfare of New Mexicans from the impacts of smoke from all sources of fire" (NMED, 2005).

The NPS Air Resources Division (ARD) tracks air quality values for NPS units by directly reporting data from in-park monitoring sites or by using an estimation method (NPS, 2022b). Air quality conditions in Valles Caldera are estimated using spatial interpolation. NPS-ARD reports overall air quality as "Fair," based on a 5-year (2017-2021) average assessment of the following individual elements: visibility/haze is Fair, ozone for human health is Fair, ozone for vegetation health is Poor, nitrogen deposition is Fair, and sulfur deposition is Good (NPS, 2021a). Internal sources of air pollution in Valles Caldera include vehicle exhaust, road dust, and smoke from wildfires or prescribed fires. External sources of air pollution include industrial facilities such as power plants, vehicle exhaust, oil and gas production, and wildfires (NPS, 2018).

The climate and fire regimes of Valles Caldera have a strong influence on air quality. The regional climate is semi-arid with seasonal variations in temperature and precipitation. The majority of annual precipitation falls during the summer monsoon period from July to September and during winter snowstorms. Spring months are typically dry, warm, and windy, producing conditions favorable for wildfire ignition and spread, leading to an annual peak in smoke emissions by June. Fire ignitions are more frequent during the summer monsoonal period when thunderstorms are common, but the extent of area burned and therefore smoke emissions are greater in spring months when temperatures are typically higher, and fuels tend to be drier (Snyderman & Allen, 1997). Vegetation communities across Valles Caldera are largely dependent on frequent fire activity of low- and moderate-severity with an average fire interval of 6-60 years (NPS, 2014). Historically, smoke emissions would likely have been frequent across the region, though of lighter concentrations and overall impacts due to lower fire severity and slower-moving fires (EPA, 2021). Approximately 100 years of fire suppression has resulted in significant accumulations of forest fuels, and the added complication of climate change has yielded drier fuels and longer, more extreme fire seasons.

Trends and Planned Actions

In addition to wildfires, a legacy of fire suppression, logging, and overgrazing and a current trend of climate change have the potential to affect air quality in Valles Caldera. Fire suppression, logging, and overgrazing led to alteration of historic fire regimes. The signal of rapid, human-caused climate change has been documented across the Southwestern U.S. broadly, and Valles Caldera specifically (Gonzalez et al., 2018). Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000, but relatively stable precipitation (Carlson & Gross, 2019). Since 1970, annual mean temperatures have increased at a rate of roughly 5° F per century (Carlson & Gross, 2019), resulting in an increasingly arid climate and lower fuel moistures, followed by significant increases in wildfire activity and greater incidences of harmful wildfire pollutants (Hallar et al., 2017). When combined with a rapidly increasing population, exposure to wildfire-emitted pollutants has increased as well (Ford et al., 2018). The U.S. EPA National Emissions Inventory reported that from 2011-2017, wildfires contributed 32-44% of national $PM_{2.5}$ emissions and 30-43% CO emissions, two wildland fire pollutants that contribute significantly to air quality (EPA, 2021).

3.2.2 Impacts of Alternative A (No Action)

Alternative A would lead to increased fuel loading across the landscape due to fire exclusion and a lack of fuel treatments. While a lack of prescribed fire would likely reduce temporary, localized degradation of air quality, the macroscale impacts have potential to be far more long-lasting and widespread. Valles Caldera's mixed-conifer forests, which rely on relatively frequent, low- and moderate-severity fire to limit fuel loading, would continue to be altered from many years of fire suppression. This would result in a greater risk of high-severity, stand-replacing (or vegetation-type conversion) fire, increasing emissions of air pollutants such as CO, PM, NO_X, VOCs, hazardous air pollutants (HAPs), and greenhouse gases such as carbon dioxide (CO_2). Fire suppression has already resulted in increases in high-severity fire as evidenced by the 2011 Las Conchas Fire, 2013 Thompson Ridge Fire, and 2022 Cerro Pelado Fire; and when coupled with increased aridification through the 21st century as a result of climate change (Y. Liu et al., 2013), the expectation is longer fire seasons and wildfires that burn more intensely.

Significant increases in fire activity are expected to produce increases in fire emissions and reductions in air quality, quantified by increased number of days per year with degraded air quality due to wildfire smoke (J. C. Liu et al., 2016). While visibility has generally improved and population-level exposure to $PM_{2.5}$ has decreased across the Southwest due to decreasing urban emissions, modeled increases in fire-derived $PM_{2.5}$ "will offset a significant amount of the improvements in exposure levels associated with decreases in anthropogenic emissions," and "visibility on the worst days could get even worse" (Ford et al., 2018). This is due to smoke from fires within the Southwest and smoke transported from outside the region. Additionally, episodes of prolonged (i.e. multi-day) hazardous air pollution from wildfires are forecast to increase across northern New Mexico due to impacts of climate change on regional aridity and fire activity (J. C. Liu et al., 2016). Climate change would thus yield fires producing greater concentrations of $PM_{2.5}$ and ozone with impacts potentially spreading and multiplying downwind from Valles Caldera to intersect with high-population areas including Los Alamos, Espanola, Santa Fe, and Albuquerque (EPA, 2021).

Following a high-severity fire and under an increasingly arid climate, vegetation-type conversions can also produce secondary air quality impacts. Forested landscapes have increasingly shifted toward drier shrub and grassland environments post-fire. Declines in soil moisture can result in less protective vegetation cover and soil stability, slower recovery from disturbance, and are thus more prone to lofting of dry soils into the atmosphere (Field et al., 2010; Munson et al., 2011). The Southwest is prone to drought and wind events during the spring that spread dust across the region. Atmospheric fine and coarse dust can have considerable impacts on human health and visibility, with dust levels forecast to increase up to 57% even without considering future fire impacts (Achakulwisut et al., 2019).

Cumulative Impacts

Alternative A, combined with a legacy of fire suppression, logging, and overgrazing and a current trend of climate change have the potential for adverse impacts to air quality. Valles Caldera is located within, and downwind of, large expanses of U.S. Forest Service (USFS) land which has been degraded by many of the same factors that impacted Valles Caldera. Fire regimes have been significantly altered from historic conditions. Increased forest density and fuel accumulation present an increased risk of high-severity wildfire across the broader Jemez Mountain landscape. Future wildfires are more likely to burn larger areas at high intensity, either spreading directly into Valles Caldera or lofting hazardous smoke emissions over the park, degrading air quality. Without implementation of fuel reduction treatments, the added emissions of future high-intensity fire would increase the likelihood of hazardous smoke pollutants to spread downwind to densely populated centers across the region. These cumulative impacts have potential to produce widespread, long-duration air quality degradation in the event of a future severe wildfire, which could burn for weeks to months under an increasingly arid climate. Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to air quality would be adverse.

3.2.3 Impacts of Alternative B (Preferred Action)

Under Alternative B, fuel reduction treatments would be implemented at Valles Caldera, including manual and mechanical thinning, prescribed fire, and allowing naturally ignited fires to burn in a defined geographic area. Fuel treatments would reduce the potential for large, high-intensity wildfire, resulting in fewer emissions overall.

Prescribed fire and naturally ignited fire would result in emissions of air pollutants (CO, PM, NO_X, VOCs, HAPs, and CO_2); a portion of those emissions would be concentrated in individual valley bottoms caused by short-term temperature inversions more common in the winter. These localized and temporary impacts would be reduced by managing under New Mexico AQB requirements (refer to Appendix E) and appropriate meteorological conditions such that smoke is adequately dispersed. Notably, in California where implementation of prescribed fire is targeted to increase to unprecedented levels to meet the growing needs of California's vast landscape, air quality impacts still remain drastically lower than that of wildfires over the same region (Kramer et al., 2023).

Manual and mechanical fuel treatments would also result in small emissions of criteria pollutants and greenhouse gases due to the use of chainsaws and vehicles; however, these impacts would be temporary and localized and would not noticeably contribute to air quality impacts.

Beneficial air quality outcomes would likely result from the implementation of a multiple strategy fire management program. Fuel treatments would expedite the return of forest health and beneficial fire regimes in a fire-adapted ecosystem, allowing the landscape to be resilient to future fire disturbances. Thinning and prescribed burning, especially when locations are prioritized by dominant west-to-east wind patterns, would decrease the likelihood of high-intensity and high-severity fire from spreading both within Valles Caldera and from adjacent lands into Valles Caldera. Effective fuel treatments would encourage high-intensity fires outside of Valles Caldera to transition to a lower-intensity fire inside Valles Caldera, as was observed in some portions of Bandelier National Monument following the 2011 Las Conchas Fire (Walker et al., 2018), thus decreasing fire pollutant emissions.

Prescribed fire, especially when upscaled to reduce fuel loading across large areas, can drastically reduce air quality impacts across the Western U.S. A study in California showed that reductions in fuel load after prescribed burning would have a linear relationship with $PM_{2.5}$ emissions for wildfires, and the entire Western U.S. would benefit from such reduced air quality impacts (Kelp et al., 2023). Another study determined that implementation of past prescribed fires in the vicinity of wildfires along the West Coast yielded significant reductions in $PM_{2.5}$ and ozone due to decreased wildfire activity. Accordingly, a 40% reduction in negative health outcomes was calculated, including cardiovascular and respiratory related emergency department visits and mortalities (EPA, 2021). This highlights reductions in wildfire intensity following prescribed fire produce substantially fewer emissions that are less likely to travel far from the source.

Cumulative Impacts
Historic widespread fire suppression, logging, and overgrazing and current trends of climate change would continue to have adverse impacts on air quality. Although there would be short-term adverse impacts on air quality from thinning, prescribed fire, and allowing naturally ignited fire to burn, the overall cumulative impacts would be reduced by reintroducing beneficial fire regimes. Prescribed and naturally ignited fire would reduce potential for high-intensity fire and wildfire emissions. As thinning and prescribed fire increases on USFS lands and in Valles Caldera, there may be concurrent prescribed burning between the agencies which can result in temporary reductions in air quality. However, smoke emissions would be mitigated by federal and state air quality regulations and collaboration between agencies. Despite these benefits, when the actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, the overall cumulative impacts to air quality would be adverse in the short-term. However, impacts would be reduced in the long-term by the reintroduction of beneficial fire regimes.

3.3 Biological Resources: Vegetation

3.3.1 Affected Environment
Prior to federal government acquisition of Valles Caldera from private owners in 2000, the landscape was impacted by past land-use practices. Beginning in the 1880s and continuing into the 1900s, sheep and cattle overgrazed the land, removing herbaceous vegetation and fine fuels, directly altering vegetation structure and composition (Parmenter et al., 2007). Logging operations that began in 1935 created more than one thousand miles of logging roads and by 2000 over 60% of available timber had been harvested (Muldavin & Tonne, 2003). Consequently, forest stand structure has been significantly altered, resulting in dense thickets of small trees divided by logging roads, creating vegetation patches in between linear road boundaries (Parmenter et al., 2007).

Prior to the period of extractive use at Valles Caldera, fire played an essential role in shaping and maintaining vegetation communities and landscapes, as evidenced by data and information gathered from packrat middens and pollen deposits, charcoal deposits from bogs, dendrochronological analysis of fire scarred wood, historic records and journals, and aerial and ground-based photography (Trader, 2013). These sources reveal a long history of frequent, low- to moderate-severity surface fires, as well as infrequent mixed-severity fires, that burned through continuous herbaceous understories and created relatively open forests and grasslands (Trader, 2013). High-severity fires were less common, relatively small, and associated with extreme drought (Margolis & Malevich, 2016). Fire intervals of forests in Valles Caldera are generally 10 to 55 years, depending on vegetation community, slope, aspect, and elevation (Margolis & Malevich, 2016). Fire was suppressed in Valles Caldera from 1860 to 2000, a period of private ownership by four different families. Like many U.S. western landscapes, fire exclusion, including Native American burning practices, has resulted in increased forest extent, density, layering, and surface fuel loading (Hessburg et al., 2019), rendering the landscape susceptible to pests, pathogens, and high-severity fire.

Compared to other high elevation locations in the southern Rocky Mountains and Colorado Plateau, Valles Caldera's vegetation communities are remarkably diverse and unique to the landscape (NPS, 2014), such that, "The highly localized occurrence of distinct plant associations, old-growth forests, and individual species found on the preserve make it one the most diverse sites in the Southern Rocky Mountains Ecoregion, representing an uncommon nexus of western North American biomes" (Muldavin & Tonne, 2003).

Vegetation communities in Valles Caldera (Figure 4) span an aspect and elevational gradient from approximately 8,000 feet up to 11,254 feet at the highest elevation (Redondo Peak). Broad vegetation communities include wetlands and wet meadows, montane grasslands and forest meadows, riparian shrublands, Gambel oak (*Quercus gambelii*) and mixed montane shrublands, ponderosa pine (*Pinus ponderosa*) forests and savannas, mixed-conifer forests (xeric (dry) and mesic (moist)), aspen (*Populus tremuloides*) forests, and spruce-fir forests (xeric and mesic) (Table 12).

Table 12. Vegetation Communities in Valles Caldera National Preserve

Vegetation Community	Description
Wetlands and Wet Meadows	Wetlands and wet meadows occur throughout Valles Caldera's lowland valleys, commonly adjacent to perennial streams in valley bottoms, and along seeps, springs, and creeks in uplands. These communities span an elevation range of 8,100 to 9,000 feet and cover approximately 6,900 acres in the park (Muldavin et al., 2006). They are dominated by species such as sedges (*Carex* spp.) and rushes (*Juncus spp*.) and grasses such as tufted hairgrass (*Deschampsia cespitosa*) and non-native Kentucky bluegrass (*Poa pratensis)*. Common forbs include western yarrow (*Achillia millefolium*) and western aster (*Symphyotrichum ascendens*). A common shrub is shrubby cinquefoil (*Dasiphora fruticosa*). Prior to the introduction of domestic grazing in the late 1880s, it is likely that lowland valleys were dominated by multi-channeled stream systems surrounded by extensive wetlands as opposed to the current single-channeled systems (NPS, 2014). While frequent low-severity fire historically surrounded wetlands and wet meadows, they burned infrequently due primarily to moisture availability (Falk et. al., 2011).
Montane Grasslands and Forest Meadows	Montane grasslands are uncommon in New Mexico; however, they comprise approximately 17,600 acres in Valles Caldera and are the primary grassland community in the park (Muldavin et al., 2006). They occupy different elevations, with the lower elevation grasslands, also known as *valles*, from approximately 8,400 to 9,000 feet and covering nearly 12,600 acres. The high elevation (8,400 to 10,500 feet) montane grasslands comprise about 5,000 acres and are found "along the caldera rim and in small interior mountain valleys" (Muldavin et al., 2006). Fire history studies show a fire return interval of two to ten years in low elevation grasslands with concurrent fire years being common (Falk et al., 2011). Cold air drainage and limited moisture availability appear to inhibit the growth of woody species in the interior of the grasslands (Coop & Givinish, 2007). Forest meadows comprise 2,300 acres in Valles Caldera and are most commonly found in higher elevations (8,900 to 10,500 feet) along ridgelines and mountaintops (Muldavin et al., 2006). They are generally the result of logging practices and higher severity fire (Muldavin et al., 2006). Bunch grasses and forbs dominate montane grasslands and forest meadows, but scattered trees or shrubs can be found in areas of infrequent fire (Muldavin et al., 2006). Common species in these communities include sedges and rushes and grasses such as Parry's oatgrass (*Danthonia parryi*) and Arizona fescue (*Festuca arizonica*). Common forbs are woolly cinquefoil (*Potentilla hippiana*) and beautiful fleabane (*Erigeron formosissimus*). A common shrub is shrubby cinquefoil.
Riparian Shrubland	Riparian shrublands are rare in the Southern Rocky Mountains and are considered globally threatened (NPS, 2014). There are approximately 14 acres of riparian shrublands in Valles Caldera, mostly occurring between 8,300 to 9,400 feet in the southwestern portion of the park along mountain streams near Redondo Peak and in canyons west of Redondo Border (Muldavin et al., 2006). Common species in this community may include thinleaf alder (*Alnus tenuifolia*), willow (*Salix spp*.), and blue spruce (*Picea pungens*). Herbaceous understories are typically composed of a species-rich assemblage of grasses and forbs (Muldavin et al., 2006), including obligate or facultative wetland species such as Canada reed grass (*Calamagrostis canadensis*), Fendler's waterleaf (*Hydrophyllum fendleri*), and seep monkey flower (*Mimulus guttatus*). Bog birch (*Betula glandulosa*) is a wetland shrub associated with riparian shrublands, with its only known location in New Mexico within Valles Caldera (NPS, 2014) (Refer to 3.6, Special Status Species (Flora)). While

Vegetation Community	Description
	frequent low-severity fire historically surrounded riparian shrublands, it is expected that they burned infrequently due to moisture availability.
Gambel Oak/Mixed Montane Shrublands	Gambel oak/mixed montane shrublands range in elevation from 8,300 to 9,400 feet and occupy approximately 1,450 acres in Valles Caldera. This community is typically located on rocky, southerly aspects and is dominated by Gambel oak and New Mexico locust (*Robinia neomexicana*) (Muldavin et al., 2006). Other shrubs such as common chokecherry (*Prunus virginiana*) and gooseberry and currant (*Ribes spp.*) may also be present. Herbaceous vegetation, including grasses and forbs, can be sparse and low in diversity due to shrub presence and cover (Muldavin et al., 2006). This vegetation community is important for wildlife, providing structural diversity, shelter, and food resources (NPS, 2014). Historically, Gambel oak/mixed montane shrubs were maintained primarily as an understory component in ponderosa pine and xeric mixed-conifer forests through frequent low-intensity surface fire and shading by overstory tree canopy (Guiterman et al., 2018).
Ponderosa Pine Forests and Savannas	Ponderosa pine forests and savannas occupy approximately 9,200 acres in Valles Caldera, ranging from 8,100 to 9,300 feet. Ponderosa pine is the dominant overstory tree in both forests and savannas (NPS, 2014). Forests are typically denser than savannas and include other conifer trees such as Douglas-fir (*Pseudotsuga menziesii*) and moderate densities of oak. Savannas are characterized by mature, widely spaced groups of ponderosa pine trees with an understory of grasses and forbs and occasionally oak. Common grass species include Arizona fescue and mountain muhly (*Muhlenbergia montana*) (NPS, 2014). Ponderosa pine is a highly fire tolerant species, historically experiencing low-severity surface fire every five to seven years (NPS, 2014).
Mixed-conifer Forests (Xeric and Mesic)	The mixed-conifer vegetation community in Valles Caldera includes both xeric and mesic forests, spanning an elevational range from approximately 8,300 to 10,000 feet and covering about 36,000 acres (Muldavin et al., 2006). Xeric mixed-conifer occupies nearly 22,000 acres and typically includes Douglas-fir, white fir (*Abies concolor*), ponderosa pine, aspen, and a smaller component of blue spruce (Muldavin et al., 2006). Shrubs and subshrubs normally dominant the understory with occasional grasses and forbs (Muldavin et al., 2006). Historically, frequent (every 5 to 15 years), low- to moderate-severity fire, pests, and pathogens were the primary disturbance regimes in xeric mixed-conifer (NPS, 2014). Mesic mixed-conifer is present on approximately 14,000 acres and includes Douglas-fir, white fir, blue spruce, Southwestern white pine (*Pinus reflexa*), ponderosa pine, and aspen (Muldavin et al., 2006). The understory typically consists of a lush diversity of forbs with grasses more prominent near montane grassland boundaries; shrubs are less common (Muldavin et al., 2006). The historic fire regime in mesic mixed-conifer is less frequent and typically of higher severity than xeric mixed-conifer, with up to 71 years between fires of a mixed severity (low, moderate, and patches of high) (NPS, 2014). In both xeric and mesic mixed-conifer forests, aspen and ponderosa pine are typically successional species after disturbances such as logging, fire, and pest and pathogen outbreaks (Muldavin et al., 2006; NPS, 2022b). Muldavin et al. (2006) also noted that blue spruce can encroach on grasslands, forming “nearly pure stands on the margins.” Engelmann spruce (*Picea engelmannii*) and corkbark fir (*Abies lasiocarpa var. arizonica*), dominant species in the higher elevation spruce-fir

Vegetation Community	Description
	forests, are generally not present in mixed-conifer or comprise less than 25% of the conifer canopy (Muldavin et al., 2006).
Aspen Forests (Xeric and Mesic)	The aspen vegetation community in Valles Caldera includes both xeric and mesic forests, spanning an elevational range from 8,600 to 10,200 feet and covering about 5,100 acres (Muldavin et al., 2006). Conifers are common in aspen forests, more often in the understory than in the canopy where they typically occupy less than 25% of the canopy cover (Muldavin et al., 2006). Both xeric and mesic aspen forests occasionally have grassy understories when they occur alongside montane grasslands (Muldavin et al., 2006). Aspen stands are often successional in mixed-conifer and spruce-fir forests post-fire, although clonal (connected underground root systems) aspen forests can persist for extended periods when burned at repeated intervals (Muldavin et al., 2006). As a key successional species, aspen typically responds by vigorously resprouting after disturbance, such as fire or logging (NPS, 2014). Preferential browsing of aspen by elk and deer can impact the density and height of resprouting aspen stands (NPS, 2014). Xeric aspen forests are present on about 3,200 acres. They typically occur on mid to upper slopes and ridges on cool, northerly aspects, and occasionally on lower slopes and ridges on southerly aspects. Shrubs and subshrubs generally comprise most of the understory vegetation; however, soil mosses replace many vascular plants in locations where temperatures are cold (Muldavin et al., 2006). Mesic aspen forests cover about 1,900 acres. They generally occupy mid to lower slopes on northerly aspects, and occasionally occur on lower slopes in canyon bottoms and coves of southerly aspects. A diverse and abundant cover of forbs typically dominates the understory; however, Rocky Mountain maple is also present (Muldavin et al., 2006). Shrubs and subshrubs are infrequent.
Spruce-fir Forests (Xeric and Mesic)	Spruce-fir forests in Valles Caldera include both xeric and mesic forests, spanning an elevational range from 9,000 to 11,250 feet and covering about 7,000 acres (Muldavin et al., 2006). Spruce-fir forests occur at the highest elevations in the park, occupying areas along the caldera rim and on Redondo Peak and are dominated by Engelmann spruce and corkbark fir. Other conifers, such as white fir, Douglas-fir, and blue spruce may be present (NPS, 2022b) at lower densities and are typically successional; aspen are common in xeric spruce-fir forests (Muldavin et al., 2006). Spruce and fir will remain the dominant species in the spruce-fir climax community unless a major disturbance, such as fire, opens a pathway for successional species (NPS, 2022b). Both xeric and mesic spruce-fir forests occasionally have grassy understories when they occur alongside montane grasslands (Muldavin et al., 2006). Xeric spruce-fir forests cover approximately 4,300 acres on north-facing, mid to upper slopes and ridges and south-facing lower slopes and ridges (Muldavin et al., 2006). Shrubs and subshrubs generally comprise most of the understory vegetation; however, soil mosses replace many vascular plants in locations where temperatures are colder (Muldavin et al., 2006). Mesic spruce-fir forests cover about 2,700 acres and occur on lower to mid slopes on northerly aspects and occasionally on lower slopes of southerly aspects, often in coves (Muldavin et al., 2006). A diverse and abundant cover of forbs typically dominates the understory (NPS, 2022b); however, Rocky Mountain maple is also present (Muldavin et al., 2006). Shrubs and subshrubs are infrequent.

Vegetation Community	Description
	Xeric and mesic spruce-fir forests were historically characterized by infrequent (often greater than 100 years), mixed-severity and occasional stand-replacing fires of smaller extent (NPS, 2014). Longer fire intervals are caused by higher fuel moistures in spruce-fir forests for much of the fire season (NPS, 2014). Stand replacing fires result from fuel accumulations during extended fire-free periods and the presence of non-fire-adapted species in mid and understories (Margolis et al., 2011). Other disturbance includes past logging, pest and pathogen outbreaks, and occasional blow-down events (NPS, 2014).

Non-native and Invasive Plants

Non-native, invasive plant species of management concern at Valles Caldera include Canada thistle (*Cirsium arvense*), ox-eye daisy (*Leucanthemum vulgare*), cheatgrass (*Bromus tectorum*), musk thistle (*Carduus nutans*), and bull thistle (*Cirsium vulgare*). These species are often observed in mixed-conifer and ponderosa pine forests, montane grasslands and shrublands, and wetlands and wet meadows. Pasture grasses are present in Valles Caldera and are typically an indicator of historic grazing practices. Non-native Kentucky bluegrass and Timothy grass (*Phleum pratense*) are common with the former being the most common species. Both Kentucky bluegrass and Timothy grass are widespread in the park and active eradication treatments are not being considered.

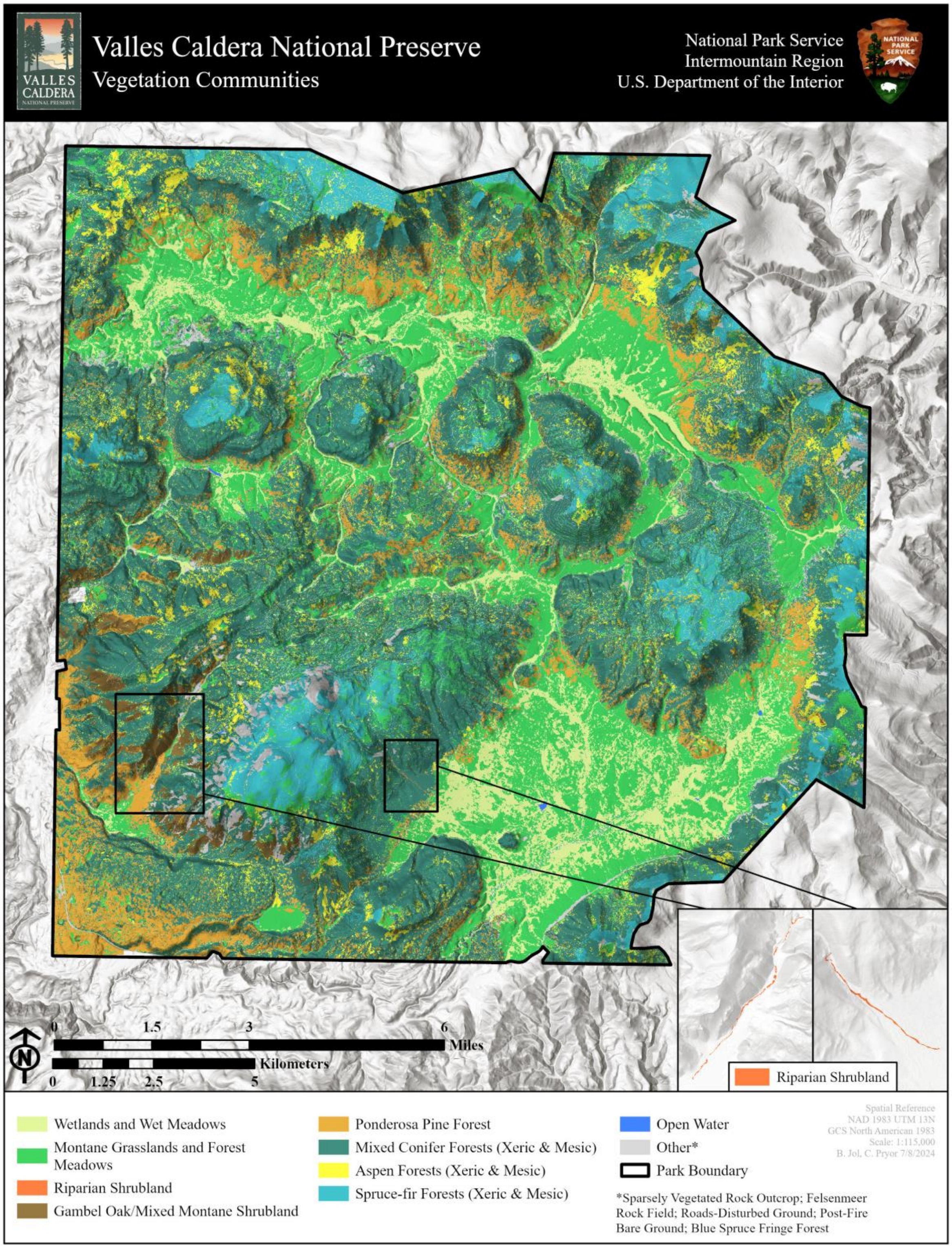


Figure 4. Vegetation Communities in Valles Caldera National Preserve

Trends and Planned Actions

Past, current, and planned actions and trends within Valles Caldera that may affect vegetation include a legacy of fire suppression, logging, and overgrazing; landscape susceptibility to pests and pathogens; trail, road, and parking lot construction; building and facility improvements; ecological restoration; and climate change.

Fire suppression, logging, and overgrazing have resulted in potential for landscape-scale high-severity fire. After the Las Conchas fire, vegetation data and soil samples were collected in burned areas in Valles Caldera to study the seed bank and vegetation response; data were collected again in 2022. Data analysis shows no natural tree regeneration in areas that burned at high-severity and no seedling tree germination in seed bank trials (Escamilla, 2023), indicating a potential forest conversion to grassland and shrubland in high-severity burn areas. Other conifer regeneration studies indicate that most recruitment and establishment occur within the first four years after a fire, supporting the notion that conifer regeneration in high-severity burn areas in Valles Caldera may be unlikely (Escamilla, 2023).

Decades of fire suppression in Valles Caldera has led to increased tree densities, rendering forests susceptible to pests and pathogens. The spatial and temporal scale of pest and pathogen outbreaks across the park has fluctuated from 2000 to present, with the percent of area damaged by pests peaking at 60% in 2008 (USFS, 2018). Shortly after this peak, in June 2011, a tree fell on a powerline and ignited the Las Conchas Fire, the largest wildfire in New Mexico history at the time at approximately 154,000 acres (NPS, 2014). A total of 30,000 acres burned in Valles Caldera, approximately 34% of the park and 51% of the park's forested landscape. Approximately 28% of the fire burned at high-severity and 26% at moderate (MTBS, 2011). Two years later, in 2013, the Thompson Ridge Fire burned 24,000 acres in Valles Caldera, approximately 27% of the park, 40% of which was forest. Only 3% of the fire burned at high-severity, and 23% at moderate (USGS, 2011). Areas in Valles Caldera with previous pest-caused tree damage and mortality were largely within the burn footprint of both fires (NPS, 2022b).

Trail, road, and parking lot construction that can affect vegetation include an accessible trail through the Cabin District, rerouting the road near the Entrance Station, and construction of two new gravel parking lots southwest of the Ranger Station. Planned building and facility improvements and construction includes demolition of movie sets; restoration of historic cabins and outbuildings; removing structures and relics of recent human activity from Sulphur Springs; and removing fencing.

Ecological restoration projects include wetland restoration and forest thinning. Approximately 700 acres of wetland restoration has been accomplished with 250 acres planned in the future. Goals include increasing the extent of wetlands and wetland plant species and improving hydrologic function. Decreases in livestock numbers are also contributing to wetland recovery. Past forest thinning and restoration projects have been implemented on approximately 10,000 acres, with additional projects planned for the near future.

Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000. Between 1895 and 2018, mean temperatures have increased by 1.4°F per century due to warming in the spring and summer months (NPS, 2022b). Precipitation over the same period has remained relatively stable (Carlson & Gross, 2019); however, the proportion of precipitation received as snow has declined (NPS, 2022b). Although precipitation overall has not declined, higher temperatures increase evaporation rates, resulting in decreases in soil moisture and water availability for plants (NPS, 2022b). Higher average temperatures and water deficit have resulted in increased aridification and lower fuel and soil moistures, contributing to landscape-scale high-severity wildfires.

3.3.2 Impacts of Alternative A (No Action)

A suppression-oriented wildland fire management program would preclude forest thinning, prescribed fire, and allowing naturally ignited fire to burn, leading to increased forest extent, canopy closure, density, layering, and surface fuel loading (Hessburg et al.,2019). These forest and fuel conditions would render the landscape susceptible to pests, pathogens, and landscape-scale high-severity fire.

High-severity fire can cause mortality of vegetation. Substantial loss of forests and plant cover could result in adverse impacts to essential ecosystem services that plants provide such as forming and retaining soil; reducing erosion; slowing water movement and flooding; purifying water; cycling nutrients; providing food and habitat for organisms; and regulating climate through sequestering carbon and moderating temperatures (Binder et al., 2017). In addition, because high-severity fire is a main cause of vegetation community conversions in Southwestern ecosystems (Guiterman, et al., 2022), Valles Caldera's coniferous forests could be at risk for persistent conversion to grassland and shrubland if reinforced by repeated high-severity fire events (Falk et al., 2022).

Densified forests with high canopy closure and surface fuel loading can have adverse impacts on native herbaceous plant cover and species richness by limiting resources such as nutrients and water and preventing light infiltration to the forest floor (Dormann et al., 2020). High-severity fire in dense forests can further impact herbaceous vegetation by reducing, or in some cases eliminating, soil seedbanks and causing declines in native plant propagation and establishment (Collins et al., 2017). Due to coevolution and mutualistic relationships between plants and pollinators, high-severity fire can also have adverse impacts on pollinator survival and recolonization (Tarbill et al., 2023). Impacts may include burning of pollinators and their nesting sites and changes in vegetation that impact pollinator foraging and nesting (Tarbill et al., 2023).

High-severity fire disturbance can encourage recruitment, establishment, and dominance of non-native plants (Prevey et al., 2023). Non-native, invasive plants often have characteristics such as efficient seed dispersal and rapid growth strategies after fire that allow them to outcompete native plants (Prevey et al., 2023). Non-native plant dominance can alter fire regimes, influence native species interactions, disrupt nutrient cycling, and impact ecosystem biodiversity (Escamilla, 2022; Prevey et al., 2023). Non-native plant invasions can also modify successional trajectories by outcompeting conifer seedlings, particularly under repeated high-severity fire events (Escamilla, 2022).

Mowing, trimming, limbing, and removal of vegetation would result in localized adverse impacts due to reduction of plant cover. Construction of fire lines and use of vehicles, equipment, and bulldozers could result in trampling, removal, and compaction of vegetation and soil. Impacts of disturbance would be localized to the suppression area and may last weeks to months. However, under the MIST framework (Appendix C), suppression actions would strive for the least environmental, cultural, and social impacts possible. Further, post-fire programs and response, such as suppression repair, emergency stabilization, rehabilitation, and restoration, would improve post-fire natural and cultural resource conditions (Refer to section 2.2.1, Features Common to Both Alternatives).

Specific impacts of long-term fire suppression and subsequent high-severity fire on each vegetation community are briefly described below.

Wetlands and Wet Meadows

Modern increases in high-severity wildfire, such as the Las Conchas Fire of 2011 and the Thompson Ridge Fire of 2013, has resulted in adverse impacts on the park's wetlands and wet meadows due to post-fire erosion (NPS, 2014). Under a fire suppression-oriented wildland fire program, post-fire erosion would continue to impact wetlands.

Montane Grasslands and Forest Meadows

The historic and frequent (two to ten year) fire return interval in montane grasslands and forest meadows served to eliminate most seedling trees near grassland and forest boundaries. Modern fire exclusion is partially responsible for encroachment of ponderosa pine trees into grassland edges as reported by Coop and Givinish, who compared aerial photos from 1935 and 1996 and reported an 18 percent decline in grasslands due to forest encroachment (Coop & Givinish, 2007). Under a fire suppression-oriented wildland fire program, conifer encroachment into grasslands and meadows would continue.

Riparian Shrublands

Riparian shrublands are considered globally threatened (NPS, 2014). Only approximately 14 acres of riparian shrublands exist within the park and a rare shrub, bog birch (*Betula glandulosa*), is associated with riparian shrublands (Refer to section 3.6, Special Status Species (Flora)). High-severity fire anticipated under Alternative A can have adverse impacts on riparian shrublands through mortality of vegetation and erosion. In addition, bog birch is susceptible to top-kill from high-severity fire (Tollefson, 2007).

Gambel Oak/Mixed Montane Shrublands

Increases in high-severity fire disturbance in Valles Caldera has resulted in prolific resprouting and formation of dense shrublands with little to no conifer regeneration (Guiterman et al., 2018). Once considered a successional stage in ponderosa pine and xeric mixed-conifer forests after low- to moderate-severity fire, Gambel oak/mixed montane shrublands may endure as an "alternate stable state" to conifer forests because theses shrublands appear to persist through high-severity fire and drought more successfully than conifers (Guiterman et al., 2018). These vegetation conversions would be anticipated to continue under Alternative A.

Ponderosa Pine Forests and Savannas

Ponderosa pine forests and savannas are impacted by a legacy of intensive logging and fire suppression, resulting in increased densities of small diameter trees and accumulations of surface fuels (NPS, 2014). These changes in forest structure and composition as a result of fire exclusion would continue under Alternative A and render these vegetation communities susceptible to landscape-scale high-severity fire and vegetation community conversion to grassland and shrubland (Hessburg et al., 2019).

Mixed-conifer Forests (Xeric and Mesic)

More than one hundred years of fire suppression has resulted in adverse impacts to mixed-conifer forests such as fuel accumulations, high-severity fire occurrence, increases in pest and pathogen outbreaks, and forest conversion to grassland and shrubland (NPS, 2022b). These conditions are expected to continue under a suppression-oriented wildland fire program.

Aspen Forests (Xeric and Mesic)

Aspen stands are often successional in mixed-conifer and spruce-fir forests post-fire, although clonal (connected underground root systems) aspen forests can persist for extended periods when burned at repeated intervals (Muldavin et al., 2006). As a key successional species, aspen typically responds by vigorously resprouting after fire disturbance. High-severity fire can result in increases in aspen sprout density and rates of growth when compared to lower-severity fire (Krasnow & Stephens, 2015). These conditions would likely continue under this alternative.

Spruce-fir Forests (Xeric and Mesic)

Although spruce-fir forests were historically characterized by infrequent (often greater than 100 years), mixed-severity and occasional stand-replacing fires of small extent (NPS, 2014), active fire suppression impacts spruce-fir forests by extending historic fire-free intervals and resulting in added fuel accumulations, a closed canopy structure, and increased potential for high-severity fire.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact vegetation under Alternative A include past land-use practices (fire suppression, logging, and overgrazing); pests and pathogens; trail, road, and parking lot construction; building and facility construction and improvements; ecological restoration; and climate change.

Past land-use practices in combination with a fire suppression-oriented fire management program would result in adverse, short- and long-term cumulative impacts to vegetation due to the continued suppression of natural fire. Valles Caldera's vegetation communities have been shaped by periodic low- to moderate-intensity fire, with occasional high-severity patches (NPS, 2014). In the absence of fire, tree densities, forest layering, canopy closure, and surface fuel loading would increase and perpetuate conditions that lead to landscape-scale high-severity wildfire. In addition, because high-severity fire is a main cause of vegetation community conversions in Southwestern ecosystems (Guiterman, et al., 2022), Valles Caldera's coniferous forests would be at risk for persistent conversion to grassland and shrubland if reinforced by repeated high-severity fire events (Falk et al., 2022).

