

Chapter Four: Affected Environment



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This chapter describes the existing environment of Lava Beds National Monument and the surrounding region. It is focused on monument resources, uses, facilities, and socioeconomic characteristics that have the potential to be affected by the General Management Plan alternatives.

Natural Resources

Air Quality

Lava Beds National Monument is located within California's Northeast Plateau air basin, an area of low population and relatively low air pollutant emissions.

The monument's 28,460 acres of wilderness is designated as a Class I airshed and the remaining monument acres are Class II. The Clean Air Act affords Class I areas extra protection against air pollution. NPS management policy protects both Class I and Class II areas equally against air pollution.

In order to fulfill these mandates the monument is committed to obtaining a better understanding of ambient air quality conditions and the sensitivity of monument resources to air pollution.

Presently Lava Beds operates two air quality monitoring stations, an IMPROVE (Interagency Monitoring of Protected Visual Environments) station monitoring aerosols, and a PM10 station (10 micron particulate detector). The PM10 was in use between 1994 and 2009 by the Siskiyou County (038) Air Pollution Control District and monitored concentrations of particulates over 10 microns for regulatory purposes. However, the program was cancelled in 2009 due to State of California budget cuts. During its run, the station detected conditions that exceeded state standards twice (1996 and 2002) and less stringent national standards once (1996). Both the 2002 and the 1996 events were caused by exceptional fire events and not representative of the ambient air quality of the basin. Neither event was recorded as a violation of state or federal regulation.

The IMPROVE monitoring station was installed in 2000 by the University of California, Davis Crocker Nuclear Lab Air Quality Group and monitors for concentrations of particulates of PM10, PM2.5, ammonium sulfate (NH₄SO₄), and ammonium nitrate (NH₄NO₃). Fine particulates of 2.5 microns or less disperse farther, reduce visibility more, and affect overall air quality more than larger particulates. This unit is not currently part of the 2002 California PM2.5 Monitoring Network nor is it used for regulatory purposes.



Great Purple Hairstreak, NPS Photo

The principal pollutants currently affecting the monument are ozone precursors (nitrogen oxides and volatile organic compounds from mobile sources) and particulates from unpaved road dust (e.g. Medicine Lake Road), construction, and agricultural activities. In addition to these

local sources, regional sources of air pollution include burning of agricultural fields and the burning of wood for heating.

Emissions from geothermal and combustion energy facilities are a growing concern. Wood-fired industrial boilers in the area emit nitrogen oxides and particulates and more of these combustion energy facilities are planned.

In November 2003, plans were approved for two geothermal power developments in the Medicine Lake Highlands, within approximately 5 miles of the monument. Since that time, the proposals have been subject to legal challenges and remain tied up in the federal courts. Geothermal development in the area could eventually be extensive, resulting in visible steam plumes, as well as significant sulfur dioxide, sulfuric acid mist, and nitrogen oxides emissions.

Soundscape

The soundscape is the total acoustic environment of an area. Both natural and human sounds may be desirable and appropriate in a soundscape, depending on the purposes and values of the park. For example, the sound of reenactment events at Gillems Camp may be appropriate and desirable, but not within Lava Beds National Monument's wilderness areas. The soundscape often varies in its character from day to night and from season to season and can be affected by changes in numbers of visitors who introduce human-caused sound into the environment. The soundscape of Lava Beds, including dripping water, scenery, silent caves, or wildlife, is a valuable resource that can easily be degraded or destroyed by inappropriate sounds or sound levels. As a result, the monument's soundscape requires careful management if it is to remain unimpaired for future generations.

The symphony of natural sounds within Lava Beds is an important natural resource and a critical component of the ecological communities the monument seeks to preserve. Understanding the role of sound and acoustics in a healthy ecosystem is critical to their effective management and protection. Birds, insects, mammals, and amphibians rely on complex communication networks to live and reproduce. In habitats where wildlife vocalizations signify mating calls, danger from predators, or territorial claims, hearing these sounds is important to animal reproduction and survival.

Given its remote location, the monument has relatively few noise intrusions. Activities that affect noise levels at the monument include vehicle traffic (including snowmobiles on the Modoc National Forest), air traffic, and agricultural activities. Traffic volumes at the monument are generally low. Occasionally, loud vehicles, such as motorcycles, disturb the monument's typically quiet setting. Unpaved roads such as Medicine Lake Road and the road through Petroglyph Point tend to generate higher traffic noise than the monument's paved roads.

Commercial air traffic infrequently affects the soundscape as the major north-south flight path for commercial traffic lies west of the monument. A small Air National Guard training base is located 40-miles from the monument. However, Air National Guard flight paths over the monument are rare.

The northern boundary of the monument and Petroglyph Point are more impacted by external noise. This area is sometimes affected by noise from agricultural equipment in the summer and fall. Trains can be heard at Petroglyph Point several times a day and in other areas in the eastern portions of the monument.

These types of issues are examined through research in acoustic ecology which is the study of sound in the relationships between organisms and their environment. Scientists also use bio-acoustics to determine the health of natural habitats. Scientists can discern details about animal populations and behavior by recording sounds in the wild. Such bio-acoustical recordings are used in a variety of ways, including bird censuses and bat echolocation studies.

Future efforts to manage soundscape within the monument include inventorying and monitoring the soundscape and implementing a "Soundscape Preservation and Noise Management Plan." The plan would establish soundscape indicators and standards as well as define impact thresholds on the monument's soundscape.

Currently, the monument has no baseline acoustic data. A preliminary soundscape assessment was completed by Dan Dugan Sound Designs in August of 2005. The assessment took a few sound recordings in the southern portion of the monument in designated wilderness areas and confirmed that the monument maintains a high quality soundscape resource. A much more thorough investigation needs to be completed.

Night Sky

Lava Beds National Monument's dark sky resource is a highly valued asset. The monument recognizes that dark skies are important natural, cultural, and scenic resources. Preserving this critical resource is important for the protection of nocturnal habitat and for the enjoyment of the public.

Visibility at the monument is still superior to that in many other national park units, but degradation by light-scattering pollutants (haze), particularly from agricultural burning and wood stove emissions is common. An analysis of 1990-99 data from Crater Lake NP and Lassen Volcanic NP indicate that visibility within the

area is improving on the clearest days and degrading on the haziest days.

Many nights offer stunning views of the Milky Way and other dim celestial objects. Lava Bed's night sky currently rates as a level 2 on the Bortle scale. The Bortle scale is a qualitative assessment of the degree to which light pollution affects local dark skies. At level 2, airglow, which is a weak emission of light from the earth's atmosphere, is apparent on the horizon, and the Milky Way is highly structured to the naked eye (Bortle, 2001). Light pollution is apparent low along the Northern horizon, with a low light dome visible over Klamath Falls. There is also some light interference from developments along the State Highway 139 corridor. Agricultural facilities adjacent to Petroglyph Point have extensive outdoor lighting that affects dark night skies at this location.

Currently no lighting ordinances to preserve the night sky have been enacted by surrounding communities. Though much of the area surrounding the monument is rural, development is occurring. Eventually, further growth without anticipatory planning will lead to the degradation of dark sky.

Lava Beds National Monument is taking a leadership role in preserving its dark night skies. The monument has replaced all exterior lighting with fixtures that prevent light pollution. The monument is also



Caver on Cave Loop, NPS Photo

planning to complete a lighting management plan. This document would restrict lumen output and the types of fixtures that are acceptable. Further assessment of existing lighting will occur, determining whether removal or replacement is possible. Other technologies such as motion detectors and timers may be implemented. South of the monument Pacific Gas and Electric has a natural gas pump station that emits lighting which effects dark night skies. They have recently reduced the intensity of these lights.

Periodic monitoring of the nightscape will be necessary to assess the decline or improvement in this resource. Between 2007 and 2009, the NPS Dark Skies Team established a night sky baseline for the monument. The monument is pursuing designation as an International Dark Sky Preserve pending confirmation in 2010.

Viewsheds and Visual Resources

Lava Beds National Monument's scenic viewsheds include dramatic geologic features such as lava flows and cinder cones and sweeping panoramic views of the surrounding landscape, including views of Mt. Shasta. Many of these panoramic views extend out over the entire Tule Lake Basin where one can see irrigated farmland, lakes and canals, grain elevators, barns and other rural agricultural development. The monument recognizes that its viewshed is an important natural, cultural, and scenic resource, and the preservation of this resource is important for the public's enjoyment.

Along the northern boundary of the monument, views are dominated by Sheepy Ridge and the Peninsula portions of the Tule Lake National Wildlife Refuge. Petroglyph Point and the surrounding agricultural lands are less prominent.

From the monument's main road, views of striking volcanic features such as pahoehoe and a'a lava flows, cinder cones, and enormous lava fields unfold. The shapes and textures of the flows add scenic variety to the landscape. Cinder cones and spatter cones (known locally as "buttes") rise up throughout the entire monument landscape. Schonchin Butte, at 5,300 feet elevation, contains an historic fire lookout that provides a 360 degree panoramic view of the basin. Other notable buttes include Eagle Nest, Whitney, Three Sisters, Juniper, Hardin and Caldwell buttes. Gillems Bluff, flanking the northwestern boundary of

the monument, features exposed formations of volcanic rocks.

Historic views associated with the Modoc War landscape contribute to the significance of the monument. For the past several years the monument has been actively removing encroaching juniper trees from the historic landscape.

The northern half of the monument is primarily an open sage and rabbit brush shrub and grassland. As one moves southward (and higher in elevation) trees and large shrubs become more frequent and increase in size and density. Because of the open nature of the vegetation and sloping landforms, visitors are frequently presented with long panoramic vistas extending for ten to thirty miles. The central monument is characterized by shrub-woodlands with western juniper (*Juniperus occidentalis*) and mountain mahogany (*Cercocarpus ledifolius*) dotting middle elevation slopes. The southern landscape is highest in elevation and dominated by coniferous forest, primarily ponderosa pine. Mammoth and Modoc Craters are giant fissures in the southern portion of the monument. A scenic trail allows visual access to the massive Mammoth Crater.

The developed infrastructure of the monument (roads, trails, buildings, and utilities) for the most part blends in well with the landscape. Exceptions include the shiny metal of cars in the visitor center parking lot, the light colored employee residences, and several buildings with light colored and/or shiny metal roofs. These structures, depending upon the time of day and lighting, can be plainly seen from the far north end of the park and much of the wilderness area.

Geological Resources

SURFACE GEOLOGY

Lava Beds is located on the northern flank of the Medicine Lake shield volcano which began eruptive activity in the Pleistocene, roughly 1 million years ago. Like other Cascades Range volcanoes, it continues to be active with its last eruption dated to around 840 years ago. Within the monument, the most recent eruption formed the Callahan lava flow about 1100 years ago. This and earlier volcanic activity is what dominates both the soils and the bedrock geology of the monument, although some older volcanic rocks are

exposed in some locations and a small deposit of volcanic glacial outwash gravel can be found.

The overall topographic setting of the monument is one of a gradual recession of elevation from the south and southwest at around 5700' to around 4000' on its northern boundary at the start of the Tule Lake Basin. However, a gravitational anomaly suggests that the sediments of this graben (a tectonically down-dropping, extensional valley associated with normal faulting) may extend up to 1.25 miles, covering over a much larger extent of Medicine Lake lava flows. This long slope is dotted with cinder cones rising 100' - 500' above their surroundings. An exception to the gradual north-south elevation trend is Gillem Bluff, the result of both normal and transform faulting and uplift relative to the Tule Lake graben. This faulting follows the same north - south or northwest - southeast trend as other regional faults, and is believed to reach significant depths. It is hypothesized that this faulting, associated with an extensional tectonic regime, provides the conduit through which the Medicine Lake derives its source magma somewhat east of the main Cascade volcanic arc.

The eruptions of the Medicine Lake volcano have been shown to have a clear spatial trend in SiO₂ (silica) content, with high SiO₂ eruptions of rhyolites and dacites concentrated around vents the central caldera, whereas flank vents (eruptions through the volcano's slopes) tend towards producing lower SiO₂ andesites and basalts. Such is the case with most of the surface geology of the Lava Beds, where lava flows of these less viscous compositions dominate virtually the entire landscape. Nearly 70% of the monument is covered by the basalt of the Mammoth and Modoc Crater vents, located along a major fissure in the southwest corner of the park, and roughly dated to around 30,000 years ago. Other vents, both younger and older, are scattered around the monument with a bias to the south, closer to the volcano's central caldera. Many of these are cinder cones of various sizes such as Caldwell, Hippo, and Schonchin Buttes, as well as fissure and spatter cone eruptions of the lowest SiO₂ basalts, as at Fleeners and Ross Chimneys. Two notable exceptions are Juniper Butte and the Petroglyph Point section, where maar volcanoes formed from the explosive tuff rings of eruptions that mingled with the waters of a more extensive precursor to Tule Lake. Petroglyph Point was subsequently eroded by wave action, exposing sheer cliffs of easily weathered tuff. Lavas of Mammoth Crater also interacted with these waters, forming

pillow basalt and littoral cones along the monument's northern edge.

Three notable exceptions to the surface geology otherwise entirely dominated by Medicine Lake volcanic events can be found in the monument. The first are areas of glacial-outwash gravel transported by melt water that left sand and gravel deposited in thin beds on the bottom of Hidden Valley and near Caldwell Butte. Second, a very small area at the northeast corner of the park preserves lacustrine deposits of the larger ancient Tule Lake. Third, the uplift of Gillems Bluff has exposed formations of volcanic rocks not found elsewhere in the monument, including a rhyodactite tuff that is estimated at 2 million years old, making it the oldest exposed formation in the monument.

The volcanic features and formations found at Lava Beds are significant geologic resources. Textbook examples of a wide variety of formations are found here within an astonishingly small geographical area. Cinder cones, spatter cones, chimneys, and maar volcanoes all represent different kinds of eruption vents. Various aged and chemically composed lavas form a further diversity of post-eruptive features including both smooth pahoehoe and blocky a'a lava flows, lava tube caves and trenches, ground cracks, hornitos, deflation and inflation depressions and ridges, and pillow lava, tumulus, and littoral cones where the flows encountered standing water. Rarely are so many features preserved and protected in such close proximity and in such pristine condition.

Extrusive volcanic rocks such as those that dominate the landscape at the monument are highly resistant to natural forms of erosion. They are chemically inert, being primarily composed of very small (often microscopic) crystals packed within a sturdy matrix of natural glass. The monument's dry environment precludes water erosion and further delays the slow invasion of plant roots or humic acids associated with decaying vegetation, thereby inhibiting the development of soils. The more massive, blocky lava flows further retard soil development by allowing windborne dust and vegetation to fall deep between their large blocks, effectively lost from the surface and any soil that might form.

Only artificial endeavors can alter most of the monument's surface geological formations. Most delicate are the barren slopes of cinder cones, where a single footfall can loosen a small avalanche of cinders that have rested at the cone's angle of repose for thousands

of years, and leave a visible scar that will take just as long to fade.

CAVES

The caves of Lava Beds National Monument are rare geologic features that contain stable-low energy environments. The environment of the caves are a mosaic of interdependent structural, climatic and ecologic relationships that harbor isolated biological communities, unique geologic processes, and important microclimates. The subterranean environment greatly influences surface topography, which in turn, create sharp transitional ecotones that greatly influence terrestrial ecologies within the monument.

Lava tube caves are made of igneous rock formed from volcanic eruptions and lava flows that occurred hundreds to thousands of years ago. Many of these features are delicate and fragile, and can be easily shattered or broken by foot traffic or even a caver's shoulder or helmet bumping the ceiling of a cave. When there is breakage of cave features or erosion of cinder cones, the result is permanent change. Only new volcanic eruptions can create new geologic resources. Thus the geologic formations and features within caves and on the surface are considered to be non-renewable resources. If lost they are unlikely to be replenished or replaced by natural processes in any of our lifetimes.

Currently there are 772 caves known within the monument. These caves have a minimum of 1146 known entrances connected to more than 31.7 miles of estimated/surveyed passages beneath the monument. In 2006, 192 previously undocumented caves were discovered within the monument. This represents a significant expansion to the known cave resources in the monument. The monument expects to discover more caves as it continues to survey lands (NPS 2006a).

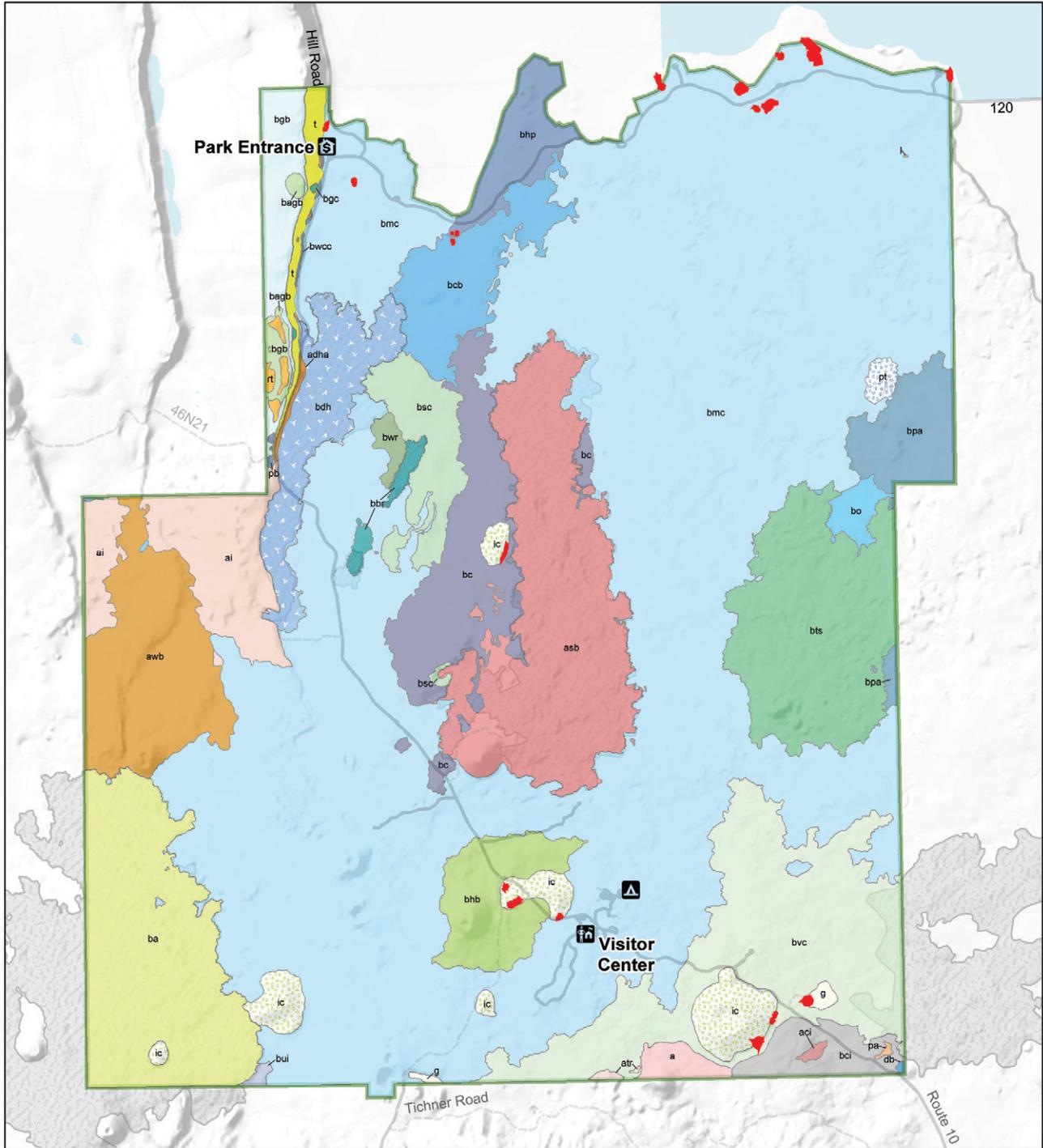
The entrance zones and collapsed segments of caves provide habitat for a variety of flora and fauna not found elsewhere in the monument. The humid and cool properties of these environments create islands of unique diversity within the region, including disjunct species of fern and liverworts now up to 150 miles from their closest known populations (Smith 2007).

Bird species like purple martins, Say's phoebe, and canyon and rock wrens nest in cave entrance environments. Larger birds like the common raven and barn owls use cave entrances for nesting locations. Amphibians such as the Pacific Tree frog have been documented

MAP 13: SURFACE GEOLOGY AND ABANDONED CINDER MINES

Lava Beds National Monument

Surface Geology & Abandoned Cinder Mines



Surface Geology



See special CORRELATION OF MAP UNITS chart for detailed information on geologic formations

Cinder Mines

Misc.

Monument Boundary

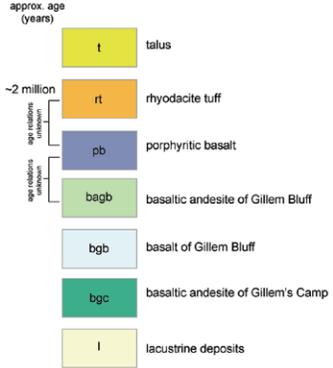
Major Lava Beds



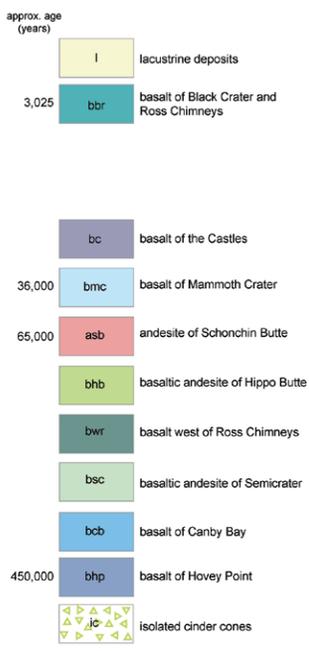


CORRELATION OF MAP UNITS

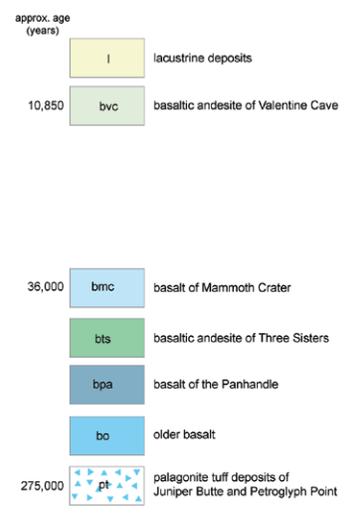
Units at GILLEMS BLUFF



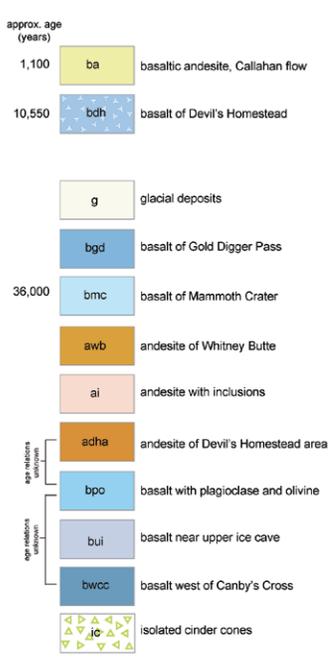
CENTRAL AREA



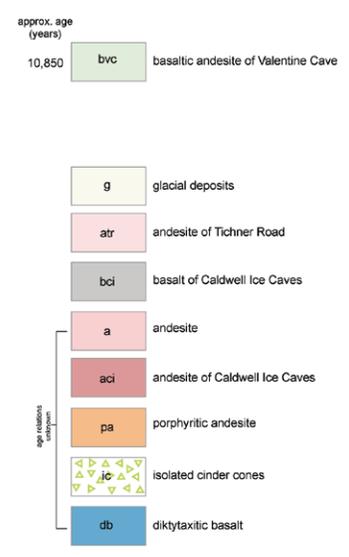
EASTERN AREA



WESTERN AREA



SOUTHEASTERN AREA



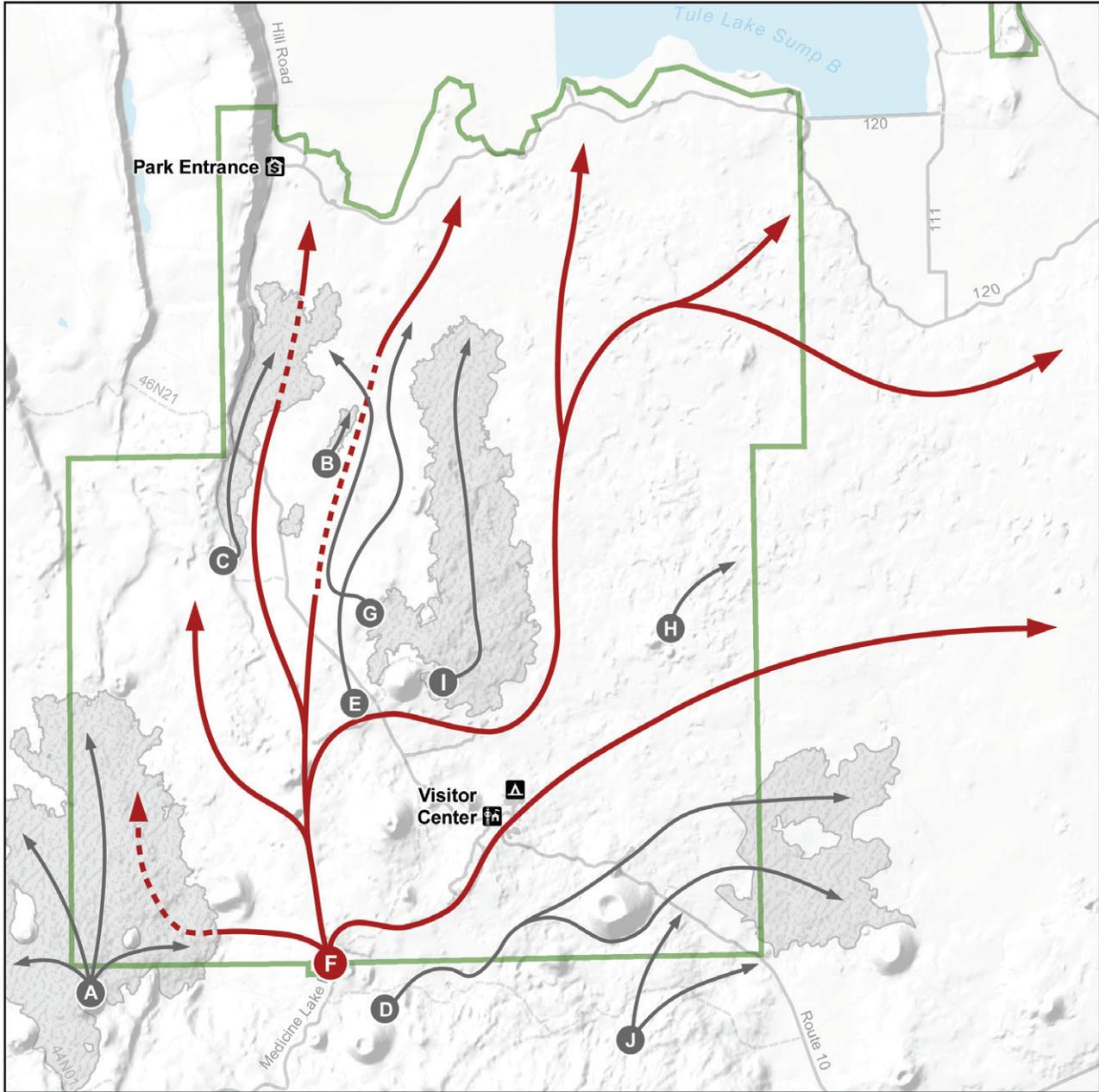
Units are listed here by relative age; younger units are above older units. However, note that in some areas relative ages are not well constrained. Relative ages between columns are unknown except where units bmc and bvc appear in more than one column. Approximate absolute ages are given where known. Unit ic in the Western Area includes Eagle Nest Butte, Island Butte, and the cinder cone southeast of Mammoth Crater. In the Central Area, unit ic includes Hardin Butte, Crescent Butte, the cone adjacent to Crescent Butte, and Red Butte. In the Southeastern Area, unit ic includes only Caldwell Butte.

MAP 14: LAVA FLOWS

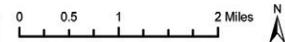
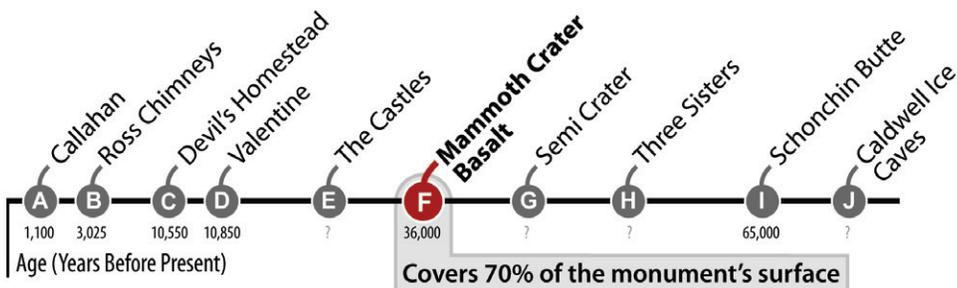
Lava Beds National Monument



Lava Flows



Lava Flow Timeline & Legend:



- Features
 - Major Lava Beds
- Land Ownership
 - Monument Boundary

in entrances along with sensitive mammalian species like pika, pack rats, and bats.

The monument currently protects fourteen documented species of bats. Of these, significant maternal roosts of Townsend's Big-eared bat, Pallid bat, Cave myotis and Brazilian Free-tailed bats have been monitored. Bats along with packrats are critical players in the ecology of caves and the regional landscape. The monument first began documenting bat use in caves in 1962 and initiated intensive monitoring of bat colonies in 1985.

Caves also shelter a rich diversity of macroinvertebrates. In 1989, an initial assessment of macroinvertebrates was completed in ten caves (Crawford 1990). In 2005, an additional 29 cave sites were assessed for macroinvertebrates, resulting in the collection of 1511 specimens. Of particular interest are a dozen or more possible troglotic (cave obligate) species, two of which (an isopod and pseudoscorpion) may be uniquely endemic to the park (NPS 2005d). Further studies are likely to uncover even greater diversities of macroinvertebrates.

Stable cave environments preserve cultural and geologic materials of scientific interest. It is likely that the first Native American use of caves occurred as early as $11,450 \pm 340$ BP. Many historical items, remains, and images have been left in situ. Artifacts from early settlement, military conflicts, and the Civilian Conservation Corps are also present in caves.

Besides cultural materials, caves also shelter geologic deposits important to dating and understanding the natural history and volcanic process that have influenced the regional topography. Cave environments protect deposits such as cristobalite, calcite, and sediments, and structural clues that are quickly eroded on the surface. Equally important are biological materials, like paleontological remains, rat middens, and organics that hold important links to climatic and past ecologic communities that once dominated the land.

The cave ice resources found at the monument are of increasing concern. Since 1990, resource management volunteers have monitored ten caves that have historically contained substantial ice resources. As of 2007 the monument has observed the dramatic loss of ice in seven of the ten monitored caves, with the near total loss of ice in four caves. A 0.5 degree rise in the mean monthly low surface temperature and a near 1.5+

degree rise in the mean monthly high surface temperatures seen over the past 60 years is the probable cause for this ice loss.

At present, visitation is monitored in 11 caves by electronic trail counters and 18 other caves by voluntary registers. The counters and registers provide a representative sample of the level of visitor use in front and backcountry caves. Photo monitoring along with speleogen breakage studies are ongoing; however, much more thorough and frequent monitoring is needed.

Future efforts will focus on tracking and permitting back country cave use, while limiting visitation within designated protected areas. The development of a new cave management plan along with increased focus on education, restoration efforts, and infrastructure improvements will help reduce future impacts. These actions along with monitoring of cave dependent species, climate, habitat integrity, formation breakage, and other anthropomorphic effects will be critical steps to preserve the monuments caves.

Hydrologic Resources

Lava Beds National Monument has no permanent or ephemeral lakes, streams, or wetlands found within the monument's boundary (USGS 1968; NPS 1999b). Only a few intermittent surface water resources in the form of seeps and ice features are found at the entrances to ice caves, such as Duffy's Well and Upper Ice. Since 1999, two baseline water quality inventories have been completed at Lava Beds. A 1999 analysis looked at eight water quality parameters in 14 ice caves (NPS 1999a). In 2005, the United States Geological Survey (USGS) completed a baseline water quality survey on 12 ice caves, looking at five water quality parameters (USGS 2005). These two surveys provided baseline water quality information showing no negative water quality issues.

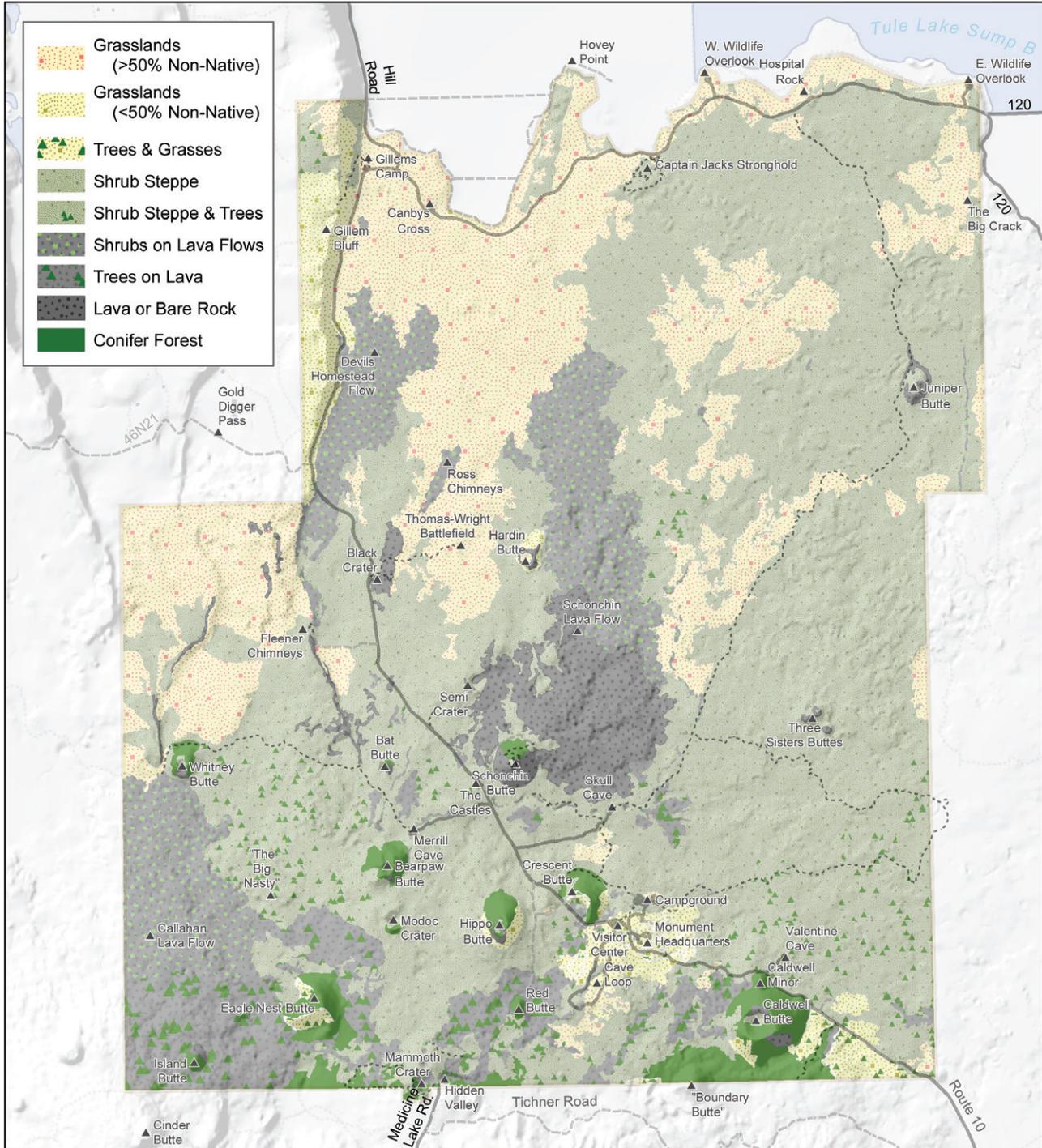
Since 1990, the Cave Research Foundation has been monitoring ice levels in nine monument caves. Over this period of time, loss of ice has been documented in seven of the nine caves. In Merrill Cave, the complete loss of the ice floor occurred over a two year period, starting in 1997 (Fuhrmann 2007). Current environmental stressors potentially impacting ice resources include climate change, micro climate within caves, fluctuations in precipitation and increasing surface

MAP 15: VEGETATION TYPES

Lava Beds National Monument



Vegetation Types



- Grasslands (>50% Non-Native)
- Grasslands (<50% Non-Native)
- Trees & Grasses
- Shrub Steppe
- Shrub Steppe & Trees
- Shrubs on Lava Flows
- Trees on Lava
- Lava or Bare Rock
- Conifer Forest

Plant Communities



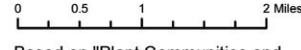
More detailed vegetation data is available in digital form, upon request, from monument staff.