Densified forests as a result of a fire suppression-oriented fire management program would exacerbate pest and pathogen outbreaks and further contribute to tree mortality, resulting in adverse cumulative impacts. Moreover, when considering climate change, it has been observed that warming temperatures have shortened the life cycle of some bark beetles, leading to increases in their population numbers and resulting in damage and mortality across large portions of forests in and near Valles Caldera (NPS, 2022b).

Planned construction and improvement projects in the park in combination with defensible space and fire suppression actions under Alternative A would result in adverse cumulative impacts to vegetation communities due to mowing, trimming, limbing, trampling or complete removal of vegetation that can occur under all actions. Impacts of construction and improvement projects would be long-term; however, they would be localized to the project footprint. Impacts of fire suppression actions would be short-term (weeks to months) and would be localized to the action areas.

Past forest thinning and future wetland restoration would alleviate some of the adverse impacts of fire suppression and defensible space actions under Alternative A.

Climate trends, in combination with fire suppression and defensible space actions are likely to result in adverse cumulative impacts due to increased potential for landscape-scale high-severity fire. Large, climate-driven wildfires are increasing in the Southwestern United States (Dennison et al., 2014; Westerling, 2016) and often cause forest stand-replacement or vegetation type conversions (Guiterman et al., 2022), impacts that are exacerbated by a fire suppression-oriented wildland fire program. In addition, rising minimum temperatures appear to be responsible for encroachment of ponderosa pine trees into grassland edges (Coop & Givinish, 2007). Coop and Givinish (2007) compared aerial photos from 1935 and 1996 and reported an 18 percent decline in grasslands due to forest encroachment.

The interaction between multiple stressors, including fire suppression, densified forests; pest and pathogen outbreaks; warming temperatures, aridification, and drier soils due to climate change; and increases in potential for high-severity fire under Alternative A would result in adverse cumulative impacts to Valles Caldera's vegetation communities. Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to vegetation would be adverse.

3.3.3 Impacts of Alternative B (Preferred Action)

Impacts of defensible space and fire suppression actions on vegetation under Alternative B would be similar to Alternative A; however, a multiple strategy wildland fire program under Alternative B would utilize a wide range of fire management actions including manual and mechanical thinning, prescribed fire, and allowing naturally ignited fire to burn in a defined geographic area under specific prescription parameters. These actions would create a vegetation structure and composition that allows for widespread reintroduction of the frequent, low- to moderate-severity fires (with occasional, small high-severity patches) that historically burned in the Jemez Mountains (Allen, 1989)—the same fire regime under which Valles Caldera's vegetation communities have persisted through time.

Thinning and prescribed fire would also reduce potential for landscape-scale high-severity fire. A recent analysis of 220 publications that focused on the effects of treatments in western coniferous forests shows that combinations of prescribed fire and thinning, including thinning and pile burning, thinning and broadcast prescribed burning, and prescribed fire alone resulted in a 62 to 72% reduction in subsequent wildfire severity when compared to untreated sites (Davis et al., 2024).

Low- to moderate severity fire can cause localized mortality of vegetation; however, species that have persisted through time in fire-prone landscapes are adapted to historical fire regimes and typically possess characteristics, such as resprouting after fire, fire-stimulated seed-release, increased growth rates, or a thick protective bark that allow them to survive or thrive in post-fire environments (Keeley et al., 2011). Prescribed fire and naturally ignited fire would not cause substantial loss of plant cover; rather, low- to moderate-severity fire typically improves plant species richness, diversity, and abundance (Strand, et al., 2019). Short- and long-term beneficial impacts can include increased nutrient availability through fire-induced nutrient cycling and canopy openings that allow light infiltration to the forest floor. In a recent study, Dormann et al. (2020) observed light availability to be "strongly positively correlated" with understory plant cover and species richness. Moreover, in the long-term, prescribed fire and naturally ignited fire would not interrupt the essential ecosystem services that plants provide such as forming and retaining soil; reducing erosion; slowing water movement and flooding; purifying water; cycling nutrients; providing food and habitat for organisms; and regulating climate through sequestering carbon and moderating temperatures (Binder et al., 2017).

Prescribed fire and naturally ignited fire would create a mosaic pattern of unburned, low- to -moderate severity, and occasional, small high-severity patches across the landscape. This mosaic pattern would increase landscape heterogeneity and complexity, resulting in greater floral and faunal diversity (Wasserman, 2015). Small, high-severity patches would serve to disrupt forest continuity, providing natural fuel breaks and increasing ecosystem resilience to future disturbances (Stevens et al., 2021). Beneficial fire regimes would also preserve soil seedbanks, limit conifer encroachment into grasslands and forest meadows, and reduce the potential of persistent forest conversion to grassland and shrubland in Valles Caldera. In addition, allowing naturally ignited fire to burn under specific prescription parameters would result in the same beneficial impacts as prescribed fire but with a greater spatial extent, and at a lower cost (Hurteau et al., 2014).

When considering coevolution and mutualistic relationships between plants and pollinators, limiting high-severity fire effects on vegetation through implementation of thinning, prescribed fire, and naturally ignited fire can improve and preserve pollinator communities and habitat (Tarbill, et al., 2023). Low- to moderate-severity fire initiates nutrient cycling and creates canopy openings, resulting in greater diversity and abundance of habitat, foraging opportunities, and nesting sites. It also decreases the travel distance and time spent by pollinators searching for resources (Tarbill et al., 2023).

Recruitment, establishment, and dominance of non-native plants can result after low- to moderate-severity fire. Non-native, invasive plants often have characteristics such as efficient seed dispersal and rapid growth strategies after fire that allow them to outcompete native plants (Prevey et al., 2023). However, a seven-year study of non-native, invasive species after low-impact thinning and low-intensity prescribed fire in Valles Caldera showed that while invasive plants increased after thinning and prescribed fire, native grass species outcompeted non-natives over time (Hall et al., 2023).

As described in Valles Caldera's LRSP and the Southwest Jemez Mountains Collaborative Forest Landscape Restoration Strategy (NPS, 2014; USFS, n.d., a), management treatments would include combinations of thinning, prescribed fire, and allowing naturally ignited fire to burn and would strive to achieve the following short- and long-term beneficial impacts and outcomes for vegetation.

Thinning would be used in Valles Caldera as a pre-treatment for prescribed fire and to achieve the following short- and long-term beneficial impacts:

- Strategically locating fuel breaks to create a patchy landscape of forest stands, grasslands, shrublands, and meadows and improving safety and effectiveness for wildland fire management.
- Reducing vegetation layering, smaller diameter tree densities, and "ladder fuels" (trees and other vegetation that can carry fire from the forest surface to the tree crown) prior to prescribed fire ignition which reduces fire behavior, limits crown fire potential, and lowers burn severity.
- Removing trees impacted by insects with signs of damage or disease and fire-intolerant species.
- Retaining the largest, most vigorous, and fire-resistant species such as ponderosa pine, Douglas-fir, aspen, and Southwestern white pine.
- Creating openings in the tree canopy to increase the abundance and diversity of herbaceous vegetation.
- Reducing inter-tree competition for nutrients, light, and water and increasing tree water balance, growth rates, and carbon sequestration.

- Retaining small groups of large diameter trees near grassland and meadow edges while reducing encroachment of smaller diameter trees.

Prescribed fire would be used in Valles Caldera to achieve the following short- and long-term beneficial impacts:

- Reducing hazardous fuels and disposing of biomass from thinning treatments.
- Restoring and maintaining beneficial low- to mixed-severity fire with patchy continuity and occasional patches of higher-severity fire.
- Restoring and enhancing vegetation structure and composition.
- Reducing inter-tree competition for nutrients, light, and water and increasing tree water balance, growth rates, and carbon sequestration.
- Creating openings in the tree canopy to increase the abundance and diversity of herbaceous vegetation.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact vegetation under Alternative B include past land-use practices; pests and pathogens; trail, road, and parking lot construction; building and facility construction and improvements; ecological restoration; and climate change as described under Trends and Planned Actions. Cumulative impacts due to a combination of these actions and fire suppression and defensible space actions would be the same as Alternative A.

Past land-use practices and pest and pathogen outbreaks in combination with thinning, prescribed fire, and naturally ignited fire would not result in adverse cumulative impacts; rather, a multiple strategy wildland fire program would alleviate cumulative impacts by reducing forest layering, density, and ladder fuels, and restoring beneficial fire regimes.

The combination of trail, road, parking lot, building, and facility construction and improvements with thinning, prescribed fire, and naturally ignited fire would result in adverse and short-term cumulative impacts due to trimming, limbing, trampling, complete removal of vegetation, and compaction of vegetation and soil that can occur under all actions. Impacts of construction and improvement projects would be long-term; however, they would be localized to the project footprint. Impacts of thinning, prescribed fire, and naturally ignited fire would be adverse in the short-term (weeks to months), beneficial in the long-term (months to years), and localized to the action areas.

Past and future ecological restoration projects in combination with thinning, prescribed fire, and naturally ignited fire would result in beneficial, short- and long-term impacts due to landscape and fire regime restoration and enhanced ecosystem stewardship.

High-severity wildfires driven by climate change and fire exclusion are a threat to vegetation. Warming temperatures and increased aridity are correlated with increases in tree mortality. In addition, tree mortality is positively correlated with tree basal area (Bradford & Bell, 2016). Thinning, prescribed fire, and allowing naturally ignited fire to burn can decrease tree basal area and density, thus reducing tree competition for nutrients, light, and water and improving chances of survival (Bradford & Bell, 2016). Further, selective forest thinning prescriptions allow forest managers to retain fire-adapted and more drought tolerant species (Bradford & Bell, 2016), improving forest resilience. Restoration of historical forest structure, composition, and fire regimes may reduce potential for climate-induced forest conversion to shrublands and grasslands (Guiterman et al., 2018).

Encouraging herbaceous plant richness and diversity through thinning, prescribed fire, and allowing naturally ignited fire to burn can improve the likelihood that a variety of plant species will be present and capable of tolerating future climates (Hurteau et al., 2014).

Terrestrial ecosystem carbon storage is another concern under climate-driven vegetation mortality (White et. al., 2023). Thinning, prescribed fire, and naturally ignited fire can increase long-term ecosystem resilience and resistance to climate change and wildfire induced vegetation mortality, improving potential for carbon stability when compared to not implementing management treatments (White et. al., 2023).

In addition, fire and resource management goals and objectives under Alternative B focus on actions that could help alleviate adverse impacts of climate change, such as promoting inquiry and flexibility in fire and ecosystem stewardship; considering historic ranges of variation, a changing climate, and a future range of variability; and considering future and changing ecological, climate, and fuel conditions, and fire regimes during the planning process and adaptive management cycle.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to vegetation would be adverse in the short-term and beneficial in the long-term due to enhanced ecosystem stewardship and the reintroduction of beneficial fire regimes.

3.4 Biological Resources: Wildlife

3.4.1 Affected Environment

A diversity of vegetation communities and availability of water resources support a variety of wildlife in Valles Caldera (NPS, 2022b). Landscape and ecosystem connectivity are also important for wildlife. Sufficient connectivity in Valles Caldera's lower montane, upper montane, riparian, and valley bottom habitats allows for movement and dispersal of species, populations, and genes between patches of habitat (NPS, 2022b).

There are 51 species of mammals, such as elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), mountain lion (*Puma concolor*), black bear (*Ursus americanus*), American badger (*Taxidea taxus*), Gunnison's prairie dog (*Cynomys gunnisoni*), and many rodent species (NPS, 2022; NPS, 2014). Six reptile species such as the greater short-horned lizard (*Phrynosoma hernandesi)* and western terrestrial garter snake (*Thamnophis elegans)* and three amphibians, the tiger salamander (*Ambystoma tigrinum*), federally endangered Jemez Mountains salamander (*Plethodon neomexicanus*), and boreal chorus frog (*Pseudacris maculata*) inhabit the park (NPS, 2014). Six species of fish are present, including native longnose dace (*Rhinichthys cataractae*), Rio Grande sucker (*Catostomus plebeius*), Rio Grande chub (*Gila pandora*), and fathead minnow (*Pimephales promelas*), and non-native brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) (NPS, 2014). Nearly 200 species of birds utilize Valles Caldera and approximately 117 of those species breed within the park (NPS, 2022b). Invertebrate diversity is high, with hundreds of species documented (Parmenter et al., 2007). (Refer to section 3.5 for information about special status wildlife species).

Post-settlement land use, including historic overgrazing by sheep and cattle (NPS, 2022b), fire suppression efforts of the 20th century (Allen, 1989), and clear-cut logging practices of the mid-1900s (Parmenter et al., 2007) contributed to substantial changes in vegetation structure (refer to section 3.3 Vegetation) that influence wildlife habitat and available resources. Habitat availability has been altered by wildfires of the 21st century. In 2011, 51% of all forested areas within the park were burned during the Las Conchas Fire (NPS, 2022b), with about 8,300 acres burning at high-severity within the park. Patches of high burn severity have little to no conifer regeneration and may be converting to grassland or shrublands (Guiterman et al., 2022), contributing to habitat loss (Kalies et al., 2010). Post-fire flooding in 2011 temporarily increased nitrate, phosphate, turbidity, and conductivity that contributed to fish mortality, particularly of non-native trout (NM EPSCoR, n.d.; Reale et al., 2021).

Trends and Planned Actions

Past, current, and planned actions and trends within the park that can affect wildlife include road and trail construction, facility improvements and construction, ecological restoration, pests, and climate change.

Planned trail construction includes an accessible trail through the Cabin District. Road and parking lot construction involves rerouting the road near the Entrance Station and construction of two new gravel parking lots southwest of the Ranger Station. Multiple building and facility improvements and construction are planned: demolition of movie sets; restoration of historic cabins and outbuildings; improving accessibility to the Ranger Station and Entrance Station; and fence removal. Ecological restoration projects such as wetland restoration, forest thinning, and restoration of Sulphur Springs are planned or ongoing. Approximately 700 acres of wetland restoration has been accomplished with 250 acres planned in the future.

Climate trends are expected to impact wildlife. Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000, but relatively stable precipitation (Carlson & Gross, 2019). Between 1895 and 2018, mean temperatures have increased by 1.4°F per century at Valles Caldera (NPS, 2022b) resulting in an increasingly arid climate, lower fuel moistures, and increases in wildfire activity.

3.4.2 Impacts of Alternative A (No Action)

Alternative A would lead to increased fuel loading due to fire exclusion and lack of fuel treatment*s*. The increased risk of an unplanned ignition causing high-severity fire could have long-term detrimental impacts to wildlife both directly, through exposure to heat and smoke, and indirectly through habitat alteration and elimination of safe movement corridors (Pausas & Parr, 2018; Snow, 2022). Many wildlife species have olfactory, visual, or auditory cues that trigger behaviors such as fleeing and sheltering (Nimmo et al., 2021), but fast moving, high-intensity fires can make it impossible to avoid direct impacts (Severson & Rinne, 1988). High-intensity fires have a variety of impacts on wildlife habitat: changes in vegetative structure and composition, vegetation type conversions, habitat fragmentation, and the creation of edge-effects. While some insects and insectivore species benefit from high-severity fire (Bond et al., 2012), most wildlife species avoid patches of high-severity (Calhoun et. al. 2023). Historical fire exclusion and continued fire suppression have reduced overall landscape heterogeneity and complexity of habitats originally maintained by frequent, low-severity fire (Wasserman, 2015).

Suppression operations in response to unplanned fire may have short- and long-term adverse impacts to wildlife. Construction of fire lines and other disturbance created by bulldozers, vehicles, and equipment could disrupt species sensitive to noise and presence of humans. Impacts of disturbance may last weeks to months during suppression, and depending on extent, for years to come. Under the MIST framework (Appendix C), suppression actions would strive for the least environmental, cultural, and social impacts possible. Mowing vegetation to maintain defensible space could have adverse impacts on wildlife in the short-term due to reduction of plant cover and forage availability. Overall, impacts of fire suppression and defensible space actions would likely occur at the species level, and it is unlikely that most wildlife populations would experience decline or extinction.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact wildlife under Alternative A include road, trail, and facility construction and improvements, ecological restoration, and climate change.

Construction and improvement of trails may increase visitation to areas that previously had little disturbance from recreation and could increase visitor-wildlife interactions. Wildlife could experience a short-term loss of energy from fleeing and stress, and potential long-term changes in habitat use due to avoidance of highly trafficked areas (Taylor & Knight, 2003). These impacts, in combination with noise and human presence during defensible space and fire suppression actions could result in adverse cumulative impacts to wildlife. Rerouting of the entrance station road and construction of parking lots could contribute to short-term noise disturbance and habitat alteration within the area, resulting in minor adverse impacts on wildlife. In combination with noise from defensible space and fire suppression actions, cumulative impacts could be adverse and short-term.

Ongoing fence removal is expected to benefit wildlife by reducing barriers that restrict movement and access to resources (Durant et al., 2015), increasing landscape and ecosystem connectivity (NPS, 2022b).
Although wetland restoration is expected to have a short-term, negative impact on wildlife due to noise and habitat alteration, the beneficial, long-term impacts include improved habitat connectivity, abundance of resources, and restored hydrology. In combination, fence removal, wetland restoration, and defensible space and fire suppression actions would not result in adverse cumulative impacts. Rather, fence removal and wetland restoration would alleviate some of the adverse cumulative impacts to wildlife under Alternative A.

Climate trends, in combination with defensible space and fire suppression actions under Alternative A, are likely to result in adverse, cumulative impacts due to increased potential for landscape-scale high-severity fire, which may cause wildlife mortality or create unsuitable habitat for many species. Large, climate-driven wildfires are

increasing in the Southwestern United States (Dennison et al., 2014; Westerling, 2016) and often cause forest stand-replacement or vegetation type conversions (Guiterman et al., 2022), impacts that are exacerbated by a fire suppression-oriented wildland fire program.
Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to wildlife would be adverse and beneficial.

3.4.3 Impacts of Alternative B (Preferred Action)

A multiple strategy wildland fire program would utilize a wide range of fire management actions including manual and mechanical thinning, prescribed fire, and allowing naturally ignited fire to burn in a defined geographic area under specific prescription parameters.

Impacts of defensible space and fire suppression actions on wildlife would be similar to Alternative A; however, implementation of thinning and prescribed fire, and allowing naturally ignited fire to burn would reduce potential for landscape-scale high-severity fire. In addition, fuel treatments would create a vegetation structure and composition that allows for reintroduction of the frequent, low- to moderate-severity fires that historically burned in the Jemez Mountains (Allen, 1989)—the same fire regime under which wildlife species in Valles Caldera have evolved.

As a natural disturbance process, fire plays an integral role in creating a mosaic of habitat types at a landscape scale, increasing both floral and faunal diversity (Wasserman, 2015). Fire suppression and exclusion reduces landscape heterogeneity and complexity of habitats originally maintained by fire (Wasserman, 2015), whereas prescribed fire typically burns in a mosaic pattern across the landscape, providing suitable habitat to a diversity of species (Snow, 2022). Prescribed fire also benefits wildlife through creation of new habitat or improvements to existing habitat. For example, in the years following a prescribed fire, burned areas often produce more grasses and forbs which are forage for wildlife (O'Malley, 2022). Further, an analysis of forest treatments in Southwestern ponderosa pine and dry mixed-conifer forest showed that wildlife (passerine birds and small mammals) density correlated positively with thinning and prescribed fire treatments and negatively with high-severity fire scars (Kalies et al., 2010). In another study, mule deer in the Jemez Mountains showed preference for areas treated with thinning and prescribed fire while avoiding areas of high burn severity within the 2011 Las Conchas and 2013 Thompson Ridge fire scars (Roerick et al., 2019).

Adverse impacts of fuel treatments due to fire, cutting of vegetation, removal or redistribution of thinned materials, presence of work crews, equipment, and vehicles are typically short-term. Impacts may include injuries; fatalities; movement into or out of areas; lack of cover and food availability; and changes in vegetation structure, diversity, and species composition (Wasserman, 2015). Implementation of mitigations and conservation measures, such as limiting thinning and prescribed fire operations to specific times of the year, would reduce potential for adverse impacts to individuals and populations (Refer to Appendix E). In addition, the long-term beneficial impacts of fuel treatments, such as increases in habitat diversity, forage, and landscape and ecosystem connectivity, and reduction in potential for landscape-scale high-severity fire, outweigh the potential of adverse impacts, particularly to wildlife populations.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact wildlife under Alternative B include road, trail, and facility construction and improvements, ecological restoration, and climate change. Cumulative impacts due to the combination of construction and improvement of trails, rerouting of the entrance station road, construction of parking lots, defensible space, and fire suppression actions would be the same as Alternative A.

The combination of construction and improvement of trails, rerouting of the entrance station road, construction of parking lots, prescribed fire, allowing naturally ignited fire to burn, and thinning treatments would result in short-term, adverse cumulative impacts due to noise disturbance from human presence, equipment, and vehicles, and habitat alteration.

Cumulative impacts of ongoing fence removal, prescribed fire, allowing naturally ignited fire to burn, and thinning treatments are expected to benefit wildlife by reducing barriers that restrict movement and access to resources (Durant et al., 2015), creating open spaces and corridors for wildlife movement, encouraging vegetation regrowth, increasing food sources for wildlife (Severson & Rinne, 1988), and increasing landscape and ecosystem connectivity (NPS, 2022b). In the long-term, these actions will improve wildlife habitat by creating a mosaic of habitats, improving hydrology, enhancing riparian and aquatic habitat, and supporting fish populations (Dwire et al., 2016).

Although wetland restoration, prescribed fire, allowing naturally ignited fire to burn, and thinning treatments are expected to have a short-term, adverse impacts on wildlife (as described under Impacts of Alternative B), the beneficial, long-term impacts include improved habitat connectivity, abundance of resources, and restored hydrology.

High-severity wildfires driven by climate and fire exclusion are a threat to wildlife habitat. While forest restoration treatments reduce potential for high-severity wildfire, climate trends may continue to contribute to large wildfire events (Ostoja et al., 2023). However, fire and resource management goals and objectives focus on actions that could help alleviate adverse impacts due to climate change, such as promoting inquiry and flexibility in fire and ecosystem stewardship; considering historic ranges of variation, a changing climate, and a future range of variability; and considering future and changing ecological, climate, and fuel conditions, and fire regimes during the planning process and adaptive management cycle.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be adverse cumulative impacts to wildlife. However, cumulative impacts would be beneficial in the long-term due to enhanced ecosystem stewardship and the reintroduction of beneficial fire regimes.

3.5 Biological Resources: Special Status Wildlife

The diversity of vegetation communities and availability of water resources in Valles Caldera provides essential habitat to special status species. The special status wildlife (SSW) (Table 13) described in this section occur in Valles Caldera and are protected under at least one of five different categories:

1. Species that have (or are being considered for) special federal legal status under the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.) as either threatened, endangered, or candidate species (Refer to Appendix H, Glossary, for definitions and additional information about the ESA).

   Species protected under the ESA and described and analyzed in this section include Jemez Mountains salamander (*Plethodon neomexicanus*), Mexican spotted owl (*Strix occidentalis lucida*), monarch butterfly (*Danaus plexippus*), New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), and Mexican wolf (*Canis lupus baileyi*).

2. New Mexico state-listed threatened and endangered species under the Wildlife Conservation Act (WCA) of 1978 (17-2-37 through 17-2-46 NMSA 1978) (Refer to Appendix H, Glossary, for definitions and additional information about the WCA).

   Species protected under the WCA and described and analyzed in this EA include Jemez Mountains salamander, bald eagle (*Haliaeetus leucocephalus*), boreal owl (*Aegolius funereus*), peregrine falcon (*Falco peregrinus*), New Mexico meadow jumping mouse, and spotted bat (*Euderma maculatum*).

3. Eagles protected under the Bald and Golden Eagle Protection Act (BGEPA) of 1940 (16 U.S.C. 668-668(c)) (Refer to Appendix H, Glossary, for definitions and additional information about the BGEPA).

   Species protected under the BGEPA and described and analyzed in this section include bald eagle and golden eagle (*Aquila chrysaetos*).

4. Species designated as New Mexico Species of Greatest Conservation Need (SGCN) and of special management concern for Valles Caldera (Refer to Appendix H, Glossary, for definitions and additional information about SGCN).

   Species designated as SCGN in New Mexico and of special management concern in Valles Caldera that are described and analyzed in this section include Jemez Mountains salamander, bald eagle, boreal owl, Mexican spotted owl, peregrine falcon, New Mexico meadow jumping mouse, Mexican wolf, spotted bat, Rio Grande chub (*Gila pandora*), Rio Grande sucker (*Catostomus plebeius*), and Gunnison's prairie dog (*Cynomys gunnisoni*).

5. Bird species protected under the Migratory Bird Treaty Act of 1918 (16 U.S.C. 701-715).

   The Affected Environment and Environmental Consequences sections in this EA for migratory birds will not focus on individual species, but rather their habitat because over one hundred species of birds breed each summer in Valles Caldera.

3.5.1 Affected Environment

Table 13. Special Status Wildlife in Valles Caldera National Preserve

Species, Taxonomic Group, and Listing Status	Description
Species: Jemez Mountains Salamander (*Plethodon neomexicanus*) **Taxonomic Group**: Amphibian **Federal Listing Status:** Endangered (2013), with designated Critical Habitat and Primary Constituent Elements **New Mexico Listing Status:** Endangered (1975), SGCN (2006) (declining, vulnerable, endemic)	The Jemez Mountains salamander (salamander) is native and endemic to the Jemez Mountains, where it has been observed in Los Alamos, Sandoval, and Rio Arriba counties (Degenhardt, et. al., 1996). The salamander has been detected in Valles Caldera, typically in mixed-conifer forests between 7,200 and 9,500 feet. USFWS has designated approximately 91,000 acres of Critical Habitat in New Mexico, with about 24,000 acres in Valles Caldera (USFWS, 2013). Primary Constituent Elements (PCEs) are the physical and biological features of a habitat a species needs to survive and reproduce (USFWS, 2013). The PCE's for salamander habitat include: **PCE I**: 50 to 100 percent tree canopy closure, providing shade, moisture, and higher relative humidity at the surface level. Overstory trees typically include Douglas-fir; blue spruce; Engelman spruce; white fir; Southwestern white pine; ponderosa pine; and aspen. Understory vegetation predominantly includes Rocky Mountain maple (*Acer glabrum*); New Mexico locust; oceanspray (*Holodiscus spp*.); or shrubby oaks (*Quercus spp*.). **PCE II:** Elevations from approximately 7,000 to 11,300 feet. **PCE III:** Aboveground habitat with a moderate to high volume of solid to decomposing woody debris, mainly coniferous (particularly Douglas-fir) logs at least 10 inches in diameter and in contact with the soil; and structural features, such as rocks, bark, and moss mats that provide food and cover. **PCE IV:** Underground habitat containing interstitial spaces provided by fractured igneous rock, loose rocky soils, rotted tree root channels, or burrows of rodents or large invertebrates. The salamander is strictly terrestrial, spending most of its lifecycle below ground, and does not use standing surface water for any life stage (USFWS,

Species, Taxonomic Group, and Listing Status	Description
	2013). Lacking lungs and gills, it breathes through mucous membranes in the mouth and throat, and through its moist skin (Degenhardt, et. al., 1996). The salamander is typically surface active during the wet summer monsoonal period from July to September, where it can be found in cool, moist locations (USFWS, 2013). Salamander prey consists of 75 percent ants; other prey includes spiders, beetles, mites, earthworms, and other small invertebrates (USFWS, 2013). The salamander's aboveground microhabitat preference includes moderate to high canopy closure and areas with higher humidity such as inside decaying logs and under bark, rocks, and moss mats (Cummer, 2007). The ideal aboveground microhabitat temperature ranges from 43 to 63 degrees Fahrenheit, with an average of 55 degrees where significantly more salamanders were observed under logs closer to that temperature (Williams, 1972). The preferred soil moisture range is 5 to 60 percent (USFWS, 2013). Aboveground movements and home ranges of the salamander are estimated to be small. One study reported individual movement distances of 0-108 feet; however, 73 percent of those movements were less than three feet. Average home ranges of salamanders that moved were estimated at 86 square feet (Ramotnik, 1988). Another study reported an average movement distance of 20 feet with a maximum of 60 feet (USFWS, 2013). Because much of the salamander's lifecycle occurs underground there is limited information. The belowground habitat appears to be soils with deep, fractured igneous rock that provide space and channels for the salamander to retreat underground during its lifecycle and to descend below the frost line in winter months (USFWS, 2013). It is estimated that female salamanders lay seven to eight eggs underground every two to three years in the spring (Williams, 1978). Salamanders are fully formed when they hatch from eggs (Degenhardt, et. al., 1996). The average life span is unknown; however, one mark and recapture study estimated an individual salamander to be 15 to 17 years old (USFWS, 2013). Population numbers for the salamander are poorly estimated. The probability of detecting a salamander during a survey fluctuates over space and time and is limited by the salamander's mostly subterranean lifecycle; the variability in aboveground environmental conditions that drive surface activity; and difficulty of conducting surveys in the often steep, rocky, mossy, log-covered habitat (Hyde and Simons, 2001 & USFWS, 2013). Even when environmental conditions are ideal for salamander surface activity, it is likely only a small percentage of individuals are detectable, leading to underestimates of population numbers (USFWS, 2013).
Species: **Bald Eagle (*Haliaeetus leucocephalus*) and Golden Eagle (*Aquila chrysaetos*)** **Taxonomic Group**: Bird	The bald eagle and golden eagle are two of the largest birds in North America, with wingspans up to six and seven feet, respectively. Both species have average lifespans of around thirty years and mate for life (USFWS, 2002; USFWS 2023). Both eagles prefer to build nests on tall, old-growth trees in open areas with long lines of site and access to prey, but will occasionally use cliff faces (USFWS, 2023a). They generally avoid nesting near human-disturbed areas (Livingston, 1990). The golden eagle's diet consists of small mammals, reptiles, coyotes, baby deer, and carrion (USFWS, 2023a). Bald eagles primarily eat

Species, Taxonomic Group, and Listing Status	Description
Federal Listing Status: Not Listed **New Mexico Listing Status**: Threatened (1994), SGCN (2006) (vulnerable, keystone); Golden Eagle Not Listed	rabbits, waterfowl, carrion, and fish (USFWS, 2002), although both species are generalists (USFWS, 2002; USFWS, 2023a). The distribution of bald and golden eagles varies greatly, with the bald eagle found only in North America, and the golden eagle found globally at northern latitudes (AOU, 2004; Katzner et al., 2020). Both species are distributed across North America in a wide variety of habitats and ecosystems. However, bald eagles are often associated with freshwater bodies such as lakes and rivers, and golden eagles are more frequently found among mountain ranges and montane meadows (USFWS 2002; Katzner et al., 2020). Although both species are known to migrate, the golden eagle resides in Valles Caldera year-round, whereas the bald eagle is only present from September to March (Cornell Lab of Ornithology, 2024).
Species: **Boreal Owl (*Aegolius funereus*)** **Taxonomic Group**: Bird **Federal Listing Status**: Not Listed **New Mexico Listing Status:** Threatened (1990), SGCN (2006) (declining, vulnerable, disjunct)	The boreal owl (owl) is a small owl, with a diet consisting primarily of small mammals, birds, and insects; its foraging pattern is described as "sit-and-wait" or "perch-and-pounce" hunting, in contrast with the pursuit hunting of other owls (Hayward & Hayward, 1993). Boreal owls have a circumpolar distribution, occurring in high latitudes such as northern Europe, northern Asia, and North America, where they are found from interior Alaska, across Canada, throughout the Rocky Mountains, south to New Mexico, and in a small band in northern Minnesota (Hayward & Hayward, 1993). Throughout its range, the owl typically inhabits forest with Engelmann spruce and corkbark fir, but is also found in stands of pine, aspen, poplar, and birch (Stahlecker et al., 2014; Hayward & Hayward, 1993). Most boreal owl records in the Rocky Mountains are in subalpine forests interspersed with meadows and small openings, above 8,000 feet. (Stahlecker & Rawinski, 1990). There is evidence the owl has been present in Colorado and northern New Mexico since the Pleistocene. However, it remains largely undocumented due to their high-elevation habitat being snowbound during their most vocal period (February to April), which is typically when breeding surveys are conducted (Stahlecker & Duncan, 1996; Stahlecker et al., 2014). In New Mexico, there are confirmed boreal owl detections and evidence of long-term residency in the northern and southern portions of the San Juan and Sangre de Cristo Mountains, and the northeast Jemez Mountains. In Valles Caldera, eight boreal owls were detected in surveys in 2012, in a large stand of spruce-fir forest in the Redondo Peak area, suggesting occupied territory (Stahlecker et al., 2014; NPS, 2022). Plans to monitor the health of this high-elevation ecosystem over time have been proposed, using the owl as an indicator species through measure of its abundance and population size (NPS, 2022b).
Species: **Mexican Spotted Owl *(Strix occidentalis lucida)*** **Taxonomic Group:** Bird	The Mexican spotted owl (owl) is one of the largest owls in North America, averaging 16 to 19 inches in length with an average wingspan of 42 to 45 inches (USFWS, 2012). The owl is typically monogamous and forms long-term bonded pairs. It is mostly nocturnal and forages from sunset to right before sunrise; prey is typically captured with its talons and can include arthropods, reptiles, mice, voles, birds, and bats (Gutiérrez et al., 2017). The owl generally inhabits mountains and canyonlands in Mexico and the Southwestern U.S., extending from Utah, Colorado, Arizona, New Mexico, and

Species, Taxonomic Group, and Listing Status	Description
Federal Listing Status: Threatened (1993) **New Mexico Listing Status**: SGCN (2006) (vulnerable)	western Texas. Critical Habitat for the owl has been designated in New Mexico, although none is within Valles Caldera. However, the park contains ample suitable habitat and the first pair (male and female) of owls were detected in 2021 (NPS, 2022b). A potential nesting and roosting site were also observed, but the subadult pair were not likely breeding at the time (NPS, 2022b). A Protected Activity Center (PAC) was designated near the location in 2021; however limited surveys after the initial siting did not detect the subadult pair (USFWS, 2023). The owl uses a diversity of habitat, including mature, old growth, "complex-structured forests" (Gutiérrez et al., 2017) consisting of a variety of tree ages and size classes for nesting and roosting. Unusually dense forests, such as those resulting from fire suppression and exclusion, present challenges for the owl, including susceptibility to high-severity fire resulting in habitat loss, limited mobility and obstruction of hunting, and potential for reduced densities of prey (Gutiérrez et al., 2017). In the 2012 Mexican Spotted Owl Recovery Plan, USFWS established three levels of management necessary to "ensure the recovery of the Mexican spotted owl," including 1) PACs of at least 600 acres that surround nesting and roosting sites; 2) Recovery habitat consisting of ponderosa pine forests with a Gambel oak understory, mixed-conifer forests, and/or riparian areas that can serve as nesting and roosting habitat or could "provide foraging, dispersal, or wintering habitat;" 3) Other forest and woodland vegetation communities managed for resilience and sustainability (USFWS, 2012). USFWS also determined that monitoring of owl occupancy and habitat, particularly after management actions, is crucial for understanding the owl's status, management impacts on owl habitat, and if the habitat can support future owl populations (USFWS, 2012). Forested Mexican spotted owl critical habitat provides for nesting, roosting, foraging, and dispersing. Canyon Mexican spotted owl critical habitat includes "landscapes dominated by vertical-walled rocky cliffs within complex watersheds with many tributary side canyons (USFWS, 2012). Canyon habitat provides for nesting, roosting, and foraging.
Species: Peregrine Falcon (*Falco peregrinus*) **Taxonomic Group**: Bird **Federal Listing Status**: Not Listed **New Mexico Listing Status**: Threatened (1996), SGCN (2006) (vulnerable, keystone)	The peregrine falcon (peregrine) is one of the largest falcons in North America, with an average body length of 13 to 24 inches and a wingspan of 29 to 47 inches. Peregrines nest in cliffs, treetops, skyscrapers, and electrical towers. They breed once per year, laying clutches of two to five eggs. Peregrines are avivores, primarily hunting birds for food. However, they will occasionally eat small mammals. The oldest known peregrines are approximately 20 years old (The Cornell Lab, n.d.; USFWS, 2004). Peregrines are found on nearly every continent except Antarctica. Most peregrines do not migrate and live along coastlines and rivers where cliffs provide nesting. However, they are also found in urban areas, mud flats, edges of lakes, and mountain ranges up to 12,000 feet where adequate nesting is available and terrain allows for long lines of sight (The Cornell Lab of Ornithology, n.d.). There is no preferred nesting habitat within Valles Caldera. However, peregrines nest in the nearby Santa Fe National Forest and have been seen hunting within Valles Caldera (NPS, 2014).