Roads & Trails

- Paved
- Unpaved
- Trail

Misc.

- Monument Boundary



Based on "Plant Communities and Habitat Types in the Lava Beds National Monument", Masters Thesis by Dean H. Erhard, 1979

temperatures. Since 1946, Lava Beds has been monitoring surface temperatures. During that time, a 1.5 degree Fahrenheit increase has been detected for the average summer high temperatures. This temperature data relates to a larger trend identified in many locations throughout the western United States.

Groundwater provides domestic water for the monument. The monument has an active 825' deep well to supply water for the the Indian Well developed area. A second older well located alongside the active well is not currently being used. Since 2001, the USGS has been conducting a ground-water study on water levels in the upper Klamath Basin. Four wells have been monitored at Lava Beds under this project. By the beginning of 2004, one shallow well on the north edge of the monument had gone dry (USGS n.d.). The monument's waters supply wells at Indian Well have remained stable since 2001 (USGS n.d.).

Infiltration of surface water from the Tule Lake sumps and underflow from adjacent volcanic rocks probably are the principal sources of recharge to ground water at Lava Beds (NPS 1968). During the last ten years, geothermal and ground water studies have been implemented on the Medicine Lake Highlands (Mariner, et al. 1998). Groundwater flow sources for Lava Beds originate off of the north slope of the Medicine Lake Highlands. Groundwater north of the caldera rim drain northward to the Tule Lake groundwater subbasin and are within the North Coast Basin ground water system (NPS 2004b; BLM 1999). Lava Beds is found within this system and could be influenced by future developments north of the caldera. Lava Beds is also located close enough to the groundwater recharge areas and far enough from irrigation pumping that the elevation of the water table is not expected to be significantly affected (NPS 2004b).

Soils

The soils of the monument can be characterized by a broad continuum of pumice to silt content, from the higher elevations near the southern boundary to the lower elevation at the northern boundary. The southern soils are, in some places, a single horizon of up to 60" of pumice gravel. This correlates with the proximity of the Glass Mountain flow on the edge of the Medicine Lake caldera, 12 miles south of the park, from which the pumice was explosively ejected during an eruption

dating to approximately 840 years ago. As the landscape descends north and away from the source of this pumice, it begins to represent a less significant portion of the soil. At the far north end of the monument, the soil is dominated by aeolian deposition of lacustrine silts. Breaking up the regularity of this pumice-silt continuum are lava flows of various ages and textures, which have more specific influences on the young soils that overlay them.

Most soils in the monument are highly permeable; especially the pumice gravel dominated southern soils. Flowing surface water is non-existent. This has a great influence on floral diversity and distribution.

No survey or mapping has been done on the soils within the monument itself. However, the Modoc National Forest conducted large scale soil surveys between 1978 and 1982, and again in 1985.

Vegetation

NATIVE VEGETATION

Despite the monument's arid environment, with an average annual precipitation of around 15", it is host to approximately 340 plant species, in 38 communities, from three major vegetation associations. These associations are:

1. Great Basin shrub-grasslands dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) and basin or mountain big sagebrush (*Artemisia tridentata* sp.) found at lower elevations. These open expanses on the northern half of the monument include many of the 30 species of grasses in the monument, as well as the ubiquitous rabbitbrush shrubs (*Ericameria* sp. or *Chrysothamnus* sp.) and many exotic weeds.
2. Shrub-woodlands dominated by western juniper (*Juniperus occidentalis*) and mountain mahogany (*Cercocarpus ledifolius*) and a diverse shrub, forb, and grass understory found on the middle-elevation slopes of the monument. The greatest abundance and variety of perennial wildflowers, of great aesthetic importance to visitors, bloom here throughout the spring and summer.
3. Coniferous forest dominated by ponderosa pine (*Pinus ponderosa*) at the southern-most, highest elevation areas of the monument, often with an

understory of bitterbrush (*Purshia tridentate*), snow brush (*Ceanothus velutinus*), or manzanita (*Arctostaphylos patula*). Patches of this association are also found on the north aspects of some large southern cinder cones and on the south wall of Mammoth crater, where some white fir (*Abies concolor*) and sugar pine (*Pinus lambertiana*) mix in.

Besides precipitation differences due to elevation, distribution of species within these three associations and subsequent communities are strongly influenced by two factors: the park's poor, fast-draining soils and its volcanic topographic features. These soils, coupled with the scarcity of summer and fall precipitation, mean that the majority of plants in the park are either spring annuals that quickly take advantage of winter precipitation, or deep-rooted perennials that can tolerate long arid summers. The notable exception to this rule and source of great floral diversity in the park is the strong influence of the volcanic topography and geologic features. These provide a broad variety of refugium for species not otherwise suited to the area's daily and seasonal temperature fluctuations, rainfall patterns, and poor soils.

The lava tube cave entrances and trench collapse areas provide insulation from temperature changes, shade from baking summer sun, elevated humidity, and more accessible groundwater. Bryophytes and nine species of ferns are the most poignant example, including *Polystichum munitum*, the western sword fern common to coastal redwood forests. Western sword fern is found at the sheltered entrances to several caves that form tiny green oases below the arid landscape. A survey conducted by the Cave Research Foundation in 1993 found significant fern populations at twenty cave entrances.

The somewhat more exposed lava tube collapse trenches, away from cave entrances, still provide shelter to a unique assembly of plants. Desert sweet / fernbush (*Chamaebatiaria millefolium*) is commonly found in these trenches, along with California figwort (*Scrophularia californica*) and purple sage (*Savilia dorrii*). The lava beds themselves, especially blocky flows or ones with deep cracks, provide shade or pockets of groundwater for desert ocean spray (*Holodiscus discolor*) and desert mint (*Monardella odoratissima*).

Small rocky outcrops of lava, common on the rugged landscape of the monument, also provide a haven for

a broad diversity of plants benefiting from their shade and collection of rainwater otherwise lost from the surrounding soils. Many flowering forbs, including cinquefoil (*Potentilla sp.*), and six species of penstemon, take advantage of these outcrops.

NONNATIVE VEGETATION

Out of 63 nonnative vegetation species within the monument, 23 are considered invasive. The lands within the monument were heavily grazed by livestock until 1974, which had a significant impact on the native vegetation and fragile soils. Cheatgrass (*Bromus tectorum*) is present throughout the monument and most common in many areas of the lower elevation shrub-grasslands. In addition, because of the monument's location adjacent to active agricultural fields, other aggressive nonnative plant species have been successful in colonizing disturbed areas within the monument. Recent improvements in cooperation with the adjoining Tule Lake National Wildlife Refuge is hoped to help slow infestations entering from refuge lands where weeds are overwhelmingly entrenched.

The monument has identified six primary non-native plants of concern:

- Cheatgrass (*Bromus tectorum*)
- Russian thistle (*Salsola iberica*)
- Bull thistle (*Cirsium vulgare*)
- Canada thistle (*Cirsium arvense*)
- Sweet clover (*Melilotus sp.*)
- Woolly or common mullein (*Verbascum sp.*)

Summer weed control crews currently work to eradicate infestations of all of these species, except the widely established cheatgrass.

Wildlife

Lava Beds National Monument contains a broad array of wildlife that varies from grassland dependent species, such as the pronghorn, yellow-bellied marmot, and western meadowlark to ponderosa pine forest species, such as the Douglas squirrel, pygmy nuthatch, and gray fox.

In addition to the above mentioned species, there are hundreds of others that occupy the varied plant communities and geologic landscapes that make up the Great Basin/Cascade ecosystem of the monument.

It was not until the early 1960s that volunteers, researchers and monument staff began to conduct wildlife studies to determine species presence and geographic distribution. For mammals this began in 1962 when Charles Smith conducted a vector-borne disease survey of rodents, bats, and carnivores. For birds, this began in the early 1960s with volunteers and staff documenting birds observed around the administrative headquarters. For the last fifty years, research and survey projects have provided a foundation for understanding wildlife within Lava Beds National Monument.

Since 1999, the National Park Service has been in the process of operating the Inventory and Monitoring Program. This program is part of the NPS Natural Resources Challenge and has been put into action to inventory 90 percent of all fauna (mammals, reptiles, amphibians, birds, fish) found within parks and to develop monitoring plans for each network of parks. Lava Beds is located within the Klamath Network and has certified species lists for the park, as approved through the Inventory and Monitoring program.



Tree frog, NPS Photo

For mammals, the certified park list identifies 67 total species. Of this total, 49 species have been confirmed as present in the monument. Species that are listed as historic, found originally in the area include American bison, gray wolf, river otter, bighorn sheep, and grizzly bear. Unconfirmed species include elk and six small ground dwelling mammals, including voles, mice, and one species of gopher. Elk species have been documented on occasion in the monument. There are five species of mammals that are probably present in the monument which include yellow pine chipmunk, three voles, and one shrew.

For birds, the certified park list identifies 234 total species. Of this total, 223 species have been confirmed present in the monument. Species that are listed as unconfirmed include sage sparrow, wrentit, least bittern, red-necked grebe, yellow-bellied sapsucker, solitary sandpiper, Bohemian waxwing, ruffed grouse, snowy plover, and lesser yellowlegs. One species of

bird that has disappeared from Lava Beds since the early 1970s is the greater sage-grouse. This species has not fared well during the last four decades due to road development, fire suppression, and habitat encroachment by exotic plants and western juniper. The nearest population of sage grouse is 15 miles to the east at Clear Lake National Wildlife Refuge. This population is significantly reduced and has been as low as three documented males observed on the breeding grounds (display lek) during the 2003 breeding season. At this time, this bird should be considered extirpated from Lava Beds.

Since 2005, the U.S. Fish and Wildlife Service has been involved in a re-introduction program around Clear Lake. Lava Beds has also been involved in cooperating on a team drafting a Greater Sage-Grouse Recovery Plan for northeastern California. This effort began in 2005 and includes the U.S. Fish and Wildlife Service, State of California, ranchers and the monument. On September 12, 2006, the U.S. Fish and Wildlife Service listed the Greater sage-grouse (*Centrocercus urophasianus*) as a candidate species for the threatened and endangered species list. A candidate species is one which the U.S. Fish and Wildlife Service

has sufficient information on biological vulnerability and threats to support proposals to list this species as endangered or threatened. Issuance of a proposed rule for this species is precluded at present by other higher priority listing actions (USFWS 2006).

For reptiles, the monument supports 12 species. The most common species include gopher snake, western rattlesnake, and western fence lizard. For amphibians, there are two species, the Pacific tree frog and the western toad. The Pacific tree frog has been confirmed in a full array of habitats ranging from cave openings to the interior of lava flows. The western toad, considered extremely rare, has only been confirmed in the administrative area of the monument. One of the rarest snake species found at Lava Beds is the desert night snake. It has been found twice in the monument since the 1960s.

The lands within the monument provide an array of habitats for many species of wildlife that are considered watchable for tourism. Mule deer is one species visitors are keen to observe. They are found throughout all elevations of the park throughout the year. During the winter season, mule deer densities increase after moving off of the upper elevations of the Medicine Lake volcano.

Pronghorn is another large mammal found in the area of the monument. Between 2003 and 2007 only two pronghorn have been observed within the boundaries of the monument. The encroachment of western juniper into grasslands, land uses outside of the monument, and limited preferred habitat has reduced the occurrence of pronghorn within the monument. Since 2004, prescribed fires and western juniper reduction projects have been implemented in the northern end of the monument. One goal of these activities has been to return the northern end of the monument to a grassland- sagebrush habitat that is preferred by pronghorn. This habitat also benefits yellow-bellied marmots, which are found in limited areas on the northern end of the monument.

The most recent efforts by the monument to document species presence has occurred with the automated wildlife camera project. Since 2003, camera operations have documented rare and elusive species. These have included mountain quail, gray fox, Douglas squirrel, mountain lion, and black bear. Many of these species have only been photographed on one occasion demonstrating their status as rare species within the monument.

RARE AND SENSITIVE SPECIES

Lava Beds National Monument has no federally listed threatened or endangered species. The bald eagle (*Haliaeetus leucocephalus*) was recently removed from the Endangered Species List on June 28, 2007. Although the bald eagle has been removed from the endangered species act protection, it is still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Since the 1980s, monument staff have

TABLE 13: RARE AND SENSITIVE SPECIES

RARE AND SENSITIVE SPECIES AT LAVA BEDS NATIONAL MONUMENT		
Common Name	Species Name	Status
Loggerhead Shrike	<i>Lanius ludovicianus</i>	*,#
Small-footed myotis	<i>Myotis ciliolabrum</i>	*
Long-eared myotis	<i>Myotis evotis</i>	*
Fringed myotis	<i>Myotis thysanodes</i>	*,#
Long-legged myotis	<i>Myotis volans</i>	*,#
Yuma myotis	<i>Myotis yumanensis</i>	*
Townsend's big-eared bat	<i>Plecotus townsendii</i>	*,#
Brazilian free-tailed bat	<i>Tadarida brasiliensis</i>	*
Northern goshawk	<i>Accipiter gentilis</i>	*,#
Burrowing Owl	<i>Athene cunicularia</i>	*,#
Swainson's Hawk	<i>Buteo swainsoni</i>	*, CA State Threatened
Brewer's Sparrow	<i>Spizella breweri</i>	*
American Badger	<i>Taxidea taxus</i>	*,#
Pallid Bat	<i>Antrozous pallidus</i>	*,#
Cave Myotis	<i>Myotis velifer</i>	*,#
Purple Martin	<i>Progne subis</i>	*,#
Olive-sided Flycatcher	<i>Contopus cooperi</i>	*,#
Short-eared Owl	<i>Asio flammeus</i>	*,#
Flammulated Owl	<i>Otus flammeolus</i>	*
American Pika	<i>Ochotona princeps</i>	*
Troglobitic cave millipede	<i>Plumatyla humerosa</i>	* (cave macro-invertebrate)
Cave Collembola springtails	6 families identified	* (cave macro-invertebrate)
Monarch Butterfly	<i>Danaus plexippus</i>	*
Northern Rubber Boa	<i>Charina bottae</i>	*
* - Lava Beds National Monument identified sensitive species.		
# - California State Species of Special Concern.		

been monitoring the two bald eagle winter roost sites. These roosts have been identified as Caldwell/Cougar Butte and Eagle Nest Butte. The Caldwell/Cougar Roost is one of four major bald eagle winter roosts located in the Klamath Basin of northern California and south-central Oregon. In 1984, bald eagle use in the Caldwell winter roost site reached 278 birds. This was the largest number of eagles ever documented in Lava Beds. Since that time winter roost occupancy has dropped significantly with the number of eagles averaged 8 per year between 2002 and 2006. The apparent reduction in prey base, ducks and geese wintering farther south into the Sacramento Valley, is one theory for the eagle reduction.

The monument provides particularly important habitat for the Townsend's big-eared bat, which makes use of monument caves both for winter hibernation and for summer maternity roosts. In the 1980s, the Townsend's big-eared bat population in Lava Beds was around 300 individuals. Since that time, additional monitoring effort and protection measures have been put in place to document over 600 individuals in three separate maternity colonies.

One additional sensitive species the monument monitors is the Brazilian free-tailed bat. This species of bat migrates into the monument every spring and forms one large maternity colony. This population of bats is migratory and leaves the monument around early September.

A joint U.S. Forest Service/NPS Bald Eagle Winter Roost Management Plan was approved in 1992. This is a comprehensive plan providing a summary of information on the bald eagle, its activities, and its habitat within the monument and on adjoining national forest lands.

Wilderness and Backcountry

On October 13, 1972, two wilderness units (Schonchin and Black Lava Flow) totaling 28,460 acres were designated under public law 92-493 at Lava Beds National Monument. Accordingly, wilderness currently represents 61% of the monument's total land area. In 2006, a *Wilderness Stewardship Plan* (WSP) was completed for Lava Beds that states wilderness and backcountry areas will be managed identically on approximately 45,626 acres (NPS 2006d). The WSP identifies backcountry as

¼ mile off of all paved roads and developments. Facilities and paved roads within the monument account for approximately 934 acres.

The Lava Beds wilderness is an island, the next closest wilderness areas being the Mountain Lakes Wilderness, 65 miles to the northwest, and the South Warner Wilderness, approximately 65 miles to the east. Currently there are 50 miles of trails in the wilderness and backcountry areas of the monument including 38 miles of maintained trails and 12 miles of un-maintained trails (NPS 2006d). Horseback riding and pack animals are currently permitted on three wilderness trails - Lyons, Three Sisters, and Whitney Butte, totaling 29.6 miles. The Powerline administrative road is also open to horse use and totals 6.9 miles.

Over the past decade day hiking, overnight use (backpacking), and caving were the monument's principal wilderness activities. Pack and trail riding stock use accounts for less than 1% of wilderness use. Caving and hiking account for most of the day use activity within the wilderness. Day use far exceeds overnight use. Lack of surface water within the monument discourages most visitors from camping overnight in the backcountry. Backpackers must carry in all the water they will need for overnight trips. Average annual overnight use of the Lava Beds National Monument backcountry is approximately 26 visitor nights. A record 103 visitor nights was recorded in the monument wilderness in 1995 (number of visitors multiplied by the number of nights = visitor nights). The year 1997 was second highest with 32 visitor nights and 1991 third highest use with 28 visitor nights.

Visitor exploration of caves is one of the most popular activities within Lava Beds National Monument. Lava Beds manages its caves within designated wilderness areas as underground "wilderness." In backcountry caves and caves located in wilderness areas where cave registers are used, visitation can vary widely. Between 1995 and 2000, 18 backcountry and wilderness caves contained registers to document use. The range of visitation in these caves fluctuated between a wilderness cave with 15 visitors and a backcountry cave with 4,000 visitors during the five year period (NPS 2006d).