Species, Taxonomic Group, and Listing Status	Description
Species: **Rio Grande Chub (*Gila pandora)*** **Taxonomic Group**: Fish **Federal Listing Status**: Petitioned for listing in 2013, under review **New Mexico Listing Status**: SGCN (2006) (vulnerable)	The Rio Grande chub (chub) is a small fish that lives in streams and lakes throughout the Rio Grande River Basin in Colorado, New Mexico, and east of the continental divide in Texas (USFWS, 2021). The chub reaches reproductive maturity at two or three years and has a lifespan of approximately seven years. It reproduces annually, with spawning occurring between March and June depending on water temperature and streamflow. The chub is an omnivore and insectivore with insects, crustaceans, small invertebrates, small fish, and some vegetation comprising its diet (USFWS, 2021). In Valles Caldera, the chub is found in Jaramillo Creek, a tributary of the East Fork Jemez River, and Rito de los Indios Creek, a tributary of San Antonio Creek (NPS, 2014). It commonly inhabits pools in cool, fast-flowing streams with gravel or cobble substrate and is found at elevations up to 11,400 feet (Platania, 1991). Undercut banks and overhanging vegetation provide cover and are important habitat features. The chub also requires upstream and downstream movement for genetic exchange, reproduction, and access to suitable habitat as streams throughout their range seasonally flood and then dry up in late summer and fall (USFWS, 2021).
Species: **Rio Grande Sucker *(Catostomus plebeius)*** **Taxonomic Group**: Fish **Federal Listing Status**: Not Listed **New Mexico Listing Status**: SGCN (2006) (declining, vulnerable)	The Rio Grande sucker (sucker) is a bottom feeding fish that uses a ridge of cartilage on their back to scrape algae off rocks, then feed with a downwardly turned mouth. Suckers hatch from eggs and have a life expectancy of seven years. They reach sexual maturity in four to five years and will swim upstream once a year to spawn. A typical female produces around 2,000 eggs per spawn (USFWS, 2016b). Suckers were once found along the mainstem of the Rio Grande but now are mostly found in upland headwater tributaries. Along with several rivers in Mexico, there are also small populations in the Gila River, San Francisco River, and isolated populations in closed basins (RGCRGSCT, 2021). The sucker has been found in San Antonio Creek and the East Fork Jemez River in Valles Caldera (Calamusso, 2002). Sucker habitat consists of flat, slow-moving streams with pools, glides, coarse sediment, woody debris, and aquatic vegetation (RGCRGSCT, 2021).
Species: **Monarch Butterfly (*Danaus plexippus*)** **Taxonomic Group**: Insect **Federal Listing Status**: Candidate (2020) **New Mexico Listing Status**: Not Listed	The monarch butterfly (monarch) is a large orange and black butterfly weighing approximately 0.02 ounces, with an average wingspan of three to four inches. Monarchs lay eggs exclusively on milkweed (*Asclepias spp*.) plants and after two to five days, the eggs hatch into caterpillars. The caterpillars feed on the milkweed and obtain toxins called cardenolides which act as defense against predators. After two weeks, the caterpillars pupate into a green chrysalis and an adult monarch emerges one to two weeks later (USFWS, 2023c). Migratory monarchs are native to North and Central America and are found from southern Canada to central Mexico wherever there is appropriate vegetation to support reproduction and feeding. In North America, adult monarchs undertake a yearly migration from their breeding habitat farther north, to wintering locations farther south. The eastern population that migrates through New Mexico overwinters in central Mexico, and then migrates north to the Great Plains during the spring and summer. At night, monarchs congregate in dense packs on trees to preserve warmth during migration. Although the lifespan of a monarch is typically only two to five weeks, overwintering

Species, Taxonomic Group, and Listing Status	Description
	monarchs enter a state known as diapause that suspends reproduction and allows them to survive as long as six to nine months (USFS, n.d., b; USFWS, 2023c). If milkweed is present for breeding and flowering plants are available as a food source for adults, monarchs can survive in a wide range of habitats including roadside ditches, suburban fields, wetlands, and prairies (USFWS, 2023c). Surveys in Valles Caldera show that milkweed is present along the East Fork of the Jemez River and San Antonio Creek, suggesting that monarchs could utilize the park in some capacity during migration (SEINET, 2017). Examples of flowering plant species present in Valles Caldera that monarchs could utilize as a food source are Fendler's ceanothus (*Ceanothus fendleri*), wavyleaf thistle (*Cirsium undulatum*), bluestem willow (*Salix irrorate),* kinnikinnick (*Arctostaphylos uva-ursi),* and redroot buckwheat (*Eriogonum racemosum)* (SEINET, 2017).
Species: **New Mexico Meadow Jumping Mouse** ***(Zapus hudsonius luteus)*** **Taxonomic Group**: Mammal **Federal Listing Status**: Endangered (2014) **New Mexico Listing Status**: Endangered (2006), SGCN (2006) (declining, vulnerable, endemic)	Due to a typical lifespan of three years and an annual litter of seven or fewer young, the New Mexico meadow jumping mouse (jumping mouse, mouse) has a limited capacity for high population growth rates (USFWS, 2016a). The mouse's diet consists of plants, fungi, and invertebrates, with grass seed being the primary food source (NMDGF, 2022). In montane areas such as Valles Caldera, the mouse has a short season of activity between June to October, and may hibernate for up to nine months of the year (Frey, 2015). It requires abundant food during the summer to accumulate sufficient fat reserves for its hibernation period (USFWS, 2016a); a lack of resources for a single season can cause stress or even death. The jumping mouse is endemic to New Mexico, southern Colorado, and Arizona (Hafner et al., 1981), typically inhabiting elevations from 4,500 to 8,000 feet. Many of the montane sites where the species persist are only a few acres in size and are widely separated from other occupied sites (NMDGF, 2022). Only ten populations are known in the Jemez Mountains, including at least one in Valles Caldera. Historically (1970's), the jumping mouse was observed along Redondo Creek and San Antonio Creek (USFWS, 2020). In 2018, jumping mice were detected by track plates in two separate locations along Redondo Creek and an adult male was observed (captured) (USFWS, 2020). In 2019, jumping mice were detected by track plate near the headwaters of Jaramillo Creek. In 2024, jumping mice were detected by track plate along Redondo Creek (S. Milligan, personal communication, September 17, 2024). Although there is no designated critical habitat within the park, due to a lack of comprehensive surveys the mouse is presumed to inhabit suitable habitat within the park (USFWS, 2023). The mouse requires approximately 60% of its habitat within dense, grassy areas close to perennial sources of water and 40% of its habitat within drier adjacent uplands for hibernation and rearing young (NPS, 2022; USFWS, 2023d). The jumping mouse also relies on herbaceous vegetation greater than 24 inches tall (USFWS, 2023d). Critical habitat for the jumping mouse was designated by USFWS in 2016. Most critical habitat exists outside of Valles Caldera, except for a short distance along San Antonio Creek in the northwest corner of the park. Critical elements of

Species, Taxonomic Group, and Listing Status	Description
	habitat include: 1) persistent emergent herbaceous wetlands with presence of forbs and sedges; 2) scrub-shrub wetlands along perennial streams dominated by willows (*Salix spp*.) or alders (*Alnus spp*.); 3) Microhabitats with moist soil along the edge of permanent water with stringers and patches of dense and tall vegetation (USFWS, 2016a). USFWS also designated areas of secondary habitat in Valles Caldera, including along the East Fork Jemez River, San Antonio Creek, Rito de los Indios, San Luis Creek, Sulpher Creek, Redondo Creek, Jaramillo Creek, and La Jara Creek. Secondary patches do not meet criteria for critical habitat but may support jumping mice (USFWS, 2020).
Species: **Mexican Wolf *(Canis lupus baileyi)*** **Taxonomic Group**: Mammal **Federal Listing Status**: Endangered (1976 as a subspecies of the gray wolf; 2015 as a separate species) **New Mexico Listing Status:** Endangered (1976), SGCN (2006) (declining, vulnerable, keystone)	The Mexican wolf (wolf) is the smallest subspecies of gray wolf. Living in packs of four to eight members, they typically inhabit ponderosa pine and spruce-fir forests above 4,500 feet. Mexican wolf packs usually consist of a monogamous male-female breeding pair and several generations of their offspring (USFWS, n.d.,a). The females breed yearly in mid-February and birth a litter of four to six pups in April. Typical diet consists primarily of elk, deer, and small mammals, and occasionally livestock (USFWS, n.d.,a). The wolves utilize their pack to hunt cooperatively and eat twice a week on average (USFWS, n.d.,a). Intentional eradication efforts caused near extinction of the Mexican wolf (USFWS, 2023b). In fall of 2023, a lone female was observed as far north as Valles Caldera; however, she was relocated to Sevilleta Wolf Management Facility to pair with a mate (NPS, 2023a). Since then, motion camera surveys in Valles Caldera have not detected Mexican wolves and there have been no reports of nocturnal wolf calls in the area.
Species: **Spotted Bat *(Euderma maculatum)*** **Taxonomic Group**: Mammal **Federal Listing Status**: Not Listed **New Mexico Listing Status:** Threatened (1994), SGCN (2006) (vulnerable)	The spotted bat (bat) is medium sized bat that primarily nests on cliff faces but occasionally in buildings. They produce a singular offspring each year in the early summer (NMDGF, 2022; WDFW, n.d.). They are a solitary species and do not form colonies (NDW, n.d.). Their diet consists primarily of moths and grasshoppers (WDFW, n.d.; NPS, 2014). Spotted bats typically live around 20 years in the wild (NVDW, n.d.). Although migratory movements of the bat are still poorly understood, preliminary research suggests that some combination of latitude-based and elevation-based migration occurs seasonally (Luce, 2007). Spotted bats are distributed sparsely throughout western North America from British Columbia to Mexico (NPS, 2014; Luce, 2007). Within this range, they are typically found within three to six miles of water, near large rocky cliffs, and in a variety of vegetation communities and elevations where they can find prey (NPS, 2014; Luce, 2007). Spotted bats have been recorded in Bandelier National Monument and are more frequently found at higher elevations of the park, suggesting they may also be present in Valles Caldera (Ellison, 2005).
Species: **Gunnison's Prairie Dog *(Cynomys gunnisoni)*** **Taxonomic Group**: Mammal	Gunnison's prairie dog (prairie dog) is a small mammal, 12 to 15 inches long. In early spring, they are born in litters of three to four pups and spend several weeks underground before surfacing (NPS, 2015). The prairie dog builds complex tunnel systems with specialized chambers used as nurseries, resting areas, latrines, and air pockets that prevent flooding (NPS, 2015). The diet of the prairie dogs consists of grasses, sedges, forbs, and occasionally insects (NPS, 2014). Vegetation height is reduced around prairie dog colonies from their

Species, Taxonomic Group, and Listing Status	Description
Federal Listing Status: Not Listed **New Mexico Listing Status:** SGCN (2006) (declining, vulnerable, keystone)	herbivory, with a secondary function of creating lines of sight that allow for detection of predators (NPS, 2015). Prairie dogs live between three to five years and are social animals that communicate complex details through a series of variable calls (NPS, 2015; Cully, 1997). Gunnison's prairie dog is found in deserts, grasslands, and shrublands across the American Southwest, with 75% of the population living in Arizona and New Mexico (Knowles, 2002). The species is split into two populations: mountain and prairie (NPS, 2014). The mountain population is found in northern New Mexico and southern Colorado, typically inhabiting intermountain valleys, and is present in Valles Caldera (NPS, 2014). The prairie population is found in deserts and shrublands in Utah, Arizona, and southern New Mexico (NPS, 2014).
Bird Species Protected Under the Migratory Bird Treaty Act (MBTA) of 1918 **Taxonomic Group**: Bird	Valles Caldera's diversity of vegetation communities and availability of water resources provide stopover and nesting habitat for migratory birds (NPS, 2014). A migratory bird engages in annual movement between regions, typically breeding in one location and spending the remainder of the year in another. Migrations can be short distances, for example from higher to lower elevations, medium distances (a few hundred miles), or long distances (thousands of miles) (Cornell Laboratory of Ornithology, 2021). Although annual long-distance migrations can be arduous for birds, approximately 350 species of birds embark on these challenging journeys (Cornell Laboratory of Ornithology, 2021). Migrations are often initiated by changes in food availability, nesting locations, daylight, and weather; genetic predisposition may be another trigger (Cornell Laboratory of Ornithology, 2021). Challenges encountered during migration may include metabolic stress, lack of food and shelter, inclement weather, predators, and encounters with infrastructure (Cornell Laboratory of Ornithology, 2021). The USFWS maintains a List of Birds of Conservation Concern (BCC) to identify species that are of the highest priority for conservation (USFWS, 2021). USFWS BCC that may occur in Valles Caldera include: black rosy-finch (*Leucosticte atrara*), black swift (*Cypseloides niger*), brown-capped rosy-finch (*leucosticte australis*), California gull (*Larus californicus*), Cassin's finch (*Carpodacus cassinii*), Clark's nutcracker (*Nucifraga colunbiana*), evening grosbeak (*Coccothraustes vespertinus*), Grace's warbler (*Dendroica graciae*), Lewis' woodpecker (*Melanerpes lewis*), long-eared owl (*Asio otus*), mountain plover (*Charadrius montanus*), olive-sided flycatcher (*Contopus cooperi*), pinyon jay (*Gymnorhinus cyanocephalus*), Virginia's warbler (*Vermivora virginiae.* The U.S. North American Bird Conservation Initiative (NABCI) developed ecologically distinct Bird Conservation Regions (BCRs) for North America to facilitate regional collaboration for bird conservation. Each region has similar bird communities, habitats, and resource management issues. Valles Caldera is part of Bird Conservation Region 16: BCR Map - NABCI (nabci-us.org). Valles Caldera is also identified as an Important Bird Area (IBA) by Audubon Southwest, a regional office of the National Audubon Society. The IBA program identifies, monitors, and protects birds and their habitats.

Trends and Planned Actions
The primary past, current, and planned actions and trends within the park that may affect SSW include past land-use practices (logging, overgrazing, and fire suppression); landscape susceptibility to pests and pathogens; trail, road, and parking lot construction; fence removal; ecological restoration; and climate change.

Post-settlement land use including clear-cut logging practices of the mid-1900s (Parmenter et al., 2007), historic overgrazing by sheep and cattle (NPS, 2022b), and fire suppression efforts of the 20th century (Allen, 1989) have contributed to substantial changes in vegetation structure and composition (refer to section 3.3, Vegetation) in Valles Caldera. These changes influence SSW habitat and resource availability. For example, extensive logging removed larger old growth trees, a key component of SSW (e.g., Mexican spotted owl) habitat; and, in combination with fire suppression, resulted in increased densities of smaller diameter trees (NPS, 2014). Densified forest conditions render forests susceptible to pests and pathogens and landscape-scale high-severity fire. The spatial and temporal scale of pest and pathogen outbreaks across the park has fluctuated from 2000 to present, with the percent of area damaged by pests peaking at 60% in 2008 (USFS, 2018). Shortly after this peak, in June 2011, a tree fell on a powerline and ignited the Las Conchas Fire. Approximately 51% of all forested areas within the park burned during the Las Conchas Fire (NPS, 2022b), with about 8,300 acres burning at high-severity within the park. Patches of high burn severity have little to no conifer regeneration and may convert to grassland or shrubland (Guiterman et al., 2022), contributing to habitat loss (Kalies et al., 2010). Post-fire flooding in 2011 temporarily increased nitrate, phosphate, turbidity, and conductivity that contributed to fish mortality, particularly of non-native trout (NM EPSCoR, n.d.; Reale et al., 2021). Two years later, in 2013, the Thompson Ridge Fire burned 24,000 acres in Valles Caldera, approximately 27% of the park, 40% of which was forest. Only 3% of the fire burned at high-severity, and 23% at moderate (USGS, 2011); however, habitat availability was altered, particularly on steep, forested slopes (NPS. 2014).

In addition to altering vegetation structure and composition, past logging operations created more than one thousand miles of logging roads in Valles Caldera (Muldavin & Tonne, 2003), resulting in vegetation patches separated by linear road boundaries (Parmenter et al., 2007). Road boundaries result in habitat fragmentation and can disrupt landscape and ecosystem connectivity critical for movement and dispersal of species, populations, and genes between patches of habitat (NPS, 2022b). Although recent studies show that sufficient connectivity exists in Valles Caldera's lower montane, upper montane, riparian, and valley bottom habitats (NPS, 2022b), SSW can be more vulnerable to disruptions in habitat connectivity. This vulnerability is related to the small population sizes, limited home ranges, and specific habitat requirements characteristic of many SSW (Bagne, et al., 2014). Moreover, when considering climate change, habitat connectivity and corridors for species that are by definition more at risk for extinction becomes paramount in facilitating movements (Bagne, et al., 2014), for example to higher elevations and cooler temperatures.

Trail, road, and parking lot construction that can affect SSW include an accessible trail through the Cabin District, rerouting the road near the Entrance Station, and construction of two new gravel parking lots southwest of the Ranger Station. Removal of fencing includes old livestock fencing.

Ecological restoration projects include wetland restoration and forest thinning. Approximately 700 acres of wetland restoration has been accomplished with 250 acres planned in the future. Goals include increasing the extent of wetlands and wetland plant species and improving hydrologic function. Past forest thinning and restoration projects have been implemented on approximately 10,000 acres.

Climate trends are expected to impact SSW. Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000. Between 1895 and 2018, mean temperatures have increased by 1.4°F per century due to warming in the spring and summer months (NPS, 2022b). Precipitation over the same period has remained relatively stable (Carlson & Gross, 2019), although there is some indication that climate change is causing more intense and sporadic rain events in the Jemez Mountains (NPS, 2024b). In addition, the proportion of precipitation received as snow has declined (NPS, 2022b). Although precipitation overall has not declined, higher temperatures increase evaporation rates, resulting in water deficit, increased aridification, and lower fuel and soil moistures. These conditions contribute to landscape-scale high-severity wildfires (NPS, 2022b). Climate change can exacerbate risks and extinction rates for species that are already vulnerable (Bagne, et al., 2014). Under a changing climate, conservation and restoration efforts for SSW and their habitat may need to be strengthened (Bagne, et al., 2014).

Specific or unique trends and planned actions for each SSW are described in Table 14.

Table 14. Unique Trends and Planned Actions for Each Special Status Wildlife Species

Species	Description of Unique Trends and Planned Actions
Jemez Mountains Salamander	In 2022, the Global Amphibian Assessment (GAA) completed their second evaluation of amphibian species for the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Luedtke et al., 2023), the global benchmark for assessing the risk of species extinction (IUCN, 2023). The GAA reported that amphibians are the most globally threatened vertebrate class with common threats including habitat loss and degradation, infrastructure development, climate change, and disease (Luedtke et al., 2023). In the 2022 assessment, the Jemez Mountains salamander was listed as “Endangered” on the IUCN Red List (IUCN, 2022), a ranking system of seven assessment categories including Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, and Extinct (IUCN, 2023). In the Jemez Mountains, the USFWS reports similar threats to the salamander including habitat loss and degradation due to historical fire exclusion and suppression resulting in high-severity, habitat-destroying wildfire; fire suppression actions during wildfires; post-fire rehabilitation efforts; forest structure and composition conversions; and habitat alteration and fragmentation due to roads, trails, and recreation (USFWS, 2013). Additional impacts include forest restoration actions that may result in decreased salamander cover object availability and reduced soil moisture retention (Cummer, 2007); direct manipulation of salamanders through invasive and repeated mark and recapture sampling (Zemanova, 2020); disruption of microhabitat conditions by repeated trampling and rearrangement of salamander cover objects during surveys; climate change resulting in warming temperatures and periods of drought; and potential susceptibility to diseases such as chytrid fungus (*Batrachochytrium dendrobatidis (BD)*) (Christman and Jennings, 2018). Although forest restoration and intensive salamander surveys pose a threat, both are critical for conservation of the salamander and its habitat. Forest restoration reduces potential for high-severity, habitat-destroying wildfire. Salamander surveys and research are vital for increasing knowledge and improving conservation measures (NPS, 2022).
Bald and Golden Eagle	Bald eagles nearly went extinct in the mid-1900s due to overhunting and reduced reproductive ability caused by pesticides such as DDT (USFWS, 2002). Golden eagles also declined, but due to differences in diet, did not decrease to the point of warranting federal listing (Katzner et al., 2020). In 1940, the Bald Eagle Protection Act prohibited the killing of bald eagles, and in 1962, protections for golden eagles were added (Katzner et al., 2020). Since the banning of DDT and passing of the BGEPA, populations of both species have recovered, although threats still exist. Human disruption continues to decrease the number of nesting sites available, and large-scale wildfires have significantly reduced available habitat (Scott, 1985; U.S DOI, 1996). Lead poisoning from the use of lead shot in hunting is frequently identified as a significant threat to eagles. Climate change has been shown to affect the abundance and distribution of prey (Slabe, 2019; Knick, 2003).
Boreal Owl	Threats to the boreal owl include habitat loss and fragmentation, and climate change. Warmer and drier conditions render forest habitats increasingly susceptible to disease, pest outbreaks and infestations, and high-severity wildfires that could decimate boreal owl habitat (Stahlecker et al., 2014). One study found mid- to upper-elevation habitat declines varying from 5% to 86%, with the owl experiencing some of the greatest habitat loss and the potential of being extirpated in New Mexico under future climate conditions (Cartron et al., 2023).

Species	Description of Unique Trends and Planned Actions
Mexican Spotted Owl	Primary threats to the owl include timber harvesting practices that produce even-aged forest stands; loss of low- and mid-elevation riparian habitat; habitat loss due to land development; disturbances due to human recreation; habitat alteration due to energy development (e.g., powerlines, pipelines, and roads); habitat fragmentation due to roads and trails; water development (e.g., dams, diversions, dewatering); potential predation by great horned owls and other raptors; epidemic levels of forest pest and pathogen outbreaks; insufficiently managed grazing; high-severity wildfire; and fire suppression actions (USFWS, 2012).
Peregrine Falcon	The peregrine falcon was federally listed as an endangered species in 1973 due to population declines caused by DDT and other pesticides, which damaged the membranes of eggs and often prevented reproduction. By the mid 1970's, the peregrine was extinct in the eastern U.S. and surveys showed only 324 known nesting pairs in the U.S and Canada (NPS, 2021b). After DDT was banned in 1972, peregrine populations rebounded to around 1,650 nesting pairs and in 1999 the species was delisted. (NPS, 2021; EPA, 2023). Although populations have rebounded, NMDGF still lists the species as threatened in New Mexico due to continued threats from chemical contamination, habitat destruction, and illegal poaching (NMDGF, *2022*).
Rio Grande Chub	The Rio Grande chub evolved alongside the Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) and the Rio Grande sucker, with each species occupying a particular niche due to their variation in diet and preferred habitat. Historically, the chub was likely the most common fish in the Rio Grande, Rio Grande Basin, and San Luis Basin (USFWS, 2021). Chub populations have declined up to 75% in the last century and occupy less than 25% of their historic range (Bestgen et al., 2003; USFWS, 2021). Populations are considered stable within the headwaters and tributaries of the Rio Grande drainage basin but thought to be extirpated from the mainstem of the Rio Grande (Rees et al., 2005). Threats facing the chub include habitat loss, fragmentation, and degradation through increased sedimentation; pollution; increased temperatures; dewatering due to overgrazing; water diversion projects; and development. Predation and competition by over 25 different species of non-native fish have also negatively impacted the chub (Rees et al., 2005; USFWS, 2021). Another threat facing the chub is increasing high-severity wildfire. High intensity fires can remove stabilizing vegetation and cause erosion, leading to flash floods with ash and debris flows (Rinne, 1996). However, after the 2011 Las Conchas Fire, native fish populations (including the chub) increased due to reductions in predatory trout populations (NPS, 2014). Native fish, adapted to frequent fire intervals, survived the high levels of ammonia that caused substantial declines in non-native trout populations in the upper reaches of Rio San Antonio, including Rito de los Indios Creek, Jaramillo Creek, and the East Fork of the Jemez River within Valles Caldera (NPS, 2014).
Rio Grande Sucker	As short segments of stream do not contain all necessary habitat elements, the greatest threat facing the sucker is habitat fragmentation caused by water diversions (RGCRGSCT, 2021) which can prevent the movement of suckers up and down stream, isolating populations and preventing access to spawning grounds. Dewatering due to reservoir construction and water extraction has also greatly reduced streamflow along most of the sucker's range, further exacerbating habitat fragmentation (RGCRGSCT, 2021). Another threat facing the sucker is increasing high-severity wildfire. High intensity fires can remove stabilizing vegetation and cause erosion, leading to flash floods with ash and debris flows (Rinne, 1996). However, after the 2011 Las Conchas Fire, native fish populations (including the sucker) increased due to reductions in predatory trout populations (NPS, 2014). Native fish, adapted to frequent fire intervals, survived the high levels of ammonia that caused substantial declines in non-native trout populations in the upper reaches of Rio San Antonio, including Rito de los Indios Creek, Jaramillo Creek, and the East Fork of the Jemez River within Valles Caldera (NPS, 2014).

Species	Description of Unique Trends and Planned Actions
Monarch Butterfly	North American monarch populations have declined by approximately 90% since the early 1990s (Xerces Society Western Monarch Count, 2024). The decline can be attributed to destruction of overwintering habitat, breeding habitat, congregation sites, and milkweed stands; herbicide and pesticide use; alteration of migration timing due to climate change; and proliferation of non-native milkweeds (Pelton et al., 2019; National Wildlife Federation, n.d.; USFS, n.d., c).
New Mexico Meadow Jumping Mouse	The mouse is vulnerable to habitat fragmentation and the corridors that provide connectivity between habitat patches should be protected or restored. Restoration may include introduction of beaver dams or human-made impoundments, and exclusion of livestock from riparian areas (NMDGF, 2022). A significant decline in presence of the jumping mouse and suitable habitat for montane populations in the Jemez and Sacramento Mountains was detected in 2005 (Frey, 2005b; Frey & Malaney, 2009). A variety of human-caused impacts resulted in habitat degradation, including the conversion of mesic areas to agricultural areas, removal of beavers and their dams, down-cutting of streams, water diversions, and development (NMDGF, 2022). Furthermore, excessive grazing and drought exacerbated by climate change caused a loss of dense herbaceous vegetation and moist soil conditions along streams (NMDGF, 2022). Increasing incidences of high-severity wildfires and post-fire runoff have also damaged or destroyed jumping mouse habitat (NPS, 2014).
Mexican Wolf	Prior to the mid-1800s, the Mexican wolf was found from eastern Arizona to west Texas, and as far south as central Mexico (USFWS, n.d.,b). Currently, most Mexican wolves are found in a zone known as the Mexican Wolf Experimental Population Area in the Gila National Forest in Southwestern New Mexico and the Apache-Sitgreaves National Forest in Arizona and western New Mexico (USFWS, 2021). Wolves in this area are not fully wild and are subject to monitoring and supervision. Within this area, they inhabit forested areas with access to water, cover, and prey species (USFWS, n.d.,b). Mexican wolves were first reintroduced to this area from breeding programs in 1998 after becoming extinct in the wild (USFWS, n.d.,b; Maestas, 2023; Nie, 2003). Since reintroduction, they have expanded in both population and range, with 241 Mexican wolves documented in 2022, 136 in New Mexico and 105 in Arizona (USFWS, 2023b). Ranchers have long come into conflict with wolves due to fears surrounding predation of livestock. Bounties were placed on wolves by local governments and in 1915, Congress established the Predatory Animal and Rodent Control Service, which allocated federal funds toward the eradication of the Mexican wolf (USFWS, n.d.,a). Presently, the Mexican wolf is protected under the ESA and does not face the same existential threat from hunting. However, the small population size makes the species vulnerable to genetic bottlenecks, inbreeding, and disease (USFWS, n.d.,b). Furthermore, as Mexican wolf populations continue to grow, the potential for negative human-wolf interactions increases.
Spotted Bat	Existing data in New Mexico suggests that spotted bat populations are stable (Luce, 2007), but because the spotted bat is a rare and solitary species, it is difficult to determine population trends. Further, the mist-netting technique used in many surveys does not appear to adequately detect the species (NPS, 2014). Small population size and fragmented distribution leaves the species vulnerable. Some studies suggest spotted bats will abandon roosts if disturbed, such as by recreational rock climbing. Alteration of wetlands, timber harvesting, and modification of riparian habitat, shrublands, and grasslands can reduce habitat available for foraging. In addition, bats are thought to be susceptible to poisoning caused by widespread pesticide use (Luce, 2007).
Gunnison's Prairie Dog	Populations of Gunnison's prairie dog predators, such as wolves, coyotes, and black footed ferrets, have significantly decreased due to human activities (NPS, 2015; USFWS, 1996). Due to a lack of predators, prairie dog populations boomed and overpopulated colonies

Species	Description of Unique Trends and Planned Actions
	became infected with bubonic plague. Under historic conditions, overpopulated colonies of prairie dogs would colonize new areas. However, fire exclusion contributes to increased vegetation heights, reducing colony expansion because prairie dogs avoid areas with tall vegetation to evade predation. (Breland, 2014). The lack of expansion worsens the impact of bubonic plague and threatens the success of the species (NPS, 2009; NPS 2015; NPS, 2024c).
Migratory Birds	Threats to migratory birds may include diseases such as avian botulism, avian influenza, avian cholera, and West Nile virus; environmental contaminants; poor water quality; loss of genetic diversity and biodiversity; invasive species; illegal wildlife trade; and climate change (Cornell Laboratory of Ornithology, 2021). Additional human-caused threats to migratory birds can include habitat conversion and loss; collisions with buildings, glass, electrical line, vehicles, turbines, and towers; electrocutions; poison; and cats (Cornell Laboratory of Ornithology, 2021). Landscape-scale high-severity wildfire, the result of a 100-year legacy of active fire suppression and exacerbated by climate change, can also impact migratory birds (Overton et al., 2022).

3.5.2 Impacts of Alternative A (No Action)

A suppression-oriented wildland fire management program would exclude forest thinning, prescribed fire, and allowing naturally ignited fire to burn, leading to increased forest extent, density, layering, and surface fuel loading (Hessburg et al.,2019). These forest and fuel conditions would render the landscape susceptible to pests, pathogens, and landscape-scale high-severity fire. Pests, pathogens, and high-severity fire can cause habitat alteration, fragmentation, and loss for species that are by definition more vulnerable and at risk for extinction due to small population sizes; limited home ranges; specific habitat requirements; and narrow physiological thresholds that are often characteristic of SSW populations (Bagne, et al., 2014).

In general, defensible space and fire suppression actions may have adverse, short- and long-term impacts on SSW and their habitat. Construction of fire lines and use of bulldozers, vehicles, and equipment may result in adverse impacts due to ground disturbance and could disrupt species sensitive to noise and human presence. Disturbance may last weeks to months during suppression actions, and depending on fire extent, for years. However, all fire suppression actions would be mitigated using the MIST framework (Appendix C), striving for the least environmental, cultural, and social impacts.

Impacts of defensible space and fire suppression actions and high-severity fire on wildlife habitat and vegetation communities under Alternative A are more fully described in sections 3.3 (Vegetation) and 3.4 (Wildlife) and are applicable to SSW. This section focuses on specific or unique impacts to SSW from defensible space and fire suppression actions and the increased likelihood of high-severity fire and under Alternative A. Impacts described below would be expected to continue under Alternative A.

Jemez Mountains Salamander

Under Alternative A, the salamander and its habitat are at risk due to continued increases in landscape-scale high-severity fire. Impacts would include injury or mortality to individual salamanders from fire and habitat alteration or destruction such as a loss of canopy cover; decreases in soil moisture; increases in temperature; removal of salamander cover objects (decaying logs, bark, and moss mats); and diminished prey base. High-severity fire can also result in a loss of habitat connectivity, reducing opportunities for breeding and increasing the risk of inbreeding and genetic drift (USFWS, 2013). These impacts can render salamander populations susceptible to disturbances, such as future high-severity fire (USFWS, 2013). Because the salamander is lungless and breathes through its skin, it requires moist conditions when surface active (USFWS, 2013), making the salamander susceptible to a high-severity post-wildfire environment. In addition, because the salamander has limited mobility and a small home range (USFWS, 2013), fleeing from wildfire, or rapidly moving to a different location is not probable, even if suitable, unburned habitat is relatively nearby.

If near the soil surface or if surface active, the salamander would be particularly vulnerable to ground disturbance from defensible space and fire suppression actions because they are relatively immobile and cannot easily flee.

Bald and Golden Eagle

A primary threat facing eagles is habitat loss due to high-severity wildfire (Lehman & Allendorf, 1989) which can destroy perching, roosting, and nesting trees, and reduce reproductive success (Landers, 1987). Nestling survivorship can be reduced in post-wildfire environments due to habitat changes and decreases in prey base. Switching from preferred prey to alternate prey may expose eagles to prey that carry disease (Heath, 2021).

Boreal Owl

Boreal owls typically nest in large, old, tree cavities in mixed-conifer forests interspersed with meadows and small openings, above 8,000 feet (Stahlecker & Rawinski, 1990). Fire suppression and exclusion can result in densified forests without openings and meadows encroached by trees, adversely impacting the owl's ability to nest and hunt. Increases in high-severity fire under Alternative A could also result in habitat loss.

Mexican Spotted Owl

Unusually dense forests, such as those resulting from fire suppression and exclusion, can obstruct hunting for spotted owls, and further, may have reduced densities of prey (Gutiérrez et al., 2017). Dense forests are also susceptible to landscape-scale high-severity fire and studies have shown that spotted owls vacate their territories after larger, high-severity fires (Gutiérrez et al., 2017, Jones et al., 2024). High-severity fire can cause mortality of larger, old trees that the owls use for nesting, resulting in declines in owl pair persistence. In addition, landscape-scale high-severity fire can cause reductions in owl prey (Jones et al., 2024).

Peregrine Falcon

Wildfire-related injury or mortality of peregrines is unlikely due to their ability to flee. The probability of nestling mortality is likely higher because they are less mobile and unable to vacate the nest (Lehman & Allendorf, 1989). However, peregrines typically nest on cliffs and rock outcrops where fire potential is lower. Peregrines nest in the spring months of April to June and nestlings may be more vulnerable to fire suppression actions, such as presence of firefighters, vehicles, and aircraft, and construction of fire lines and fire camps, during this timeframe (Ellis, 1982).

Rio Grande Chub and Rio Grande Sucker

High-severity wildfires remove stabilizing vegetation, potentially causing soil erosion, flooding events, suspended sediment load, debris flows containing deadly ash, and reduced water quality. For example, after the 2011 Las Conchas Fire, debris flows in San Antonio Creek and Rito de los Indios Creek after the onset of the monsoon caused mortality of non-native trout populations in the headwaters, likely caused by a spike in ammonia that exceeded New Mexico state water quality standards (NPS, 2014). Although chub and sucker populations survived the high levels of ammonia, their habitat was adversely impacted.

Monarch Butterfly

Severely declining North American monarch populations are vulnerable to high-severity wildfire because it can further destroy their overwintering habitat, breeding habitat, congregation sites, and milkweed stands (MacDougall, 2020). Moreover, monarchs are not able to quickly flee from a fire environment and mortality from heat and fire is possible.

New Mexico Meadow Jumping Mouse

The jumping mouse is vulnerable to disturbance due to its life history such as a short life span, short active period in summer, long hibernation period in winter, low population growth rate, specialized habitat needs, small home range, and limited mobility (USFWS, 2014). These specializations render the jumping mouse susceptible to extirpation when wildfire and post-fire flooding occur within their habitat, particularly when fire moves across the habitat at high-intensity and in a continuous (not patchy) manner. Further, jumping mouse habitat at Valles Caldera is highly fragmented and high-severity wildfire would exacerbate fragmentation and reduce the likelihood of survival and recolonization post-fire (without reintroduction efforts).

Mexican Wolf
There are currently no resident Mexican wolves in Valles Caldera. If Mexican wolves were present, wildfire-related injury or mortality would be unlikely due to their mobility and large home ranges. Although there is little research specifically related to Mexican wolf response to wildfire, observations show that other subspecies of gray wolves return to burn areas post-fire because vegetative regrowth results in increased prey populations and open forests provide longer lines of sight for hunting (Popescu, 2023; Fonseca, 2021). Similar to other apex predators, Mexican wolves could be impacted by bottom-up trophic cascades in portions of their habitat if high-severity fire drastically reduces primary producers and other lower trophic levels, however this is unlikely.

Note: Fire is currently not a primary focus of Mexican wolf conservation. A search of the Mexican Wolf Recovery Plan, Second Revision (2022), resulted in no instances of the word "wildfire" and only one instance of the word "fire." However, "adequate habitat availability and suitability" is listed as the number one condition that may influence recovery of the species. The Vegetation (3.3) and Wildlife (3.4) sections of this EA are fully applicable to the Mexican wolf.

Spotted Bat
Impacts of high-intensity fire on bats may include heat, smoke, and carbon monoxide (Dickinson et al., 2009); however, direct fire-related injury or mortality is unlikely due to a bat's ability to flee a fire environment. Further, spotted bats typically nest on cliff faces where fire is likely not a concern (NPS, 2014). Large high-severity fires can create expansive homogenous patches where vegetation and insect diversity may be low, reducing foraging opportunities (Steel, et al., 2019). Spotted bats are also typically associated with water; damage to wetlands and riparian habitats in Valles Caldera due to high-severity fire could result in adverse impacts to spotted bats.

Gunnison's Prairie Dog
The exclusion of frequent fire from prairie dog habitat has caused an increase in woody plants, which compete with herbaceous plants, reducing forage (grasses, sedges, forbs) and prey (insects) for prairie dogs. Fire exclusion has also caused increases in vegetation height, limiting colony expansion because prairie dogs avoid tall vegetation (Breland, 2014). High-severity fire, (resulting from decades of fire suppression, can cause mortality of native plants and insects and encourage non-native plants.

Migratory Birds
Increases in landscape-scale high-severity wildfire can have adverse impacts to migratory birds. Habitat loss and lack of food due to fire and increases in migration flight time and distance due to smoke avoidance can contribute to starvation and mortality (Overton et al., 2022). In one study, migrating geese altered their flight path to avoid dense smoke from wildfire, resulting in a 118% increase in flight duration and a 27% increase in flight distance compared to the previous years' migration (Overton et al., 2022).

Cumulative Impacts
The primary past, present, and reasonably foreseeable future actions and trends with potential to impact SSW include past land-use practices, landscape susceptibility to pests and pathogens; trail, road, and parking lot construction; fence removal; ecological restoration; and climate change. Cumulative impacts on wildlife habitat and vegetation communities under Alternative A are more fully described in sections 3.3 (Vegetation) and 3.4 (Wildlife) and are fully applicable to SSW. This section focuses on cumulative impacts of climate change on SSW under Alternative A.

Climate change in combination with fire suppression actions under Alternative A would result in increases in high-severity fire, resulting in adverse impacts to SSW habitat on a landscape scale. Spatial and temporal shifts in climate, particularly precipitation and temperature, can have disproportionate impacts on SSW due to attributes that are often characteristic of SSW such as small population sizes; limited home ranges; specific habitat requirements; narrow physiological thresholds, and a lack of plasticity (Bagne, et al., 2014). Moreover, fluctuations in precipitation and drought as a result of climate change can have adverse impacts on primary producers, initiating bottom-up trophic cascades (Heath et al., 2013) that can impact all SSW. A changing climate can also initiate top-down trophic cascades, causing declines in top or apex predators, such as raptors, by influencing species distribution, diseases and parasites, breeding, migration, physiology, behavior, and more (Martínez-Ruiz et al., 2023).

Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to special status wildlife would be adverse.

3.5.3 Impacts of Alternative B (Preferred Action)

Impacts of defensible space and fire suppression on SSW under Alternative B would be similar to Alternative A. However, a multiple strategy wildland fire program under Alternative B would utilize a wide range of fire management actions including manual and mechanical thinning, prescribed fire, and allowing naturally ignited fire to burn in a defined geographic area under specific prescription parameters. These actions would create a vegetation structure and composition that allows for widespread reintroduction of the frequent, low- to moderate-severity fires (with occasional, small high-severity patches) that historically burned in the Jemez Mountains (Allen, 1989)—the same fire regime under which SSW in Valles Caldera have persisted through time.

As a natural disturbance process, fire plays an integral role in creating a mosaic of habitat types at a landscape scale, increasing both floral and faunal diversity (Wasserman, 2015). Reintroducing prescribed fire and allowing naturally ignited fire to burn can reduce surface loading, tree densities and forest layering, and the potential for future high-severity fire (Walker, 2018). Implementation of low- to moderate-severity fire in a mosaic pattern of burned and unburned patches is an important prescription parameter for prescribed fire and naturally ignited fire in SSW habitat, especially for those species with limited mobility and small home ranges, such as the Jemez Mountains salamander, New Mexico meadow jumping mouse, and Gunnison's prairie dog.

In current fire-deprived and densified forests, thinning often must be used as a pre-treatment for prescribed fire or naturally ignited fire to remove "ladder" fuels that can allow fire to enter and travel through the tree canopy, resulting in higher-severity crown fire. Allowing naturally ignited fire to burn would result in the same beneficial impacts as prescribed fire but with a greater spatial extent, and at a lower cost (Hurteau et al., 2014).