The Wilderness Act restricts activities in designated wilderness areas. No forms of mechanical transport, no permanent roads, and only "minimum tools" are permitted. The Lava Beds wilderness will remain an area characterized by an essentially unmodified natural

environment: interaction between users is very low; opportunities for experiencing solitude are high, especially if one stays overnight; motorized use within the area is not permitted.

There are opportunities for public use, enjoyment, and understanding of the wilderness, through experiences that depend upon a wilderness setting. Outstanding opportunities for solitude or a primitive and unconfined setting exist. However, due to the separation of the two small wilderness units, in some areas visitors can see and hear surrounding developed landscape which includes grain elevators, and freight trains.

Within the Lava Beds wilderness areas, air quality meets federal and state standards. There is no measurable degradation to water resources. The ability of soils to support naturally occurring vegetation communities is not significantly impaired by human activities. Plant communities are affected by natural process and maintain their natural appearances.

Wildlife is recognized as an integral part of the wilderness and contributes significantly to overall biodiversity. The Lava Beds wilderness acts as a component to maintain indigenous species.

Cultural and historic sites are recognized as an integral component of the wilderness resource. Past human uses of the land are understood and values of cultural resource sites are preserved

Over the past three years, management steps have been taken to improve the wilderness experience at Lava Beds. Updated wilderness information and boundary signs were placed at trailheads to inform visitors of the boundaries and “leave no trace” guidelines. Old vehicle access gates into monument wilderness areas were removed and replaced with rock structures. A wilderness boundary adjustment proposal was developed and sent to Congress to adjust wilderness boundaries around five developed features (e.g. the main road, campground, amphitheater) that were inadvertently included in the original wilderness boundaries. This boundary adjustment proposal also corrects discrepancies in acreage, adds resources not previously designated as wilderness, and improves boundary management.

In the future, wilderness management challenges will include maintaining desired natural and cultural conditions as outlined in the 2006 *Wilderness Stewardship Plan*, effectively monitoring visitor use in the wilderness and backcountry, and evaluating the use of permits and boundary access issues.

Fire

Since the establishment of the Modoc National Forest in 1904 and the subsequent establishment of Lava Beds National Monument in 1925, fire suppression was the dominant management strategy for the monument and the surrounding shrub-steppe and dry-conifer forest communities (USGS 1966).

It wasn't until the mid-1960s that fire was recognized as an important natural process in western ecosystems (Leopold et al. 1963) and institutionalized as U.S. Department of Interior policy in 1968 (Kilgore 1973).

Lava Beds first applied fire in a research context in 1974 (NPS 1982, and Olson et al 1982).

From 1974-1979, 56 prescribed fires were conducted using several fire prescriptions. The monument formalized its fire program with a management plan in 1982. Additional fire management activities were assessed and documented in an environmental assessment and management plan in 1992 and 2004. A formal fire monitoring plan was established in 2004. The monument has been systematically collecting fire effects information on prescribed fires since 1989 (NPS 2004a) using up to seven different vegetation categories (monitoring types).

The current *Lava Beds Fire Management Plan* (FMP) was approved in February 2005. Subsequent annual updates through 2009 have been completed on the FMP. The plan contains current policy and guidance that implements a comprehensive fire management program. The FMP serves as the implementation plan to help achieve resource management and fire protection goals defined in a park's general management plan and resource stewardship strategy. The current FMP is reviewed for validity annually, and revised annually as needed to be consistent with current policy, but in



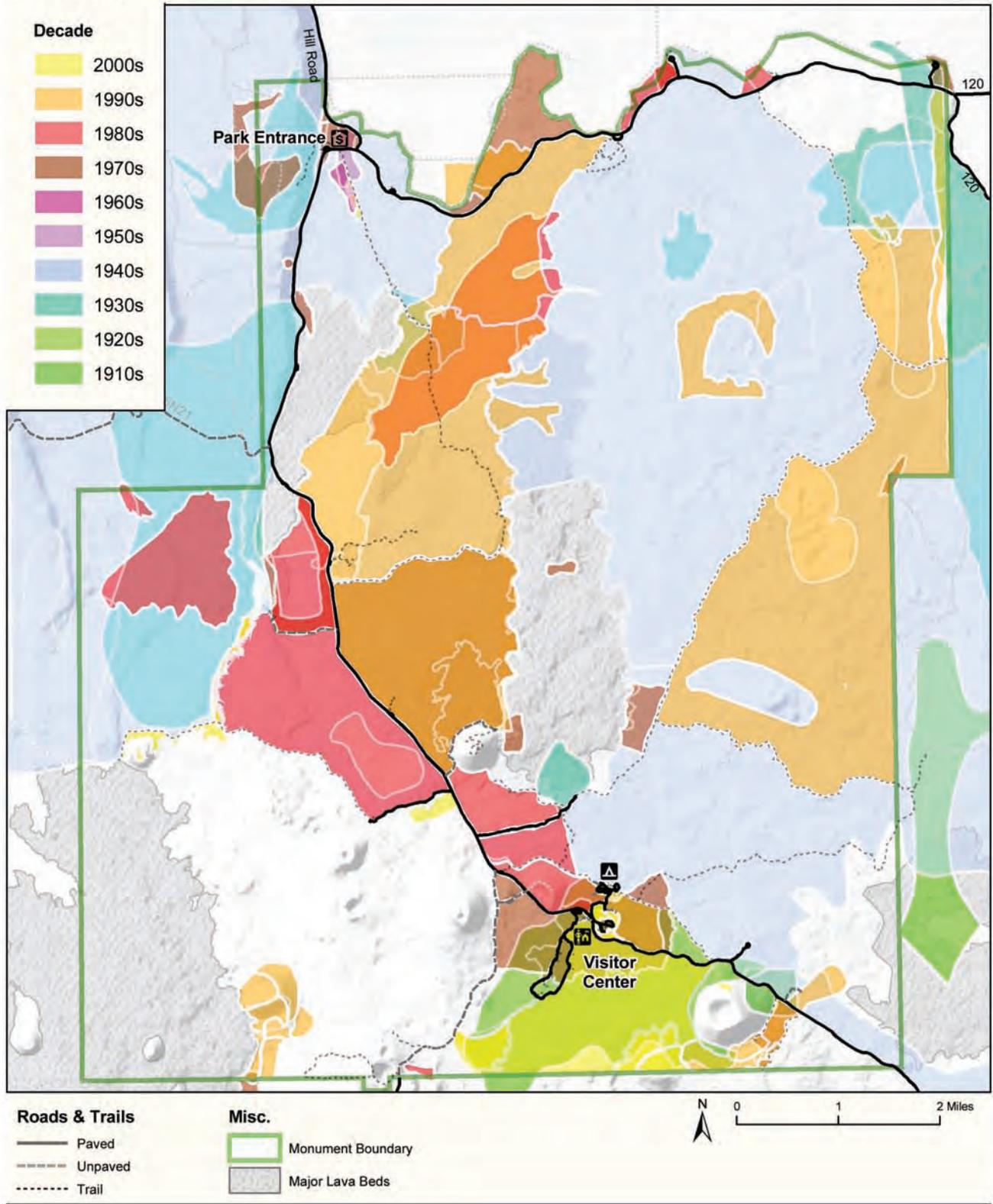
Prescribed fire ignition, NPS Photo

MAP 16: FIRE HISTORY

Lava Beds National Monument



Fire History



compliance with the existing and approved environmental analysis (NPS 2005f).

The 1996 *Lava Beds National Monument General Management Plan* reinforced the implementation of a fire management program that included the use of suppression and prescribed fire. The 1996 GMP objectives specified that the monument would maintain the natural role of fire in monument ecosystems to the maximum extent possible through the use of wildfire (unplanned ignitions) and the use of prescribed fire (planned ignitions).

While acknowledging that human safety remains the number one goal, the goal of the 2005 FMP is to provide the maximum amount of protection for the important natural and cultural resources of the monument while helping restore natural ecological processes, including native vegetation function and structure. Using wildland fire to achieve the goals of the GMP is an allowed strategy. 'Use of Wildland Fire' is the strategy of using natural ignitions (i.e. lightning) to achieve goals appropriate for the area where the ignition occurred. The FMP identifies over 33,000 acres where using unplanned ignitions is an appropriate management strategy to meet GMP objectives when conditions are conducive. The fire is assessed relative to very specific parameters of topography, weather, fuel types, and resource risk, and if appropriate the fire is allowed to burn in a low intensity manner to achieve resource objectives while being monitored. The application of this strategy is dependent on the natural ignition falling within strict fire behavior parameters.

A prescribed fire program has been in effect at the monument since the mid 1970s. In 28 years, approximately 21,000 acres (approximately 52% of the monument's burnable vegetation) has been treated, or approximately 750 acres per year. Fires burning under natural conditions would burn an average of 1,822 acres per year for a total of approximately 51,000 acres (many areas burning more than once) over the same time period. The net result of the prescribed fire program is that approximately 30,000 acres have not been burned that should have been burned since the inception of the prescribed fire program. In addition, many of the areas that have not been treated with the prescribed fire program have not been burned for a very long time.

Research completed at the monument by Rick Miller and Karl Hopkins at the Eastern Oregon Agricultural Research Center, Oregon State Univer-

sity found evidence that suggest fire has played an active and complex roll in plant communities across the monument. The more arid plant communities, dominated by Thurber and western needlegrass were probably characterized by a relatively long mean fire return interval of 60 to 100 years, which supported a shrub steppe community with few juniper. However on the more arid western needlegrass communities fire return intervals were considerably longer, allowing for the development of old growth juniper woodlands. On some of the recent lava flows and rock outcrops fires were rare or absent allowing juniper trees to exceed ages of 500 (very possibly >1000) years. In contrast, fire return intervals were relatively short (10 to 20 years in the wetter more productive communities dominated by bluebunch wheatgrass and Idaho fescue. These communities would have been dominated by a herbaceous layer with an open scattered stand of shrubs. Western juniper has encroached and/or increased in density in many of these sites since the 1870s resulting from the altered fire regime.

Fire effects monitoring is an important component of the fire management program in the monument. The long-term effects of burning on the composition and structure of vegetation communities are assessed using two primary approaches. First, a systematic prescribed fire monitoring program has been implemented using the nation-wide NPS Fire Effects Handbook (FMH) protocol. A series of standardized plot-level inventory designs are used to quantify vegetation and fuels attributes before and after burning at set time-intervals. Once a sufficient sample size and temporal record is obtained for each monitoring type, long-term succession trends and fuels dynamics can be assessed. Currently, the monument has more than 50 plots in five different monitoring types, but most were established relatively recently (last ten years) and only a small handful of plots have burned more than once. The second major fire monitoring approach utilizes repeat satellite image analysis to map landscape-scale patterns of fire severity and vegetation patch dynamics. Fire severity is classified for any fire >300 acres in size that burns in woody vegetation. In addition to these programs, special monitoring efforts may be conducted on a case by case basis by monument personnel when special issues arise that cannot be addressed through the FMH or satellite analysis.

Future fire management challenges in the monument revolve around the best way to protect resource values and public safety in a changing environment. It is

becoming increasingly clear that “no fire” is not a realistic long-term option given the high flammability of vegetation and local ignition sources in the monument – areas will eventually burn either under wildfire conditions or prescribed fire conditions. Nonnative invasions and fire-exotic interactions will continue to be a key issue. In particular, type conversion from shrub-steppe communities to exotic annual grasslands is a key concern in some areas. Maintaining habitat for rare and sensitive species, such as greater sage-grouse, will also be a challenge, especially as those habitats become increasingly rare due to urbanization, grazing, or large wildfires outside the monument boundary. A proper balance between the positive effects of fire on vegetation communities and fuels and potentially adverse effects in degraded areas must be struck. This challenge will grow more complex in the face of changing climate regimes that favor more severe burning conditions. Public safety due to high fuel loads will also continue to be a growing concern as visitation increases and fuels accumulate in the absence of fire in some areas. Smoke management and the impacts this can cause on visitor experience, air quality, and human health will also be a growing concern.

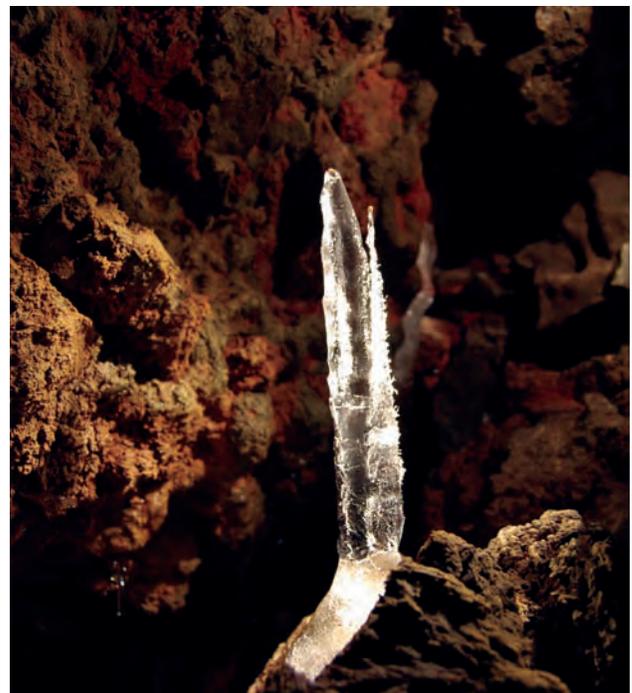
Another key challenge for fire managers involves the need for comprehensive pre-planning to manage unplanned natural ignitions in a manner that best meets ecological objectives in a cost-efficient manner. A more complete spatial inventory of fuels characteristics and other fire behavior data (weather and terrain) are needed to facilitate fire behavior projections during the fire season. Fire prediction and fire spread simulation modeling need to be tested and calibrated to better represent monument fuels. This will help fire and resource managers make better real-time decisions about the potential for natural ignitions to be safely managed for resource benefit. Fires that pose a low potential for growth and/or that can be confined by natural barriers or existing burn scars can be identified, thereby reducing cost and risks to firefighter safety.

Current and future research activities that enhance our understanding of the key fire management challenges are needed. Some research is already in progress. For example, researchers at Oregon State University are examining the effects of spring and fall burns on cheat-grass and soil dynamics in low elevation shrub-steppe communities. This will help to assess suitable burn prescriptions to promote native species. Other work is being conducted to look at historic fire dynamics in old-growth mahogany woodlands. The Klamath

Bird Observatory conducted avian population surveys along point-count routes in the monument to assess fire effects on bird species. As part of the monument’s FMH monitoring program, two key long-term “fire management control” units have been established to obtain baseline vegetation trends in the absence of prescribed burning. The first unit contains only wildfires and the second unit contains the only small enclave of unburned (during the 20th century) low elevation shrub-steppe.

Among the additional research needs is an improved understanding of cave-fire interactions. Despite the abundance and importance of caves in the monument, virtually nothing is known about how fire – and particularly altered fire regimes – influences the bio-physical characteristics of cave environments (e.g., flora and fauna, root dynamics, benthic ecology, pH, humidity, temperature).

A better understanding of the effects of fire on special habitats is needed, such as isolated aspen or old-growth shrub relicts like bitterbrush. Experimental treatments that compare and contrast different fuels management and restoration treatments would help refine strategies for maintaining landscape diversity of native species. This would include the use of increasingly utilized manual treatments such as cutting and pile burning to manage species composition and structure (e.g., how does pile burning and exotic response differ between cutting and broadcasting material?). Manual treatment



Cave ice, NPS Photo

is the use of handtools or hand operated power tools (chainsaws, weed eaters, etc). Mechanical treatment is the use of heavy equipment (which also generally implies ground disturbance).

Another key knowledge gap relates to the historical and future (projected) fire-vegetation dynamics at the monument’s major forest-shrub ecotones. This is particularly pertinent given that ecotones are most sensitive to altered climate and disturbance regimes. Finally, landscape-scale multivariate analyses that examine the influence of land management variables (e.g., fire frequency, fire severity, roads, developments) on vegetation composition in the context of underlying bio-physical gradients would be beneficial from a landscape planning perspective.

Climate Change

Projected shifts in the regional climate, as part of broader anthropogenic global climate change, will affect both natural and cultural resources at Lava Beds National Monument. These impacts may come from both the climate itself (i.e. precipitation or temperature trends, etc) and from related pollutants (i.e. elevated atmospheric CO2 levels). Though it lies within 125 miles of the Pacific Ocean, the higher elevation and physiographic setting of Lava Beds National Monument in the rain shadow of the Klamath Coastal and the Southern Cascade Ranges may reduce the ocean’s climate-moderating effects. Regional climate changes will be further influenced by the cyclic Southern Oscillation (El Nino / La Nina) Pacific warming events and longer scale Pacific Decadal Oscillation trends.

Climate projections for the Pacific Northwest, including the Klamath Basin and Southern Oregon, have been developed by the National Center for Conservation

Science and Policy (NCCSP) and the Pacific Northwest Research Station’s Mapped Atmosphere-Plant-Soil System team. Current projections use the three most popular climate models; the HADCM, CSIRO and MIROC. These models agree on future temperature rises, although they diverge greatly when it comes to precipitation forecasts. According to the NCCSP, the Pacific Northwest region has seen a 1.5 degree Fahrenheit increase, 0.5 degrees higher than the global average. This 1.5 degree assessment concurs with observations taken at Lava Beds from weather data collected from 1946 to present. If carbon emissions are not curbed, projections are that the Klamath Basin may see a total of a +4 to +8 degree Fahrenheit rise by 2080 (NCCSP 2009).

The regional climate is also expected to become more extreme both in drought severity and duration, winter storm strength, and snowpack levels. Forecasts for the Pacific Northwest (including Oregon) indicate up to a 20% increase in precipitation (See Table 14). By contrast, predictions for California predict a greater increase of between 20% and 50% in average annual precipitation statewide. The future climate of Lava Beds National Monument proper may lie somewhere between these two broad, regional-scale forecasts, but they do point to some specific resources most likely to be negatively impacted.

Among the most obviously climate-sensitive resources are the perennial ice formations in many lava tube caves, and certain ecological components of terrestrial ecosystems such as fire, drought, and invasive species. All of these are directly sensitive to changes in precipitation and temperature changes

(e.g. melting, desiccation) and indirectly (increased plant susceptibility to pathogens).

TABLE 14: PREDICTED CHANGES

PREDICTED CHANGES IN ANNUAL MEAN		
	Temperature	Precipitation
2020s		
Low	+ 1.1°F (0.6°C)	-9%
Average	+ 2.2°F (1.2°C)	+1%
High	+ 3.4°F (1.9°C)	+12%
2040s		
Low	+ 1.6°F (0.9°C)	-11%
Average	+ 3.5°F (2.0°C)	+2%
High	+ 5.2°F (2.9°C)	+12%
2080s		
Low	+ 2.8°F (1.6°C)	-10%
Average	+ 5.9°F (3.3°C)	+4%
High	+ 9.7°F (5.4°C)	+20%
Model predictions of Pacific Northwest climate change from 20 different climate models. Low, Average and High reflect the range of model predictions and their effects on average annual temperature and precipitation. Source: University of Washington Climate Impacts Group		

ICE RESOURCES

Cave ice formation, fluctuation, and longevity are subjects of current scientific investigation. This resource is proving to be part of a complex system of interacting variables involving precipitation rates (directly affecting groundwater availability), surface air temperature, cave depth (affecting bedrock and groundwater temperature), and cave morphology (affecting airflow and temperature), as well as interactions of all the aforementioned components. Climate change will affect all but cave depth and morphology. An analogous system may be the glaciers on the slopes of Mt. Shasta, 40 miles to the southwest of the monument. The Mt. Shasta glaciers, the largest glaciers in California, have been growing in recent years. Their growth has been extensively studied. Howat, et. al. (2007) deduce that the glaciers of Mt. Shasta are only able to grow during increasing summer temperatures due to a matching increase in winter snowpack on the mountain. The ratio calculated from past glacial growth and climate data was an additional 20% in winter precipitation for every 1°C in average annual temperature increase to maintain stability in the extent of the glaciers.

Since temperature change is predicted to greatly exceed any possible increase in precipitation, Howat, et. al. also forecast a near total loss of snow from Mt. Shasta by the end of this century. These findings for Mt. Shasta may predict and explain fluctuations that can be expected in cave ice. While some ice formations may persist, or even increase, due to near-term increases in precipitation, long-term climate trends will likely have an overall deleterious effect on ice volume. This change may or may not be as catastrophic as the predictions for Mt. Shasta's glaciers. Further investigation into these ice resources, including determining the age of current ice formations, is key to better understanding how they have reacted to past climate changes, and therefore how they may react to future conditions.

VEGETATION

Typical of other Pacific Northwest areas, winter precipitation provides the overwhelming majority of moisture available to monument vegetation. Research predicts that the greatest loss of snowpack volume in Sierra Nevada, south of the monument, is expected to occur in the 4,300-8,800' elevation range (Knowles and Cayan 2006). These elevations include those of the monument, and with other trends, indicate that summer droughts will be longer and more severe. This will cause changes in plant communities, selecting for more drought tolerant species in areas most prone to

desiccation (south aspects, fast draining pumice soils, exposed ridges, etc). Overall shifts in ecotones should be anticipated, with grasslands, sagebrush steppe, and juniper woodland vegetation communities all moving up in elevation. Ponderosa pine currently established in marginal environments would be at the greatest risk of loss, particularly the small patches growing on the north aspects of Hippo and Caldwell Buttes and remnant trees in the Crescent Butte and Indian Wells Areas. Post-fire recruitment of pine seedlings in fire treated areas along the southern boundary of the monument can also be expected to diminish as the juniper woodland / ponderosa pine forest ecotone shifts to the south along the increasing elevational gradient.

Anthropogenic increases in atmospheric CO₂ levels will also have a direct effect on the invasiveness of exotic weeds. These non-native plants will benefit more from greater availability of CO₂ levels (Patterson 1995), and may change how they grow. These changes may include increased development of storage roots or rhizomes, causing them to be more difficult to control. Laboratory studies have already shown that certain weeds become resistant to common herbicides like glyphosate (Roundup) at elevated CO₂ levels (Ziska 1999).

WILDLIFE

Wildlife species that depend on these changing vegetation types will respond by changing their distribution or phenological behavior. Either they will find necessary food or shelter elsewhere, or change the season of year or time of day that they use these resources. Due to the confines of fixed political boundaries, national parks may experience losses of 20% of their species and drastic influxes of new species (Burns et al. 2003). At Lava Beds, the possible loss of the ponderosa pine forest type would result in the reduction or total loss of several species of birds from the park, including the white-headed woodpecker and other large-conifer dependant species. Expected changes to grassland and sagebrush steppe habitats would also affect wildlife, both currently in the park and those species of concern that might be re-introduced. Among these are the pronghorn, bighorn sheep, and sage grouse. Without appropriate vegetation, the change of successful reintroduction is low. Certain sensitive species such as pika and marmot may also be susceptible to climate change effects.

DISTURBANCE

The same projected climate changes that increase drought stress will also affect the frequency, spatial extent and intensity of wildland fires and insect outbreaks, two principal mechanisms of disturbance on the monument landscape. Large wildfire activity increased suddenly and dramatically in the western United States in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons. The greatest increases occurred in mid-elevation, Northern Rockies forests, where land-use histories have relatively little effect on fire risks, and are strongly associated with increased spring and summer temperatures and an earlier spring snowmelt. Northern California forests have had substantially increased wildfire activity, with most wildfires occurring in early-snowmelt years (Westerling et al. 2006). Similar increases in average temperatures and reduction in annual precipitation should diminish fire return intervals and make fire a stronger disturbance mechanism for monument landscapes. Climate change could also affect fire frequency and the area burned annually, with most of the scenarios resulting in increased fire (Lenihan 2005). Fire intensity and severity would also increase with drier fuels, causing future fires to have more severe effects than current fires. Fire severity influences vegetative response, and can greatly favor invasive weeds in areas with land use histories that included grazing or other anthropogenic disturbances. Along with wildland fire, mountain or western pine beetle infestation have become increasingly common in western forests, and climate change-driven outbreaks are expected to increase (Ayres 2000). These forest pathogens are opportunistic pests of native pines, and take advantage of drought-stressed trees to infest and kill them. Increases in winter temperatures and longer droughts both favor these insects, and are another reason the monument risks losing its ponderosa pine forest community.

VISITOR EXPERIENCE

Many visitors to Lava Beds place a high value on experiencing the Great Basin environment for activities such as hiking, wildlife viewing, camping, and photography. Potential changes in vegetation regimes and an increase in the frequency and intensity of fire could reduce the diversity and condition of resources visitors currently enjoy. Wildlife viewing and photography opportunities could also decrease, especially concerning birds, pronghorn, elk, pika, and marmot.

In general, hotter summer conditions resulting from climate change could potentially deter visitors from visiting during certain times, spending time enjoying resources above ground, prolonging a visit, or camping.

Ice cave resources are also among the most popular caving experiences for visitors. The loss of ice in Skull Cave (viewed by many thousands of visitors each year) and the loss of ice formations in Crystal Ice Cave (viewed by a few dozen visitors per year, but considered a very high quality resource experience in high demand) would be particularly impacted.

CULTURAL RESOURCES

The cultural landscape of the monument is likely to change as vegetation types react to new temperature and precipitation regimes. However, the grasslands and sagebrush steppe of the Modoc War battle sites is likely to persist, perpetuating the valuable visitor experience in these sites, though they may become more prone to summer wildfires. These fires present issues for resource protection, as artifacts revealed by removal of vegetation leaves them vulnerable to theft until vegetation regrows. Visitor access, and therefore the enjoyment of cultural and historic resources, may need to be restricted more frequently in the future in order to protect sensitive resources. Generally, the effects of unnaturally high intensity fires may have detrimental effects on some kinds of artifacts, hindering research and interpretation of them in turn.

Cultural Resources

Lava Beds National Monument contains numerous, significant cultural resources including archeological sites, rock art, ethnographic sites, historic structures, Modoc War fortifications, cultural landscapes, and objects. Nearly all of the monument's archeological sites and Modoc War fortifications are included in the Modoc Lava Beds Archeological District, listed on the National Register of Historic Places. The boundaries of this district include the entire monument and some U.S. Fish and Wildlife Service refuge lands along the south shore of Tule Lake. In addition, five other monument properties, three associated with the Modoc War and two rock art sites, are also listed on the National Register of Historic Places.

Because of the long history of preservation, the cultural resources of Lava Beds National Monument exhibit an exceptional level of integrity and lack of disturbance.

Prehistory

Eleven and a half thousand years of human occupation throughout the Klamath Basin has provided an extensive array of cultural resources associated with Lava Beds National Monument. The Modocs, their ancestors, and the predecessors of their ancestors were hunters and gatherers, living in semi-permanent villages along the shores of the ancient lake. At sacred sites, they painted pictographs and carved petroglyphs. Their foraging forays and vision quests took them into every part of their territory where their routes are marked today by obsidian chips, projectile points, and various stone tools.



Historic Overview

As European settlement moved westward into the Klamath Basin, conflicts between cultures escalated, culminating in the Modoc Indian War of 1872-1873. During the war, a small band of Modoc Indians successfully held off an Army twenty times their strength because of their detailed knowledge and use of natural fortifications formed by the lava flows just south of Tule Lake. These flows provided rifle pits, connecting trenches, shelters from mortar fire, and finally, a natural escape from encirclement. Occurring only seven years after the end of the Civil War, it was the only Indian war on record in which the army used mortars to assault an Indian stronghold. The war was characterized by embarrassing reversals for the military and it incurred significant costs. It culminated with the only death of a general officer at the hands of Indian warriors.

Before the creation of Modoc National Forest, the area which now encompasses the monument was grazed by large numbers of wild horses, left in the area after the Modoc War of 1872-73. After the Modoc War, cattle raising was the chief industry, and thousands of these animals were grazed in this general vicinity. About 1900,

sheep were brought in, and gradually the cattle industry decreased. By 1920, the only grazing within present day boundaries was by sheep. Many sheep grazing allotments remained valid even after the monument management was handed over to the National Park Service in 1933, and grazing continued within the monument to some extent until 1974.

The monument hosted a Civilian Conservation Corps (CCC) camp from 1933 to 1942. Initially located at Bearpaw, the camp was moved in 1935 to the Gillems Camp area. The CCC contributed significantly to the monument during its period of operation, constructing a number of rustic buildings and structures which remain in the monument today, and are included on the List of Classified Structures. Lava Beds also contains significant infrastructure from the NPS's last major infrastructure development initiative, Mission 66. The majority of development used today by visitors and staff date from that era including paved roads and parking areas, much of the campground, employee housing, and

maintenance buildings. The monument road system is unusual among national parks in that it was planned, designed and fully constructed during Mission 66. Other park units only had part of their road system constructed.

Contemporary Tribal Interests

Lava Beds National Monument encompasses lands long inhabited and used by Native Americans. The Modoc people retain strong spiritual ties to these lands and continue to visit the area. Descendants of the Modocs are now members of the multicultural, federally recognized The Klamath Tribes. The monument staff maintains regular contact with Modoc interests through The Klamath Tribes, with headquarters in Chiloquin, Oregon. The monument also maintains contact with the organizers of the annual Modoc Gathering, and with individual Modocs regarding traditional interests in the park.

In 1988, Lava Beds National Monument consulted with The Klamath Tribes and repatriated all of the human remains contained in the monument collections. More

recently, since the mid-1990s, monument staff have been working with representatives from The Klamath Tribes to address management issues associated with sensitive resources.

Archeological Resources

ARCHEOLOGICAL SITES

Lava Beds National Monument has a variety of archeological sites that span the Holocene era. Many of these sites, because of the potential to inform us about past people and their adaptations, contribute to the Modoc Lava Beds Archeological District (1990). Sites situated along the historic lakeshore within the monument are particularly significant because they represent a sample of sites in the Tule Lake Basin unaltered by modern agricultural activity.



Rock wall at Captain Jacks Stronghold, NPS Photo

The Modoc Lava Beds Archeological District was listed in the National Register of Historic Places in 1991. The District spans the monument and includes 221 significant sites. The assessed material remains represent a sample of pre-contact, historic human occupation sites, and early park development including CCC activities in the monument. The range of site types summarized in the district nomination include fortifications constructed during the Modoc War (1872 - 1873), rock art, occupation sites, production areas and vision quest features. There is also potential for the identification of historical archeological sites related to the CCC and early settlement. Sites are determined to be contributing to the district based on their assessed data potential (Criterion D) or their association with the Modoc War (Criterion A). The district nomination justified the need for enhanced protection of these sites because of the diminished integrity of contemporaneous sites in the basin. Future archeological work should incorporate formal National Register eligibility assessments of sites documented from recent survey efforts. The nomination boundary should also be revisited to better define boundaries associated with the various site types and historic themes represented in the district.

Archeological site types include domestic, trade, subsistence, processing, funerary, religious and defense sites. These cultural resources are significant under a number of National Register of Historic Places themes: in the area of military history and architecture; for their traditional cultural significance to contemporary Modoc; for the association with Captain Jack, the principal Modoc leader during the 1872-1873 War; and for their potential to yield information important to a range of prehistoric, ethnohistoric, and historic research domains.

Three archeologically sensitive environmental zones are identified in the Modoc Lava Beds Archeological District. The most archeologically sensitive zone is the lakeshore zone. Sites are heavily concentrated in this zone and most of the sites represent multi-activity use. The second most sensitive area is the ice cave zone. Since the only sources of water in the monument are Tule Lake and ice caves, these

were intensively used by prehistoric peoples. Almost all ice caves have associated prehistoric archeological sites. Last, the least archeologically sensitive area in the monument is the intermediate zone. Archeological sites in this zone are likely to be task-specific sites characterized as lithic scatters.

MODOC WAR ERA FORTIFICATIONS

Many of the Modoc War era fortifications are included in the Modoc Lava Beds Archeological District. In addition, three Modoc War era fortifications/sites, because of their size and importance during the conflict, were previously listed on the National Register of Historic Places. These include Captain Jacks Stronghold, where Modocs took advantage of the rugged topography to hold off a much larger U.S. Army force for several months; Hospital Rock, which served twice as an encampment for U.S. troops attacking the Stronghold; and Thomas-Wright Battlefield, where a surprise attack by Modocs soundly defeated a detachment of U.S. Army troops. Gillems Camp is also included in the Modoc Lava Beds Archeological District. In the future, NPS funding will potentially become available

to complete a survey of all Modoc War era fortifications within Lava Beds.

ROCK ART

Lava Beds National Monument contains exceptional examples of rock art. Petroglyph Point, separated from the contiguous boundary of the unit, is approximately 200 acres in size and contains more than 5,000 petroglyphs. Petroglyph Point was listed on the National Register of Historic Places in 1975. A number of the monument's caves, included in the Modoc Lava Beds Archeological District, also contain extensive rock art or pictographs.

Ethnographic Sites

A number of the cultural resources in Lava Beds National Monument, i.e. archeological and historic sites, hold traditional significance for contemporary Modoc who are now primarily affiliated with the Klamath Tribes of Oregon, the Modoc Tribe of Oklahoma, and the Confederated Modoc and Paiute Tribes. Monument sites serve as one of the tangible links for the Modoc with their ethnic heritage. The significant population decline and cultural disruption after historic contact, coupled with dispersal of the remaining Modoc population after the war of 1872-1873, led to fragmentation and dissipation of knowledge of the Modoc culture. Today there is a revitalized interest among Modoc about their traditional culture, and the Modoc Lava Beds District serves as one of the foci of this interest.

A recent study completed by John Allison (1994), "The Cultural Landscape of the Klamath, Modoc and Yahooskin Peoples: Spirit, Nature, History" and Douglas Deur (2008), "In the Footprints of Gmukamps," confirmed the importance of Lava Beds National Monument to Modoc people.

Historic Structures

Lava Beds National Monument manages 30 buildings and structures that are on the List of Classified Structures (LCS). These historic features have been evaluated to contain historical and architectural significance. Three structures related with the Modoc War are on the LCS and are individually listed on the National

Register of Historic Places. These include Hospital Rock Army Camp site, Captain Jacks Stronghold and Thomas-Wright Battle Site. Gillems Camp, Gillems Camp Rock Circle, and Gillems Camp Cemetery Wall are also on the LCS, although these features are not individually listed on the National Register, rather, they are part of the Modoc Lava Beds Archeological District. In addition to these sites, the Canbys Cross Memorial reconstruction is listed on the LCS. Although it has been determined to be ineligible for the National Register, Canby's Cross is managed as a cultural resource.

The LCS also includes numerous buildings and structures associated with the Public Works Administration (PWA) and Civilian Conservation Corps (CCC) era of development in Lava Beds. These features include the Superintendent's Residence, Service Station (Gas & Oil House), Garage/Shop (Operations Building), Indian Well Pump House, Schonchin Butte Fire Lookout, and 18 Rustic picnic tables. In addition to these buildings and structures, several PWA and CCC-built circulation features may also qualify for inclusion on the LCS, pending the completion of a certified Cultural Landscape Inventory (CLI). In 2007, a CLI was initiated by staff in the National Park Service's Pacific West Region, which evaluated PWA and CCC constructed buildings, structures and circulation features. As of 2010, the CLI is still in progress and, as a result, the National Register eligibility of these buildings and structures has not been determined. In the future, buildings and structures associated with the Mission 66 period of development may also qualify for listing on the LCS and the National Register.