To lessen adverse impacts of thinning, prescribed fire, and naturally ignited fire, SSW vulnerability would be considered in all fire and resource management actions and activities. Valles Caldera and Pueblo Parks Fire would consult with USFWS regarding impacts to federally listed species when developing all prescribed fire and thinning treatment plans. Implementation of treatments would adhere to all conservation and protection measures, performance requirements, best management practices, and mitigations as described in the USFWS Biological Opinion (Appendix E).

Valles Caldera and Pueblo Parks Fire would also limit adverse impacts to SSW by engaging in adaptive management (Appendix D) and collectively evaluating pre- and post-treatment datasets. For example, Valles Caldera's Fire Ecology Program has been monitoring the impacts of forest treatments, including thinning, piling, burning of thinned materials, and broadcast prescribed fire on Jemez Mountains salamander aboveground habitat since 2015. The data is used to evaluate if objectives are met; measure the effectiveness of thinning and fire prescriptions; alter prescriptions to reduce impacts; and to determine if additional research is needed.

Detailed impacts to wildlife habitat and vegetation communities from thinning, prescribed fire, and allowing naturally ignited fire to burn are more fully described in sections 3.3 (Vegetation) and 3.4 (Wildlife) and are applicable to SSW. This section focuses on specific or unique impacts to each SSW from thinning, prescribed fire, and allowing naturally ignited fire to burn.

Jemez Mountains Salamander

Fire is an essential ecosystem process in the habitat Jemez Mountains salamanders have persisted for at least 10,000 years (Margolis, 2016). Forest treatments, such as thinning and low- to moderate-severity fire are important for forest resilience and recovery of this rare species (USFWS, 2013; Margolis, 2016).

Due to the assessment of the salamander as "Endangered," both in the U.S. and globally, the vulnerability of the species is a primary concern for fire and resource managers when planning, preparing, and implementing forest treatments, including thinning, piling, burning of thinned materials, and broadcast prescribed fire. The primary long-term, beneficial impact of treatments is reducing potential for landscape-scale high-severity wildfire that can destroy both the salamander and its habitat. Adverse impacts from treatments may include injury or mortality; habitat alteration or destruction; decreases in soil moisture; increases in temperature; removal of salamander cover objects; and diminished prey base. However, conservation measures can help mitigate adverse impacts to the salamander and its habitat, such as creating a mosaic of unburned and burned patches of low- to moderate-severity to facilitate habitat connectivity and burning slash and wood piles when the salamander is not surface active (Appendix E).

Monitoring, science, and adaptive management also mitigate adverse impacts to the salamander and its habitat, making it a key component of the forest treatment process (Appendix D). Pueblo and Four Winds Fire Ecology Program has monitored the impacts of forest treatments on the salamander's aboveground habitat in Valles Caldera since 2015. Data collection includes variables associated with PCE's of the salamander's habitat, for example canopy closure; tree density; tree basal area; log density, count, and volume by decay class; percent cover of rocks, bark, and moss; and more. Measurements of fire behavior and severity are also included, for example rate of fire spread, flame length, flame height; vegetation, substrate, and log burn severity rankings; and char height, scorch height, and percent of crown scorched on trees. Monitoring and adaptive management will continue into the future and will help alleviate adverse impacts to the salamander and its habitat while promoting inquiry and flexibility in fire and ecosystem stewardship. Managers will also consider historic ranges of variation, a changing climate, and a future range of variability in the adaptive management process.

Bald and Golden Eagle

Frequent low-severity fires, including prescribed fire and allowing a naturally ignited fire to burn within prescription, can benefit eagle populations. Prescribed fire protects eagle habitat by reducing potential for high-severity stand-replacing fire (Covington, 1992) while creating and maintaining snag trees that eagles can use to perch and roost (Baldwin, 2022). Low- to moderate-severity fire increases the prey base (e.g. small mammals) for raptor species, including eagles (JFSP, 2017), and creates open forest conditions which provide long lines of site and increase hunting efficiency (Landers, 1987; USFWS, 2023).

Boreal Owl

Thinning, prescribed fire, and naturally ignited fire would create and maintain the old-growth, mixed-conifer forests interspersed with small openings and meadows that are preferred boreal owl habitat. Like other raptors, boreal owls would benefit from increases in prey that are visible when fleeing prescribed fires or naturally ignited fires (Lehman & Allendorf, 1989).

Mexican Spotted Owl

Prescribed fire and thinning of smaller diameter trees can create "complex-structured forests," consisting of a low to moderately dense variety of tree ages and sizes and a forest structure and composition that is both beneficial to spotted owls and resilient to high-severity fire (Gutiérrez et al., 2017). Forest management that reduces the extent of high-severity fire, such as implementing prescribed fire, thinning, and allowing naturally ignited fore to burn, is also expected to support Mexican spotted owl conservation objectives (Jones et al., 2024). Given that all landscapes spotted owls populate are characterized by historical frequent-fire regimes, it can be concluded that the owls' persistence through time in fire-prone landscapes has made it resilient to low- and moderate-severity fire (Gutiérrez et al., 2017). Several studies show that low- and moderate-severity fire had no adverse impacts on spotted owls (Roberts et al., 2011; Lee et al., 2012); rather, owls were observed foraging in burned areas (Bond et al., 2009) and on the edge of burned areas (Eyes, 2014).

Peregrine Falcon

As there are no known peregrine nesting sites within Valles Caldera, thinning, prescribed fire, and naturally ignited fire are not anticipated to have adverse impacts on peregrine populations. In the southwest, peregrines occur in fire-evolved vegetation communities such as ponderosa pine and Douglas-fir (Lehman & Allendorf, 1989). The peregrine's persistence in these communities over time show a co-evolution with wildland fire, where they opportunistically feed off fleeing prey species. Raptor populations near active wildland fires have been recorded as much as seven times higher (JFSP, 2017) due to prey availability. Prescribed fires that create a mosaic of unburned patches and burned patches of low- to moderate-severity can result in greater vegetation diversity, followed by increases in prey abundance and diversity that are beneficial to peregrines (NPS, 1991). Prescribed fire should be avoided near nesting sites during nesting season (April to June).

Rio Grande Chub and Rio Grande Sucker
Thinning and prescribed fire would be beneficial to individual fish, fish populations, and their habitat by reducing the likelihood of high-severity wildfire (Walker, 2018) and subsequent adverse impacts such as erosion, debris flows, and low water quality (NPS, 2014).

Monarch Butterfly
Thinning, prescribed fire, and naturally ignited fire conducted outside of peak breeding and migration periods and resulting in a mosaic of unburned and burned patches of low- to moderate-severity would likely have beneficial impacts on the monarch butterfly. Thinning and prescribed fire reduce forest density and open the forest canopy; low- to moderate-intensity fire initiates nutrient cycling processes. These outcomes result in increased sunlight transmission to the forest floor and improved plant vigor and cover, particularly of milkweed and other floral resources that pollinators such as the monarch rely on (USDA NRCS, 2022; USDA NRCS, n.d.).

New Mexico Meadow Jumping Mouse
Thinning is not likely to occur in jumping mouse habitat (wet meadows, grassy uplands, and riparian vegetation). However, if implemented, it would be minimal in extent, MIST would be employed, and it would not occur when jumping mice are surface active (June to October), therefore adverse impacts would be minimal to none. Beneficial impacts would include a reduction in potential for high-severity fire. Prescribed fire and allowing naturally ignited fire to burn has potential for adverse impacts to the mouse and its habitat. However, prescribed fire and naturally ignited fire would be implemented in a mosaic of unburned patches and low- to moderate-severity patches that would serve to restore, protect, and maintain habitat. In addition, conservation measures would be implemented (Appendix E) to reduce adverse impacts to the mouse and its habitat. Long-term beneficial impacts of prescribed fire and naturally ignited fire include increases in food sources for the mouse and a reduction in potential for high-severity fire.

Mexican Wolf
As there are currently no resident Mexican wolves in Valles Caldera, thinning, prescribed burning, and allowing naturally ignited fire to burn are not anticipated to have adverse impacts on Mexican wolf populations. If Mexican wolves were present, direct wildfire-related injury or mortality would be unlikely due to their mobility and large home ranges. Impacts from treatments would likely be beneficial and short- and long-term due to restoration of fire regimes, a diversity of native vegetation communities and prey species, open forests with long lines of sight for hunting, and a reduction in the potential for landscape-scale high-severity fire. In addition, conservation measures designed to support the USFWS recovery strategy concepts of resiliency, redundancy, and representation for the Mexican wolf would be implemented (USFWS, 2022).

Note: Fire is currently not a direct, primary focus of Mexican wolf conservation. A search of the Mexican Wolf Recovery Plan, Second Revision (2022), resulted in no instances of the words "prescribed fire" and only one instance of the word "fire." However, "adequate habitat availability and suitability" is listed as the number one condition that may influence recovery of the species.

Spotted Bat
Thinning, prescribed fire, and allowing naturally ignited fire to burn would likely have short- and long-term beneficial impacts on spotted bat populations due to increased habitat heterogeneity. Changes in forest structure and composition such as increases in herbaceous vegetation cover, opening of the forest canopy, and reductions in smaller diameter trees create habitat that promotes a diversity of insects, improving forage for bats (Loeb, 2020).

Moreover, treatments reduce the potential for high-severity fire which is particularly important in wetland and riparian areas for spotted bats (NPS, 2014).

Gunnison's Prairie Dog

Thinning, prescribed fire, and naturally ignited fire can reduce vegetation height and encourage prairie dogs to colonize new territory. This creates habitat dispersion, increases genetic diversity, helps prevent overpopulation, and slows the spread of bubonic plague (Breland, 2014). Prescribed fire and naturally ignited fire can also decrease woody plants that compete with herbaceous vegetation, initiate nutrient cycling processes, and improve the cover and vigor of prairie dog forage (grasses, sedges, forbs) and prey (insects).

Migratory Birds

Thinning, prescribed fire, and naturally ignited fire can have short-term adverse and short- and long-term beneficial impacts on migratory birds. Treatments would protect and enhance habitats for migratory birds by creating landscape heterogeneity, a diversity of habitats, an abundance of food sources, and reductions in high-severity fire. Studies show that prescribed fire can result in increased occupancy rates for bark-insectivores, cavity-nesters, aerial insectivores, and ground insectivores (Russell et al., 2009). Foliage insectivores and seed specialists may decline following treatments (Russell et al., 2009) but can increase over time as vegetation recovers and increases in diversity. Additional adverse impacts may include noise and heat and smoke from fire; however, birds can temporarily relocate from treatment areas. In addition, treatment actions would be conducted outside of migratory bird nesting season and would follow conservation measures (Appendix E).

Cumulative Impacts

The primary past, present, and reasonably foreseeable future actions and trends with potential to impact SSW include past land-use practices, landscape susceptibility to pests and pathogens; trail, road, and parking lot construction; fence removal; ecological restoration; and climate change. Cumulative impacts on wildlife habitat and vegetation communities under Alternative B are more fully described in sections 3.3 (Vegetation) and 3.4 (Wildlife) and are fully applicable to SSW. This section focuses on cumulative impacts of climate change on SSW under Alternative B.

Climate change in combination with thinning, prescribed fire, and naturally ignited fire under Alternative B would be similar to Alternative A; however, treatments would reduce potential for high-severity fire and partially alleviate the disproportionate impacts of climate change on SSW by improving outcomes for their habitat. Although adverse impacts are identified for each SSW, without exception treatments would help offset the adverse impacts by emphasizing long-term beneficial outcomes that would happen at the project and landscape scale. Trophic cascades would be less likely because treatments would promote heterogeneity, increase biodiversity, and encourage landscape resilience to climate impacts. In addition, the conservation measures and mitigations for SSW under Alternative B would improve outcomes. Ultimately, under a changing climate, conservation and restoration efforts for SSW and their habitat may need to be strengthened (Bagne, et al., 2014); the forward-looking goals and objectives under Alternative B would facilitate that effort.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be adverse cumulative impacts to special status wildlife. However, cumulative impacts would be beneficial in the long-term due to enhanced ecosystem stewardship and the reintroduction of beneficial fire regimes.

3.6 Biological Resources: Special Status Plants

The diversity of vegetation communities and availability of water resources in Valles Caldera provides essential habitat to special status plants (SSP). The SSP described in this section occur in Valles Caldera and are of management concern.

3.6.1 Affected Environment

Wood Lily (*Lilium philadelphicum var. andinum*)
Taxonomic Group: Forb
Federal Listing Status: Not Listed
New Mexico Listing Status: Endangered

Wood lily is a tall, orange- or red-flowered perennial herb in the Liliaceae family. It has a widespread range across the northeastern U.S. and southern Canada, and throughout the southern Rocky Mountains. It is listed as Endangered in New Mexico, where it is found between 7,550 to 10,000 feet in mixed-conifer forests, mountain meadows, and canyon bottoms (New Mexico Rare Plant Technical Council, 2020). Wood lily is vulnerable to disturbances such as high-severity fire and development that cause habitat loss, in addition to fire suppression, overgrazing, and specimen collection pressure (New Mexico Rare Plant Technical Council, 2020; Nodvin & Waldrop, 1991). Wood lily has underground, overwintering buds that protect it from surface fire (Schepens, 2022). The 2011 Las Conchas and 2013 Thompson Ridge fires reduced wood lily habitat in areas of high burn severity.

Bog Birch (*Betula glandulosa)*
Taxonomic Group: Shrub
Federal Listing Status: Not Listed
New Mexico Listing Status: Not Listed

Bog birch is a deciduous wetland shrub in the Betulaceae family. It stands up to 10 feet tall (Allred & Jercinovic, 2020), has smooth bark, leathery leaves, and an extensive root system (Tollefson, 2007). It has widespread distribution throughout Canada, Alaska, and the northern and western contiguous United States (Tollefson, 2007). Bog birch is prevalent in the Rocky Mountains; however, Alamo Bog in Valles Caldera is the only known location in New Mexico (NPS, 2014). A unique plant association between bog birch, water sedge, and stiff club moss has been identified as part of the fen (a type of wetland) complex in Alamo Canyon (NPS, 2014), and according to Muldavin & Tonne (2003), “this highly acidic and deep fen along with the bog birch make up a globally rare ecosystem type that is worthy of special management attention." Wetlands burn infrequently and can act as firebreaks (Everett et al., 2003). When exposed to fire, bog birch is susceptible to top-kill, though it can survive low- to moderate-intensity fire and is among the first plants to regenerate post-fire by sprouting vegetatively (Tollefson, 2007).

Trends and Planned Actions
Past, current, and planned actions and trends in the park that can affect wood lily and bog birch include improvements to trails, increased visitation, impacts of trespass cattle, ungulate browsing pressure, and climate change. Many of the current or planned actions in Valles Caldera do not take place in wood lily or bog birch habitat.

In 2023, 125 miles of trails were improved in the park (NPS, 2024e). Additionally, recreational visitors increased from 63,738 in 2022 to 76,090 in 2023, a 19% increase (NPS, 2024a). Increased trail access and increased visitation would impact wood lily habitat. Trespass cattle continue to be an issue across Valles Caldera, especially near wetlands (NPS, 2022b) and may impact bog birch. Likewise, ungulate browsing pressure of bog birch within Alamo Bog (the sole locality in Valles Caldera) is high (Hartman et al., 2006).

Climate trends are expected to impact special status plant species. Between 1895 and 2018, mean temperatures have increased by 1.4°F per century at Valles Caldera (NPS, 2022b). Increased mean temperatures, particularly since 2000, and relatively stable precipitation characterize climate change in the park (Carlson & Gross, 2019). While precipitation overall remains unchanged, the proportion of precipitation received as snow has declined (NPS, 2022b). Higher temperatures increase evaporation rates, resulting in decreases in soil moisture and water availability for plants (NPS, 2022b). Increased aridification and lower fuel and soil moistures has contributed to landscape-scale, high-severity wildfires.

3.6.2 Impacts of Alternative A (No Action)

A suppression-oriented wildland fire program would lead to increased fuel loading due to fire exclusion and lack of fuel treatments. Wood lily is slightly shade-intolerant (Skinner, 2002) and may be shaded out by dense tree canopies resulting from fire exclusion. Increased risk of an unplanned ignition causing large, high-severity fire could have long-term, adverse impacts to wood lily habitat due to possible stand replacement or vegetation type conversion (Ostoja et al., 2023). Bog birch is less vulnerable to unplanned fire as wetlands like Alamo Bog may act as a firebreak (Everett et al., 2003), making it unlikely that high-intensity fire would occur in the Alamo Bog wetland complex itself. However, due to the small population size of bog birch, (Hartman et al., 2006) high-severity fire near Alamo Canyon could have adverse impacts on the population, such as temporarily reducing the population size.

Suppression actions such as construction of fire lines and roads and use of bulldozers, trucks, and other equipment could cause compaction and displacement of soil and vegetation, resulting in adverse short- and long-term impacts to wood lily and bog birch populations. The impact may last for weeks to months during active suppression efforts, and depending on extent of disturbance, for years to come. Under the MIST framework (Appendix C), suppression actions would strive for the least environmental, cultural, and social impacts possible. Mitigations to avoid special status plant species as described in Appendix E would also minimize impacts of fire suppression actions.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact wood lily and bog birch under Alternative A include improvements to trails, increased visitation, trespass cattle, ungulate grazing pressure, and climate change.

Improvements of trails and increased visitation may result in more recreation occurring within wood lily habitat. Wood lilies are vulnerable to collection pressure (New Mexico Rare Plant Technical Council, 2020) and improved visitor access to wood lily habitat could contribute to off trail trampling and illegal collection of wood lily flowers for their appearance (Reif, 2006). These impacts, in combination with continued loss of habitat from both high-severity fire and fire exclusion could contribute to both short- and long-term adverse habitat disturbance and alteration that considerably threatens wood lily populations in Valles Caldera.

Increased visitation to Alamo Bog would have a negligible impact on bog birch as collection for appearance is not a concern. Herbivory and trampling by trespass cattle are an ongoing issue within Valles Caldera wetlands, as well as herbivory pressure from the large elk population (NPS, 2022; Hartman et al., 2006). Intensive browsing has reduced the height and extent of bog birch shrubs and trampling of wetlands can impact hydrology. These issues, in combination with potential for high-severity fire in the vicinity of Alamo Canyon that may impact Alamo Bog hydrology, could result in considerable long-term, adverse impacts to the small population of bog birch within the park.

Impacts of an increasingly arid climate, lower fuel moistures, and potential for extreme fire behavior could impact wood lily and bog birch habitats. Climate trends may negatively impact the hydrology of Alamo Bog (White et al., 2023) and contribute to drought stress of bog birch. Climate trends such as increased aridity and climate-driven high-severity wildfire (Ostoja et al., 2023) may continue to impact wood lily through low soil moisture and habitat loss from stand-replacing fires.

Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to special status plants would be adverse in the short- and long-term.

3.6.3 Impacts of Alternative B (Preferred Action)

A multiple strategy wildland fire program would utilize a wide range of fire management actions including manual and mechanical thinning, prescribed fire, and allowing naturally ignited fire to burn under certain conditions and parameters. Impacts of suppression actions on wood lily and bog birch habitats would be similar to

Alternative A, including MIST (Appendix C) to strive for the least amount of environmental, cultural, and social impacts during suppression efforts.

Temporary presence of work crews, equipment, and vehicles during manual and mechanical thinning treatments could potentially occur in wood lily habitat and cause disturbance to vegetation and soil. Mitigations as described in Appendix E would strive to avoid trampling or displacement of wood lilies and impacts to populations are not likely. Wood lily is slightly shade-intolerant has been found inhabiting cleared powerline rights-of-way in the eastern United States (Skinner, 2002). It is expected wood lily would benefit from a more open canopy and would tolerate minor ground disturbance from thinning operations. Forest thinning reduces the potential for landscape-scale, high-severity fire that has contributed to wood lily habitat loss in Valles Caldera. Thinning would not have a direct impact on bog birch because it would not occur within the Alamo Bog wetland complex, however the species would benefit indirectly by thinning near Alamo Canyon that would lower risk of high-severity fire.

Under Alternative B, prescribed and natural fire would likely occur in wood lily habitat. Wood lily evolved with frequent, low- to moderate-severity surface fire in Valles Caldera and would benefit from reintroduction of fire on the landscape. A study by Catling (2009) comparing burned and unburned forest vegetation in Ontario nine years after a fire found the burned site had nearly double species richness and included more rare species than the unburned site, including wood lily. It is unlikely prescribed or naturally ignited fire would occur in the Alamo Bog wetland complex, however *in situ* charcoal deposits in Alamo Bog indicate surface fires historically spread through the wetland during dry years prior to 20th century fire suppression efforts (Allen et al., 2008).

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact special status plant species under Alternative B include improvements to trails, increased visitor access, trespass cattle, ungulate grazing pressure, and climate change. Trail improvements and increased visitor access may contribute to trampling and illegal collection of wood lily flowers, and likely will not have an impact on bog birch. Trampling by trespass cattle and intensive ungulate browsing contribute to reduced growth and extent of bog birch in Alamo Canyon. Cumulative impacts due to the combination of increased visitation and access, cattle and ungulate trampling and herbivory, and fire suppression actions would be the same as Alternative A.

Cumulative impacts of increased visitation and access to wood lily habitat, thinning, prescribed fire, and allowing naturally ignited fire to burn would result in potential adverse, short-term impacts to wood lily from ground disturbance, and long-term, beneficial impacts from increased canopy openings and reduced threat of high-severity fire. Thinning and reintroduction of fire to wood lily habitat are expected to benefit the population size in the long-term and would alleviate negative impacts from increased visitation and access to habitat.

There is no potential for cumulative impacts on bog birch due to trespass cattle, ungulate herbivory, prescribed fire, and thinning because these fuel treatments would not be implemented within the Alamo Bog wetland complex. However, there is potential for a naturally ignited fire to be managed in the vicinity of Alamo Canyon. Cumulative impacts of naturally ignited fire, trespass cattle, and ungulate herbivory would likely be minor because fire typically does not burn in areas with high fuel moisture.

High-severity wildfires driven by climate and fire exclusion are a threat to wood lily habitat. While thinning, prescribed fire, and naturally ignited fires would reduce potential for high-intensity fire behavior, climate trends will continue to contribute to large wildfire events (Ostoja et al., 2023). Wood lily in Valles Caldera would continue to be at risk under both alternatives, however actions under Alternative B are more likely to result in frequent, low- to moderate-severity surface fire characteristic of the conditions wood lily evolved under. While bog birch has fire-adapted traits such as post-fire vegetative sprouting (Tollefson, 2007), and may benefit from infrequent fire, prescribed fire within the vicinity of Alamo Bog is unlikely and therefore would have negligible impact on the species. Forest treatments in the vicinity of Alamo Canyon would help alleviate some of the long-term impacts of climate change by reducing potential for high-severity fire in Alamo Canyon that could alter the hydrology of Alamo Bog in the event of post-fire flooding. To further protect bog birch in Valles Caldera, important priorities include reducing trespass cattle and ungulate browsing pressure and maintaining the hydrologic function of Alamo Bog.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be adverse cumulative impacts to special status plants. However, cumulative impacts would be beneficial in the long-term due to enhanced ecosystem stewardship and the reintroduction of beneficial fire regimes.

3.7 Cultural Resources: Archaeological Resources, Cultural Landscapes, Ethnographic Resources, Prehistoric and Historic Structures

3.7.1 Affected Environment

Archaeological Resources

Approximately 39% of Valles Caldera has been surveyed for cultural resources, resulting in the identification of 791 archaeological sites. Most prehistoric archaeological sites (73%) are non-structural scatters of stone tool manufacturing debris. The next most common site type (15% of known sites) is agricultural fieldhouses, which consist of small, stacked rock structures located exclusively in the Banco Bonito area at the southwestern corner of the park. Obsidian quarries constitute 5% of known sites by count and consist of dense concentrations of obsidian flakes, cores, bifaces, and cobbles at natural obsidian outcrops. Although the numeric count of these sites is relatively low, the acreage covered by obsidian quarries is significant. Other prehistoric site types found in low numbers on Valles Caldera include rock shelters, artifact scatters that include prehistoric ceramics, and rock alignments.

Most historic archaeological sites are non-structural artifact scatters dominated by cans, bottles, and other domestic trash. Corrals, log cabin remains, stock tanks, and lumber processing sites occur in small numbers across the park. A significant number of carved aspen trees dating to the 1890s-1950s have been documented as isolated cultural features outside designated sites.

In 2020, Valles Caldera archaeologists reviewed site records to assess the fire sensitivity of all known archaeological sites in the park. Seventy-eight sites (9.8% of Valles Caldera sites) were classified as “high concern” due to the presence of wooden elements, carved aspen, or complex multi-material artifact assemblages. Two hundred forty-four sites (30.8% of Valles Caldera sites) were classified as “moderate concern” based on the presence of volcanic tuff stacked-rock structures, prehistoric ceramics, obsidian or chert quarries, or artifact assemblages with organic components other than wood. The remaining 453 sites were assessed as “probable low concern.”

Cultural Landscapes

A cultural landscape is a geographic area, including cultural and natural resources and the wildlife or domestic animals within, associated with a historic event, activities, or person, or that exhibits other cultural or aesthetic values. A preliminary cultural landscape inventory of the Cabin Area in Valles Caldera front country is in-progress (NPS, 2022a). The Cabin Area cultural landscape is a historic vernacular landscape that contains 20th century log cabins, ranching infrastructure, old growth conifer forest, and open grassland. The rest of Valles Caldera has not been formally assessed for cultural landscapes.

Ethnographic Resources

Ethnographic resources are sites, structures, objects, landscapes, or natural resource features that are significant to traditionally associated groups. Ethnographic resources typically hold significance for traditionally associated groups whose sense of purpose, existence as a community, and development as an ethnically distinctive people are closely linked to specific resources and places. Valles Caldera consults with 38 Pueblos and Tribes with cultural connections to the park. Based on past and ongoing consultation, NPS is aware of ethnographic resources, such as Redondo Peak, with importance to specific affiliated groups. However, Valles Caldera lacks a formal, comprehensive inventory of these resources.

Prehistoric and Historic Structures
Archeological sites are usually not considered buildings or structures unless they have been excavated and stabilized to be aboveground. Although no prehistoric sites at Valles Caldera meet that definition, approximately 123 prehistoric sites contain above-ground structural elements. These elements include dry laid masonry wall foundations and rubble mounds, cairns, low walls, rock alignments, and rock-lined terraces.

Historic structures at Valles Caldera include cabins, corrals, sheds, and barns dating from the early to late 20th century. Construction materials are almost always logs or dimensional lumber. Buildings tend to be small, vernacular architecture. Most standing historic structures at Valles Caldera exist in the front country Cabin Area along the northwest edge of the Valle Grande, but a few backcountry cabins, corrals, and outbuildings also exist. Most standing structures are in fair to poor condition due to deferred maintenance needs.

Trends and Planned Actions
Past, current, and planned actions within the park that can affect Cultural Resources include road and trail construction, facility construction, utility improvements, forest and watershed restoration, and climate change. NPS will complete site specific Section 106 compliance for all undertakings with the potential to impact cultural resources.

3.7.2 Impacts of Alternative A (No Action)
Under moderate weather conditions, when suppression tactics are more likely to be effective at containing unplanned ignitions, a suppression-oriented fire management program could result in fewer fires in Valles Caldera. This could have short-term beneficial impacts on cultural resources due to fewer impacts from firefighting and fire. Under this strategy, however, ongoing and “tremendous fuel buildup, with a resultant increase in fire intensity, burn times, and fire severity” (Ryan et al., 2012) would be inevitable. High-intensity wildfire and associated emergency response to fire could have long-term, adverse impacts on cultural resources.

Approximately 70% of Valles Caldera has burned in wildfires over the past 20 years. Much of this area burned in the Las Conchas (2011) and Thompson Ridge (2013) fires. The Las Conchas Fire burned substantial acreage at high fire intensity, and the Thompson Ridge Fire had smaller patches of high-severity fire. These fires removed forest canopy, promoted erosion on steep burned slopes, and required intensive suppression and repair interventions. These fires and associated suppression actions damaged cultural resources through direct fire effects, line construction, and erosion. They also produced areas of heavy fuel loading as fire-killed trees fell. In these areas, identification of cultural resources is inhibited due to heavy ground cover and difficult travel. In the event of a new fire in the burn scar, heavy fuels could cause localized high-intensity fire and adverse impacts on cultural resources. They also inhibit direct attack on new fires in these areas due to firefighter safety concerns. Finally, remaining live and dead fuels within these scars can effectively carry fire, especially under windy conditions, as was observed during the Cerro Pelado fire in 2022. Suppressing all fire under Alternative A would eventually result in more stand-replacing fire with burn scars and fire effects similar to those from the Las Conchas Fire.

Adverse effects to cultural resources could include damage to prehistoric and historic structures, sites, artifacts, and features by heat flux and flame impingement, which can spall architectural stone, consume organic artifacts and wooden structural elements, alter or destroy ceramics, deposit soot, resins, or other residues, and crack, spall, or deform lithic artifacts. Impacts of high-intensity wildfire may also include heavy post-fire erosion due to hydrophobic soils and altered soil stability, and potential for increased vandalism and looting at archaeological sites exposed by consumption of litter, duff, and vegetative material. Impacts to cultural landscapes, including the Cabin Area, and ethnographic resources include extirpation of some culturally important plant populations and long-term changes to plant communities; damage to traditional trails, water-control features, and other small-scale landscape modifications; and alteration of viewsheds due to erosion and stand-replacing fire.

Traylor et al., (1983, as cited in Ryan et al., 2012) note that “The key factors that seem to affect the nature and extent of fire damage to archaeological resources, including lithic artifacts, are fire intensity, duration of heat, and penetration of heat into soil.” These factors are all generally greater in a high-intensity unplanned ignition with large amount of available fuel. Although a suppression-oriented fire management program would attempt to quickly suppress all fire, the fire history of the past 100 years demonstrates that this strategy results in high fuel loads that eventually burn at high intensities.

Cumulative Impacts
Past, present, and reasonably foreseeable future actions with the potential to impact Cultural Resources under Alternative A include past fire events and burn scars, past suppression actions and burned area restoration, current forest and watershed restoration actions, future wildfires and suppression efforts, and future park projects with impacts analyzed through the Section 106 process.

Past suppression actions were frequently anchored off old ranching and logging roads. Valles Caldera has over 1,000 miles of such roads, and line construction along these previously disturbed road prisms can disturb, dislodge, and displace cultural resources. The high density of logging roads in Valles Caldera somewhat lessens the cumulative impacts of fire suppression on cultural resources due to abundant opportunities to use these disturbed linear corridors for line construction. However, suppressing high intensity wildfire under emergency conditions may not allow fire managers the opportunity to fully utilize the decommissioned road network for fire line. Past suppression and burned area repair actions had adverse cumulative impacts on cultural resources due to ground disturbance. However, they also had beneficial cumulative impacts by suppressing ongoing high-intensity fire and mitigating post-fire erosion.

Through the Section 106 process, site-specific mitigation measures would be developed to reduce or avoid adverse effects to cultural resources due to forest and watershed restoration actions. These actions result in more resilient forests and valles, with live and dead fuel conditions that tend to burn at lower intensity. These restoration actions have a long-term, beneficial cumulative impact on cultural resources by reducing fuel loading on sites, promoting herbaceous vegetation, and decreasing the potential for fire-caused erosion.

The cumulative impact of not implementing more comprehensive fire management could be substantial over time for cultural resources. Since cultural resources are generally considered non-renewable, impacts are permanent, and a no action decision could potentially increase cumulative impacts from high-severity fires. Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to cultural resources would be adverse in the short- and long-term.

3.7.3 Impacts of Alternative B (Preferred Action)
Unplanned ignitions that result in high intensity wildfire are also possible under Alternative B. In the event of a high intensity fire burning in heavy fuels, the adverse impacts to cultural resources would be the same under both alternatives. However, Alternative B reduces the likelihood of high intensity fire by using the full range of fire management strategies to reduce excessive fuels and restore resilient, fire-adapted ecosystems. The additional fire management actions proposed under Alternative B, including thinning, pile burning, broadcast burning, and allowing a naturally ignited fire to burn in a defined geographic area under specific prescription parameters could produce fire behavior that is less likely to damage cultural resource sites that do not have combustible remains. However, effects may still include sooting, resin deposition, or crazing, and generally do not result in a loss of information potential (Loehman et al., 2016).

Thinning and planned ignitions would occur only after site-specific Section 106 compliance is complete, allowing for cultural resource identification and proactive mitigations, such as reducing fuels within or adjacent to sensitive sites, or creating fuel breaks around sensitive sites to reduce the risk of adverse impacts on cultural resources. Ignitions would be undertaken when temperature, humidity, wind, and other factors promote low fire intensities, low flame lengths, and slow rates of spread. Impacts from fire management actions (line construction, staging of equipment, and engines) would be avoided during planned ignitions by implementing mitigations prior to the fire (Refer to Appendix E). Reducing fuels in this way would have long-term beneficial impacts on cultural resources by reducing fuel loading and the potential for high-severity fire and associated adverse impacts to cultural resources and ethnographic landscapes.

Cumulative Impacts
Past, present, and reasonably foreseeable future actions with the potential to impact Cultural Resources under Alternative B include past fire events and burn scars, past suppression actions and burned area restoration, current

forest and watershed restoration actions, future wildfires and suppression efforts, and future park projects with impacts analyzed by the Section 106 process.

Cultural resources in the park and surrounding areas have been adversely impacted to varying degrees from past construction-related disturbance (prior to the advent of archeological resources protection laws), visitor use, and vandalism. It is likely that ongoing and upcoming projects involving ground disturbance in combination with thinning and planned fire actions could impact cultural resources. Construction and maintenance actions and fire management actions in the park are undertakings subject to cultural resource protection laws. Potential adverse effects to cultural resources would be avoided or minimized by adhering to conservation and protection measures for cultural resources as described in Section 106 agreement documents. The potential for cumulative effects on cultural resources over time would remain but would be reduced when compared with Alternative A. Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be adverse cumulative impacts to cultural resources. However, cumulative impacts would be beneficial in the long-term due to enhanced ecosystem and resource stewardship and the reintroduction of beneficial fire regimes.

3.8 Geological Features: Obsidian

3.8.1 Affected Environment

Geologic features are those of earth or rock exposed on earth's surface. Obsidian, an igneous rock, is a geologic feature found in Valles Caldera. It is formed during periods of volcanism when molten lava cools so rapidly that a crystalline structure cannot be formed, resulting in a volcanic glass (Steffen, 2005). Obsidian is common throughout Valles Caldera where it has been found in Valle Toledo, Banco Bonito, and Cerro del Medio. It also occurs in other locations in the Jemez Mountains, such as Obsidian Ridge in the Santa Fe National Forest (Civitello, 2006). In addition to being a notable geologic feature of Valles Caldera, obsidian is considered an important archaeologic resource (Steffen, 2005; Civitello, 2006). Obsidian artifacts from the last 12,000 years, such as spear points, arrowheads, knives, and scrapers, are abundant both locally and regionally. Through scientific analysis, it is also known that obsidian tools found across the U.S. were made from obsidian gathered at Valles Caldera, demonstrating the significance of this source, and illustrating the extensive geographic ranges used by past hunter-gatherers (Steffen, 2005).

Trends and Planned Actions

Past, current, and planned actions and trends within the park that could affect obsidian include trail and road construction, building and facility construction and improvements, ecological restoration, and climate change.

Planned trail construction includes an accessible trail through the Cabin District. Road and parking lot construction includes rerouting the road near the Entrance Station and construction of two new gravel parking lots southwest of the Ranger Station. Building and facility construction and improvements that could impact obsidian include demolition of movie sets and removal of fencing. Ecological restoration projects include past forest thinning and restoration projects that have been implemented on approximately 10,000 acres, with additional projects planned for the near future.

Climate trends may impact obsidian. Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000, and relatively consistent precipitation amounts (Carlson & Gross, 2019), although there is some indication that climate change is causing more intense and sporadic rain events in the Jemez Mountains (NPS, 2024b). Between 1895 and 2018, mean temperatures increased by 1.4°F per century at Valles Caldera (NPS, 2022b), resulting in an increasingly arid climate, lower fuel moistures, and increases in wildfire activity.

3.8.2 Impacts of Alternative A (No Action)

Under Alternative A, suppression actions including construction of fire lines, vehicle and equipment use, and backburning operations may cause displacement (movement) of obsidian or undesirable fire effects, such as fracture, crazing, vesiculation, sheen, or color change. These impacts would be adverse and long-term. The MIST framework would be used to identify the minimum tools to accomplish tasks safely and effectively and to meet suppression and resource objectives while causing the least environmental, cultural, and social impacts. (Appendix C).

A lack of prescribed burning, thinning treatments, and fuel removal actions under Alternative A would increase fuel loading and the potential for high-severity, landscape-scale wildfire which can physically alter obsidian by causing fracture, crazing, vesiculation, sheen, and color change, as described above. The alteration of obsidian by fire may also cause loss of obsidian hydration bands, hindering obsidian hydration dating techniques used in archaeological studies (Steffen, 2005; Civitello, 2006). Numerous examples of these fire effects were observed and categorized in the aftermath of the 1996 Dome Fire, which ultimately "revealed the potential for forest fires to fully or partially destroy obsidian artifacts by vesiculation" (Steffen, 2005). Impacts of fire on obsidian are most extreme in landscapes burned at moderate- or high-severity (Steffen, 2005; McGuire et al., 2021). Thus, the potential increase in high-severity, landscape-scale fire under a suppression-oriented wildland fire program would result in adverse impacts to obsidian.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact obsidian under Alternative A include those described under Trends and Planned Actions.

The potential for destruction, disturbance, or movement of obsidian deposits due to increased high-severity fire events would likely not be exacerbated by trail, road, and building construction and improvements because locations for implementation have previously been surveyed for obsidian deposits and artifacts.

Climate trends may impact obsidian primarily through increase of extreme, erratic weather events that can exacerbate fire behavior and post-fire effects. Obsidian artifacts and other archeological resources are non-renewable and are vulnerable to high-severity fire (Steffen et al., 2024). When climate trends are considered in addition to outcomes of a fire-suppression oriented wildland fire program, and historic fire suppression, impacts to obsidian would be adverse and long-term due to potential for widespread, adverse fire effects including fracture, crazing, vesiculation, sheen, and loss of hydration dating of obsidian artifacts (Steffen et al., 2024).

Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to obsidian would be adverse in the short- and long-term.

3.8.3 Impacts of Alternative B (Preferred Action)

Under Alternative B, impacts to obsidian due to high-severity fire and fire suppression actions would be similar to those described under Alternative A. However, actions under Alternative B, would reduce fuel loading and potential for high-severity wildfire. In the long-term, wildfires would be less frequent and of lesser severity due to fuel treatments, minimizing adverse post-fire impacts on obsidian.