Cultural Landscapes

Lava Beds National Monument contains a number of significant cultural landscape resources. Extant features include rock shelters and stacked rock fortifications associated with the Modoc War as well as roads, trails and several historic buildings and structures associated with Public Works Administration (PWA) and Civilian Conservation Corps (CCC) development. Many of these features have been evaluated and inventoried; however, the documentation, evaluation, and registration of cultural landscapes in the monument is not complete. Currently, the monument has one documented cultural landscape—the Modoc War Historic District. Additionally, PWA and CCC-era infrastructure

MAP 16: HISTORIC STRUCTURES

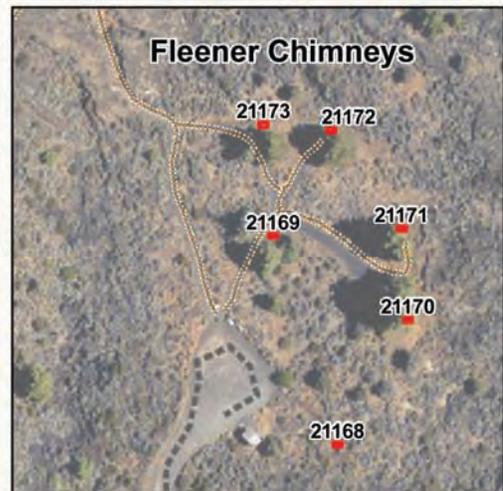
Lava Beds National Monument



Historic Structures



LCS #	NAME
<i>Headquarters Area</i>	
21150	Residence 40
21151	Old Fire Cache
21152	Gas Station
21153	Pump House
21156	CCC Picnic Table A3
21157	CCC Picnic Table A5
21158	CCC Picnic Table A6
21159	CCC Picnic Table A9
21160	CCC Picnic Table A10
21161	CCC Picnic Table B2
21162	CCC Picnic Table B3
21163	CCC Picnic Table B4
21164	CCC Picnic Table B7
21165	CCC Picnic Table B14
21166	CCC Picnic Table B15
21167	CCC Picnic Table B16
<i>Fleener Chimneys Area</i>	
21168	CCC Picnic Table 1
21169	CCC Picnic Table 2
21170	CCC Picnic Table 3
21171	CCC Picnic Table 4
21172	CCC Picnic Table 5
21173	CCC Picnic Table 6
21154	Schonchin Lookout*
* Not shown	



Roads & Trails

- Paved
- - - - Unpaved
- · · · · Trail

associated with the monument has been identified as a potential cultural landscape. In 2007, a CLI documenting development associated with the PWA and CCC in the monument was initiated, although at the time of this writing, it is still in progress.

In 2005, a Cultural Landscape Inventory (CLI) was completed for the Modoc War Historic District. This inventory identified and documented the landscape's location, physical development, significance, National Register of Historic Places eligibility, and condition of the Modoc War landscape.

The boundaries of the historic district encompass 16,764 acres of land. Located in the northern half of Lava Beds National Monument, the boundary also includes three discontinuous locations within the monument: the Petroglyph Point unit, the Caldwell Ice Caves, and Captain Jacks Ice Cave. The boundaries of the district were drawn to include areas where significant events and battles associated with the 1872-1873 Modoc War occurred. The primary battle sites within the district include the locations of the first and second Battles for Captain Jacks Stronghold and the Thomas-Wright Battlefield. Also included within the boundaries of the district are two important U.S. Army encampments—Gillems Camp/Hospital Rock and the Modoc encampment, referred to as Captain Jacks Stronghold.

According to the CLI, the Modoc War Cultural Landscape is nationally significant under National Register of Historic Places criterion A, B and D for the dates 1872-1873. Under criterion A, the district is associated with the Modoc War, a nationally significant event in the history of Native American-Anglo relationships as well as in the history of journalism in the United States. Furthermore, under criterion B, the district is nationally significant for its association with Captain Jack, the principal Modoc leader during the war. Captain Jack was also a significant figure in American military history and Modoc ethnic heritage. Finally, under criterion D, the archeological sites encompassed by the district have potential to yield information important to the history and documentation of events associated with the Modoc War.

Identified as in "Fair" condition, the Modoc War Historic District landscape shows clear evidence of minor disturbances and deterioration by natural and/or human forces. Some degree of corrective action is needed within three to five years to prevent further harm to its cultural and/or natural values. If no correc-

tive action is taken, the cumulative effect of the deterioration of the landscape characteristics will cause the landscape to degrade to poor condition.

Primary impacts to the landscape are vegetative succession and invasive plants. A secondary impact is visitation. Stabilization measures identified in the CLI include western juniper removal, continued implementation of the fire management program and its goal of restoring the lands to pre-1873 conditions, and the education of visitors to prevent impacts on contributing features/structures. Regardless, it is recommended that the Modoc War Historic District be preserved and maintained.

Since the completion of the CLI in 2005, Lava Beds staff have implemented stabilization measures for the Modoc War Historic District. Between 2006 and 2009, approximately 3,000 acres of land found within the Historic District have been cleared of western juniper. During 2010 to 2012, additional areas of the landscape are scheduled for juniper removal. In 2010, NPS staff will conduct a review of the CLI to determine if the current listed condition of the Modoc War Historic District as "fair" should be adjusted to "good." A landscape in "good" condition shows no clear evidence of major negative disturbance and deterioration by natural and/or human forces.

In 2007, NPS staff initiated field work associated with a CLI, documenting PWA and CCC-era resources within the monument. Many of these resources are associated with the infrastructure of the monument as developed between 1933 and 1942, and include some road segments, trails, the Schonchin Butte fire lookout, the superintendent's residence, as well as several additional buildings and structures. Archeological sites with the potential to yield information about the CCC include features at Gillems Camp, a site near Heppe Cave, the Old Visitor Center Site. This effort will potentially identify and establish a second cultural landscape within Lava Beds, which will provide valuable information for future management. Currently (2010), the PWA and CCC-era Cultural Landscape Inventory is still in progress and is anticipated to be completed in fiscal year 2010. In the future, a CLI for Mission 66 development at Lava Beds may be initiated to assess the National Register eligibility of buildings, structures, and circulation features associated with this era of development in the monument.

The following contributing structures are located within the Modoc War Historic District

- Captain Jacks Stronghold Fortifications
- Gillems Bluff Trail
- Gillems Camp Cemetery Wall
- Gillems Camp Howitzer Circle
- Gillems Camp Sentry Posts/Fortifications
- Hospital Rock Army Camp Fortifications
- Other Battlefield Stacked-Rock Fortifications
- Thomas-Wright Battle Fortifications

Museum Collections

In 2009, there was a total of 36,744 museum objects managed by Lava Beds National Monument. Total museum collections included the following classifications:

- Archeology - 7,761
- Ethnology - 53
- History -1,535
- Archives -24,172
- Art- 54
- Biology – 3,104
- Paleontology -14
- Geology - 25

Items include historic objects from the Modoc War era, prehistoric objects from Native American occupation, and specimens of the area's plants and animals.

In 2002, a *Museum Management Plan* (MMP) was finalized and approved for Lava Beds National Monument. This plan identified an additional 176,300 items to be added to the collection. Currently, as identified in the 2009 *Collections Management Report*, a total of 1,550 museum objects are in need of cataloging (NPS 2009). Lava Beds is working towards cataloging these items and has received funding to complete this backlog catalogue project.

In 2004, Lava Beds moved the cultural resources collection into the new visitor center. A collections room was developed in the visitor center to house cultural objects, as recommended in the 2002 MMP. Currently, the natural collections are housed in a building that is next to the administration office. The MMP also identified the need to improve professional curatorial oversight. In 2004, Lava Beds National Monument signed an

agreement with Crater Lake National Park to receive assistance from their curator. This agreement has improved the professional management of the collections program. Since 2002, storage management within the two locations has included the development of a vertical art rack and installation of storage cabinets.

Future project needs for collections include the development of improved staff access and use, public involvement in partnerships, and location and documentation of collections from the monument which are housed elsewhere. The monument will also identify, process, document, and duplicate monument records and archives, and make these available for staff and public use (NPS 2002). The 2009 *Collections Condition Report* identified 173 applicable management standards for the museum collection. In total, 151 standards were met in 2009 and 22 items were listed as deficient and in need of review.

Visitor Use and Opportunities

Access and Circulation

The vast majority of visitors visit Lava Beds National Monument using private or rental automobiles or recreational vehicles (RVs). A smaller percentage of visitors arrive by chartered school or tour bus, and occasionally a rare visitor arrives by touring bicycle. There is no public transit service serving the monument. All of these modes of travel use the monument road system. Lava Bed's road system consists of a north-south trending 20-mile long, paved primary road, with connecting spur roads that lead to various attractions and routes out of the monument. The total mileage of monument roads is approximately 33 miles, of which 28 miles are paved, and all roads are owned and maintained by the National Park Service.

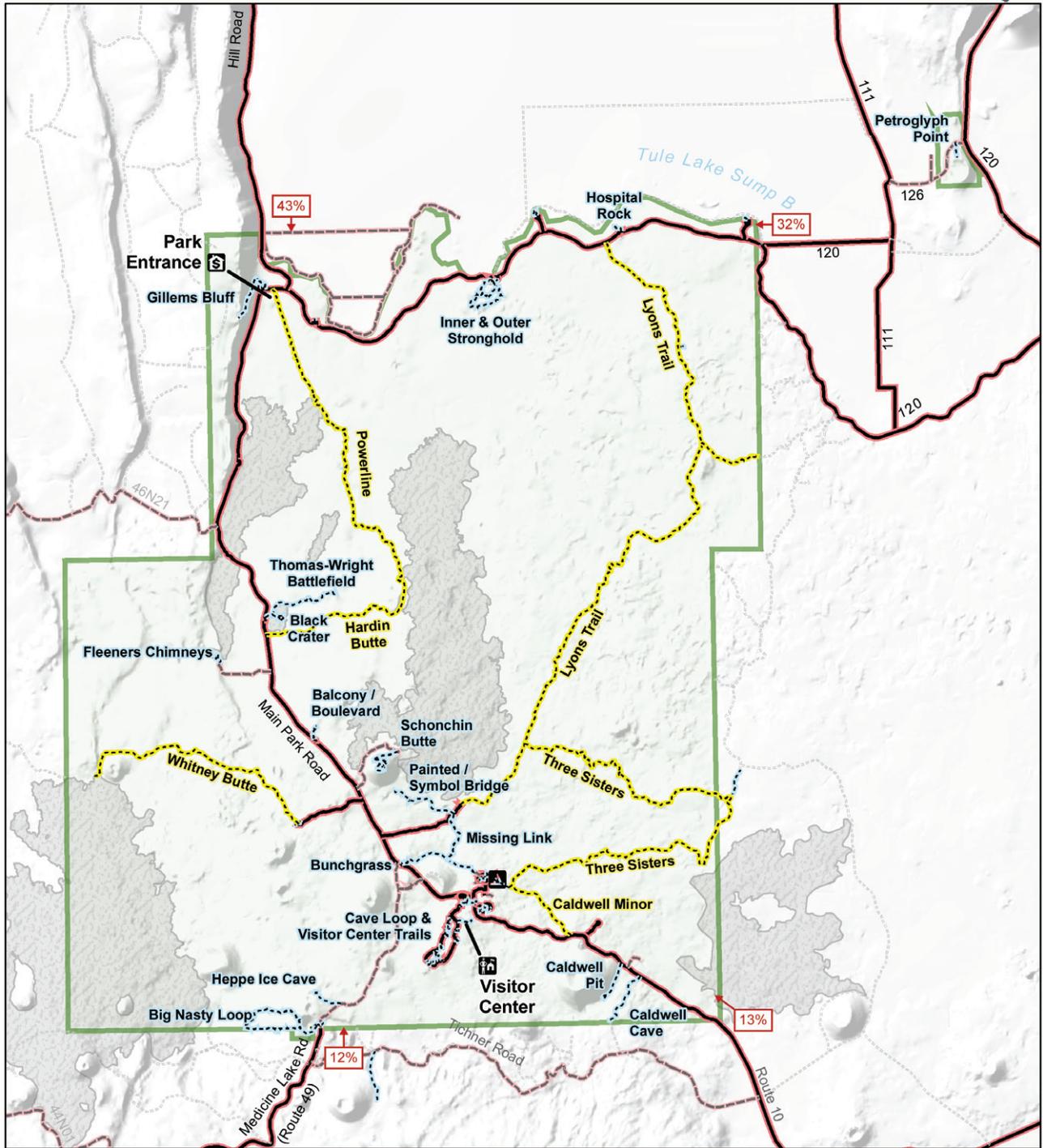
The monument's paved roads are kept open year round. There are four entrances to the monument, two from the north and two from the south. Northern monument entrances are the primary access routes to the monument (75% of visitors). Northeast of the main portion of Lava Beds, the Petroglyph Point section is accessed by the unpaved Modoc County Road 126, which connects with County Road 111 to the west and

MAP 17: ROADS AND TRAILS

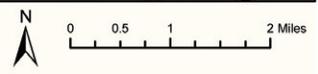
Lava Beds National Monument



Roads & Trails



Trails	Roads	Misc.	
Horse Trail	Paved	Monument Boundary	Lava
Foot Traffic Only	Unpaved	Average daily percentage of traffic (2008)	



County Road 120 to the east. Access from Hill Road from the northwest is the most common access route by monument visitors. Roads that access the northern entrances are paved and in good condition.

The southeastern entrance from Forest Service Route 10 has been deteriorating over time due to a lack of funding for U.S. Forest Service maintenance. On the southwest, the unpaved Medicine Lake Road is kept open during the winter through the monument to the Doorknob Snowmobile Park, which is located approximately 1.5 miles south of the monument boundary. This snow plowing service is paid for by the State of California Off-Highway Vehicle “Green Sticker” program fees. South of that staging area, the Medicine Lake Road (Forest Service Route 49) climbs to over 6,500’ in elevation through the Modoc National Forest where it is typically closed by snow between November and late May. The monument trail system generally is not used as a way to access the monument from the outside.

The Lyons Road is maintained as a one lane, primitive “two track” road between the gate on the northern boundary road and 1.8 miles south to the Fern Cave trailhead. A locked gate is maintained at the north end of the road and is closed to general public vehicle traffic. Although the road is passable in a two wheel drive automobile, motor vehicle use is limited to official vehicles and only in the dry seasons as the road can be rutted when wet. Weekly Fern Cave tours drive to the trailhead in a government van from the Hospital Rock parking area during the dry seasons. The remaining two miles of the road leading south connects with a U.S. Forest Service road on the eastern boundary. This section is very rough and passable only for high clearance and short wheel base vehicles. Another locked gate is maintained on the east boundary of Lava Beds. The two mile segment south of the Fern Cave trailhead is used by official vehicles engaged in wildland fire fuels treatment project work on a very infrequent basis (less than once a year). Lyons trail hikers also walk on the road between the Juniper Butte junction and the main gate.

ACCESS HISTORY

Up until the late 1980s the only paved access road leading to the paved internal monument roads was the southeast entrance road (Forest Service Route 10) that connects the monument with Forest Service Route 97 and in turn the community of Tionesta and State Route 139. The 9.9 mile long southeast entrance road between the boundary of Lava Beds and the intersec-

tion of Forest Service Route 97 was initially “surfaced” by the NPS in 1965. This surfacing consisted of multiple applications of chip seal surfacing approximately 1-inch thick over a graded base of native soil. Little or no aggregate material was placed under the surfacing to construct a foundation that is typical of a primary paved road. Between 1965 and 1995, the NPS maintained the sections of the road south of the monument under an agreement with the Modoc National Forest. In the 1980s and early 1990s the NPS received inadequate funding to maintain its paved roads, and many roads rapidly deteriorated. Only the most heavily traveled roads or roads with high accident rates received funding for repaving or major maintenance projects. Projects proposed for the southeast entrance road, given it’s very low traffic volumes and non-NPS ownership were not funded.

Without funding for proper maintenance treatments, the lack of aggregate foundation, and the thin pavement, the southeast entrance road deteriorated. In 1995, out of concern over the poor conditions of the road pavement, and poor prospects to get future funding, the NPS terminated the agreement with the Modoc National Forest, and turned the responsibility for maintenance back to the U.S. Forest Service. However in the years since 1995, the U.S. Forest Service’s financial resources to rehabilitate and maintain roads have proven to be even more inadequate than the NPS’ resources. The result is that the road is now in extremely poor condition with large areas of failed and broken up pavement.

Visitor complaints about the road are frequent, and many feel that they should be warned in advance that the road is in such bad condition so that they could choose other routes. The U.S. Forest Service has patched the road on several occasions, and may be able to apply a layer of chip seal surfacing in 2010, but these repairs are stop gaps and will not result in a road surface that will provide a reasonable length of pavement life. The low volume of traffic on the road will always handicap the road when it competes for project funds with other more heavily traveled roads. Modoc County also lacks financial resources to maintain or rehabilitate the road and is not willing to accept ownership or responsibility for the road. The long term prognosis to maintain this road as paved route or to accomplish any major rehabilitation project work is poor.

Around 1989, Modoc County and the NPS paved the Dike Road to provide the first paved access to the northern end of the monument. In 1995, the Siskiyou County road that serves the northwest corner of the monument (Hill Road) was paved. The only remaining unpaved entrance road is the Medicine Lake Road (Forest Service Route 49) that connects the southwest corner of the monument with the Medicine Lake Highlands and in turn, State Route 89 between McCloud and Burney. The majority of Medicine Lake Road between the monument and State Highway 89 is paved.

TRAFFIC VOLUMES

Traffic on the monument's roads is generally light in comparison with other more visited national parks and urban areas. Average Daily Traffic (ADT) on the main monument road can be as low as 25 vehicles on weekdays in the winter months and as high as 350 on summer weekend days. Given these traffic volumes, there are generally no traffic congestion problems. The highest volumes of traffic enter and exit the monument via the Hill Road entrance (48% of total volume) as that is the most direct route to Klamath Falls, followed by the Dike Road entrance on the northeast (25%), followed by the Medicine Lake Road (14% - which is only open as a through route for approximately five months of the year), and lastly by the southeast entrance road (13%). The monument does not keep traffic count data on the Petroglyph Point through road.

ROAD AND PARKING CONDITIONS

The main north-south monument road is generally well designed and constructed with a visually pleasing, smooth alignment and 30- to 50-mph design speeds. The north-south main monument road is 22 to 26-feet in width, thus it is comfortable to drive in all vehicle types. The road also has periodic paved parking areas that allow visitors to pull off and view or visit the monument's attractions. Spur roads are generally narrower (20') and have lower design speed alignments. The parking areas along all of the paved roads are generally separated from the traffic lanes and paved. The capacity of the parking areas is also adequate for the busiest summer months, with the only exception being some of the parking areas on the Cave Loop Road that can fill on busy summer weekends. Most parking areas have pedestrian sidewalks and basic access ramps and or curb cuts for disabled access.

Given the relatively well designed road and low traffic volumes, motor vehicle accidents are rare and when they do occur are, generally, the result of driver error (high speed), inattention, intoxication, or hitting wildlife (primarily deer). In the most recent condition survey of the paved roads of Lava Beds National Monument, the road pavements were found to be in fair and poor condition. This low rating is primarily due to the pavement now being approximately 40 years old, and suffering from rutting in the wheel paths, and extensive thermal (expansion and contraction) cracking of the pavement. Given the age of the pavement, the roads have been well maintained with periodic sealing of the cracks and applications of chip seal surfacing.