Prescribed fire and thinning can impact obsidian. The duration of fire and degree of heating influence fire effects on obsidian (Civitello, 2006). Low- to moderate-severity fire is less likely to have significant effects. According to Civitello (2006), during a low-intensity prescribed fire in the grasslands of Valle Toledo, obsidian hydration bands were altered on 10% of exposed artifacts and the most common effect was buildup of soot and plant residue on artifact surfaces. In the long-term, prescribed fire and thinning treatments would reduce impacts to obsidian by reducing forest fuels and potential for high-severity fire. In addition, conservation measures and mitigations, such as cultural resource assessments, site preparation, and creating defensible space would further limit impacts.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact obsidian under Alternative B include those described under Trends and Planned Actions.

Impacts of fire suppression and defensible space actions, and prescribed fire, allowing naturally ignited fire to burn, and thinning treatments in combination with trail, road, and building construction and improvements would not likely result in cumulative impacts because locations for project implementation have previously been surveyed for obsidian deposits and artifacts. In addition, the potential for high-severity, landscape-scale wildfire under Alternative B would be reduced by prescribed fire, thinning treatments, and allowing naturally ignited fire to burn, reducing potential for adverse cumulative impacts.

Climate trends are expected to increase potential for high-severity wildfire and therefore impacts to obsidian (as described under Alternative A). Fuel treatments under Alternative B would reduce potential for landscape-scale high-severity wildfire but would not, in the short-term, alleviate climate impacts. However, forward-looking goals and objectives under Alternative B would consider future and changing ecological, climate, and fuel conditions, and fire regimes during the planning process and adaptive management cycle. It would also use monitoring, research, and partnerships to advance science-based wildland fire management decision-making and facilitate adaptation to changing environmental conditions.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be adverse cumulative impacts to obsidian. However, cumulative impacts would be beneficial in the long-term due to enhanced ecosystem and resource stewardship and the reintroduction of beneficial fire regimes.

3.9 Soil Resources and Geological Processes

3.9.1 Affected Environment

Valles Caldera formed approximately 1.25 million years ago as part of the Jemez Mountains volcanic field and today is considered the best example of a resurgent caldera (a giant circular volcano with an uplifted central floor) in the world (Goff et al., 2011). An assortment of basalt, andesite, dacite, and rhyolite make up the Jemez volcanic field, the result of erupted domes, cinder cones, lava flows, and pyroclastic deposits (Goff, 2009). Elevations range from 2,300 meters in the valles to 3,432 meters at the summit of the Redondo Peak resurgent dome (Pelletier & Orem, 2014). Smaller rhyolitic domes formed along the rim during eruptions 1.2 and 0.5 million years ago (Orem & Pelletier, 2016).

Interaction of geological processes, landforms, and disturbance agents such as fire, determines natural patterns of ecosystems over landscapes (Swanson, 1981). Correspondingly, fire impacts on geological processes are strongly influenced by interactions among soil, topography, vegetation, and climate (Swanson, 1981). Active geological processes such as erosion, denudation, chemical weathering, and sediment transport are prevalent throughout Valles Caldera.

There are 59 soil series in Valles Caldera that can be grouped into two broad categories: forest soils on the sloped domes and rimrock; and grassland soils formed from alluvial and colluvial fans on the edges of the valles (Rodriguez & Archer, 2010). Soil texture on the domes is well-drained sandy loam (Rodriguez & Archer, 2010) and primarily Andisol, Alfisol, and Inceptisol soil orders (Muldavin & Tonne, 2003). Soil is generally less productive on the steeper slopes, although organic material in the grassy understories creates a dark topsoil. Grassland soils are dark, highly productive Mollisols (Muldavin & Tonne, 2003) with loamy texture (Rodriguez & Archer, 2010).

Forest soils are derived from volcanic rhyolite, andesite, and dacite with some windblown deposition (Muldavin & Tonne, 2003) and welded or non-welded ash flow that creates a chunky matrix (Rodriguez & Archer, 2010). Grassland soils have a mix of landslide, alluvial, and colluvial material derived from upper slopes (Rodriguez & Archer, 2010) and lake-deposited sediments (Muldavin & Tonne, 2003). Unlike soils of the forested slopes, the valles have minimal rock accumulation (Muldavin & Tonne, 2003). The Felsenmeer rock slopes, comprised of volcanic rhyolite or andesite, have poorly developed soil with low water retention. Most of the biotic cover is non-vascular lichens, with vascular plants being less than 10% cover (NPS, 2022b).

Soil Integrity

Soil integrity relates to how structure and function of soil supports biotic life. The grassland Mollisols are the most productive in Valles Caldera, with rich organic material and higher water retention than the sloped domes (Rodriguez & Archer, 2010). Vegetative cover of the grasslands is predominately perennial bunchgrass species with deep root systems. Hillslope soils provide faster drainage than grassland soils and lend themselves to growth of conifer species. Researchers have noted ash accumulation in the topsoil and clay accumulation in the subsoils of the slopes, which increase water holding capacity (Rodriguez & Archer, 2010).

Integrity of soils in Valles Caldera have been impacted by post-settlement land use. Historic overgrazing by sheep beginning in the 1860s and cattle from the mid-1900s have contributed to loss of organic matter and soil degradation (NPS, 2022b). During periods of extensive overgrazing, stream hydrology was altered with fewer plants to stabilize banks. Erosion of creek banks has improved by reducing herbivory pressure by domestic animals on wetlands (Parmenter et al., 2007) and through ongoing wetland restoration projects. Compaction to soil with construction of over 1,100 miles of logging roads in the 1960s and soil disturbance during jammer logging operations between 1963-1972 had detrimental impacts to soil integrity on the forested domes (Parmenter et al., 2007). Compaction reduces water permeability, porosity of soil, gas exchange, and plant growth (Parajuli et al., 2022) which are important elements of soil integrity. Erosion issues due to compaction are ongoing (Parmenter et al., 2007). Sulfur mining and geothermal exploration in the 20th century degraded soil resources around Sulphur Springs (Anschuetz & Merlan, 2007). Signs of excavation and limited vegetation growth is apparent.

Soil Stability

Soil stability is the ability to resist loss or redistribution of soil from wind and water (Goss & Oliver, 2023). Soil stability throughout the park has been impacted by past anthropogenic factors, including sheep and cattle grazing, logging operations, sulfur mining, and geothermal exploration. Soil stability improved after reductions in sheep and cattle grazing and the elimination of logging, mining, and geothermal exploration. However, more recent disturbances such as high-severity wildfire have altered soil stability. In 2011, the Las Conchas Fire burned 51% of all forested areas within the park, and in 2013 the Thompson Ridge Fire burned 40% of forested areas within the park (NPS, 2022b). Due to forests primarily growing on the sloped domes, some areas of high burn severity had extensive erosion where soil was mechanically weak without support from plant roots and surface materials (Orem and Pelletier, 2016). Soil stability across burned areas in the park has improved as vegetation communities recover from past wildfires.

Faulting along rimrock continues to destabilize slopes within Valles Caldera. Examples can be found on the northern rim where hummocks have formed (Rodriguez & Archer, 2010). The volcanic domes are relatively stable, with little evidence of active surface erosion on upper hillslopes. Research prior to the 2011 Las Conchas Fire showed few drainages on the domes, demonstrating that soil through-flow is mostly responsible for movement of rainwater and snowmelt (Rodriguez & Archer, 2010), indicating good hydrologic function (Goss & Oliver, 2023). Erosivity is highest on finer-textured footslope soils of the valles, where rainfall and snowmelt runoff are concentrated (Rodriguez & Archer, 2010). Minor post-fire erosion events may have maintained fens in the valles prior to fire suppression efforts of the 20th century (NPS, 2022b).

Post-wildfire erosion is responsible for more than 90% of all erosion in Valles Caldera (Orem and Pelletier, 2016). After the Las Conchas Fire and subsequent rain events, extensive erosion occurred, stripping litter, duff, and uppermost soil layers from the hillslopes (Pelletier & Orem, 2014). The most common form of hillslope erosion in patches of high burn severity was rilling, which is an incision (or cut) that forms on a hillslope that was previously not incised. Observed rilling was on average half a meter deep at sites associated with moderate-to-high burn severity (Pelletier & Orem, 2014), but deeper incisions were present at the bottoms of larger watersheds draining into grasslands (Figure 5).

Figure 5. Erosion and alluvium deposit in Valles Caldera after the Las Conchas Fire
Left: Rill erosion from Cerro del Medio into the Valle Grande following post-fire flooding from the Las Conchas Fire. **Middle**: Alluvium deposit of post-flood debris consisting of large boulders and tree trunks in Valle Grande. **Right**: Deep erosion cut on the flank of Cerro del Medio. Note: a person standing in bottom of gulley for scale.

Trends and Planned Actions

Past, current, and planned actions and trends within the park that can affect soil resources and geological processes include road and trail construction, building and facility construction, utility improvements, ecological restoration, and climate change.

Planned trail construction includes an accessible trail through the Cabin District. Road and parking lot construction involves rerouting the road near the Entrance Station and construction of two new gravel parking lots southwest of the Ranger Station. Multiple building and facility improvements and construction are planned: demolition of movie sets; restoration of historic cabins and outbuildings; improving accessibility to the Ranger Station and Entrance Station; and fence removal. Planned utility improvements include removal of utility poles and construction of EV charging stations. Ecological restoration projects such as wetland restoration, forest thinning, and restoration of Sulphur Springs are planned or ongoing. Approximately 700 acres of wetland restoration has been accomplished with 250 acres planned in the future. Past forest thinning and restoration projects have been implemented on approximately 10,000 acres, with additional projects planned for the near future.

Climate trends are expected to impact soil resources and geological processes. Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000, but relatively stable precipitation (Carlson & Gross, 2019), although there is some indication that climate change is causing more intense and sporadic rain events in the Jemez Mountains (NPS, 2024b). Between 1895 and 2018, mean temperatures have increased by 1.4°F per century at Valles (NPS, 2022b) resulting in an increasingly arid climate, lower fuel moistures, and increases in wildfire activity.

3.9.2 Impacts of Alternative A (No Action)

Alternative A would lead to increased fuel loading due to fire exclusion and lack of fuel treatments. The increased risk of an unplanned ignition causing high-severity fire could have long-term adverse impacts to soil integrity and stability due to loss of ground cover and potential for soil hydrophobicity. Extent of soil erosion after high-severity wildfire increases with steeper slopes and heavy rainfall before understory vegetation has regrown (Rodriguez & Archer, 2010). In a comparison of burned and unburned watersheds, McGuire et al. (2021) observed that unburned watersheds were less likely to produce debris flows than watersheds burned at moderate- to high-severity, despite similar rainfall intensities. In this study, 85% of watersheds that burned in wildfire produced debris flows while only 54% of unburned watersheds did the same (McGuire et al., 2021). Additionally, loss of soil by wind erosion would be more severe in areas that burned at high-severity due to low soil stability and low soil moisture (Achakulwisut et al., 2019).

Suppression operations such as construction of fire lines and roads, and use of bulldozers, equipment, and vehicles may cause compaction and displacement of soils, resulting in adverse, short- and long-term impacts on soil resources and geological processes. Roads can also alter hydrology of hillslopes, reduce vegetation growth, and limit soil productivity (Muldavin & Tonne, 2003). Impacts of disturbance may last weeks to months during suppression, and depending on extent, for years to come. Under the MIST framework (Appendix C), suppression actions would strive for the least environmental, cultural, and social impacts possible.

Cumulative Impacts
Past, present, and reasonably foreseeable future actions and trends with potential to impact soil resources and geological processes under Alternative A include those outlined in the Trends and Planned Action section.

Road and parking lot construction may have long-term, adverse impacts including permanent loss of soil resources within the footprint of the parking areas and road, as well as compaction, decreased water permeability, and localized changes in water drainage. Removal of movie sets in the Valle Grande may have temporary adverse impacts to soil due to compaction from equipment and vehicles, however long-term impacts to soils are expected to be beneficial as the footprint of buildings revegetate. Planned utility projects may impact soil resources temporarily by disturbing soil but are expected to have long-term beneficial impacts due to closure of powerline access roads. Wetland restoration has a temporary adverse impact on soil resources due to disturbance required by heavy machinery to create topography for redirecting water. Long-term soil health should improve by raising the water table, reducing channelization and erosion from cut banks, and restoring fens that resemble historic hydrology of the valles (NPS, 2022b). Improving soil moisture will increase wetland plant biomass and the amount of organic material in the soil (Goss & Oliver, 2023) and improve soil stability with plant root growth. Restoration of Sulphur Springs has been initiated with removal of structures in 2023, and soil resources are expected to improve due to reduction in surface cover by building foundations and trailers. Remaining planned restoration would cause temporary disturbance due to movement of soil by heavy machinery but is expected to repair damage caused by sulfur mining in the mid-1900s (Anschuetz and Merlan, 2007) and would have long-term beneficial impacts to soil resources.

The impacts of road, parking lot, and building improvements and construction within the park in combination with impacts from fire suppression and defensible space actions under Alternative A would likely result in short- and long-term, adverse cumulative impacts to soil resources and geological processes. Soil displacement, disturbance, and compaction and potential for erosion as a result of all the actions could be considerable. However, restoration projects and actions would produce beneficial impacts, such as restoring vegetation, improving soil stability, and reducing erosion, potentially alleviating some of the adverse cumulative impacts.

Climate trends in combination with actions under Alternative A are likely to result in adverse cumulative impacts to soil and geological processes primarily through increase of extreme, erratic weather events that can exacerbate fire behavior and post-fire effects. Wildfires of moderate- to high-severity can cause increased soil hydrophobicity; reduced infiltration capacity of soil; loss of vegetation, litter, and other organic matter through combustion; and strong convective winds, all of which contribute to debris movement down steep slopes (Swanson, 1981). In addition, peak wildfire season is from April through June, followed by onset of the monsoon in early July, bringing fifty percent of the region's annual precipitation. While these short, high-intensity monsoonal thunderstorms may suppress wildfires, they have potential to produce post-wildfire debris flows (Gorr et al., 2023). More intense rainfall in shorter periods of time can translate to an increased likelihood of largescale erosion events. Warmer temperatures and increased drought can alter soil conditions, particularly soil moisture regimes (Goss & Oliver, 2023). Low soil moisture increases plant stress and mortality (Bradford et al., 2020) and reduces soil stability.

Overall, when actions under Alternative A are combined with other past, present, and reasonably foreseeable future actions and trends, the cumulative impacts to soil resources and geological processes would be adverse and beneficial.

3.9.3 Impacts of Alternative B (Preferred Action)

Under Alternative B, impacts of suppression operations and defensible space actions would be similar to Alternative A.

Ecosystem stewardship goals with a focus on fire as a natural disturbance process under Alternative B (Refer to section 2.2.3) would have impacts to soil resources and geological processes throughout the park. Prescribed fire is an effective way to reintroduce low-severity fire to the landscape while limiting impacts on vegetation, ground cover, and soil hydraulic properties (Hueso-Gonzales et al., 2018). Prescribed fire and manual and mechanical thinning would require presence of work crews, vehicles, and equipment. During the use of mechanized equipment, there could be disturbance to vegetation cover, weakening soil stability. Soil compaction is possible and mitigations to minimize compaction would be implemented as described in Appendix E. Long-term impacts of thinning are expected to be beneficial, by reducing unnaturally high fuel loads and creating an open understory of grasses and forbs. Increased plant cover improves soil integrity and contributes to soil stability (Goss & Oliver, 2023). Immediate impacts of prescribed burns include scorched or consumed understory vegetation and heterogenous fire effects on soil. Post-burned areas with exposed soil are subject to erosion, although less erosion is expected during low-severity surface fire (Orem and Pelletier, 2016). For example, a 2006 prescribed fire in ponderosa pine and grassland vegetation of the Valle Toledo resulted in "negligible" erosional impacts of ash and soil constituents into streams within the park (Caldwell et al., 2013), indicating minimal erosion occurred. Prescribed burns have the potential to burn localized pockets of trees. Higher rates of soil erosion may be observed in these patches.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions in the park with potential to impact soil resources and geological processes include construction, improvements, and restoration as outlined in Trends and Planned Actions. The impacts of these actions in combination with fire suppression and defensible space actions under Alternative B would be the same as under Alternative A; however, fuel treatments under Alternative B would reduce the potential for landscape-scale high-severity wildfires and subsequent soil hydrophobicity and erosion from post-fire floods.

Impacts of thinning, prescribed fire, and naturally ignited fire, as described under Alternative B in combination with impacts of construction, improvements, and restoration actions within the park may result in both short-term adverse and long-term beneficial cumulative impacts. Adverse impacts of the combined actions may include vegetation disturbance; soil displacement, disturbance, and compaction; and potential for erosion.

Utilizing thinning, prescribed fire, natural fire, and other planned restoration actions in the stewardship of ecosystems would have long-term beneficial cumulative impacts across the landscape, such as producing non-continuous fire effects on soils; encouraging nutrient cycling; restoring vegetation; improving soil health and stability; reducing erosion; and maintaining beneficial fire regimes.

Climate trends may impact soil resources and geological processes by altering soil moisture regimes, increasing vegetation stress and mortality, and increasing potential for high-severity fire events that can damage soil properties and contribute to debris flows. Fuel treatments under Alternative B would reduce potential for large-scale high-severity wildfire but would not considerably lessen the overall short- and long-term impacts of climate change. However, use of innovative strategies under Alternative B would provide tools for adapting to changing fuel structures, fire regimes, and environmental conditions.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be adverse cumulative impacts to soil resources and geological processes. However, cumulative impacts would be beneficial in the long-term due to enhanced ecosystem stewardship and the reintroduction of beneficial fire regimes.

3.10 Water Resources: Floodplains and Water Quality or Quantity

3.10.1 Affected Environment

Valles Caldera contains the headwaters of the East Fork Jemez River and San Antonio Creek, as well as smaller tributaries that are both perennial and ephemeral (Figure 6). Additionally, the park contains numerous seeps, springs, and geothermal features that support unique wetland ecosystems, fisheries, and vegetation. Figure 7 shows sub-basin delineation and the stream order for streams both ephemeral and perennial within the park. Stream ordering is a spatial analysis tool used by hydrologists to determine size and drainage area within a hydrologic system (Fitzpatrick, et. Al., 1998). Various springs and small zero-order snowmelt-fed streams feed the river systems of Valles Caldera. Many of these springs are unmonitored and unclassified. These water sources flow from the higher, steeper elevations of Valles Caldera down into the individual valleys and plains, where they become perennial streams.

As streams flow into the valleys, floodplain features become more pronounced. Previous fires and associated debris flows have defined, reformed, and changed these floodplains over time. Floodplains are defined by the Federal Emergency Management Agency (FEMA) analysis from 2008 (FIRM panel 35043C0925D) and is based on FEMA Policy 204-078-1. An informal, unpublished analysis done by NPS staff in 2022 shows that floodplains in the Cabin District are very difficult to define due to debris flows from 2013, and that floodplains in the lower valleys are effectively the same as active wetlands. In Valle Jaramillo, and the upper Valle Grande, streamflow of only 12 cfs (cubic feet per second) is necessary to cause an overbank condition. This level of streamflow is common during snowmelt on a yearly basis, making the traditional flood definitions of 5-year, 10-year, etc. impossible to calculate. No other defined terracing exists in these floodplains, which results in the extent of the floodplain being tied to the extent of the wetland. Steeper, upland habitat above these wetlands does not appear to show signs of routine or rare inundation, though further geomorphological study is needed.

No complete definition and extent of wetland habitat exists for the entire park. Wetlands are found predominately along the slopes and bottoms of all valleys and grasslands throughout the area, where perennial water is present. Wetlands are defined by the NPS using NPS standards set forth by Procedural Manual (PM) 77-1. (NPS, 2016)

Wetland restoration has occurred throughout the park’s history as managed by both the Valles Caldera Trust and Valles Caldera National Preserve. Wetland restoration projects within the park are typically in-stream rock structures designed to slow the water and spread that water away from the channelization that has occurred due to overgrazing.

Streamflow is impacted throughout the park by the presence of stock tanks and dams that were created primarily during the 1960s ranching era. Currently, removal of these tanks is a priority for the NPS.

Water quality throughout Valles Caldera is monitored seasonally via four permanent stations: Indios Creek, East Fork Jemez River, and the Rio San Antonio at Valle Toledo and Valle San Antonio. These stations measure for key water quality indicators including dissolved oxygen, pH, turbidity, temperature, and specific conductance (EPA, 2012). These stations show that the overall, long-term water quality of the park is stable, with some signatures such as temperature and turbidity decreasing because of ecosystem restoration projects. Water quality trends are difficult to predict in relation to climate change due to the many other inputs to a watershed system (Ryberg, 2022).

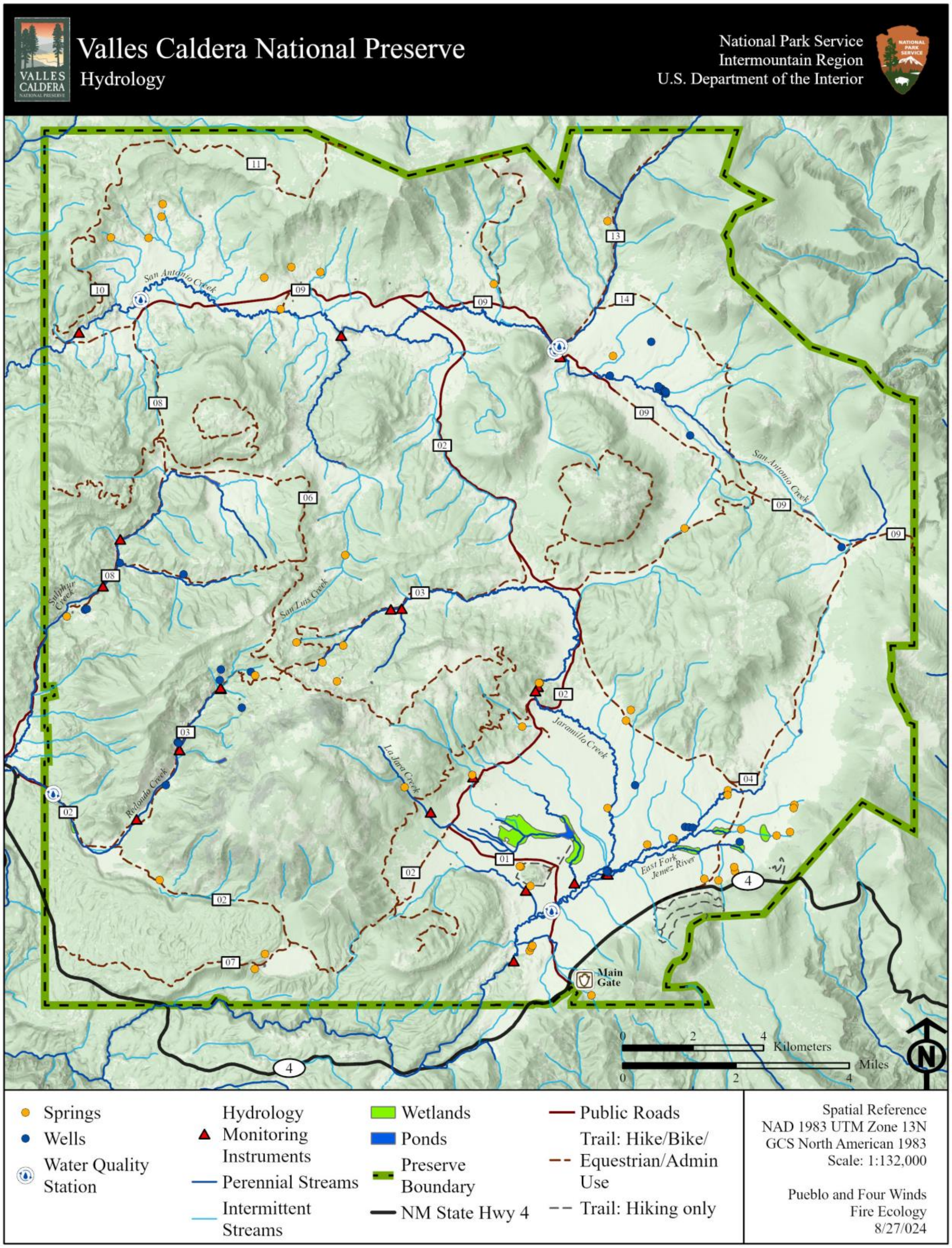


Figure 6. Hydrology of Valles Caldera National Preserve

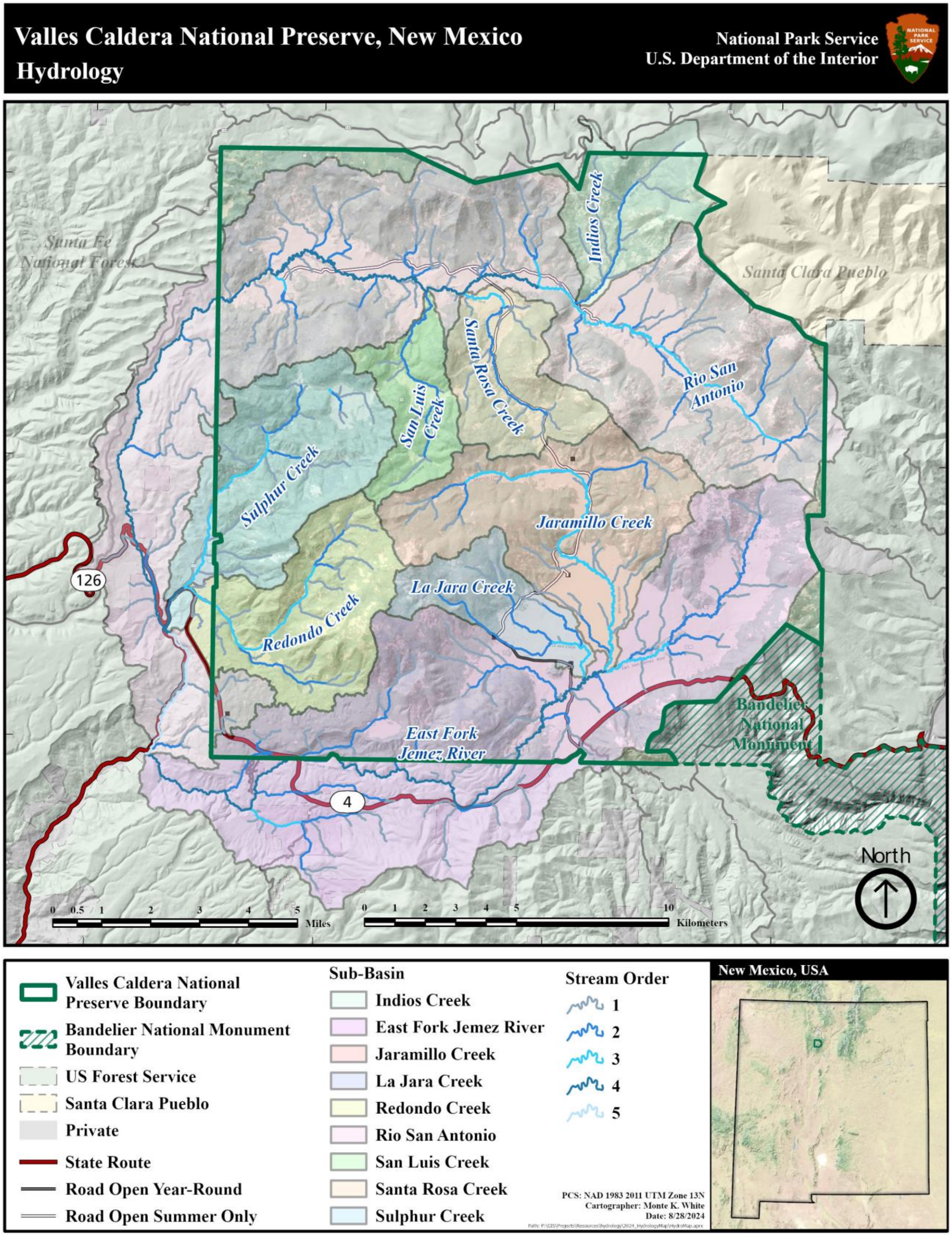


Figure 7. Sub-basins and Stream Orders in Valles Caldera National Preserve

Trends and Planned Actions

Past, current, and planned actions and trends within the park that can affect water resources include wetland ecosystem restoration, infrastructure construction, water quality, and climate change.

Valles Caldera is mandated by founding legislation to continue ecosystem restoration. Since 2005, internal GIS data shows that over 700 additional acres of wetland ecosystem has been added to the East Fork Jemez River system, comprising over 30 river miles. Additional wetland restoration work is scheduled in the next year to include at least another 250 acres and 15 river miles. These projects are expected to add at least another 20 acres, increasing the wetland ecosystem area by 10%. As funding allows, similar projects will continue to benefit Valles Caldera's wetland ecosystems indefinitely.

Infrastructure development is a key source of sediment into the East Fork Jemez River system. Currently, Valles Caldera has over 1000 miles of logging and ranch roads incorporated into the park. These roads do not have adequate, engineered drainage systems, and erosion is a constant source of turbidity pollutants into various watersheds. These erosion events generally do not contribute to long-term degradation of the watershed, and only impact streams during intense monsoon events. The NPS continues to monitor long-term changes and respond accordingly.

Climate change in Valles Caldera is characterized by a 1.4-degree Fahrenheit increase in mean annual temperature over the last century, but relatively stable yearly precipitation (Carlson & Gross, 2019). There is some indication that climate change is causing more intense and sporadic rain events in the Jemez Mountains (NPS, 2024b). While precipitation is stable, the increased temperatures have adverse impacts on snowpack and winter storm systems (White, et al., 2023). Valles Caldera is largely a monsoon-dominated watershed, meaning that peak flows occur with the summer monsoon, rather than spring snowmelt. Current hydrologic data collected by the NPS confirms the trends that are reported on a regional scale: peak snowmelt is happening earlier, high flow events are more significant and more sporadic, and overall stream discharge is slowly decreasing. (Stackpoole, et al., 2023)

3.10.2 Impacts of Alternative A (No Action)

Under Alternative A, fuel loads throughout the park would increase, rendering the landscape susceptible to high-severity wildfire. High-severity wildfire can impact water resources with associated soil impacts and destruction of vegetation communities, leading to flooding and water quality degradation.

Post-fire flooding is a well-studied phenomenon that can put human life and property at danger. These floods are often not categorized on usual flood timelines (5-year, 20-year, etc.) due to the abnormal environmental changes that occur during and after wildfire events.

The unpredictable deposition of sediment that usually follows wildfire can block and/or permanently damage infrastructure and permanently deform landscapes. Within these sediment flows, internal data collected by the NPS (NPS, 2024d) also indicates high ammonia loads, which can lead to fishery destruction, as well as highly concentrated amounts of heavy metals such as lead. These sediment flows can impact downstream irrigation systems, water supply systems, and fisheries as well, compounding regional impacts across an otherwise un-impacted landscape.

Floodplains are a dynamic and important ecological resource. Unplanned fire can permanently alter the hydrologic composition of these ecosystems; by sediment deposition, interrupting groundwater and surface water exchanges, and causing topological changes that can affect surface water flow and erosion. (Kleindl et al., 2015). These changes can be exacerbated by post-fire flood pulses. The Cabin District area of Valles Caldera has had floodplains change from the published FEMA maps by the Thompson Ridge fire of 2013.

These effects, while damaging, are usually short-term. Figure 6 shows the water quality response to rain events after the Las Conchas Wildfire of 2011, where 30,000 acres burned in the park, approximately 28% at high-severity and 26% at moderate (USGS. 2011). Each graph represents a similarly sized rainfall event at one gage within Valles Caldera. Immediately following wildfire, high flows are detected, along with significant degradation throughout the watershed. The degradation persists through year three, though the high flow signature is now reduced. By year 11, the flow signature and watershed degradation no longer exist, as the stream has returned largely to a pre-fire condition. Internal data collected throughout the park show that streams return to a pre-fire condition within 7-10 years of wildfire events; however, this depends on watershed location, soil types, aspect, and slope.

Fire suppression actions additionally impact the short-term health of park watersheds. Fireline construction will remove vegetation and topsoil, allowing for channelization and direct deposition of sediments and potential contaminants into streams. Potential contaminants along fire lines can be hydrocarbons from fuels, waste from firefighters or other personnel, and the introduction of eroded sediments. Fire retardant drops are a particular concern for water quality. They are composed of nitrogen and phosphorus and can lead to eutrophication of surface water. Eutrophication refers to the excess of nutrients, which can lead to rapid growth of algae and the depletion of dissolved oxygen in a stream system. The depletion of dissolved oxygen will lead to fish and other animal die-off (Backer, et. Al. 2004).

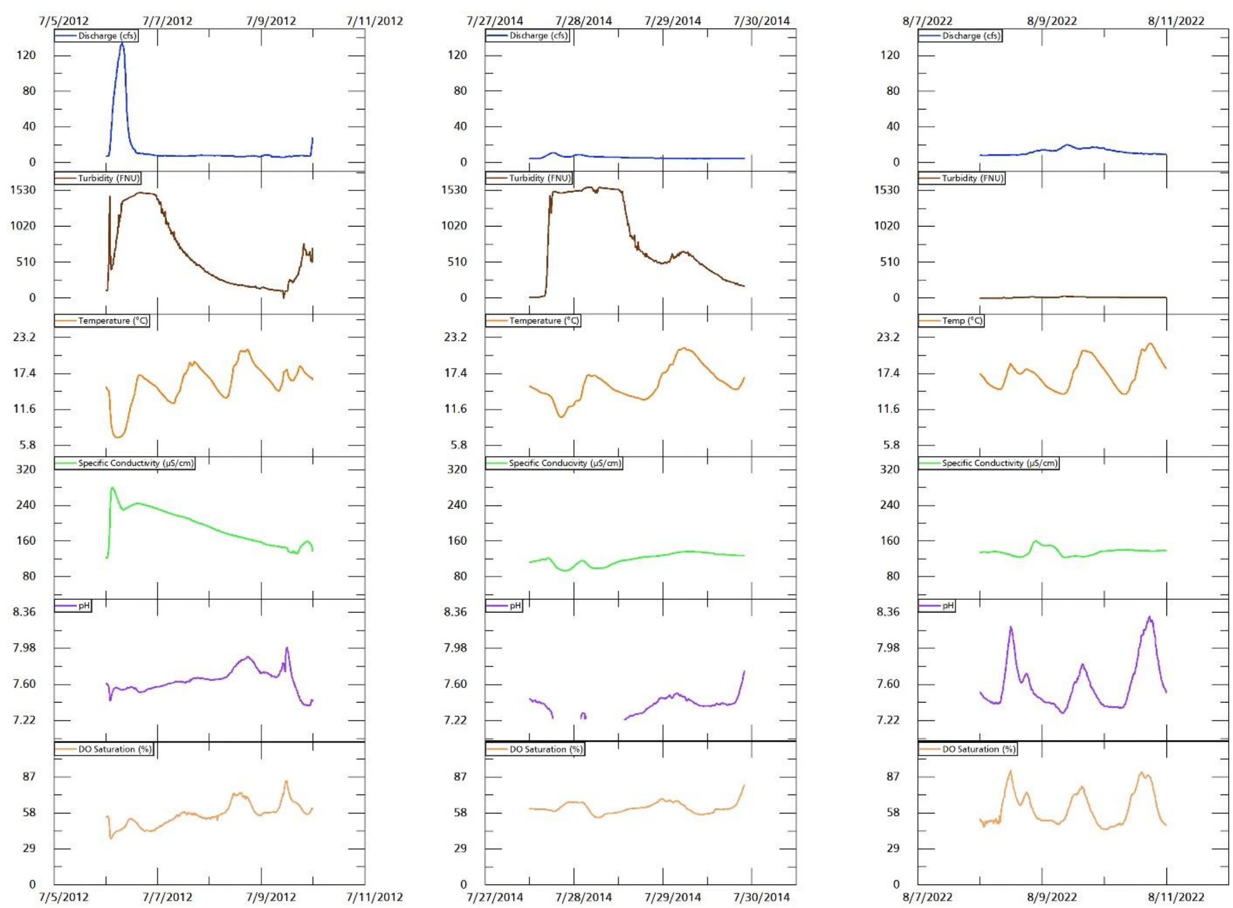


Figure 8. Water Quality Response in Valles Caldera after the Las Conchas Fire

Note: The graphs show analysis of water quality response to rain events at one, three, and eleven years after the Las Conchas Wildfire of 2011.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with the potential to impact water resources under Alternative A include those discussed in Trends and Planned Actions section.

Construction of roads and expansion of visitation and visitor facilities can have negative impacts on watershed function and water quality. These effects can include the introduction of pollutants from vehicles along impermeable surfaces including petroleum hydrocarbons and nitrates; increased sedimentation and soil denuding from construction projects, additional dirt roads and parking lots; and increased soil compaction. Planned utility projects associated with the expansion of visitor facilities can temporarily increase sediment loads in streams and rivers.

Further restoration of Valles Caldera's watersheds will improve the overall hydrologic function of the streams and rivers by reducing channelization and erosion from cut banks, and restoring wetlands and fens that resemble the historic hydrology of the area (NPS, 2022b).

Climate change and current trends, in association with actions under Alternative A will result in adverse impacts to the hydrology of Valles Caldera. Increased temperatures and increased variability in precipitation amounts and timing can reduce the availability of water within the hydrologic system, as well as impact the soil and sediment systems as described in section 3.8.

When the impacts of Alternative A are combined with the impacts of other past, present, and reasonably foreseeable future actions and trends, the total cumulative impacts on water resources would be adverse in the short- and long-term.

3.10.3 Impacts of Alternative B (Preferred Action)

Under Alternative B, prescribed fire, allowing naturally ignited fire to burn, and thinning would reduce fuel loads and potential for landscape-scale high-severity fire. While the risk will never be eliminated, by mitigating or minimizing the risk, the NPS is acting in the best interest of the water resources in the park.

Proper fire planning would reduce the chance of high-severity fires on the landscape, but similar impacts may occur due to temporary removal of vegetation and potential for soil disturbance. These impacts would be substantially reduced from high-severity wildfire, as a 2006 prescribed fire in ponderosa pine and grassland vegetation of the Valle Toledo resulted in "negligible" erosional impacts of ash and soil constituents into streams within the park (Caldewell et al., 2013). As fire intensities in planned actions are much lower, these impacts would be focused on the short-term and would generally be unnoticeable within a few months.

Pile burning would have negligible long-term impacts on watershed function, as fuels are stacked and burned while the ground is frozen.

Forest thinning can increase hydrologic discharge and long-term water yield from treated areas (Bosch and Hewlett, 1982). Increased water yield from thinned areas can help reduce the effects of long-term climate change by returning water to stream systems and wetlands.

An increase in the quantity of water runoff can be detrimental, especially over bare-mineral soil (Refer to section 3.8, Soil and Geologic Resources). Forest thinning can temporarily increase the prevalence of bare mineral soil due to the mechanical impact of heavy equipment. Bare mineral soil impacts can be reduced by limiting heavy equipment use to low-and-intermediate slopes (0-25% slope) (Cram, et al., 2007).
Implementing Alternative B would reduce the fuel load that can cause widespread impacts to watersheds, while reducing long-term risks.

Cumulative Impacts

The trends and conditions described in the affected environment resulting from past, current, and reasonably foreseeable future actions would continue. Fuel treatments and the introduction of planned fire would reduce the risk of high-severity wildfire, thereby reducing the risk of damage from sedimentation and introduction of pollutants to watersheds.

Impacts of fire operations such as thinning, prescribed fire, and naturally ignited fire in combination with infrastructure development, increased visitation, and restoration activities may have short-term negative impacts on watersheds, such as soil compaction, increased sediment runoff, and the possibility of fuel spills or another contaminant introduction. These impacts are expected to be short-term.

Climate trends will continue to impact watersheds in Valles Caldera as described under Alternative A, however, by restoring a beneficial fire regime, and decreasing the potential for high-severity wildfire, these impacts can be mitigated.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be adverse cumulative impacts to water resources. However, cumulative impacts would be beneficial in the long-term due to enhanced ecosystem stewardship and the reintroduction of beneficial fire regimes.

3.11 Human Health and Safety

3.11.1 Affected Environment

Health and safety of visitors, adjacent property owners, staff, and firefighters is a high priority of the NPS. Wildfires and fire management actions present risks to the public, fire personnel, and staff through smoke inhalation, flames, falling rocks or trees, debris slides, equipment or vehicle accidents, tripping or falling, and possible injury or loss of life.

Valles Caldera is surrounded by Santa Fe National Forest, except where it shares a border with Pueblo of Santa Clara along its northeastern boundary, and with Bandelier National Monument along the southeastern corner.

The town of Los Alamos (population 13,270) is located approximately 18 miles east of the park; Jemez Springs (population 375) is 22 miles southwest; and White Rock (population 5,716) is 25 miles southeast of the park, all along New Mexico Highway 4. Several small neighborhoods are in the vicinity of the park, primarily along the southern and western boundaries. Visitation ranges from 30,000 to 76,000 annually and peaks from May through October (NPS, 2024a). Health and safety risks related to wildfire peak in May and June, prior to the onset of summer monsoons, when fire danger is higher. Impacts are immediate in the event of a wildfire and threats can persist through the fire season.

Trends and Planned Actions

Past, current, and planned actions and trends within the park that may affect human health and safety include trail, road, and parking lot construction, building and facility improvements and construction, and climate change.

Planned trail construction includes an accessible trail through the Cabin District. Planned road and parking lot construction includes rerouting the road near the Entrance Station and construction of two new gravel parking lots southwest of the Ranger Station. Planned improvements and construction on buildings and facilities includes demolition of movie sets, restoration of historic cabins and outbuildings, and improving accessibility to the Ranger Station and Entrance Station.

Climate trends may also impact human health and safety. Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000, but relatively stable precipitation (Carlson & Gross, 2019). Between 1895 and 2018, mean temperatures have increased by 1.4°F per century (NPS, 2022b), resulting in an increased aridity, lower fuel moistures, and increases in wildfire activity.

3.11.2 Impacts of Alternative A (No Action)

Alternative A would include goals and objectives to prioritize health and safety and manage risk to visitors, staff, and surrounding communities. Response to wildfire would be based on safety, ecological, social, and legal consequences of fire. The circumstances under which a fire occurs, and the likely consequences to firefighter and public safety and welfare would help dictate the management response.

Full fire suppression strategies and a lack of fuel reduction treatments (e.g., prescribed fire, thinning.) under Alternative A would lead to increased fuel loading, higher fire severity, and risk of wildfire causing undesirable outcomes. Impacts from wildfire can include injuries; loss of life; damage to property; episodic smoke exposure; evacuations; and closures. Use of hand crews, fire engines, and aircraft to suppress fire involves inherent risk. However, training and mitigations can reduce adverse impacts to a level of short-term and minor.

Smoke and particulate matter in the atmosphere resulting from wildfire could affect respiratory systems and vision of personnel, visitors, and surrounding communities. Severity of impact would depend on individual sensitivity to irritants and duration of exposure could range from hours to days. Smoke impacts on human health and safety could be adverse, localized, and short-term as described in section 3.2, Air Quality. In the event of a wildfire, affected areas of the park and access to those areas would be temporarily closed to visitors. As a result, adverse impacts to visitor health and safety from fire suppression actions would be minimized.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact human health and safety under Alternative A include those described in the Trends and Planned Action section. Trail, road, and parking lot construction, and building and facility improvements and construction would temporarily introduce dust and exposure to vehicles and equipment. These actions, in combination with defensible space and fire suppression actions such as use of chainsaws, hand tools, fire vehicles, bulldozers, aircraft, and construction of fire lines could result in adverse cumulative impacts to human health and safety. However, in the event of a wildfire, area closures would likely be implemented and would mitigate the potential for adverse impacts to human health and safety. Visitors would also be excluded from constructions areas during planned actions within the park, further lessening the cumulative impact.

Climate trends, including excessive heat, drought, extreme precipitation patterns, and environmental conditions such as dust storms, and particulate air pollution from wildfires present risks to health and human safety in the region (Gonzalez et al., 2018). These trends, in addition to a suppression-oriented wildland fire management program, could have adverse impacts to human health and safety due to increased risk of wildfires.

When the impacts of Alternative A are combined with the impacts of other past, present, and reasonably foreseeable future actions and trends, the total cumulative impacts on human health and safety would be adverse in the short- and long-term.

3.11.3 Impacts of Alternative B (Preferred Action)

Under Alternative B, the impacts of fire suppression and defensible space actions would be the same as Alternative A.

Under Alternative B, prescribed fire, manual and mechanical thinning, and allowing naturally ignited fire to burn may pose a threat to human health and safety due to episodic smoke (Refer to section 3.2, Air Quality) and exposure to chainsaws and vehicles. Impacts would generally be adverse and short-term, and severity of impact would depend on individual sensitivity to irritants and length of exposure. Pre-planning for protection of human health and safety, implementation of on-site weather and smoke monitoring, and appropriate notification prior to implementation of actions would reduce adverse impacts. Further, all fuel treatments would be implemented with well-trained and qualified staff, interagency partners, and contractors, and mitigation measures would be implemented as described in Appendix E. Treatment areas would be closed to park visitors if necessary to minimize risk associated with vehicles, equipment, or debris. Fuel treatments are an effective tool for reducing hazardous fuels and risk of landscape-scale high-severity fire. Overall, the potential for adverse impacts of these planned actions on human health and safety is less than impacts of unplanned fire events. Further, implementation of prescribed fire and naturally ignited fire would provide long-term beneficial reductions in high-severity fire.

Cumulative Impacts
Past, present, and reasonably foreseeable future actions and trends with potential to impact human health and safety under Alternative B include trail, road, and parking lot construction, building and facility construction, utility improvements, and climate change. The cumulative impacts on human health and safety from construction and improvements and defensible space and fire suppression actions would be the same as Alternative A.

There may be adverse impacts to health and human safety due to the combination of prescribed fire, thinning, and allowing naturally ignited fire to burn and planned construction and improvements due to the presence of smoke and the use of chainsaws, equipment, and vehicles. However, the long-term beneficial impacts of reducing potential for high-severity fire and implementing park infrastructure improvements would outweigh the short-term, adverse impacts.

Climate trends are expected to increase aridification, frequency and size of high-severity wildfires, and smoke impacts. While these impacts are similar to Alternative A, fuel treatments under Alternative B would reduce potential for landscape-scale high-severity wildfire. Additionally, forward-looking goals and objectives under Alternative B would utilize science-based adaptive management to account for changing ecological, climate, fuel conditions, and fire regimes. While human health and safety would be impacted by ongoing actions and climate trends under both alternatives, actions under Alternative B are more likely to result in low- to moderate-severity fire that has fewer short- and long-term impacts to firefighters, park employees, adjacent landowners, and park visitors.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be short- and long-term adverse cumulative impacts to human health and safety. However, cumulative impacts would be beneficial in the long-term due to the reintroduction of beneficial fire regimes.

3.12 Visitor Use, Experience, and Recreation

3.12.1 Affected Environment
The scenic setting of Valles Caldera attracts visitors year around, with most visitation occurring between July and August. In 2023, 76,090 visitors engaged in a wide range of recreational opportunities across both front and backcountry areas of the park, a 19% increase from 63,738 recreational visitors in 2022 (NPS, 2024a). Visitor contacts (people who stopped and interacted with a ranger or volunteer) reached a record high in 2023, reported at 57,022, a 34% increase from 2022 at 42,536 (NPS, 2024a). While visiting Valles Caldera, people engaged in exploring historic cabins, hiking, biking, camping, horseback-riding, stargazing, hunting, fishing, cross-country skiing, backpacking, and backcountry vehicle access. Visitor infrastructure in Valles Caldera includes an Entrance Station/Visitor Center, Ranger Station, mixed use trails (hiking, biking, equestrian), groomed ski trails in winter, gravel parking lots, trailheads with pit toilets, and picnic areas.

Trends and Planned Actions
Past, current, and planned actions and trends within in the park that may affect visitor use, experience, and recreation include trail construction, road and parking lot construction, building and facility improvements and construction, ecological restoration, and climate change.

Planned trail construction includes an accessible trail through the Cabin District. Road and parking lot construction includes rerouting the road near the Entrance Station and construction of two new gravel parking lots southwest of the Ranger Station. Planned building and facility improvements and construction includes demolition of movie sets; restoration of historic cabins and outbuildings; installing a mechanized gate at the Entrance Station; improving accessibility to the Ranger Station and Entrance Station; removing structures and relics of recent human activity from Sulphur Springs; and removing fencing. Ecological restoration projects include wetland restoration and forest thinning. Approximately 700 acres of wetland restoration has been accomplished with 250 acres planned in the future. Past forest thinning and restoration projects have been implemented on approximately 10,000 acres, with additional projects planned for the near future.

Climate trends may impact visitor use, experience, and recreation. Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000, but relatively stable precipitation (Carlson & Gross, 2019). Between 1895 and 2018, mean temperatures increased by 1.4°F per century at Valles Caldera (NPS, 2022b), resulting in an increasingly arid climate, lower fuel moistures, and increases in wildfire activity.

3.12.2 Impacts of Alternative A (No Action)

Alternative A may adversely affect visitor use, experience, and recreation through an increase in suppression actions, aircraft use, and temporary road, area, or park closures. Visitors would not be able to enter closed or restricted areas for short or long periods of time, depending on the location, size, intensity, time of year, and duration of the wildfire, and post-fire conditions. Wildfire information would be communicated via press release to inform the public about road, area, or park closures, smoke impacts, situational updates, or other impacts to the public. Information would also be posted on Valles Caldera's website and social media accounts. Although press releases would mitigate some inconvenience to visitors by informing expectations, restrictions and closures would nonetheless result in adverse, localized to park-wide, short-term to long-term impacts. Additionally, aircraft and chainsaw use would increase noise levels locally. The intensity of noise intrusions would depend on the visitor's distance from actions and number of aircraft in operation.

Defensible space and structure protection actions, including manual and mechanical thinning treatments such as mowing, trimming, limbing, and removal or redistribution of vegetation and hazardous fuels, would occur under Alternative A. Although these fuel treatments would be limited, they could cause noise intrusions and localized, short-term (hours to a couple days depending on the project) area closures, resulting in adverse, short-term disruptions to visitor use, experience, and recreation.

Under this suppression-oriented alternative, park-wide fuel accumulations due to fire exclusion would result in increased potential for landscape-scale high-severity wildfires. This would exacerbate impacts to visitor use, experience, and recreation due to closures and restricted use of forests during extreme fire danger periods. These adverse impacts could be short-term; however, a larger high-severity wildfire could have longer-term impacts to visitors due to trail, road, and area closures resulting from hazardous tree fall, erosion, flooding, and impacted infrastructure. Viewsheds can also be altered by high-severity wildfire; and heavy smoke can impact visitor health (refer to section 3.2, Air Quality, and section 3.13, Viewsheds).

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact visitor use, experience, and recreation include trail construction, road and parking lot construction, building and facility improvements and construction, ecological restoration, and climate change. These actions and trends, in combination with increases in landscape-scale, high-severity wildfire, fire suppression actions, and defensible space actions under a suppression-oriented wildland fire program (Alternative A), could produce a range of beneficial and adverse, short- and long-term impacts.

Constructing an accessible trail through the Cabin District would have a temporary adverse impact to visitors during construction; however, in the long-term it would provide greater accessibility. Planned rerouting of the road near the Entrance Station and construction of two gravel parking lots may have temporary adverse impacts to visitors during construction but the project is expected to improve visitor experience and access in the long-term. It will also reduce visitor impacts to the area by concentrating cars to the parking lots rather than roadside in the Cabin District. Building and facility construction are expected to have long-term, beneficial impacts to visitors by improving access and promoting a more natural environment and scenery. Restoration efforts are estimated to have beneficial impacts to visitor experience by creating greater species richness of flora and fauna and reducing impacts of erosion and cutbanks.

Climate trends in combination with actions under Alternative A, particularly increases in high-severity wildfires, are anticipated to result in adverse, short- and long-term cumulative impacts. Warming and drying trends can cause vegetation stress and mortality (Bradford et al., 2020), resulting in changes to the ecosystems and habitat that visitors enjoy. In addition, average monthly temperatures above 80°F are shown to decrease visitation, and general warming trends can produce shifts in the timing of visitation (Fisichelli et al., 2015). Increases in fire intensity, size, and length of fire seasons can increase the number of days per year that visitors are impacted by smoke (NPS, 2022b).

Overall, impacts of Alternative A in combination with past, present, and reasonably foreseeable future actions and trends would have short-term adverse and long-term beneficial cumulative impacts on visitor use, experience, and recreation.

3.12.3 Impacts of Alternative B (Preferred Action)

Under Alternative B response to wildfire would range across a spectrum of strategies, from monitoring to intensive management actions. Fuel treatments, such as manual and mechanical thinning, prescribed fire, and allowing a naturally ignited fire to burn under specific prescription parameters would be used to reduce fuel loading and potential for high-severity wildfire and to create defensible space (refer to section 2.2.3, Alternative B).

Fire suppression actions and impacts may occur under Alternative B as described under Alternative A; however, in the long-term, wildfires would be less frequent and of lesser severity due to fuel treatments, resulting in fewer noise disturbances, closures, and less impacts from smoke. Communication with the public would be via press release, Valles Caldera's website and social media accounts, and information boards in Valles Caldera. Communications would include information pertaining to wildfire, forest thinning, prescribed fire, goals and objectives, situational updates, fire restrictions, closures, smoke, and other impacts to the public. Although communications would mitigate some inconvenience to visitors by informing expectations, restrictions and closures could nonetheless result in adverse, localized to park-wide, short-term impacts.

Allowing a naturally ignited fire to burn and implementing prescribed fire may result in an increase in the number of acres burned by fire, but the fire effects would generally be low-severity and beneficial. There could be temporary traffic congestion, road closures, area closures, and smoke, but impacts on visitor use, experience, and recreation would be short-term (typically days to a week). Additionally, most prescribed fires would occur when park visitation is at its lowest, typically during early spring or late fall when fire danger is low and fire intensity is low to moderate.

Fuel treatments would have both beneficial and adverse impacts on visitor use, experience, and recreation. All fuel treatments can produce noise intrusions, visual impacts, and temporary closures of areas, roads, and trails. However, treatments are typically conducted during times of lower visitation, such as fall, winter, and spring, resulting in fewer impacted visitors; and the presence of work crews and evidence of fuel treatments on the landscape would be temporary. In addition, prescribed fire, both pile burning and broadcast fire, would be planned in accordance with weather conditions and air quality regulations to minimize impacts to health and safety.

Fuel treatments may temporarily disrupt hunting activities in specific areas; however, in the long-term, these actions improve wildlife habitat by creating open spaces and corridors for wildlife movement, encouraging vegetation regrowth, and increasing food sources for wildlife (Severson & Rinne, 1988). Reducing forest density also improves visibility and access for hunters (Fawcette et al., 2021). Further, fuel treatments can create a mosaic of habitats, improve hydrology, enhance riparian and aquatic habitat, and support fish populations, benefiting anglers and recreationalists alike (Dwire et al., 2016). Moreover, implementing a multiple strategy wildland fire program would provide opportunities for visitor and public engagement regarding wildland fire, fire management, fire ecology, and ecosystem stewardship. The park would focus on communication, collaboration, education, and fostering fire-adapted human communities through ranger talks and programs, exhibits and signage, and collaboration with local nature centers, community groups, and schools. Overall, adverse impacts of fuel treatments on visitors would be short-term and localized, and in many instances, there may be no impacts, depending on visitor proximity to operations. Beneficial impacts would be both short- and long-term.

Cumulative Impacts
When combining fire suppression and fuel treatments with current and reasonably foreseeable actions, cumulative impacts to visitor use, experience, and recreation under Alternative B would be both beneficial and adverse. Beneficial localized and park-wide, short- and long-term impacts would result from fuel reduction treatments by decreasing potential for high-severity fire and therefore potential for noise disturbance, road and area closures, and smoke impacts. Additionally, fuel treatments protect visitors and infrastructure and the natural, cultural, and biological resources that bring visitors to the park. Adverse impacts would be localized and short-term due to the combined impacts of fire suppression, fuel treatments, and past, present, and reasonably foreseeable future actions.

Climate trends are expected to increase potential for high-severity wildfire which can increase park closures and smoke impacts (as described in section 3.2 Air Quality). Climate trends can also impact visitation patterns, for example visitors may avoid parks during warmer times of the day and year. Fuel treatments under Alternative B would reduce potential for landscape-scale high-severity wildfire, reducing smoke impacts and park closures.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be short-term adverse cumulative impacts to visitor use, experience, and recreation. However, cumulative impacts would be beneficial in the short- and long-term due to the reintroduction of beneficial fire regimes.

3.13 Viewsheds

3.13.1 Affected Environment
A viewshed includes everything observed from a location, such as forests, cliffs, rivers, mountains, waterfalls, monuments, roads, and historic features. The NPS is responsible for preserving natural, cultural, biological, and historical views now and into the future. Iconic views within Valles Caldera include the expansive Valle Grande, old growth trees in the History Grove framing Cerro la Jara, San Antonio Cabin alongside San Antonio Creek, among countless others. These views are dynamic yet evoke the feeling of being transported through geologic and human history.

Wildfire has notably altered viewsheds of Valles Caldera in the past decade and a half. The 2011 Las Conchas fire burned approximately 30,000 acres in Valles Caldera, with about 8,300 acres (28%) burning at high-severity. This wildfire caused detrimental visual impacts to the forested domes on the eastern side of the park, and exposed logging road scars from the late 1960s (NPS, 2018). The 2013 Thompson Ridge fire burned approximately 24,000 acres within the park. While the fire produced a mosaic burn severity, it had visual impacts on the historic Cabin District and slopes of Redondo Mountain, the highest peak in Valles Caldera.

Trends and Planned Actions
Past, current, and planned actions and trends within the park that may affect viewsheds include road and parking lot construction, building and facility construction, utility improvements, ecological restoration, and climate change.

Planned road and parking lot construction includes rerouting the road near the Entrance Station and construction of two new gravel parking lots southwest of the Ranger Station. Planned construction on buildings and facilities includes demolition of movie sets, restoration of historic cabins and outbuildings, improving accessibility to the Ranger Station and Entrance Station, removing structures and relics of recent human activity from Sulphur Springs, and removing fencing. Planned utility improvements include removal of utility poles and construction of Electrical Vehicle charging stations. Ecological restoration projects include wetland restoration and forest thinning. Approximately 700 acres of wetland restoration has been accomplished with 250 acres planned in the future. Past forest thinning and restoration projects have been implemented on approximately 10,000 acres, with additional projects planned for the near future.

Climate trends may also impact viewsheds. Climate change in Valles Caldera is characterized by increased mean temperatures, particularly since 2000, but relatively stable precipitation (Carlson & Gross, 2019). Between 1895 and 2018, mean temperatures have increased by 1.4°F per century (NPS, 2022b), resulting in an increasingly arid climate, lower fuel moistures, and increases in wildfire activity.

3.13.2 Impacts of Alternative A (No Action)

Alternative A would lead to increases in fuel loading due to fire exclusion and a lack of fuel treatments, resulting in continued increases in landscape-scale high-severity wildfire. High-severity wildfire can cause extensive damage to vegetation and create blackened landscapes that appear stark and desolate. Vegetation recovery from high-severity fire may take years to decades and vegetation community conversions may occur, resulting in long-term adverse impacts to viewsheds.

Suppression response to wildfire may include creating fire lines and operating equipment such as chainsaws, vehicles, and helicopters. These actions can impact viewsheds by interrupting the natural aesthetic and producing visual disturbance of vegetation and soils. All fire suppression actions would be mitigated using the MIST framework (Appendix C), striving for the least environmental, cultural, and social impacts; however, impacts could still occur. Defensible space actions, such as mowing, trimming, limbing, and removal or redistribution of vegetation and hazardous fuels could have short-term, adverse impacts to viewsheds due to reduction in grasses and wildflowers and a manicured, unnatural appearance.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact viewsheds include road and parking lot construction, building and facility construction, utility improvements, ecological restoration, and climate change. These actions and trends, in combination with increases in landscape-scale, high-severity wildfire, fire suppression actions, and defensible space actions under Alternative A, could produce a range of beneficial and adverse, short- and long-term impacts.

Planned rerouting of the road near the Entrance Station may have a temporary negative impact on viewsheds during construction. However, when completed, the project is expected to improve views of Valle Grande as seen from the Cabin District and NM State Highway 4 corridor. Construction of two parking lots southwest of the Ranger Station may have temporary adverse visual impacts during construction but will increase visitor access to improved viewsheds in the long-term. Building and facility construction such as demolition of movie sets, restoration of historic cabins and outbuildings, improving accessibility to the Ranger Station and Entrance Station, removal of structures and relics of recent human activity in Sulphur Springs, and removal of fencing are expected to have long-term, beneficial impacts to viewsheds by promoting a more natural environment and scenery. Removal of utility poles is expected to improve viewsheds by reducing infrastructure that obscures natural scenery. Visual impacts of visitor center construction would be adverse and short-term but in the long-term would provide greater access to and appreciation for viewsheds. Restoration efforts are estimated to have beneficial impacts to viewsheds due to greater species richness of flora and fauna and a reduction in visual impacts of erosion and cutbanks.

Warming and drying climate trends in combination with actions under Alternative A, particularly increases in high-severity wildfires, are anticipated to result in adverse cumulative impacts. Climate trends are expected to increase vegetation stress and mortality (Bradford et al., 2020), resulting in visual impacts such as dried or dead vegetation. Climate-driven high-severity wildfires can reduce visibility in viewsheds due to smoke and dust as a result of aridification. In addition, increases in fire intensity, size, and length of fire seasons can increase the number of days per year that viewsheds within Valles Caldera are impacted by smoke (NPS, 2022b).

Overall, the impacts of actions under Alternative A in combination with other past, present, and reasonably foreseeable future actions and trends would have short- and long-term adverse and long-term beneficial cumulative impacts on viewsheds.

3.13.3 Impacts of Alternative B (Preferred Action)

Under Alternative B, the impacts to viewsheds from high-severity wildfire and suppression and defensible space actions could be similar to Alternative A. However, fuel treatments, such as thinning, prescribed fire, and allowing a naturally ignited fire to burn under specific prescription parameters would reduce fuel loading and therefore the potential for landscape-scale high-severity wildfire (Walker et al., 2018).

Goals and objectives under Alternative B prioritize utilizing the full range of fire management actions and activities in ecosystem stewardship; allowing naturally ignited fire to function; employing monitoring, research, and adaptive management; and incorporating adaptation to changing environmental conditions. Implementation of these goals and objectives would have mostly beneficial but some adverse impacts on viewsheds throughout the park.

Thinning treatments require the temporary presence of work crews, equipment, and vehicles. Disturbance to vegetation and soil may be noticeable, resulting in adverse and short-term impacts. Long-term visual impacts of thinning are expected to be beneficial by reducing tree density and canopy closure, resulting in a more diverse and abundant understory of grasses and wildflowers. Additional scenic vistas would be created through openings in the forest and more wildlife would be visible.

Prescribed burns also require the temporary presence of work crews, equipment, and vehicles, and may result in decreased visibility due to smoke (refer to section 3.2, Air Quality). Visual impacts would also include blackened areas and temporary reductions in flora and fauna; however, the long-term impacts of prescribed fire include vigorous regrowth of vegetation and increased food sources for and presence of wildlife (Severson & Rinne, 1988). Exposure to recovering prescribed burn areas would provide visitors a valuable lens through which to consider ecosystem function and natural disturbance regimes, such as fire, as a scenic quality.

Cumulative Impacts

Past, present, and reasonably foreseeable future actions and trends with potential to impact viewsheds include road and parking lot construction, building and facility construction, utility improvements, ecological restoration, and climate change.

Impacts to viewsheds from planned construction, improvements, and restoration would be the same as described under Alternative A. These actions, in combination with fuel treatments (which reduce potential for landscape-scale, high-severity wildfire), fire suppression actions, and defensible space actions under Alternative B would enhance long-term, beneficial outcomes for viewsheds. Implementing a full range of fire management actions in the stewardship of Valles Caldera's ecosystems would result in restoration of beneficial fire regimes, improving wildlife habitat, watershed function, and ecosystem resilience (NPS, 2014), ultimately improving the visual quality of the landscape.

Climate trends in combination with actions under Alternative B are anticipated to result in adverse cumulative impacts due to climate-driven increases in high-severity wildfire and vegetation stress and mortality, (Bradford et al., 2020), resulting in visual impacts such as dried or dead vegetation. Climate-driven high-severity wildfires can reduce visibility in viewsheds due to smoke and dust as a result of aridification. Fuel treatments under Alternative B would reduce potential for landscape-scale high-severity wildfire but would not, in the short-term, alleviate climate impacts.

Overall, when actions under Alternative B are combined with other past, present, and reasonably foreseeable future actions and trends, there would be short-term adverse cumulative impacts to viewsheds. However, cumulative impacts would be beneficial in the short- and long-term due to enhanced ecosystem stewardship and the reintroduction of beneficial fire regimes.

4. Consultation and Coordination

Agencies and Individuals Consulted

The following agencies, organizations, and individuals were contacted and invited to participate in the planning process. Affiliated tribes were also invited to participate in the planning process and are listed below under *National Historic Preservation Act and Tribal Consultation*.

- New Mexico State Historic Preservation Office
- Local Tribal Foresters from four pueblos
- NPS Climate Change Planning Specialist
- Washington Support Office Climate Change Ecologist
- Research Ecologists from U.S. Geological Survey
- Fire Ecologist from U.S. Forest Service
- Fuels Program Manager from U.S. Forest Service
- Professor of Fire Ecology and Fire Science from Northern Arizona University
- Professor of the School of Natural Resources from University of Arizona
- Research Scholar from University of New Mexico
- Fire Management Officer and Forest Health Program Manager from Los Alamos National Laboratory

The NPS conducted public meetings on September 4th and 5th, 2024 to ensure public opportunity to provide input on the project. Public meetings were announced via press release and social media and included posters and a StoryMap computer station. Park staff were available for questions and conversation.

National Historic Preservation Act and Tribal Consultation

Valles Caldera is of spiritual and ceremonial importance to numerous American Indian tribes and pueblos. Valles Caldera and Pueblo Parks Fire seek to cultivate and maintain inclusive, authentic, and durable partnerships with tribal communities, supporting cultural practices and honoring the sacredness of the land in all fire management actions and activities. Valles Caldera and Pueblo Parks Fire consult and coordinate with 38 traditionally associated American Indian Tribes (Refer to Appendix F).

As required by Section 106 of the National Historic Preservation Act, Valles Caldera and Pueblo Parks Fire sent a letter to the New Mexico State Historic Preservation Office (SHPO) on February 23, 2024, and received a response on March 13, 2024, concurring with Valles Caldera's determination that the FMP would have No Adverse Effect on cultural resources.

As the FMP is implemented, Valles Caldera and Pueblo Parks Fire will continue to consult and coordinate with tribes and pueblos in accordance with Section 106 of the NHPA, Executive Order 13175 Consultation and Coordination with Indian Tribal Governments, and President Biden's Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships, dated January 26, 2021.

Endangered Species Act

Valles Caldera and Pueblo Parks Fire are preparing a BA for this EA and will consult with USFWS as they develop a Biological Opinion.

Appendices

Appendix A: Valles Caldera National Preserve: A High-Elevation Ecosystem

Appendix B: Impact Topics Dismissed from Further Analysis

Appendix C: Minimum Impact Strategy and Tactics for Valles Caldera National Preserve

Appendix D: National Park Service Fuel Treatment Flow Diagram (Adaptive Management)

Appendix E: Conservation and Protection Measures, Performance Requirements, Best Management Practices, and Mitigations

Appendix F: American Indian Tribes Traditionally Associated with Valles Caldera National Preserve

Appendix G: References Cited

Appendix H: Glossary

Appendix I: Acronyms

Appendix A. Valles Caldera National Preserve: A High-Elevation Ecosystem

Valles Caldera and Vicinity

Valles Caldera National Preserve (Figure 1) is located at the southern edge of the Rocky Mountains, in the Jemez Mountains of north-central New Mexico. It is approximately 18 miles west of Los Alamos and 22 miles northeast of Jemez Springs, along New Mexico Highway 4 (Figure 2). Most of the park is in Sandoval County, with a small portion in Rio Arriba County. It is surrounded by Santa Fe National Forest, except where it shares boundaries with the Pueblo of Santa Clara to the northeast and Bandelier National Monument to the southeast.

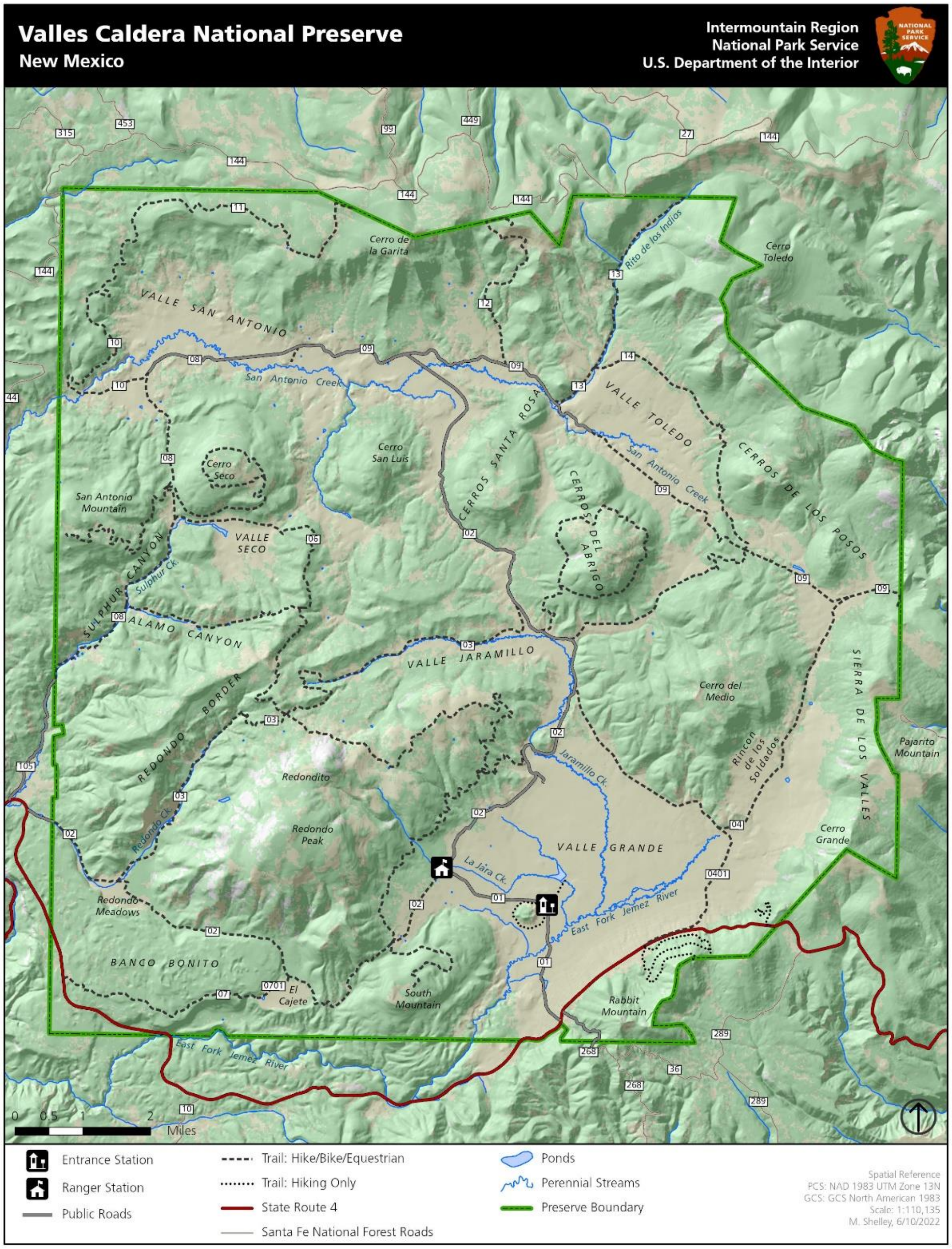


Figure 1. Valles Caldera National Preserve, New Mexico

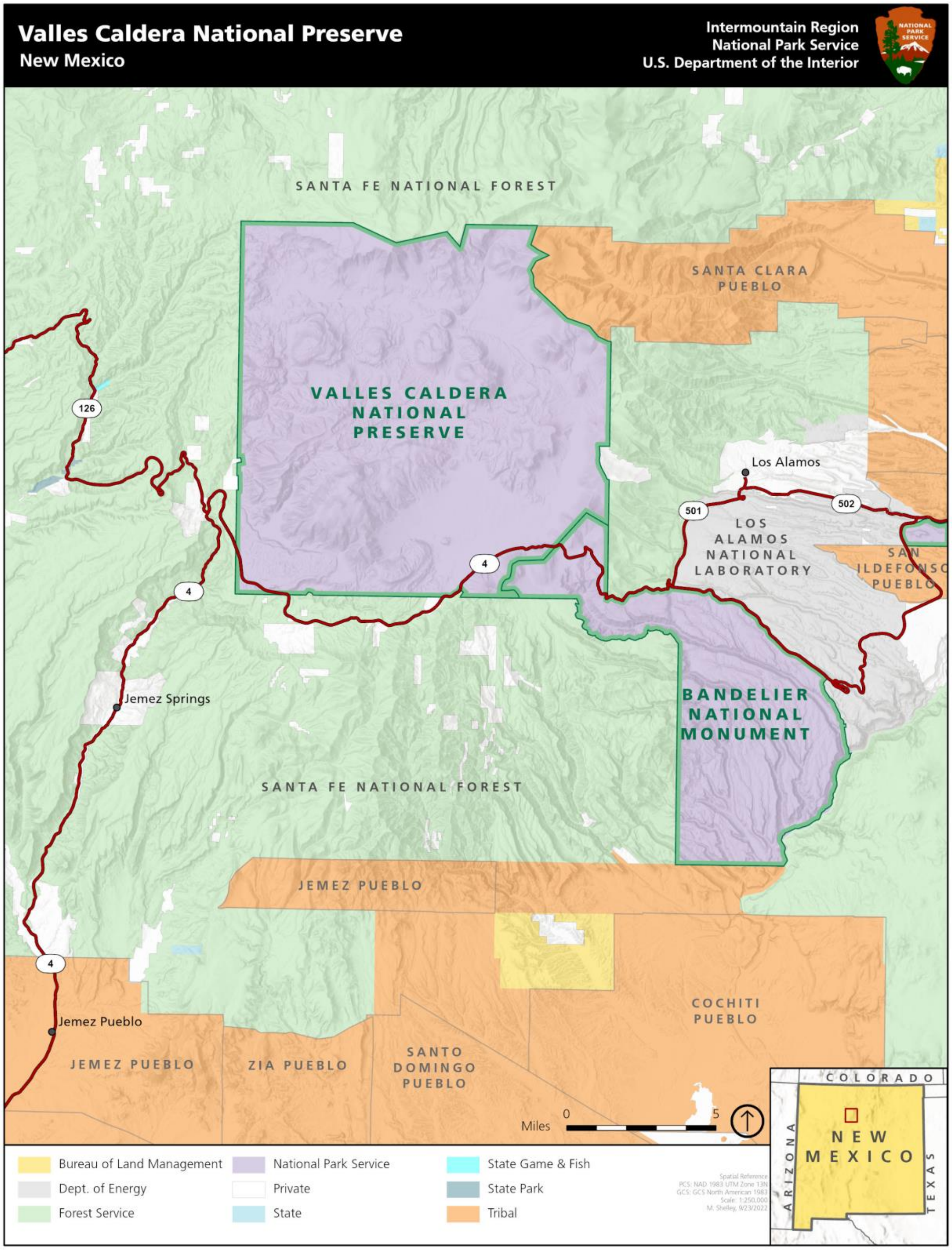


Figure 2. Valles Caldera National Preserve and Vicinity

Jemez Mountains Volcanic Field

The park sits at the intersection of two fault systems, the Rio Grande Rift, a north-south trending valley of rifting that spans from Colorado to Mexico, and the Jemez Lineament, a northeast-running chain of volcanic features that extend from New Mexico to Arizona (Figure 3). A massive eruption occurred in this volcanic field approximately 1.25 million years ago, creating the 13-mile-wide circular depression known as the "Valles Caldera." Today, hot springs and fumaroles (openings of hot sulfuric gases) provide evidence that the caldera is not extinct, though it is currently dormant.

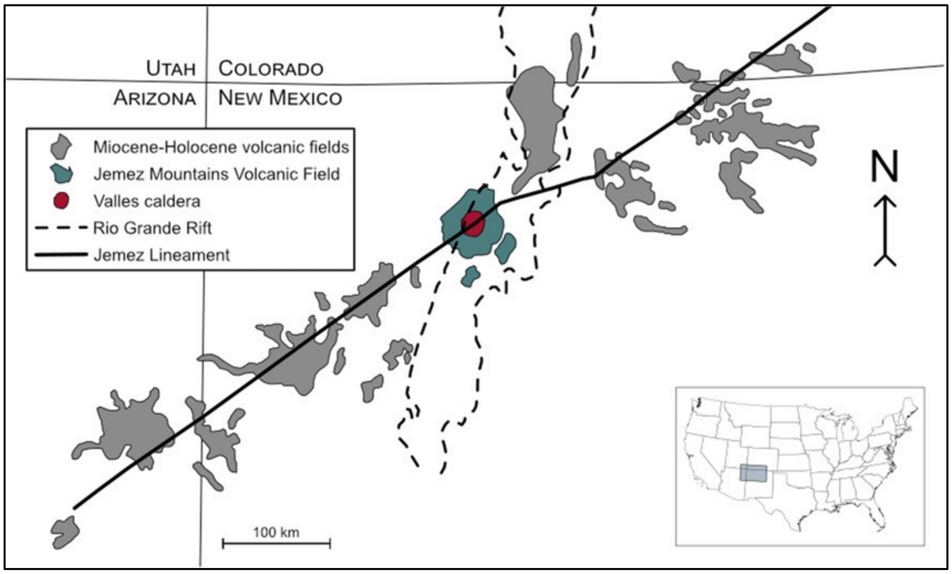


Figure 3. Valles Caldera sits at the intersection of two fault systems, the Rio Grande Rift and Jemez Lineament. Waelkens et al., (2022), adapted from Goff and Gardner (2004).