FUTURE ROAD IMPROVEMENTS

Sometime during the 20 year life of this general management plan, a project to rehabilitate all of the paved roads and parking areas in the monument by pulverizing the existing pavement and applying new hot mix asphalt pavement over the former roadway will need to occur. The project is designed and awaiting funding.

Another project to realign and pave the Medicine Lake Road within the monument has been partially designed, but design work was halted due to lack of funding and a general National Park Service-wide policy prohibiting adding additional paved road infrastructure. The U.S. Forest Service has long had plans in place to pave and improve the currently unpaved segments of the Medicine Lake Road, but these too have stalled due to the lack of funding.

Accessibility and Special Populations

Lava Beds offers limited opportunities for those with impaired hearing, sight, mobility, and cognitive function, as well as people with difficulty understanding English. Some additional accommodations beyond what is currently available at Lava Beds are required. As directed by the standards of the Interpretive Development Program, all interpretive contacts are modified to best meet the physical and cognitive abilities and knowledge base of each visitor to the greatest extent possible.

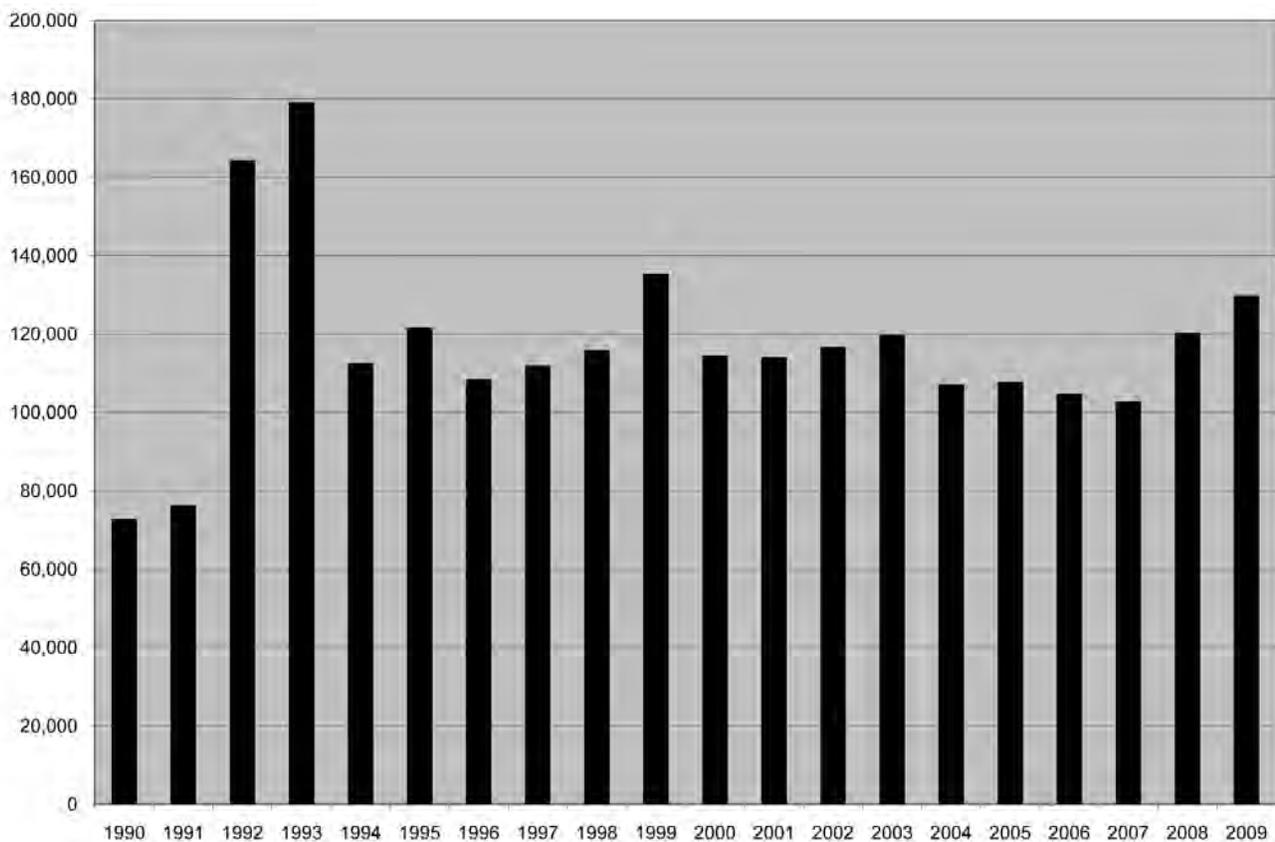
By the nature of the rugged volcanic terrain, most natural areas of Lava Beds are not easily accessible to visitors with physical impairments, especially cave environments that require steep descents and contain rough lava floors. However, some developed areas offer access to disabled visitors. The visitor center contains exhibits, some bookstore shelving, and a portion of the front desk at wheelchair height. All curbside wayside exhibits and bulletin board displays in the field are located on low-graded pavement with ramps from parking areas. Interpretive programming available to the mobility-impaired includes evening slide programs and porch talks at the visitor center. Some easier caves and relatively level, short hiking trails may be accessible for those with mild mobility impairment, including ranger guided interpretive programs offered in these locations. One self guided trail at Petroglyph Point travels along a level, relatively smooth natural rock surface, which may be accessible to some using wheelchairs. Additional visitor services such as accessible campsites, restrooms, and picnic sites are also available throughout the monument, though all doors must be manually opened.

Although the exhibits in the Lava Beds Visitor Center include many tactile displays and audio stations of benefit to the hearing impaired, there are currently

no assistive materials in Braille. Generally, a severely sight-impaired visitor would need assistance from a sighted person to fully experience the exhibits. This is especially true of all non-personal interpretive services outside the visitor center such as wayside exhibits, bulletin boards, and site bulletins, which depend entirely on written material. The 15-minute introductory video, though it includes audio narration, also lacks an audio description track (an additional track which describes the visual content of video programs, typically listened to on a headset). Additionally, the website lacks an audio component to narrate its written content. Generally, a sight-impaired person could independently enjoy the orally-presented portion of a stationary interpretive program such as an evening slide program or porch talk, but may need assistance from another person to attend a guided cave tour or other guided walk of appropriate difficulty.

All written interpretive materials throughout the monument and on the Internet are of benefit to the hearing-impaired that can read. However, NPS standards encourage sites to include assistive listening devices (headsets that narrate audio-visual programming at increased volume) as well as provide interpreters fluent in sign language. Currently, neither of these

FIGURE 1: ANNUAL VISITATION (RECREATION VISITS)



services is available, and personal communication with hearing-impaired visitors occurs either through writing or a companion who can sign.

Lava Beds strives to provide appropriate informal interpretation to cognitively-impaired adults. Sometimes these visitors enjoy participating in the Junior Ranger program. Lava Beds also receives moderate visitation from those who are not fluent in English. Though many visitors speak English as a second language, Lava Beds particularly receives visitors that sometimes struggle with services in English: Spanish speakers from the local area, and Asian-Americans on tour buses from the San Francisco area (typically speaking Cantonese or Mandarin). Recently, monument staff has made an effort to provide interpretation in a number of languages, including Spanish, Chinese, Japanese, German, and French.

Monument Visitation

OVERVIEW

The National Park Service reports visitor use as recreation visits. A recreation visit is one person entering a park for any part of a day for the purpose of recreation. One person may be counted as a “visit” more than once if he/she enters the park at more than one location. Thus we use the term “recreation visit.”

VISITATION

During the 1990s the average annual recreation visits to Lava Beds National Monument were approximately 120,000 people. In the 2000s, the average annual recreation visits were slightly lower (6%) at about 112,000. Visitation has remained relatively low for most of the 2000s, ranging from a low of about 102,000 visitors in 2000 to a high of 130,000 visitors in 2009. Figure 1 shows the total annual recreation visits for Lava Beds from 1990-2009. Note that the high visitation spikes in the early 1990s were due to non-recreational traffic associated with a nearby construction project. On a monthly basis most visits occur from June through September with July and August receiving the highest number of visitors.

VISITOR SURVEY PROJECT

In 2007, a Visitor Survey Project was completed for Lava Beds National Monument. The visitor survey

provided important information on visitor demographics and patterns and identified visitor concerns and suggestions for future planning. A total of 340 questionnaires were distributed to visitor groups. Of those, 223 questionnaires were returned resulting in a 65.6% response rate. The survey was conducted in May and June, over a holiday weekend, and may not be characteristic of the rest of the season.

Demographics

United States visitors were from California (47%), Oregon (26%), Washington (8%), and the remaining from 18 other states. International visitors were from 13 countries and comprised 9% of total visitation to the monument during the survey period. Of the international visitors that completed the survey, 25% were from Germany and 15% were from the United Kingdom.

Of the visitors surveyed, the majority were part of a group of two or more. Fifty-one percent of visitors surveyed were in groups of two and 16% were in groups of five or more. The survey indicated that many of the visitors travel together with their family. Of the visitors that described themselves as part of a group, 66% defined their group as family, while 18% described their group as friends.

Seventy-three percent of visitors visited the monument for the first time, while 37% had visited two or more times. Prior to their visit, most groups obtained information about Lava Beds National Monument through maps and brochures (44%), the monument website (41%), and friends/relatives/word of mouth. Nine percent of visitor groups did not obtain any information about the monument prior to their visit.

Length of Stay/Lodging

Of those visitor groups who spent less than 24 hours at the monument, 33% percent stayed up to six hours. Of those that spent more than 24 hours in the monument, 41% stayed for two days. The average length of stay was 14.4 hours. This length of stay is quite long when compared to the length of stay for visitors to many other national park units. The majority of visitors surveyed (82%) stayed in the monument campground, and 71% stayed in a lodge, hotel, motel, or cabin outside the monument.

Most visitor groups (95%) were able to obtain needed support services from communities in the area (within

60 miles of the monument). Over one-half (60%) obtained services in Klamath Falls. The average group expenditure within and outside the monument was \$206 with a median (50% paid more and 50% paid less) of \$113. Average total expenditure per person was \$71.

Visitor Services

Most visitor groups (93%) rated the overall quality of services, facilities, and recreational opportunities at Lava Beds National Monument as “very good” or “good.” Less than 1% of visitor groups rated the overall quality as “very poor” or “poor.” The most used services/facilities by survey respondents were the restrooms (91%), the visitor center (91%), and the monument brochure/map (90%). The services/facilities that received the highest combined proportions of “extremely important” and “very important” ratings included campgrounds (92%) and restrooms (90%). The services/facilities that received the highest combined proportions of “very good” and “good” quality ratings were assistance from monument staff (93%) and the visitor center (93%).

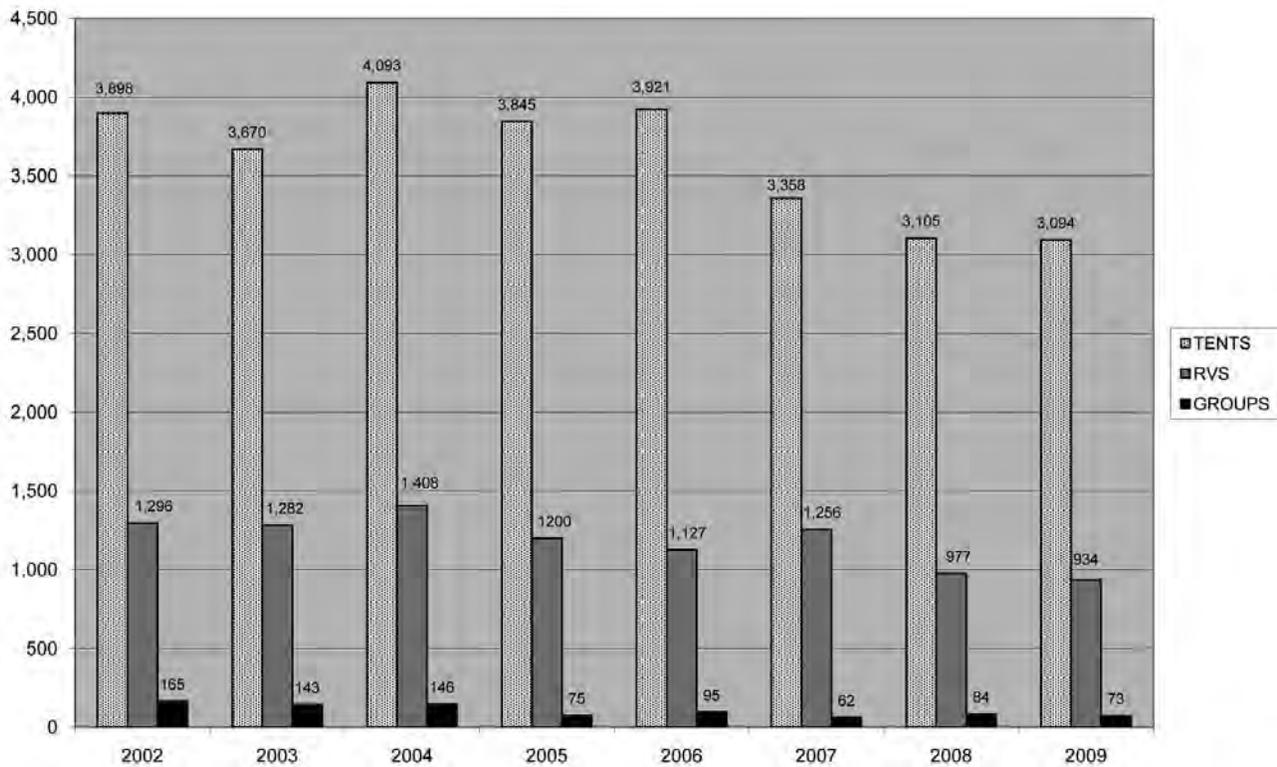
Suggestions for Future Planning

The visitor questionnaire included the question, “If you were planning for the future of Lava Beds National Monument, what would you propose?” The most commonly proposed suggestion was improving regional information for the monument. Visitors desire more directional signage when entering the monument, and many would like more information and advertising about the monument to be available in the region. More overnight accommodations in the area are also desired.

Improvements to southern access roads were suggested by many of the respondents, including repaving the southeastern entry road and paving the Medicine Lake Road. Aside from road improvements, campground improvements and requests for new overnight accommodations were the most common type of facility improvements requested.

Survey respondents would like to see more information/interpretation about the monument resources. This includes more information on history, geology, Modoc culture, Japanese internment camps, and viewing night skies. Better guides and information for caving activities were also common requests.

FIGURE 2: CAMPGROUND USE **Campground Use (2002-2009)**



While many suggestions for changes were provided by the survey respondents, a number of the respondents would rather see the monument stay the same. Visitors like that the monument is undeveloped - "not like Yosemite." These visitors appreciate solitude and the un-crowded conditions. They do not want to see more development or new facilities.

OVERNIGHT STAYS

Visitors that stay overnight at Lava Beds typically stay at the Indian Well campground, a historic campground built by the Civilian Conservation Corps and later expanded under the Mission 66 program. Most overnight stays are tent campers. However, RVs also stay overnight at the Indian Well campground. Since 2002, RV overnight stays have comprised approximately 25% of campground visits. Figure 2 depicts the distribution of overnight stays in the campground from 2002-2009.

A very small number of visitors stay overnight in the monument's backcountry. The monument has seen an average of 26 overnight stays in the backcountry annually over the past decade. This small number is typical for the monument. Often the monument has gone several years without any overnight camping in the backcountry. In 1991, the monument had over 200 overnight stays in the backcountry. This appears to be an anomaly in the overall trends for backcountry overnight stays at Lava Beds.



Student Conservation Association intern leading a cave tour, NPS Photo

VISITOR CENTER USAGE

Visitor Center visitation has averaged over 41,000 annually since 1992 (measured by door counts). A downward trend in the 1990s seems to have been reversing since 2003, with FY2006 visits reaching almost 46,000. Visitor center visitation also varies greatly throughout the year. Peak visitation occurs in July and August with an average of 290 visits per day (with approximately double that amount on holiday weekends), and reaches its lowest point in December and January with an average of 16 visits per day. Moderate visitation extends well into the shoulder seasons, from early May into mid-October, especially in years with mild spring and fall weather and when multiple school classes are visiting. The extensive assis-

stance most visitors need in order to cave safely on their own increases the amount of time necessary per visitor contact, and consequently the number of interpreters necessary to adequately staff the visitor center.

FEE COLLECTION

Lava Beds National Monument began collecting entrance fees in 1996 under the Recreational Fee Demonstration legislation (camping fees have been collected for decades). In 2005, this temporary authorizing legislation was replaced by the Federal Lands Recreation Enhancement Act. The current seven-day entry fee to Lava Beds National Monument is \$10 per vehicle and the joint Lava Beds / Crater Lake annual pass is \$20. Eighty percent of the fees collected at Lava Beds (averaging approximately \$108,000 annually) stay within the monument to fund improvements that will directly benefit visitors. The current entrance station, completed in 2006, is located on the main monument road near the northwest entrance. Entrance station

staff collect monument fees, sell passes, and provide information and brochures to incoming visitors. The entrance station is open during weekends in spring and fall, and seven days per week from Memorial Day weekend to Labor Day. Fees are collected in honor boxes (pipe safes) near and inside the visitor center in the off season when the entrance station is closed.

EDUCATION

The ability of Lava Beds National Monument to provide curriculum-based services for education groups has fluctuated considerably over the past decade, in correlation with frequent staff turnover and the urgency of other divisional priorities. At current staffing levels, the equivalent of one-third of one full-time position is dedicated to the Education Program each year by an interpretive staff that is also responsible for a wide range of other duties. The materials and programs now offered successfully present some subjects for students in a limited grade

range, but services addressing other significant subjects and geared towards other grades are not available.

The use of loan materials accounts for a significant portion of educational contacts made by Lava Beds National Monument each year. The five traveling education trunks currently available were developed to meet Oregon and California history, earth science, and life science curriculum standards generally for 3rd through 6th grades, and address volcanic geology, cultural history of the area, and the ecology of local birds, bats, and the monument's caves. These kits contain activities, lesson plans, hands-on materials, and audio-visual media to be used by teachers in the classroom. Most teachers use the trunks to prepare for a field trip to the monument, but they are occasionally requested for post-visit activities or by groups that are not able to make an on-site visit. Recent updates have made the trunks more suitable for these multiple uses, as well as aligning them with current curriculum standards and research.