Climate

The regional climate is semi-arid continental with annual precipitation occurring primarily during the summer monsoon period from July through September, and during winter snowstorms from December through March. Weather data collected at the Valle Grande weather station from 2004 to 2022, a 20-year period, show an average precipitation of 24 inches per year (Table 1), with July averaging the highest at approximately five inches (Table 2). Minimum relative humidity was recorded at five percent, typically occurring in December or the warm and dry months of May and June. Temperatures in January and July average 23°F and 60°F, respectively. Temperature extremes range from a low of -25°F in winter to a high of 89°F in summer. The lowest temperature (including the wind-chill factor) recorded on the park was -50°F (-45.6°C) in December 2013. Prevailing winds are south and southwest, with maximum gusts as high as 60 mph.

Table 1 (Left). Total Precipitation by Year, Valles Caldera National Preserve. **Table 2** (Right). Average Precipitation by Month, Valles Caldera National Preserve

Year	Total Precipitation (inches)
2004	25.57
2005	21.84
2006	29.95
2007	28.78
2008	25.81
2009	19.37
2010	21.36
2011	26.91
2012	16.06
2013	26.12
2014	21.48
2015	35.01
2016	22.37
2017	23.37
2018	18.14
2019	25.64
2020	14.50
2021	20.74
2022	25.71
Average	**23.62**

Month	Average Precipitation (inches)
January	1.33
February	1.24
March	1.42
April	1.57
May	1.34
June	1.26
July	4.84
August	3.39
September	2.34
October	2.05
November	1.10
December	1.73

Note: Total precipitation (in inches) by year (Table 1) and average precipitation by month (Table 2) is from 2004 to 2022. Data was collected from the Valle Grande Weather Station in Valles Caldera (WRCC, 2023).

Hydrology

The park is situated at the top of the Jemez River watershed. Nine sub-basins are delineated within the park (Figure 4). The headwaters of two primary streams, San Antonio Creek and the East Fork Jemez River, occur within the park (Figure 5). San Antonio Creek begins in the northeast portion of the park and flows for approximately 30 miles until it meets the East Fork Jemez River; 18 of those miles occur within the park. The headwaters of the East Fork Jemez River are in the southeastern end of the park, flowing for 21 miles until reaching the confluence of San Antonio Creek; nine of those miles occur within the park. San Antonio Creek and the East Fork Jemez River join to form the Jemez River, a tributary of the Rio Grande.

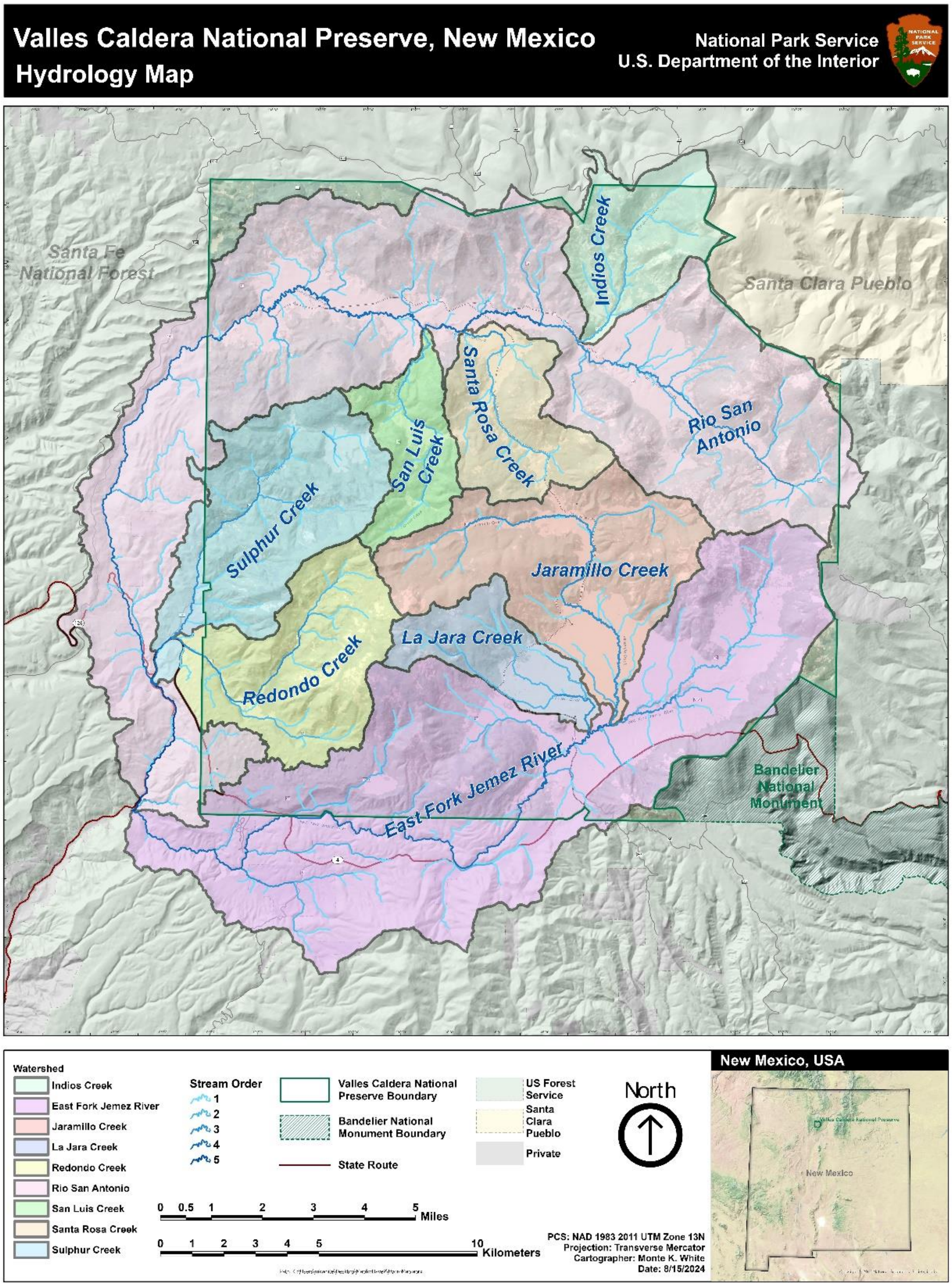


Figure 4. Sub-basins and Stream Orders in Valles Caldera National Preserve

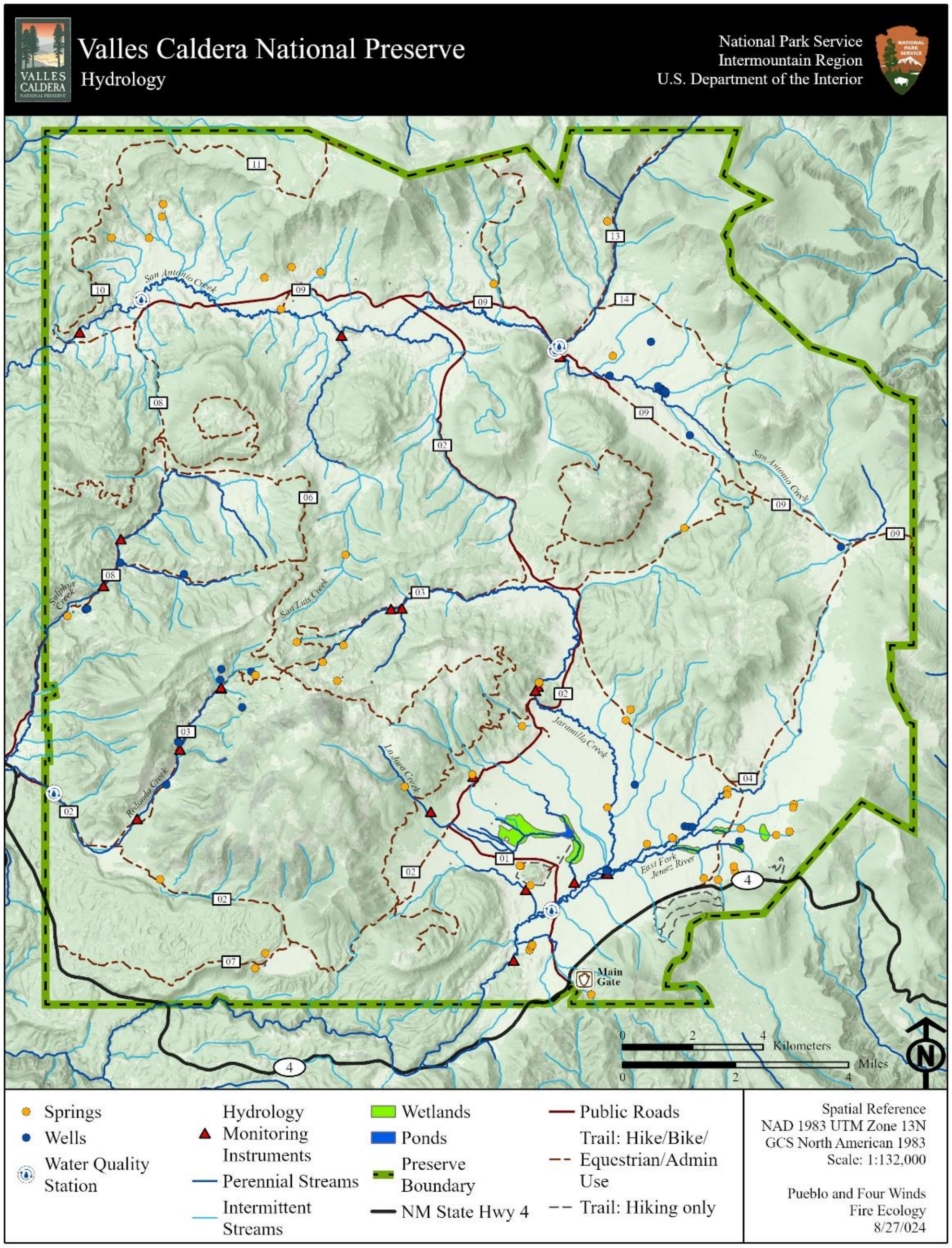


Figure 5. Valles Caldera National Preserve Hydrology

Fire History

Frequent fire has shaped and maintained the vegetation communities and landscapes of Valles Caldera. Many factors, including climatic conditions, a high occurrence of lightning strikes, availability of surface fuels and flammable vegetation, and topography make fire one of the dominant natural disturbance processes. Abundant lightning ignitions appear sufficient to explain most fire patterns prior to colonization; however, Indigenous peoples certainly used fire and likely reinforced frequent, low-intensity fire regimes. Consequently, most of the vegetation communities and wildlife are fire tolerant, fire dependent, or enhanced by fire.

Historic fire regimes have been disrupted for more than one hundred years due to 19^{th} and 20^{th} century land-use practices including over-grazing by sheep and cattle (beginning in 1860), clear-cut logging and road building (1930-1970), and widespread fire suppression (early 1900s). Departure from historic fire regimes has resulted in substantial changes in vegetation communities. Of particular concern to fire and resource managers is the accumulation of forest surface fuels, such as litter, duff, and fine and coarse woody debris, and increases in understory and midstory tree density. These forest conditions create potential for high-intensity fires that can damage forest vegetation, produce deleterious effects on plant root systems and soil properties, impact watersheds, and threaten human life, property, and wildlife. Wildfires in 2011 (Las Conchas Fire) and 2013 (Thompson Ridge Fire) collectively burned 60% of the park and approximately 30% of the acreage burned at high severity (NPS, 2014). In addition to impacts on historic fire regimes, land-use practices of the 19^{th} and 20^{th} centuries have caused riparian damage, degraded wetlands, and reduced stream function. Current and future landscape stewardship efforts focus on promoting ecosystem resiliency and biodiversity, improving watershed function, and reducing the potential for future high-intensity wildfires.

Cultural Connections

Valles Caldera preserves the homeland of ancestral native peoples. Numerous American Indian tribes and pueblos in the region have deep cultural connections to the caldera. These connections are both contemporary and of great antiquity and are expressed today through ceremonial activities, rich oral histories, and sacred traditions.

Natural and Biological Resources

The landscape within the park contains numerous volcanic domes, canyons, ridges, streams and wetlands, and a diverse assemblage of vegetation communities, including wetlands and wet meadows, montane grasslands and forest meadows, riparian shrublands, Gambel oak/mixed montane shrublands, ponderosa pine forests and savanna, mixed-conifer forests, aspen forests, and spruce-fir forests. This high-elevation ecosystem spans an elevational gradient from approximately 8,000 to 11,300 feet and supports a diversity of plants, fungi, and animals such as herds of several thousand elk and populations of mountain lion, black bear, and coyote.

Appendix B. Impact Topics Dismissed from Further Analysis

1. **Cultural Resources: Museum Collections**
   Museum collections will not be impacted by implementation of a fire management plan at Valles Caldera. Therefore, this impact topic was dismissed from further analysis.

2. **Indian Trust Resources and Sacred Sites**
   Indian Trust Resources are assets or interests (e.g., land, minerals, natural resources, hunting rights) that are held in trust for American Indian and Alaska Native tribes and individual Indians by the federal government through treaties, statutes, judicial decisions, and executive orders. Sacred Sites are those places identified by an American Indian or Alaska Native tribe or Indian individual as having established religious significance or ceremonial use by an Indian religion. (Executive Order No. 13007, 1996). Through consultation efforts, Valles Caldera and Pueblo Parks Fire is aware that the entire landscape of Valles Caldera National Preserve is of religious, spiritual, and ceremonial importance to numerous Indian tribes and peoples, with specific importance placed on sacred sites. Although fire management actions and activities (e.g., fire suppression, prescribed fire, allowing naturally ignited fire to burn, thinning operations) may be implemented throughout Valles Caldera, conservation and protection measures, performance requirements, best management practices, and mitigations will preserve the physical integrity of scared sites. Further, the implementation of a fire management plan at Valles Caldera will not propose restrictions of access by Indian tribes to sacred sites. Therefore, Indian Trust Resources and Sacred Sites were dismissed from further analysis.

3. **Water Resources: Wetlands**
   Wetlands and wet meadows occur throughout Valles Caldera's lowland valleys, commonly adjacent to perennial streams in valley bottoms, and along seeps, springs, and creeks in uplands. These communities cover approximately 6,900 acres in the park (Muldavin et al., 2006). Although wetlands can be adversely impacted by post fire erosion and flooding (described in section 3.8, Soil Resources and Geological Processes), they are often spared the acute adverse impacts of even the most intense wildfire. Due to high soil and fuel moisture content, wetlands burn infrequently and can actually serve as firebreaks (Everett et al., 2003). Charcoal deposits in Alamo Bog indicate surface fires historically spread through the wetland during dry years prior to 20th century fire suppression efforts (Allen et al., 2008). However, impacts under a natural fire regime would have been minor and beneficial. Implementation of a fire management plan at Valles Caldera would have negligible impacts on wetlands. Therefore, this impact topic is dismissed from further analysis.

4. **Environmental Justice**
   The Environmental Protection Agency defines Environmental Justice as, "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations*, requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing whether their programs and policies have disproportionate environmental or health effects on minorities and low-income populations and communities. Implementation of a fire management plan at Valles Caldera would not have disproportionate environmental or health effects on minorities or low-income populations or communities; therefore, environmental justice has been dismissed as an impact topic.

5. **Socioeconomic Environment**
   The National Environmental Policy Act requires consideration of impacts to the "human environment," including economic, social, and demographic elements in the affected area. Although there may be some impacts, such as increased employment for firefighters (beneficial) and short-term closures (negative) of Valles Caldera, implementation of a fire management plan is not expected to have measurable impacts on

the population, income, or employment base of neighboring communities. Therefore, this impact topic is dismissed from further analysis.

6. **Lightscapes**
Natural lightscapes are the resources and values that exist without artificial light sources at nighttime, such as the starry sky and nocturnal wildlife habitat. Lightscapes may also be essential to the historical character of a location. Implementation of a fire management plan at Valles Caldera does not propose the use of any artificial light sources. Fires may burn overnight causing impacts to lightscapes, but these effects are anticipated to be temporary and negligible.

7. **Soundscapes**
A soundscape is the acoustic environment of an area; each national park has a unique soundscape. Valles Caldera's soundscapes may be impacted by implementation of a fire management plan due to periodic and short-term noise from mechanical equipment, fire engines, and possible use of heavy machinery and helicopters. Use of this equipment would be temporary, infrequent, and dispersed over different areas in Valles Caldera at different times, and therefore would not substantially interfere with the character of the natural soundscape. This topic was dismissed from further analysis.

Appendix C. Minimum Impact Strategy and Tactics for Valles Caldera National Preserve

NATIONAL PARK SERVICE WILDLAND FIRE MANAGEMENT REFERENCE MANUAL 18, Chapter 2, Managing Wildland Fire, Exhibit 1

MINIMUM IMPACT STRATEGY AND TACTICS (As adjusted for Valles Caldera National Preserve)

The change from fire control to fire management has added a new perspective to the roles of fire managers and firefighters. Traditional thinking that "the only safe fire is a fire without a trace of smoke" is no longer valid. Fire management now means managing fire "with time" as opposed to "against time." The objective of putting the fire dead out by a certain time has been replaced by the need to make unique decisions with each fire start to consider the land, resource, and incident objectives, and to decide management actions that result in minimum cost and minimum resource damage while considering firefighter and public safety.
This change in thinking and way of doing business involves not just firefighters—it involves all levels of management. Fire management requires the fire manager and firefighter to select management tactics commensurate with the fire's existing or potential behavior while causing the least possible impact on the resource being protected. The term used to describe these tactics is Minimum Impact Strategy and Tactics, commonly called MIST. Simply put, MIST is a "do least damage" philosophy.

MIST is not intended to represent a separate or distinct classification of firefighting tactics but rather a framework for identifying ways to manage a wildfire while minimizing the long-term effects of the management action. MIST is the concept of using the minimum tool to accomplish the task safely and effectively. MIST should be considered for application on all fires in all types of land management areas.

While MIST emphasizes managing wildfire with the least impact to the land, actual fire conditions and good judgment will dictate the actions taken. Consider what is necessary to halt fire spread and containment within the fire line or designated perimeter boundary while safely managing the incident.

Use of MIST must not compromise firefighter safety or the effectiveness of management efforts. Safety zones and escape routes must continue to be a factor in determining fire line location.

Effective minimum impact fire management techniques originate with instructions that are understandable, stated in measurable terms, and communicated both orally and in writing. Once the techniques have been implemented, on-the-ground monitoring helps ensure that minimum impact objectives are being met. Evaluating the tactics both during and after implementation furthers the understanding and achievement of good land stewardship during fire management activities.

GUIDELINES
The intent of this guide is to serve as a checklist for all fire management personnel.

INCIDENT MANAGEMENT CONSIDERATIONS
Fire managers and firefighters select tactics that have minimal impact on values-at-risk. These values are identified in approved land or resource management plans. Standards and guidelines are then tied to implementation practices that result from approved fire management plans. In implementing MIST, follow these recommendations:

- Emphasize firefighter and public safety (safety cannot be compromised)
- Evaluate management tactics during planning and strategy sessions to ensure they meet agency administrator objectives and MIST. Include the agency resource advisor and/or designated representative.
- Communicate MIST where applicable during briefings and implement during all phases of operations.
- Evaluate the feasibility of managing fire for achieving resource objectives in conjunction with MIST when appropriate.

RESPONSIBILITIES

Agency Administrator or Designee

- Ensures agency personnel are provided with appropriate MIST training and informational/educational materials at all levels.
- Communicates the land and fire management objectives to the incident commander.
- Ensures agency personnel are provided with appropriate MIST training and informational/educational materials at all levels.
- Communicates the land and fire management objectives to the incident commander.
- Periodically monitors the incident to ensure resource objectives are met.
- Participates in the incident debriefing and assists in the evaluation of performance related to MIST.

Incident Commander

- Communicates the land and fire management objectives to the general staff.
- Evaluates management tactics during planning and strategy sessions to see that they meet the agency administrator's objectives and MIST guidelines.
- Monitors operations to ensure MIST is implemented during line construction as well as during other resource-disturbing activities.
- Includes the agency resource advisor and/or local representative during planning, strategy, and debriefing sessions.

Resource Advisor

- Ensures that interpretation and implementation of Wildland Fire Decision Support System decisions and other oral or written line officer direction is adequately carried out.
- Participates in planning/strategy sessions and attends daily briefings to communicate resource concerns and management expectations.
- Reviews Incident Action Plans (IAP) and provides specific direction and guidelines as needed.
- Monitors on-the-ground applications of MIST.
- Provides assistance in updating decision support documentation when necessary.
- Participates in debriefing and assists in evaluation of performance related to MIST.

Planning Section

- Uses the information provided by the resource advisor to help assess whether management tactics are commensurate with land/resource and incident objectives.
- Ensures that instructions and specifications for MIST are communicated clearly in the IAP.
- Anticipates fire behavior and ensures all instructions can be implemented safely.

Logistics Section

- Ensures actions performed around Incident Command Posts (ICP), staging areas, camps, helibases, helispots, drop points, etc. result in minimum impact on the environment.

Operations Section

- Evaluates MIST objectives to incorporate into daily operations and the IAP.
- Collaborates with Resource Advisers and Safety Officer to ensure that MIST applications do not compromise firefighter safety.
- Monitors effectiveness of management tactics in minimizing impacts to resources and recommends necessary changes during planning/strategy sessions.
- Communicates MIST to division supervisors and air operations/support during each operational period briefing. Explains expectations for instructions listed in the IAP.
- Participates in incident debriefing and assists in evaluation of performance related to MIST.

Division/Group Supervisor and Strike Team/Task Force Leader

- Communicates MIST objectives and tactics to single resource bosses.
- Recommends specific tasks to divisions to implement MIST.
- Monitors the effectiveness of management tactics in minimizing impacts to resources and recommends necessary changes to the operations section chief.

Single Resource Bosses

- Communicates MIST objectives to crew members.
- Monitors work to ensure that crews are adhering to MIST guidelines and specific incident objectives.
- Provides feedback to supervisor on implementation of MIST.

IMPLEMENTATION

Keep this question in mind: What creates the greater impact, the fire management effort, or the fire?

Safety

- Apply principles of Lookouts, Communications, Escape Routes, and Safety Zones (LCES) to all planned actions.
- Constantly review and apply the "18 Watch-Out Situations" and "10 Standard Fire Orders."
- Be particularly cautious about the following:
    - Burning snags allowed to burn.
    - Burning or partially burned live and dead trees.
    - Unburned fuel between you and the fire
- Designate Escape Routes and Safety Zones.
    - In any situation, the best escape routes and safety zones are those that already exist. Identifying natural openings, existing roads and trails, and taking advantage of "safe black" will always be a preferred tactic compatible with MIST. If safety zones must be created, follow guidelines similar to those for helispot construction.
    - Constructed escape routes and safety zones in heavier fuels will have a greater impact, be more time consuming and labor intensive, and ultimately will be less safe.

General Considerations

- Consider the potential for introduction of noxious weeds and mitigate by removing weed seed from vehicles, mechanized equipment, personal gear, cargo nets, etc.
- Consider impacts to riparian areas when locating water handling operations.
    - Ensure fish screens are used on pumps when drafting water.
    - Use longer draft hoses to place pumps out of sensitive riparian areas.
    - Plan travel routes for filling bladder bags to avoid sensitive riparian areas.
- Ensure adequate spill containment at fuel transfer sites and pump locations. Stage spill containment kits at the incident.
- Integrate cultural resource management with park fire management operations. Advance planning, cooperation, and coordination are key elements in ensuring that cultural resources are fully considered when planning and implementing wildland and structural fire-related activities.

Fire Lining Phase

- Select tactics, tools, and equipment that have the least impact on the environment.
- Give serious consideration to the use of water or foam as a fire lining tactic.
- Use alternative mechanized equipment such as excavators and rubber-tired skidders rather than bulldozers when constructing mechanical line.
- Utilize firing techniques and/or allow fire to burn to natural barriers and existing roads and trails.
- Monitor and patrol fire lines to ensure continued effectiveness.

Surface and Ground Fuels

- Use cold trail, wet line, or a combination when appropriate. If a constructed fire line is necessary, use minimum width and depth to stop fire spread.
- Consider the use of fire line explosives (FLE) for line construction and snag falling to create more natural-appearing fire lines and stumps.
- Burn out and use low impact tools like swatters and gunny sacks.
- Minimize bucking to establish fire lines. It is preferable to move or roll downed material out of the intended constructed fire line area. If moving or rolling out is not possible, or the downed log/bole is already on fire, build line around it and let the material be consumed.

Aerial Fuels (brush, trees, and snags)

- If fuels are adjacent to the fire line, limb only enough to prevent additional fire spread.
- If fuels are inside the fire line, remove or limb only those fuels which would have potential to spread fire outside the fire line.
- Cut brush or small trees necessary for fire line construction flush to the ground.
- Follow these guidelines for trees, burned trees, and snags:
    - Minimize cutting of trees, burned trees, and snags.
    - Do not cut live trees unless it is determined they will cause fire spread across the fire line or seriously endanger workers. Cut stumps flush with the ground.
    - Scrape around tree bases near the fire line if the base is hot and likely to cause fire spread.
    - Identify hazard trees with flagging, glow-sticks, or a lookout.
- Follow these guidelines when using indirect attack
    - Do not fall snags on the intended unburned side of the constructed fire line unless they are an obvious safety hazard to crews.
    - Fall only those snags on the intended burn-out side of the line that would reach the fire line should they burn and fall over.

Mop-up Phase

- Consider using “hot-spot” detection devices along the perimeter (aerial or hand-held).
- Use extensive cold trailing to detect hot areas.
- Cold trail charred logs near fire line. Do minimal scraping or tool scarring. Restrict spading to hot areas near the fire line.
- Minimize bucking of logs to check for hot spots or extinguish fire. It is preferable to roll the logs and extinguish the fire.
- When the ground is cool, return logs to their original position after checking.
- Refrain from piling. Burned/partially burned fuels that were moved should be arranged in natural positions as much as possible.
- Consider allowing larger logs near the fire line to burn out instead of bucking into manageable lengths. Use a lever, etc., to move large logs.
- Use gravity socks in stream sources and/or a combination of water blivets and fold-a-tanks to minimize impacts to streams.
- Avoid using rehabilitated fire lines as travel corridors whenever possible because of potential soil compaction and possible detrimental impacts to rehabilitation work.
- Avoid use of non-native materials for sediment traps in streams.
- Remove or limb only those aerial fuels (brush, small trees, and limbs) which if ignited have the potential to spread the fire outside the fire line.
- Follow these guidelines regarding burning trees and snags:
    - Be particularly cautious when working near snags (ensure adequate safety measures are communicated).
    - The first consideration is to allow a burning tree/snag to burn itself out or down.
    - Identify hazard trees with flagging, glow-sticks, or a lookout.
    - If there is a serious threat of spreading firebrands, extinguish them with water or dirt.

    - Consider felling by blasting, if available.

Aviation Management

- Minimize the impacts of air operations by incorporating MIST in conjunction with the standard aviation risk assessment process.
- Keep in mind these possible aviation related impacts:
    - Damage to soils and vegetation resulting from heavy vehicle traffic, noxious weed transport, and/or extensive modification of landing sites.
    - Impacts to soil, fish and wildlife habitat, and water quality from hazardous material spills.
    - Chemical contamination from use of retardant and foam agents
    - Biological contamination to water sources, e.g., whirling disease
    - Safety and noise issues associated with operations in proximity to populated areas, livestock interests, urban interface, and incident camps and staging areas.
    - Balance aircraft size and efficiency against the impacts of helispot construction.
    - Use natural openings as much as possible. If tree felling is necessary, avoid high visitor use locations unless the modifications can be rehabilitated. Fall, buck, and limb only what is necessary to achieve a safe and practical operating space.
- Helispot Planning
    - When planning for helispots, determine the primary function of each helispot, e.g., crew transport or logistical support.
    - Consider using a long-line remote hook in lieu of constructing a helispot.
    - Consult resource advisors in the selection and construction of helispots during incident planning.
    - Estimate the amount and type of use a helispot will receive and adapt features as needed.
- Retardant, Foam, and Water Bucket Use
    - Also refer to Suppression Chemicals & Delivery Systems Chapter in the Interagency Standards for Fire and Fire Aviation Operations (commonly referred to as the Red Book)
    - Assess risks to sensitive watersheds from chemical retardants and foam. Communicate specific drop zones to air attack and pilots, including areas to be avoided.
    - Weigh use of retardant with the probability of success by unsupported ground force. Retardant may be considered for sensitive areas when benefits will exceed the overall impact. This decision must consider values-at-risk and consequences of expanded fire response and impact on the land.
    - Consider biological and/or chemical contamination impacts when transporting water.
    - Replace limited water sources expended during aerial fire management efforts. Consult resource advisors prior to extended water use beyond initial response.

Logistics, Camp Sites, and Leave No Trace Conduct

- Minimize camping, cooking, and human waste impacts on natural and cultural resources and present and future visitors.
- Provide portable toilets at areas where crews are staged or camping.
- Good campsites are found, not made. If existing campsites are not available, select campsites which are not likely to be observed by visitors.
- Select impact-resistant sites such as those with rocky or sandy soil or openings within heavy timber. Avoid camping in meadows and along streams, rivers, or lakeshores.
- When there is a small group, try to disperse use. In the case of larger camps, concentrate, mitigate, and rehabilitate.
- Lay out camp components carefully from the start. Define cooking, sleeping, latrine, and supply areas. Cooking and supply areas tend to receive the most impact so site them on the most durable ground available.
- Prepare sleeping areas with minimal disturbance to vegetation and ground.
- Follow the following guidelines for personal sanitation:
    - Designate a common area for personnel to wash up. Provide fresh water and biodegradable soap.
    - Do not introduce soap, shampoo, or other chemicals into waterways.
    - Dispose of wastewater at least 200 feet from water sources.

    - Locate toilet sites a minimum of 200 feet from water sources. Dig holes 6 to 8 inches deep.
    - If more than one crew is camped at a site, strongly consider portable toilets, and remove waste. If portable toilets are not an option, consider digging a long, shallow latrine, 6-8" deep and as long as necessary. Do not dig a deep hole for human waste as it significantly retards decomposition.
- Store food so that it is away from camp, not accessible to wildlife, and in animal-resistant containers.
- Do not let garbage and food scraps accumulate in camp. These and other items should be stored in animal-proof containers.
- All trash, litter and leftover food should be packed out.
- Monitor travel routes for damage and mitigate by dispersing travel on alternate routes or by concentrating travel on one route and rehabilitating the route when it is no longer being used.
- If a campfire is built, leave no trace of it. Use an existing fire ring if one exists where available. Do not build a rock fire ring. Use dead and down wood no larger than your wrist for the fire and scatter any unused firewood. Do not burn plastics, metal, or other trash.
- Before leaving an area used for camping, cooking, or staging equipment, minimize any sign that your crew was there. Consider replacing leaf litter or other organic material to naturalize the site and encourage recovery. Impacts to a site that occur in as little as a few nights can take decades to recover.

Restoration and Rehabilitation

Fire Lines

- After fire spread has stopped and lines are secured, fill in deep and wide fire lines and cup trenches. Obliterate any berms.
- Ensure stumps are cut flush with the ground. Camouflage cut stumps by flush-cutting, chopping, covering, or using FLE to create more natural appearing stumps.
- Scatter any trees or large brush cut during fire line construction to create a natural appearance.
- Discourage the use of newly created fire lines and trails by blocking them with brush, limbs, poles, and logs in a naturally appearing arrangement.
- Use water bars to prevent erosion or use woody material to act as sediment dams.
- Consider maximum water bar spacing for erosion control; however, take advantage of natural slope breaks, grade dips, natural drainage features and diversions.

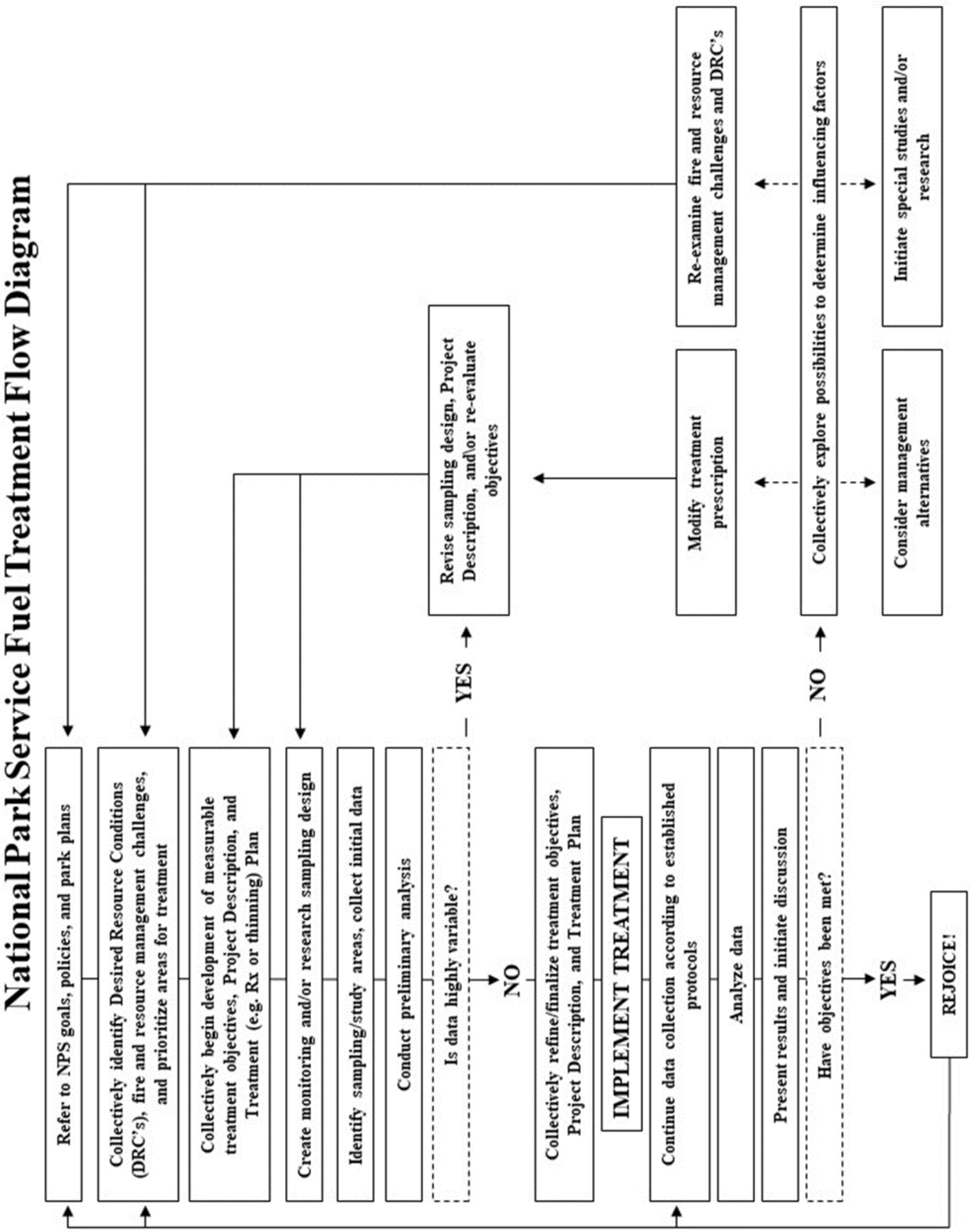
Camps

- Restore campsites to natural conditions prior to departure.
- Scatter fire rings and ash from fires, cover fire ring with soil, and blend the area with natural cover.
- Pack out all garbage - including any leftover food.

General Guidelines

- Remove all signs of human activity.
- Restore helicopter landing sites.
- Fill in and cover latrine sites if used.
- Walk through adjacent undisturbed areas and look at your rehabilitation efforts to determine your success at returning the area to as natural a state as possible.

Appendix D. National Park Service Fuel Treatment Flow Diagram (Adaptive Management)



Appendix E. Conservation and Protection Measures, Performance Requirements, Best Management Practices, and Mitigations

Air Quality

New Mexico Environment Department's (NMED) Air Quality Bureau (AQB) administers New Mexico's Smoke Management Program (SMP). The SMP meets the requirements of the Clean Air Act and Regional Haze Rule (40 CFR 51.309) and enforces New Mexico's Smoke Management Regulation (20.2.65 NMAC) and Open Burning Regulation (20.2.60 NMAC). As such, management of wildfires and prescribed fires at Valles Caldera will adhere to requirements of New Mexico's Smoke Management Regulation. Primary elements of New Mexico's SMP and Smoke Management Regulation include considering alternatives to burning; using emission reduction techniques; evaluating smoke dispersion; monitoring air quality; notifying the public; obtaining burn authorizations; and tracking fire activity (NMED, 2005).

Wildfire Suppression

- Submit wildfire activity tracking form to the AQB for fires greater than 100 acres within six weeks after firefighting activity is completed, or by November 1st, whichever happens first.
- Notify the public, via press releases, for suppression wildfires that exceed 100 acres.
- Consider visual monitoring of smoke impacts and/or instrument monitoring of air quality on large or long duration wildfires.
- Consider assigning an Air Resource Advisor for large or long duration wildfires.

Naturally Ignited (Lightning) Fire

- Register the naturally ignited fire with the NMED Smoke Management System if the fire is greater than 10 acres and notify the AQB on a daily basis through the SMP notification form or form ICS 209.
- Submit wildfire activity tracking form to AQB within two weeks following the completion of the burn project.
- Implement emission reduction techniques when possible and, if used, document them on the registration form and/or tracking form.
- Monitor and document visual impacts of smoke and keep records for one year.
- Consider instrument monitoring of air quality on large or long duration fires.
- Consider assigning an Air Resource Advisor for large or long duration fires.
- Notify the appropriate authorities on the day of the decision to manage the naturally ignited fire for multiple objectives.
- Notify (via press releases) public populations within a 15-mile radius no later than one day following the decision to manage the naturally ignited fire for multiple objectives.
- Coordinate with the AQB and Santa Fe Interagency Zone partners to mitigate potential cumulative impacts of smoke.
- Consider implementing tactical firing actions during periods of better ventilation and dispersion.

Prescribed Fire

The following mitigations apply to prescribed fire projects greater than 10 acres in size, pile burns greater than 1,000 cubic feet of material per day, and projects estimated to produce greater than or equal to one-ton PM10 per day.

- Obtain a burn authorization from the AQB by registering the prescribed fire with the AQB a minimum of two weeks prior to ignition; notifying the AQB no later than 10:00 am one business day prior to ignition; ensuring smoke management education for all burners; and adhering to airshed cumulative effects assessments.
- Submit wildfire activity tracking form to AQB within two weeks following the completion of the burn project.
- Consider alternatives to burning and if not used, provide rationale on the registration form.
- Implement at least one emission reduction technique and document it on the registration from and on the tracking form. If no emission reduction technique can be used, consult with the AQB for a waiver.

- Evaluate smoke dispersion and ventilation category and conduct burning only under ventilation categories of “good” or better or request a waiver from the AQB.
- Conduct and document visual impacts of smoke. Consider instrument monitoring of air quality for projects with a downwind population within 15 miles, or within a 15-mile radius of a population if wind direction is not specified.
- Notify the local fire authority prior to igniting the burn.
- Notify (via press releases) public populations within a 15-mile radius or 15 miles downwind no earlier than 30 days prior and no later than two days in advance of ignitions.
- Coordinate with the AQB and Santa Fe Interagency Zone partners to mitigate potential cumulative impacts of smoke.
- Consider implementing tactical firing actions during periods of better ventilation and dispersion.
- Communicate with the AQB to resolve complaints about wildland fire operations and impacts.

Vegetation

Wildfire Suppression

- Avoid the spread of noxious weeds by inspecting and cleaning heavy equipment that will be used outside road corridors. Clean dirt and mud that could contain weed seeds, rhizomes, or other plant propagative parts prior to entering the park. Carefully wash the tracks, feet, tires, and undercarriage with special attention to axles, frame, cross members, motor mounts, underneath steps, running boards, and front bumper/brush guard assemblies (this does not include initial attack operations).
- Prioritize the use of water drops to suppress fires over the use of fire retardant after initial response. Retardant mix contains fertilizer that can cause a proliferation of noxious weeds. However, air tankers are usually preloaded with retardant and aircraft using water may not be available.

Naturally Ignited (Lightning) Fire

- Establish action points and site-specific mitigations for plant species of management concern or invasive plant populations.

Prescribed Fire

- Develop and implement site-specific mitigations for plant species of management concern in areas planned for prescribed fire.
- Develop and implement site-specific mitigations for streamside vegetation such as limitations for live fuel moisture content or “greenness” of riparian vegetation; ignition patterns to limit spread of fire in riparian areas; and buffers to keep fire outside of riparian areas.

Manual and Mechanical Thinning

- Include selection criteria (leave tree or cut tree) based on tree form, species, size, health, and forest structure in silvicultural prescriptions and contract specifications.
- Emphasize retention of large and old trees (based on characteristic bark and crown). Cut large trees only if their presence would negatively impact future health and vigor due to genetics or host status (poorly formed, fire intolerant, diseased, mistletoe-infected, insect infected, etc.); or the location presents a threat to facilities or public safety (hazard trees).
- Retain healthy limber pine (as “leave” trees) to ensure the greatest degree of genetic diversity is retained within the species.
- Avoid the spread of noxious weeds by implementing weed treatment prior to project implementation when the risk of spread is moderate or high; identifying the occurrence of noxious weeds within or near a project area during operational planning; establishing plant cover on all heavily disturbed areas such as decommissioned roads, landings, and main skid trails by seeding with locally sourced native plant seed, and/or placing fine and coarse slash material as mulch.
- Avoid the spread of noxious weeds by including equipment cleaning in contracts, agreements, and other operations plans; inspecting and cleaning heavy equipment that will be used outside road corridors; cleaning dirt and mud that could contain weed seeds, rhizomes, or other plant propagative parts prior to

entering the park; inspecting and washing (as-needed) other contract vehicles that will be frequently entering and exiting the project area.

Wildlife

- Implement surveys and document active bird nests prior to proposed fire management actions located within suitable nesting or breeding habitat for raptors and migratory birds.
- Implement appropriate buffers or other mitigation measures for active bird nests prior to fire management actions, based on species requirements and following consultation with New Mexico Department of Game and Fish and U.S. Fish and Wildlife Service.

Wildfire Suppression

- Avoid aerial fire-retardant application within a 300-foot buffer of waterways, wet meadows, and wetlands unless necessary for firefighter or public safety.

Prescribed Fire

- Use prescribed fire lighting techniques to minimize ignition and consumption of coarse woody debris and snags.
- Remove large concentrations of surface fuels surrounding snags when possible.
- Avoid prescribed fire actions during migratory bird nesting season, April 1 to August 15.

Manual and Mechanical Thinning

- Leave a portion of felled coniferous logs greater than 10 inches in diameter on the forest surface during thinning treatments.
- Leave existing logs greater than 10 inches in diameter on the forest surface regardless of decay stage.
- Avoid manual and mechanical thinning during migratory bird nesting season, April 1 to August 15.

Special Status Species

To be determined after consultation with US Fish and Wildlife Service and New Mexico Department of Game and Fish.

- Implement project-specific planning (e.g., prescribed burn and manual and mechanical thinning plans) with specificity and attention to unique features associated with each project area.
- Conduct threatened and endangered species consultation as needed as site-specific fire management actions are determined.
- Conduct threatened and endangered species consultation for all unplanned ignitions on an emergency basis.

Cultural Resources

Wildfire Suppression and Allowing Naturally Ignited (Lightning) Fires to Burn

- Conduct fire containment actions, such as breaking apart and scattering burning fuels and mixing hot embers and cool soil, outside of site boundaries.
- Conduct mop-up actions, such as creating piles of burning fuel (“bone-piling”) and felling snags, outside of site boundaries. Cut snags to fall away from site boundaries.
- Avoid all sites when staging vehicles, equipment, and fire personnel, allowing for parking and staging equipment within a road prism that passes through a site.
- Allow construction of fire containment line within sites only if line is constructed by hand along existing roadbeds or other previously disturbed areas or is monitored by an archaeologist familiar with the location of the features and artifacts within the site boundary.
- Solicit the advice of an archeologist and/or a qualified resource advisor, whenever possible, to aid in positioning crew camps, holding lines, spike camps, helispots, drop zones, and other fire suppression related activities away from culturally sensitive areas.

- Assign a qualified archeologist(s) and/or qualified resource advisor(s) to fire management teams to advise of known important cultural resources in areas where impacts of fire could be reduced or avoided through emergency fuel reduction.
- Solicit the advice of archeologists, cultural resource specialists, and/or other resource management staff regarding cultural resource issues and concerns to avoid impacts to cultural resources.
- Avoid application of fire retardant in areas with known archeological sites unless the fire directly threatens life or property. Use fire retardant only with Superintendent approval.
- Conduct emergency consultation with the New Mexico State Historic Preservation Office (SHPO) and affiliated Tribes during and throughout fire incidents, communicating completed, planned, and potential operational actions.
- Keep hard copy and digital archeological site location information confidential throughout fire incidents, sharing only with Incident Management Teams and overhead team members and controlling access to secure information.

Prescribed Fire

- Protect known cultural resources using mitigations as recommended by a qualified archeologist(s) and/or qualified resource advisor(s).
- Conduct intensive surveys in project areas that contain unsurveyed tracts of land on slopes less than 30 degrees; assess previously inventoried areas for the presence of historic properties through examination of cultural resource databases.
- Evaluate and reduce hazardous fuels on known cultural resources through inspection by an archeologist and a prescribed fire specialist (or equivalent).
- Consult with Native American Tribes and Pueblos regarding fire management planning and projects to identify resources of concern, issues, and appropriate treatment actions.
- Consider the needs of cultural practitioners to access and use traditional resources in traditional use areas.
- Consult with the New Mexico SHPO and other appropriate parties in accordance with 36 CFR 800.6 during project planning to avoid adverse effects; if avoidance or resolution cannot be attained, or if SHPO objects to a finding of no adverse effect, partial prescribed fire or thinning actions in the analysis area may be rescinded to resolve the adverse effects.
- Allow prescribe-burning in all sites that lack combustible cultural materials where the fuel load, temperatures, and durations of heating are not expected to damage non-combustible archaeological remains.
- Conduct fire containment actions, such as breaking apart and scattering burning fuels and mixing hot embers and cool soil, outside of site boundaries.
- Conduct mop-up actions, such as creating piles of burning fuel (“bone-piling”) and felling snags, outside of site boundaries. Cut snags to fall away from site boundaries.
- Avoid all sites when staging vehicles, equipment, and fire personnel, allowing for parking and staging equipment within a road prism that passes through a site.
- Ensure an archaeologist and/or qualified resource advisor is present to monitor prescribed burns.
- Allow construction of fire containment line within sites only if line is constructed by hand along existing roadbeds or other previously disturbed areas or is monitored by an archaeologist familiar with the location of the features and artifacts within the site boundary.
- Do not place slash and wood piles within site boundaries; avoid pile burning in all sites.

Manual and Mechanical Thinning

- Avoid archaeological sites during mechanical thinning operations unless action-specific compliance has been conducted; small scale mechanized equipment (e.g., rubber-tracked skid steer) may be acceptable inside sites under specific pre-determined conditions.
- Allow manual thinning within site boundaries if cutting will be accomplished using hand tools, such as axe and chain saws.
- Utilize existing logging roads and skid trails rather than constructing new trails; if permission is given to construct new ones, do not construct them within site boundaries.

- Fell trees away from archaeological features.
- Do not deposit thinning materials, including slash and large and small debris (such as chips), within site boundaries.
- Do not deck logs within site boundaries; use only previously established decking and landing areas outside of sites or consult with resource specialists before creating new landings (outside of sites).
- Use slash for erosion control only outside of site boundaries.
- Carry thinned materials out of sites by hand and do not drag materials within sites or across site boundaries.
- Solicit an archeologist or cultural resource specialist to clearly mark sites so operational crews can avoid dragging and/or placing slash, wood, and other debris in or across sites.
- Do not cut mature aspen trees; protect historic aspen carvings.

Soil Resources and Geological Processes

- Reduce soil compaction and erosion by limiting vehicles and heavy equipment to hard surfaces.
- Do not operate heavy equipment on slopes greater than 30 percent.
- Implement erosion control around prescribed fire and thinning treatments when necessary.

Wildfire Suppression

- Implement an approved rehabilitation plan following wildfires to reduce impacts to soil resources.

Naturally Ignited (Lightning) Fire and Prescribed Fire

- Include prescription parameters that encourage low- to moderate-intensity fire with a mosaic pattern of burned and unburned areas to limit consumption of duff and prevent soil hydrophobicity.

Manual and Mechanical Thinning

- Move or remove thinned materials by elevating off the ground rather than dragging or skidding.

Water Resources

Wildfire Suppression

- Limit retardant drops, bulldozer, and heavy equipment over wetland and riverine areas.
- Ensure proper fuel spill containment protections are followed for any small engine use near waterways.

Naturally Ignited (Lightning) Fire and Prescribed Fire

- Minimize the proportion of steep slopes (> 30%) that are burned within a watershed to minimize sediment loading.
- Avoid allowing a naturally ignited fire to burn in a continuous pattern up both sides of the vertical gradient of a watershed.

Manual and Mechanical Thinning

- Conduct manual and mechanical thinning actions at least 200 feet away from streams and rivers when possible.

Human Health and Safety

- Coordinate access, ingress, and egress for all fire management actions and activities with Valles Caldera Law Enforcement to minimize impacts to public health and safety.
- Implement area closures during planned and unplanned fire events and thinning operations to ensure human health and safety.
- Consider and investigate impacts to human safety (including noise issues) in all fire management operations (e.g., aircraft, incident camps, staging areas) near populated areas, livestock, and wildland urban interface.
- Refer to the Air Quality section for further mitigations regarding air quality.

Visitor Use, Experience, and Recreation

- Provide timely and accurate information to visitors, neighbors, and the public including responses to unplanned fire, fire suppression actions, situational updates, fire danger ratings, fire restrictions, smoke, closures, and other impacts.
- Limit fire management actions on holidays or during special events, when possible, to avoid adversely impacting visitor use, experience, and recreation.

Viewsheds

- Place monitoring and research instrumentation (e.g., weather stations), vehicles, and equipment in locations that would minimize impacts to viewsheds.
- Smooth the edges of treated and untreated areas to avoid abrupt changes and to preserve the visual connectivity in viewsheds.
- Limit stump height of cut trees to less than six inches near areas of high visitation.
- Provide information to the public to explain expected visual impacts from prescribed fire.

Appendix F. American Indian Tribes Traditionally Associated with Valles Caldera National Preserve

Apache Tribe of Oklahoma
Cheyenne and Arapaho Tribes, Oklahoma
Comanche Nation, Oklahoma
Fort Sill Apache Tribe of Oklahoma
Hopi Tribe of Arizona
Jicarilla Apache Nation, New Mexico
Kewa Pueblo, New Mexico
Kiowa Indian Tribe of Oklahoma
Mescalero Apache Tribe of the Mescalero Reservation, New Mexico
Navajo Nation, Arizona, New Mexico, and Utah
Ohkay Owingeh, New Mexico
Pawnee Nation of Oklahoma
Pueblo of Acoma, New Mexico
Pueblo of Cochiti, New Mexico
Pueblo of Isleta, New Mexico
Pueblo of Jemez, New Mexico
Pueblo of Laguna, New Mexico
Pueblo of Nambe, New Mexico
Pueblo of Picuris, New Mexico
Pueblo of Pojoaque, New Mexico
Pueblo of San Felipe, New Mexico
Pueblo of San Ildefonso, New Mexico
Pueblo of Sandia, New Mexico
Pueblo of Santa Ana, New Mexico
Pueblo of Santa Clara, New Mexico
Pueblo of Taos, New Mexico
Pueblo of Tesuque, New Mexico
Pueblo of Zia, New Mexico
San Carlos Apache Tribe of the San Carlos Reservation, Arizona
Southern Ute Indian Tribe of the Southern Ute Reservation, Colorado
Standing Rock Sioux Tribe of North and South Dakota
Tonto Apache Tribe of Arizona
Ute Indian Tribe of the Uintah and Ouray Reservation, Utah
Ute Mountain Tribe of the Ute Mountain Reservation, Colorado, New Mexico, and Utah
White Mountain Apache Tribe of the Fort Apache Reservation, Arizona
Wichita and Affiliated Tribes
Ysleta Del Sur Pueblo of Texas
Zuni Tribe of the Zuni Reservation, New Mexico

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Appendix H. Glossary

Adaptive capacity: The ability of species to cope with or adjust to climatic changes; a key component of measuring vulnerability.

Adaptive management: A type of natural resource management in which decisions are made as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices.

Agency Administrator: Managing officer of an agency, division thereof, or jurisdiction having statutory responsibility for incident mitigation and management. Examples: NPS Park Superintendent, BIA Agency Superintendent, USFS Forest Supervisor, BLM District Manager, FWS Refuge Manager, State Forest Officer, Fire Chief, Police Chief.

Alfisol (soil): One of the 12 orders of soil taxonomy. Alfisols occur in semiarid to moist areas. These soils result from weathering processes that leach clay minerals and other constituents out of the surface layer and into the subsoil, where they can hold and supply moisture and nutrients to plants. They formed primarily under forest or mixed vegetation cover and are productive for most crops. Alfisols make up about 10% of the world's ice-free land surface.

Alluvial (soil): Made up of or found in the materials that are left by the water of rivers, floods, etc.

Altered ecosystem: An ecosystem that has been modified in structure and function by human activity or other disturbance.

Andesite: Any member of a large family of rocks that occur in most of the world's volcanic areas. Andesites occur mainly as surface deposits. Many of the deposits are not normal lava flows but rather mudflows, tuffs, and other fragmental rocks.

Andisol (soil): One of the 12 orders of soil taxonomy. Andisols form from weathering processes that generate minerals with little orderly crystalline structure. These minerals can result in an unusually high water- and nutrient-holding capacity. As a group, Andisols tend to be highly productive soils. They include weakly weathered soils with much volcanic glass as well as more strongly weathered soils. They are common in cool areas with moderate to high precipitation, especially those areas associated with volcanic materials. Andisols make up about 1% of the world's ice-free land surface.

Aridification: A transition of the climate and hydrology of a region to drier conditions, typically representing a more permanent change.

Auditory: Relating to hearing or the ears.

Bald and Golden Eagle Protection Act (BGEPA) of 1940: The BGEPA of 1940 prohibits the "taking" (live or dead) of bald eagles or golden eagles, including their parts (as well as feathers), nests, or eggs, without a permit issued by the Secretary of the Interior. The BGEPA also prohibits disturbing or agitating a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. The act also defines criminal penalties for take, disturbance, or agitation of bald and golden eagles.

Basalt: Extrusive (rock formed from magma ejected at Earth's surface) volcanic rock that is low in silica content, dark in color, and comparatively rich in iron and magnesium. Some basalts are quite glassy, and many are very fine-grained and compact. Basaltic lavas are frequently spongy or pumiceous.

Best Management Practices (BMPs): Practices that apply the most current means and technologies available to not only comply with mandatory environmental regulations, but also maintain a superior level of environmental performance.

Biological Assessment (BA): The information prepared by or under the direction of the Federal agency concerning listed and proposed species and designated and proposed critical habitat that may be present in the action area and the evaluation of potential effects of the action on such species and habitat.

Biological Opinion (BO): The document that states the opinion of the U.S. Fish and Wildlife Service as to whether the Federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

Biological resource: Genetic resources, organisms, populations, substances, and objects in the environment derived from living organisms.

Blackline: Preburning of fuels adjacent to a control line before igniting a prescribed burn. Blacklining is usually done in heavy fuels adjacent to a control line during periods of low fire danger to reduce heat on holding crews and lessen chances for spotting across control line. In fire suppression, a blackline denotes a condition where there is no unburned material between the fireline and the fire edge.

Broadcast burning: Prescribed burning activity where fire is applied generally to most or all of an area within well-defined boundaries for reduction of fuel hazard, as a resource management treatment, or both.

Burn out: Setting fire inside a control line to consume fuel between the edge of the fire and the control line.

Carbon sequestration: The long-term storage of carbon in plants, soils, geologic formations, and the ocean.

Coarse woody debris: Pieces of woody material derived from tree limbs, boles, and roots in various stages of decay, having a diameter of at least three inches.

Code of Federal Regulations (CFR): The official legal print publication containing the codification of the general and permanent rules published in the Federal Register by the departments and agencies of the Federal Government.

Coevolution: The process of reciprocal evolutionary change that occurs between pairs of species or among groups of species as they interact with one another.

Cold trailing: A method of controlling a partly dead fire edge by carefully inspecting and feeling with the hand for heat to detect any fire, digging out every live spot, and trenching any live edge.

Colluvial (soil): Develops from recently deposited colluvium (soil and debris that accumulate at the base of a slope by mass wasting or sheet erosion.)

Confine/confinement: The strategy employed in appropriate management responses where a fire perimeter is managed by a combination of direct and indirect actions and use of natural topographic features, fuel, and weather factors.

Control line: An inclusive term for all constructed or natural barriers and treated fire edges used to control a fire.

Council on Environmental Quality (CEQ): Coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives. The Council's Chair, who is appointed by the President with the advice and consent of the Senate, serves as the principal environmental policy adviser to the President. In addition, CEQ reports annually to the President on the state of the environment; oversees federal agency implementation of the environmental impact assessment process; and acts as a referee when agencies disagree over the adequacy of such assessments.

Crazing: The presence of fine, shallow, non-linear or latticed cracks on the surface of a specimen.

Critical habitat: Specific areas within the geographical area occupied by a species at the time of listing under the Endangered Species Act that contain physical or biological features essential to the conservation of the species.

Cultural resource: An aspect of a cultural system that is valued by or significantly representative of a culture or that contains significant information about a culture. A cultural resource may be a tangible entity or a cultural practice. Tangible cultural resources are categorized as districts, sites, buildings, structures, and objects for the National Register of Historic Places and as archeological resources, cultural landscapes, structures, museum objects, and ethnographic resources for National Park Service management purposes.

Dacite: Volcanic rock that may be considered a quartz-bearing variety of andesite. Dacite forms lava flows, dikes, and sometimes massive intrusions in the centers of old volcanoes.

Debris flow: A type of landslide and are sometimes referred to as mudslides, mudflows, lahars, or debris avalanche. Debris flows are fast-moving landslides that are particularly dangerous to life and property because they move quickly, destroy objects in their paths, and often strike without warning. They generally occur during periods of intense rainfall or rapid snowmelt and usually start on hillsides or mountains.

Defensible space: An area surrounding a structure that has vegetation characteristics that minimize the spread of wildland fire and allows for safely defending the structure against fire.

Denudation: The wearing away of the terrestrial surface by processes including weathering and erosion.

Disturbance: Any natural event that significantly alters the structure, composition, or dynamics of a natural community: e.g., floods, fires, and storms.

Duff: The layer of decomposing organic materials lying below the litter layer of freshly fallen twigs, needles, and leaves and immediately above the mineral soil.

Ecosystem resiliency: The ability of an ecosystem to maintain its normal patterns of nutrient cycling and biomass production after being subjected to damage by disturbance.

Ecosystem stewardship: The responsible use and protection of the natural environment through conservation and sustainable practices to enhance ecosystem resilience and human well-being.

Endangered species: Species listed under the Endangered Species Act of 1973 by either the U.S. Fish and Wildlife Service or the National Marine Fisheries Service; any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA): The ESA of 1973 is a U.S. federal law that establishes protections for fish, wildlife, and plants that are listed as threatened or endangered. The Department of the Interior's U.S. Fish and Wildlife Service (USFWS) and the Department of Commerce's National Marine Fisheries Service are the two federal agencies responsible for administering the ESA to protect and recover imperiled species and the ecosystems upon which they depend. USFWS is dedicated to the conservation and management of freshwater and terrestrial organisms including insects, fish, wildlife, plants, and natural habitats, and the National Marine Fisheries Service is mainly responsible for marine wildlife (e.g., fish, whales, turtles). The ESA defines threatened, endangered, or candidate species as follows:

Threatened: A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Species for which a final rule has been published in the Federal Register to list the species as threatened. Species is legally protected by the Endangered Species Act.
Endangered: A species in danger of extinction throughout all or a significant portion of its range. Species for which a final rule has been published in the Federal Register to list the species as endangered. Species is legally protected by the Endangered Species Act.
Candidate: A species for which the USFWS has sufficient information to propose that it be added to the list of endangered and threatened species, but the listing action has been precluded by other higher priority listing activities.

Environmental Screening Form (ESF): Used by the National Park Service prior to the implementation of a project to identify impacted areas, the scale and scope of the impacts, what additional evaluation may be needed, and what mitigation is appropriate for those impacts.

Extirpation (also known as 'local extinction'): Describes the situation in which a species or population no longer exists within a certain geographical location. Unlike extinction, whereby a species no longer exists anywhere, extirpation means that at least one other population of the species still persists in other areas.

Fauna: The vertebrate and invertebrate animals of an area or region.

Fine woody debris: Woody material less than 3 inches in diameter.

Fire-adapted (community): A human community that takes mitigation actions in order to live with wildfire without harm and without extensive wildfire suppression efforts.

Fire-adapted (organism): A species with traits that allow it to withstand flames and smoke, reproduce following a fire event, or take advantage of resources created by wildfire.

Fire behavior: The manner in which a fire reacts to the influences of fuel, weather, and topography; fire dependent plants and vegetation communities which have evolved adaptations such as a reliance on fire as a disturbance agent, protection as a species against the effects of wildland fire, or even a strengthening or enhancement by it.

Fire ecology: The study of the effects of fire on living organisms and their environment.

Fire effects: The physical, biological, and ecological impacts of fire on the environment.

Fire regime: Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects, in a given area or ecosystem. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval.

Fire return interval: The average time between fires in a given area.

Fire science: The study of fire and its related phenomena.

Fire-tolerant: Species of plants that can withstand a certain frequency and intensity of fire.

Firewise: A program of the National Fire Protection Association that teaches people how to adapt to living with wildfire and encourages neighbors to work together proactively to prevent losses.

Flora: All the plants that live in a particular area, time, period, or environment.

Forest stand: A delineated area of forest similar in structure and composition.

Forest thinning: Felling and removal of trees from the forest to reduce the likelihood of ignition or to lessen potential damage and resistance to fire control.

Four Winds Parks: The Four Winds Fire Group includes El Malpais National Monument, El Morro National Monument, Gila Cliff Dwellings National Monument, Petrified Forest National Park, Petroglyph National Monument, and Salinas Pueblo Missions National Monument.

Fracture (in obsidian): Fire fracture describes rapid fracture through the body of the obsidian or nodule that can look similar to intentional lithic reduction but that initiates from within the obsidian rather than at a margin or an edge from an externally applied force.

Fuel: Plants, both living and dead, and woody vegetative materials capable of burning.

Fuel break: A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled.

Genetic drift: A change in the gene pool of a small population that takes place strictly by chance.

Hand crew: A number of individuals that have been organized and trained and are supervised principally for operational assignments on an incident.

Heritage resources: a variety of natural and cultural resources valued by traditionally associated people; may include plant and animal communities, structures, and geographic features, each with their own special local names.

Historic range of variation: A means to define the boundaries of ecosystem behavior and patterns that have remained relatively consistent over long periods. Usually defined for centuries to millennia before the period of widespread human population increases and associated ecosystem changes that began in roughly the early to middle 1800s for many regions of western North America.

Hot spots: A particularly active part of a fire.

Hydrophobicity (soil): Soil water repellency. Hydrophobicity is a phenomenon that reduces the affinity of soils for water. It occurs when the soil is not completely wettable and is a reduction in the rate of wetting and retention of water in the soil caused by the presence of hydrophobic coatings on soil particles.

Inceptisol (soil): One of the 12 orders of soil taxonomy. Inceptisols are soils of semiarid to humid environments that generally exhibit only moderate degrees of soil weathering and development. Inceptisols have a wide range in characteristics and occur in a wide variety of climates. Inceptisols make up about 17% of the world’s ice-free land surface.

Incident Commander (IC): This position is responsible for overall management of the fire incident and reports to the Agency Administrator for the agency having incident jurisdiction. This position may have one or more deputies assigned from the same agency or from an assisting agency(s).

Incident Management Team (IMT): The incident commander and appropriate general and command staff personnel assigned to an incident.

Indigenous Knowledge: a body of observations, oral and written knowledge, innovations, practices, and beliefs developed by Tribes and Indigenous Peoples through interaction and experience with the environment. It is applied to phenomena across biological, physical, social, cultural, and spiritual systems. Indigenous Knowledge can be developed over millennia, continues to develop, and includes understanding based on evidence acquired through direct contact with the environment and long-term experiences, as well as extensive observations, lessons, and skills passed from generation to generation.

Interagency: Involving multiple Federal agencies, possibly including the National Park Service, Forest Service, Bureau of Land Management, Fish and Wildlife Service, National Marine Fisheries Service, Environmental Protection Agency, and/or other Federal agencies.

Invasive species: A non-native species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Jackpot burning: A modified form of broadcast slash burning in which the greater accumulations of slash are fired and the fire is confined to these spots. Sometimes called "spot burning."

Litter: The top layer of forest floor, composed of loose debris of dead sticks, branches, twigs, and recently fallen leaves or needles; little altered in structure by decomposition.

Lop and scatter: A method of forest treatment where thinned trees and other vegetation (slash) are manually lopped and limbed into smaller pieces and distributed across the site. Lop and scatter can increase surface fuel loading, however, benefits can include breaking up concentrations of fuel, reducing soil erosion, and retaining water and nutrients on-site.

Manual thinning: A method used to trim limb and fell trees and remove other vegetation using a chainsaw, crosscut saw, or axe.

Mechanical thinning: A method used to cut down trees and other vegetation using vehicles, equipment, and other specialized apparatus.

Mesic: Pertaining to conditions of moderate moisture or water supply; used of organisms occupying moist habitats.

Migratory Bird Treaty Act of 1918: The Migratory Bird Treaty Act (MBTA) of 1918 implements four international conservation treaties the U.S. entered with Canada, Mexico, Japan, and Russia. The MBTA ensures the protection of migratory birds (and their nests and eggs) and prohibits their take, including capturing, selling, trading, transport, and killing.

Minimum Impact Strategy and Tactics (MIST): A framework for identifying and applying strategies and tactics to manage wildland fire while minimizing long-term effects of management actions. The aim is to help identify the minimum tools to accomplish tasks safely and effectively and to meet suppression and resource objectives while having the least environmental, cultural, and social impacts.

Mitigation: avoidance of an impact through not taking an action or parts of an action; minimizing impacts through limiting the degree or magnitude of an action; rectifying impacts by repairing, rehabilitating, or restoring the affected environment; reduction or elimination of impacts by preservation and maintenance operations during the life of the action; and compensation for the impact by replacing or providing substitute resources or environments.

Monitor: The systematic process of observing, collecting, and recording of fire-related data, particularly regarding fuels, topography, weather, fire behavior, fire effects, smoke, and fire location. This may be done onsite from a nearby or distant vantage point, or off-site using a sensor or through remote sensing (aircraft or satellite).

Mutualistic: An association between organisms of two different species in which each benefit; mutualistic arrangements are most likely to develop between organisms with widely different living requirements.

National Environmental Policy Act of 1969 (NEPA): Requires federal agencies to prepare in-depth, objective analysis of a proposed action to determine the degree of its environmental impact on the natural and physical environment; alternatives and mitigation that reduce that impact; and the full and candid presentation of the analysis to, and involvement of, the interested and affected public.

Natural resource: Any biological, mineral, or aesthetic asset afforded by nature without human intervention that can be used for either material or immaterial benefit.

Naturally ignited fire: Wildfire caused directly or indirectly by lightning or other natural combustion.

Novel ecosystem: a system of abiotic, biotic, and social components that, by virtue of human influence, differ from those that prevailed historically, having a tendency to self-organize and manifest novel qualities without intensive human management.

Obsidian hydration dating: A method of computing archaeological ages based on measuring water absorption by obsidian artifacts. It is as method widely used in the western U.S.

Old-growth Forest: A forested area characterized by all components of mature forest from the reference period. These components include large, old trees, large snags, large down logs in various stages of decomposition, understory species, and cover.

Olfactory: The bodily structures that serve the sense of smell.

Planned fire: See Prescribed fire.

Point protection: A variety of suppression actions taken to protect a specific area from fire while not actively lining the entire fire perimeter, usually with tactics that contain progressive fire encroachment away from values at risk such as homes, communities, and areas of high resource value.

Prescribed fire: Any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met, prior to ignition.

Prescription: Measurable criteria that define conditions under which a prescribed fire may be ignited, guide selection of appropriate management responses, and indicate other required actions.

Proposed species: Any species of fish, wildlife, or plant that is proposed in the Federal Register to be listed under section 4 of the Endangered Species Act of 1973.

Pueblo: Describes both the permanent residential structures and the people living in these communities throughout the middle Rio Grande Valley. When the Spanish arrived in 1540, there were possibly more than 100 pueblos located along the Rio Grande Valley, from northern Taos Pueblo to southern Isleta Pueblo. Today there are 19 pueblos in New Mexico, each with its own government but sharing a common prehistory and culture.

Pueblo Parks Fire: The Pueblo Parks Fire Group includes Valles Caldera National Preserve, Bandelier National Monument, Fort Union National Monument, and Pecos National Historical Park. The group is served by a single Fire Management Program, stationed at Bandelier National Monument.

Record of Decision (ROD): An official document separate from, but associated, with a final environmental impact statement in which a deciding official identifies all alternatives, and specifies which were environmentally preferable, states the decision, and states whether all practicable means to avoid environmental harm from the alternative have been adopted, and if not, why not (40 CFR 1505.2)

Refugia: Areas that have not been exposed to great environmental changes and disturbances undergone by the region as a whole; refugia provide conditions suitable for survival of species that may be declining elsewhere.

Resilience: The ability of an ecological system to resist damage and recover from a disturbance.

Resin deposition: Secondary plant metabolites that vaporize during the combustion process; one of many combustion products resulting from wildland fires.

Resist-Accept-Direct (RAD): A framework of stewardship options ranging from 1) Resisting ecosystem transformations by focusing actions on maintaining current or historical ecosystem conditions, 2) Accepting ecosystem transformations by not intervening and accepting the ecosystem conditions that result, and 3) Directing ecosystem transformations toward a desired outcome by actively intervening to shape ecosystem change in the direction of new conditions. The RAD framework provides managers and decision-makers a pathway to manage for change, not just persistence.

Resistance: The ability of a system or species to prevent disturbance, pests, and other impacts from having an effect on the system.

Resource advisor: A person who advises firefighting personnel on how to protect valued natural and cultural resources.

Retardant: A substance or chemical agent which reduces the flammability of combustibles.

Rhyolite: Extrusive (rock formed from magma ejected at Earth's surface) igneous rock that is the volcanic equivalent of granite (formed from magma within the Earth's crust). The rock may consist of well-developed, large, single crystals or of a microcrystalline or partly glassy matrix. Obsidian is a glassy rhyolite.

Rilling: Small intermittent watercourses with steep sides that are initiated by differential erosion caused by overland flow. Rill erosion is the process of dispersing, scouring, and transportation of soil during rill formation and development.

Savanna: A mixed woodland-grassland with widely spaced trees and an open canopy.

Section 106: A section of the National Historic Preservation Act (NHPA), 54 USC § 306108 which establishes a process for review of Federal undertakings and their effects on historic properties. The provision requires Federal agencies to consider the effects on historic properties of projects they carry out, assist, fund, permit, license, or approve. More specifically, Section 106 requires Federal agency heads to take into account effects of their proposed undertakings on historic properties (which are defined as properties eligible for listing or listed in the National Register of Historic Places) prior to the approval of the expenditure of any Federal funds on the undertaking or prior to the issuance of any license. Section 106 also requires Federal agency heads to provide the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment.

Sheen: The characteristic of a "gun-metal" appearance commonly observed on burned obsidian. This additive material is a coating or residue from combustion of fuels located near the obsidian object.

Slash: Debris resulting from such natural events as wind, fire, or snow breakage; or such human activities as road construction, logging, pruning, thinning, or brush cutting. It includes logs, chunks, bark, branches, stumps, and broken understory trees or brush.

Snag: A standing dead tree or part of a dead tree from which at least the leaves and smaller branches have fallen; often called a stub, if less than 20 feet tall.

Sooting: The carbon-based solid residue created by incomplete combustion of carbon-based fuels, resulting in smudging and blackening of the surface.

Species of Greatest Conservation Need (SGCN): The New Mexico Department of Game and Fish created a State Wildlife Action Plan to provide an assessment of New Mexico's wildlife and habitats. The focus of the plan is species designated as SGCN and their habitats, threats or constraints to both, and potential conservation actions to enhance both the species and their habitats. Criteria for designating a SGCN includes "populations that are declining, vulnerable, endemic, disjunct, or keystone. Definitions are as follows:

> **Declining**: Species that have experienced substantial long-term declines in habitat or numbers.
>
> **Vulnerable**: Species in which some aspect of their life history and ecology makes them disproportionately susceptible to decline within the next 10 years. Factors include, but are not limited to, concentration to small areas during migration or hibernation; low reproductive rates; susceptibility to disease; inability to respond to changing climate conditions; habitat loss; wildfire; and overexploitation for anthropogenic purposes.
>
> **Endemic**: Species that are limited to New Mexico.
>
> **Disjunct**: Species that have populations geographically isolated from other populations of the same species and are thereby disproportionately susceptible to local decline or extirpation.
>
> **Keystone**: Species that are crucial to the integrity and the functioning of their ecosystems. These species may represent more value to conservation of biological diversity than the size of their population or their distribution would suggest.

Spotting: Behavior of a fire producing sparks or embers that are carried by the wind and which start new fires beyond the zone of direct ignition by the main fire.

Succession: The natural, sequential change of species composition of a community in a given area.

Suppression: All work and activities connected with control and fire-extinguishing operations, beginning with discovery, and continuing until the fire is completely extinguished.

Threatened species: A federally listed, protected species that is likely to become an endangered species in all or a significant portion of its range.

Trophic cascade: An ecological phenomenon commonly triggered by the addition or removal of top predators and involving reciprocal changes in the relative populations of predator and prey through a food chain, which often results in dramatic changes in ecosystem structure and nutrient cycling.

Unplanned fire: Fire that is either naturally ignited or human caused/related.

Vegetative composition: All plant species found in a landscape, including trees, shrubs, forbs, and grasses.

Vegetative structure: The physical arrangement of vegetation within a community, stand, landscape, or ecological system.

Vesiculation: The formation of abundant and interconnected bubbles throughout the interior and at the surface of the glass object (obsidian) as a result of heating. The formation of bubbles often causes deformation (bloating) and an increase in object volume or size.

Visual: Relating to seeing or to the eyes.

Water balance: The equilibrium between evaporation and water uptake.

Watershed: The geographic area within which water drains into a particular river, stream, or body of water. A watershed includes both the land and the body of water into which the land drains.

Wildland fire management program: The mission of the National Park Service Wildland Fire Program is to manage wildland fire to protect the public, park communities, and infrastructure, conserve natural and cultural resources, and maintain and restore natural ecosystem processes.

Wildland Urban Interface (WUI): The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation.

Wildlife Conservation Act (WCA): The WCA of 1978 provides for protection and conservation of wildlife in the state of New Mexico. Species or subspecies of native amphibians, birds, crustaceans, fishes, mammals, mollusks, and reptiles native to New Mexico may be listed as threatened or endangered and protected under the WCA of 1978. The WCA defines threatened or endangered species as follows:

> **Threatened**: A species or subspecies that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in New Mexico.
>
> **Endangered:** A species or subspecies that is in jeopardy of extinction or extirpation from the state of New Mexico.

Xeric: Dry region or climate; tolerating or adapted to dry conditions. Dry soil moisture regime.

Zone protection: A variety of suppression actions taken to protect a specific area from fire while not actively lining the entire fire perimeter, usually with tactics that contain progressive fire encroachment away from values at risk such as homes, communities, and areas of high resource value.

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Appendix I. Acronyms

BAR: Burned Area Rehabilitation
BGEPA: Bald and Golden Eagle Protection Act
CEQ: Council on Environmental Quality
CFLRP: Collaborative Forest Landscape Restoration Program
CFR: Code of Federal Regulations
DOI: Department of the Interior
EA: Environmental Assessment
EIS: Environmental Impact Statement
EPA: Environmental Protection Agency
ES: Emergency stabilization
ESA: Endangered Species Act
FMP: Fire Management Plan
FMU: Fire Management Unit
IDT: Interdisciplinary Team
LSRP: Landscape Restoration and Stewardship Plan
MBTA: Migratory Bird Treaty Act
MIST: Minimum Impact Strategy and Tactics
NAAQS: National Ambient Air Quality Standards
NEPA: National Environmental Policy Act
NMED AQB: New Mexico Environment Department Air Quality Bureau
NPS: National Park Service
PCE: Primary Constituent Element
PIO: Public Information Officer
PM: Particulate matter
RAD: Resist-Accept-Direct Framework
RAWS: Remote Automated Weather Station
RM: Reference Manual
SGCN: Species of Greatest Conservation Need
SNOTEL: SNOwpackTELemetry network
SSS: Special status species
USFWS: United States Fish and Wildlife Service
WCA: Wildlife Conservation Act
WUI: Wildland Urban Interface