The four on-site ranger-led programs currently available address volcanic geology, cultural history, and fire ecology at 4th-through-6th-grade levels. These programs are intended to continue the learning process begun in the classroom, which ideally has made use of the traveling education trunks. The two available geology programs—a slide show in Mushpot Cave and a tour of Valentine Cave—tell the story of the Medicine Lake shield volcano and lava tube caves from inside a cave, and also introduce caving ethics to ensure safety and resource preservation. A guided walk through Captain Jacks Stronghold addresses the points of view of all participants in the Modoc War, reinforced by traveling through a landscape where two battles actually happened. A new fire ecology program developed in 2010 also introduces students to the ecological effects of a wildfire that occurred in the monument's grasslands in 2008 as well as the challenges of land management to meet multiple natural and human goals. Occasionally teachers and other group leaders request ranger-led programs on other topics and at other sites. With current staffing levels, these program requests cannot always be met and generally with inappropriate ranger-to-visitor numbers. All ranger-led programs contain a stewardship message and encourage awareness of the mission of the National Park Service.

Teachers are involved to a limited degree in the development and update of educational services at Lava Beds. Traveling trunks include feedback forms, and

teachers have an opportunity to give feedback after ranger-led programs. Two lightly attended Teacher Workshops held at the monument in fall 2005 and spring 2010 invited teachers to become more familiar with available materials, provide feedback for updates, and comment on future needs. In-classroom programs and the meetings with teachers that precede them have also increased local teacher knowledge of the resources and programs offered at Lava Beds. Despite these attempts, teacher involvement in the Lava Beds Education Program is well below expectations set by Director's Order #6 and the Centennial Renaissance Action Plan. Increasing efforts in this area would greatly benefit teachers, students, and the monument.

While the Lava Beds Education Program provides high-quality services in some areas, further development is needed to bring the program up to National Park Service standards and meet public demand. NPS standards for education programs include a pre-visit lesson, on-site activity, and post-visit reinforcement of learning, all designed to support state curriculum standards; as well as learning based in student inquiry and direct experience as opposed to teacher- or ranger-directed lessons. Although inquiry-based learning is beginning to be incorporated into programs and materials, very few classes complete a pre-visit lesson with a ranger or teacher, attend an on-site program with a ranger, and complete a post-visit lesson with a ranger or teacher. Approximately 45 percent of visiting students are in the age range served by current education services; Lava Beds has the staffing and material resources to provide about half of these students with loan materials or a ranger-led program. In order to reach the three-quarters of visiting students that are not currently served, it is necessary to increase program availability, develop services for other age groups, and expand the range of topics covered. Encouraging more significant teacher involvement and providing more in-school programs would round out the education program, making Lava Beds resources more widely available and creating a larger role for the monument as an education partner in area communities. Increased staffing devoted exclusively to the Education Program is necessary to begin making this transition.

INTERPRETATION

INTERPRETIVE PLANNING

Interpretive staff has worked to plan and achieve several long-range goals over the past 10 years including training, auditing, and encouraging the submission of interpretive products to national Interpretive Development Program standards; expanding and retooling education services based on both Oregon and California curriculum standards; revising site bulletins, bulletin boards, and website content in line with new themes and interpretive writing standards.

VISITOR CENTER/ INFORMAL INTERPRETIVE CONTACTS

The current Lava Beds Visitor Center was constructed in 2004 to replace a much smaller facility. It is open every day except Christmas, with slightly extended hours during the summer season. Though located in the southern part of the monument, most visitors interested in caving make the visitor center one of their first stops in order to obtain the necessary information and equipment. Services offered include: personal assistance at the desk; availability of maps, site bulletins, and information about Lava Beds and surrounding attractions; daily loans of flashlights for self-guided caving; museum exhibits that adequately cover the majority of the monument's primary interpretive themes and are inclusive of audio stations, a computer program, and tactile items; and a 15-minute video covering several interpretive themes and way-finding information. Most incoming public phone calls as well as inquiries via mail and e-mail are also handled by visitor center staff. In addition, the visitor center houses a small Lava Beds Natural History Association outlet that sells educational items as well as convenience items such as snacks and protective equipment for caving, since there are no concession services available in the monument.

Visitor satisfaction with the new visitor center has averaged a 95 percent rating of "very good" or "good." Visitor satisfaction with assistance from monument

employees, the majority of which occurs in the visitor center, has also remained high, averaging a 96 percent rating of "very good" or "good" since 1999. Additional informal interpretive contacts occur daily in summer, and on weekends in spring and fall, at the fee booth in the northwest corner of the monument. Park interpretive staff also performs limited roving interpretation throughout the monument, primarily during summer weekends.

INTERPRETIVE PROGRAMS

In the past few years, permanent staff have striven to train, coach, and audit all formal interpretive programs to the professional standards of the NPS Interpretive

Development Program, including encouraging the submission of programs for national certification. This provides greater opportunities for a wider range of visitors to connect both intellectually and emotionally to the meanings of Lava Beds' many and varied resources, in accordance with national standards for interpretation.



Cave tour NPS Graphic

Interpretive programming is focused on the summer season. In summer, evening programs are offered in the monument's campground amphitheater. These programs allow a more in-depth look at the monument's diverse interpretive themes, and can greatly enhance the depth of visitor understanding and appreciation. Ranger-guided cave tours are also currently offered to a different developed cave daily in summer, and provide a safer and more interpretive experience of the monument's geology than self-guided tours. These tours vary widely in difficulty level to meet the needs of a variety of visitors, as well as public demand for ranger-guided tours for those not comfortable caving on their own. Additionally, guided walks through natural and historical areas and porch talks on a variety of monument interpretive themes are offered in summer as staffing allows. Though these types of programs are sometimes sparsely attended at sites in the south end of the monument, there is currently not enough flexibility in summer staffing to offer frequent summer walks and talks at popular sites in the north end of the monument, particularly at Petroglyph Point.

In general, evening programs are very well attended by percentage of visitors camping in the campground, and participants could be easily garnered for additional ranger-guided cave tours if staffing levels allowed. There is also demand for ranger-guided programs from non-school based groups (such as Scouts and church groups) visiting the monument throughout the year, and these are able to be occasionally arranged only as staffing permits.

Several special resource cave tours are also offered to caves that are otherwise not accessible to the public. Currently, this includes once weekly tours of Crystal Ice Cave early December through late March, and once-weekly tours of Fern Cave mid-May through late October. Due to the sensitivity of the cave environments, difficult caving, and/or sensitivity of the interpretive material, these tours are only led by permanent interpretive staff. Concerns in Crystal Cave include human impact on a delicate meteorological environment that sustains year-round ice formations, and having a small enough number of tour participants for one ranger to guide and coach them safely through challenging sections. Concerns in Fern Cave include human impact on, and balanced interpretation of, a sensitive cultural environment. The monument has also received numerous formal and individual comments against public ranger-guided tours of Fern Cave from members of the Klamath Tribes due to its cultural significance. However, the monument currently receives far more public demand than it can meet for tours to these two, and/or additional closed special resource caves, since only six participants are permitted per once-weekly tour.

The monument conducts a year-round Junior Ranger program for children between 5 and 13 years of age via a self-conducted Adventure Book that is reviewed with an interpretive ranger for a small award. Additionally, the monument offers a ranger-guided Junior Firefighter program and a Junior Lookout program which can be completed by hiking to the fire lookout and completing a questionnaire about fire and fire management.

The number of visitors attending formal interpretive programs at Lava Beds has varied greatly over the last eight years for which there is accurate data. The highest number of participants in formal programming occurred in 1999, with 7002 participants, or approximately 19% of those visiting the visitor center (5.2% of total monument visitation). The lowest participation occurred in 2004, with 2194 visitors attending a formal program, or about 5.5% of those visiting the visitor center (2.1% of total monument visitation). This wide fluctuation can be explained by the small size of permanent interpretive staff and the reliance on volunteer and other labor through internship programs, particularly the Student Conservation Association. The dependence on seasonal staff consumes a significant amount of permanent interpreters' time

to train and coach to professional standards, while still being able to complete off-season projects, ensure daily visitor center coverage, and meet in-monument and national collateral duty contributions. Over the past few years, this trend has been somewhat alleviated, however, by the addition of several uniformed seasonal

interpretive staff through the NPS Centennial program funding.

NON-PERSONAL SERVICES: EXHIBITS, TRAIL GUIDES, PUBLICATIONS, AND PARK WEBSITE

The wide variety of natural and cultural resources and interpretive themes at Lava Beds dictates a need for a great number and diversity of exhibits, publications, and web pages. Visitors often arrive at the monument unaware of the diversity of resources and visitor experiences offered here.

Lava Beds has approximately 40 wayside exhibits (large interpretive panels with graphics) in addition to smaller interpretive and informational signs in the field. Most are set into a base made of native lava rock, which is a distinctive and attractive style for the Lava Beds landscape. However, many of these wayside bases are now in fair to poor repair. Interpretive content covers mainly geologic features and historic events of the Modoc War, though other panels touch upon pre-war cultural history (such as rock art), monument



Interpretive Display NPS Graphic

wildlife and vegetation communities, air quality, and 20th century history. Smaller signs identify rock and vegetation types outdoors and lava tube features inside Mushpot, the monument's one lighted and interpreted cave.

The last comprehensive wayside exhibit plan was completed in 1981, and until recently, the majority of the monument's waysides were replacement copies of panels designed and installed in 1987. However, significant updates and additions have been made in recent years, such as a complete redo of 16 geologic science panels, and eight panels at Modoc War sites to more interpretively tell the story of both sides. Limiting factors in wayside exhibit replacement include difficulty obtaining project funding for large-scale panel replacements in a competitive funding environment, and ensuring adequate off-season professional staff are available to facilitate panel design.

The monument currently provides three self-guided trails with brochures: Captain Jacks Stronghold, Petroglyph Point, and Gillems Camp (added in 2006). All are at least somewhat interpretive in style, partially fill in the gap created by a scarcity of personal interpretive programming offered in the north end of the monument, and are quite popular.

Lava Beds currently makes 26 site bulletins (specialty brochures providing in-depth interpretation of a subject) available to the visiting and non-visiting public. These range from basic information about self-guided caves and above ground sights to see, to in-depth historic and geologic background information and interpretation. Site bulletins must constantly be updated and added to in order to meet a variety of visitor interests. The range of site bulletins currently available offers additional detailed informational resources, above standard visitor contacts at visitor center or interpretive programs. All printing costs are covered by donations from the Lava Beds Natural History Association.

The Lava Beds website offers visitor information, interpretation, maps, a webcam at the visitor center, and contact information. In recent years, the monument has received up to six times as many "virtual visitors" annually than in-person visits to the visitor center. In-person visits to the monument can be greatly enhanced by a visit to the website.

In general, the monument provides a great variety of important non-personal services. More comprehensive planning, funding, and staffing is needed, however, to fully address all the monument's interpretive themes. Homesteading and other early historical activities in the monument, caving ethics and equipment, and scientific resource study and management remain among the subjects inadequately covered by non-personal services.

SPECIAL EVENTS, INTERPRETIVE PARTNERS, AND COMMUNITY OUTREACH PROGRAMS

Although Lava Beds is not able to meet all community demands for participation in special events, fairs, and community meetings, there is currently significant special in-monument and out-of-monument programming and participation for a monument of relatively small size.

The largest in-monument special event, the Timeline living history event, occurs in May. This two-day event brings historic re-enactors from local groups, monument staff, and tribal representatives together to operate stations throughout the monument where visitors can explore "stops in time" from different eras of Lava Beds' history. Typically one day is open to visiting local school classes, and a second for the general public. This event receives excellent reviews for the ability to experience Lava Beds history first-hand on the landscape where it happened. Lava Beds has also hosted a Junior Ranger Day each summer, with special resource-related craft activities for kids.

The largest out-of-monument special event that garners annual participation from Lava Beds staff is the Tulelake-Butte Valley Fair in September. This includes staffing a very busy booth for four days, with monument-related exhibits, videos, and children's activities. This event promotes enormous knowledge about, and support for, the monument among the local population. Volunteers and staff from other divisions support booth staffing, as well as design and display of a Lava Beds float in the fair's parade. In recent years, Lava Beds National Monument staff has also offered courses both in and out of the monument to participants in the annual Winter Wings Festival, a locally-organized event celebrating the migratory birds of the Klamath Basin. In addition to these annual events, the monument maintains a year-round display inside the historical museum at the fairgrounds. In recent years, Lava Beds has also sent unstaffed displays to several other fair-style community events, such as the Merrill Potato Festival and the Horse Packers' Clinic in Klamath Falls.

Personal contacts at these and other community-based events would certainly increase local support for the monument. Several new bulletin board panels are also maintained in the towns of Merrill, OR and Tulelake, CA to garner local and tourist interest in visiting Lava Beds.

Lava Beds staff also support other requests for outreach presentations and displays as staff is available. These have included a scholarly article and associated slide presentation for the Shaw Historical Library of the Oregon Institute of Technology in Klamath Falls, events for International Migratory Bird Day, the Tulelake Migratory Bird Festival (coordinated by the Klamath Basin National Wildlife Refuges and the Klamath Basin Wildlife Refuge Association), and National Parks Day at the Science Center in Ashland, OR and Fort Vancouver National Historic Site in Vancouver, WA.

Lava Beds does participate with local public, private, and non-profit partners. These include attendance at local meetings of Rotary International, the Answer People (a group supporting tourism in the Klamath Basin), and the Volcanic Legacy National Scenic Byway (part of which runs through Lava Beds), as well as liaison to the Lava Beds Natural History Association.

While the Tule Lake National Wildlife Refuge and Modoc National Forest have contiguous ecosystems with Lava Beds on both the north and south boundaries and much potential crossover in interpreting geology and ecology, interpretive staff coordination is limited by the staffing levels, time constraints, and funding potentials within all three agencies. Monument interpretive staff has coordinated seasonal training sessions and participation in the Timeline living history event in recent years with representatives of the Klamath Tribes (of which one Modoc band is a part). However, there is significant opportunity to work with the tribes on a more extensive level in order to present a tribal perspective in interpretive programming and non-personal interpretation. This could also include personal services presented at the monument by tribal

members themselves, as NPS staff members and/or at additional special events or programs. Limited coordination has also occurred in the past with the Klamath County Parks on historical special events.

Monument staff participates in a moderate number of in-park and community outreach activities, but there is considerable room to grow to meet demand and increase local support. This important “third foundation” of interpretation (along with visitor and education services) should continue to expand in the future, especially in coordination with neighboring agencies and tribes to bolster a perspective that supports both the ecological and sociological continuity of the Klamath Basin’s people and lands.



Swans at Tule Lake National Wildlife Refuge
Photo by Dave Menke

Recreational Opportunities

Lava Beds provides a variety of visitor recreational opportunities both above and below ground. Main attractions include Modoc War historic sites and lava tube caves. A variety of visitor facilities including a visitor center, surface trails, cave trails, roadside pull-outs and overlooks, and a campground are available to monument visitors. The following section describes the major recreational opportunities.

VISITOR CENTER AREA

Exhibits and audio-visual displays inside the visitor center’s museum, as well as personal contact with interpretive staff, provide visitors with the opportunity to plan their visit and learn about regional geology, high desert ecology, Modoc culture, the Modoc War, rock art, lava tube caves, and other topics. Mushpot Cave is located walking distance from the visitor center and provides an introductory caving experience for most visitors. It features lights, a paved trail, and interpretive displays.

CAVE EXPLORATION

Cave exploration is the most popular recreational activity at Lava Beds. Twenty-five lava tube caves contain various levels of development from entrance ladders to cleared trails, while hundreds more are open to exploration in the monument's backcountry. Difficulty levels also vary widely. With the exception of a few seasonal closures to protect sensitive resources and Cave Loop's nightly closure to vehicle access, Lava Beds' caves are open year round for visitors to explore on their own.

HIKING TRAILS

There are 13 hiking trails within Lava Beds. Many trails are relatively short and level and lead to historic sites, geologic features, rock art, or wildlife viewing areas. Three of the monument's trails range from 3.3 to 8.1 miles in length and provide a more immersive experience in a high desert wilderness environment.

WILDERNESS

More than half of the monument is designated wilderness. Lava Beds provides an opportunity to experience the opposite of civilization and progress, and encounter untamed wildlife and rugged landscapes. Backcountry camping is permitted at Lava Beds, as is horse use on longer trails. Overall backcountry usage is quite low, providing a place to experience solitude.

WILDLIFE AND LANDSCAPE VIEWING / PHOTOGRAPHY / SCENIC TOURING

Many visitors come to view and photograph wildlife at Lava Beds, especially birds. A great variety of waterfowl are visible at the north end of the monument which overlooks Tule Lake National Wildlife Refuge. Mule deer, bats, and many other mammals large and small, reptiles, and a variety of upland birds are also visible throughout the monument. Scenic views of Ponderosa pine, juniper woodlands, sagebrush, and grassland habitats, as well as adjacent wetlands, are abundant from overlooks accessible both by vehicle and by relatively short trails. Photography is also popular in and around the monument's caves and other geologic features.

MODOC WAR HISTORIC SITES

The majority of the battle and camp sites associated with the Modoc War of 1872-1873 can be explored at Lava Beds. These historic sites provide a personal experience

of how the Modoc Indians used the geologic features of their homeland to their tactical advantage.

INDIAN WELL CAMPGROUND

Lava Beds' 42-site historic campground is used by both tent campers and recreational vehicle users, although no RV hook-ups are provided. A group site is also available. The campground area provides excellent scenic views, and low usage during the off-season affords a relatively solitary camping experience.

REGIONAL RECREATIONAL OPPORTUNITIES

Regional recreational facilities and outdoor opportunities complement or directly relate to the recreational visitor experience of Lava Beds National Monument in terms of education, environment, and enjoyment.

Tule Lake National Wildlife Refuge, part of the Klamath Basin National Wildlife Refuges, encompasses 39,116 acres and borders Lava Beds to the north. This refuge, managed by the Fish and Wildlife Service, provides a variety of recreational opportunities including a 10-mile wildlife observation route, waterfowl hunting, canoe trails, and photography blinds.

The Emigrant Trail Scenic Byway begins in New Pine Creek, OR and ends in Tulelake, CA. This culturally significant route guides visitors past lakes, mountain peaks, deep canyons, lava flows, and wide-open meadows.

The Applegate Immigrant Trail, part of the California Trail, was a major overland route used by farmers to reach homesteading areas in the mid 19th century. It is now a historic driving route with wayside exhibits.

The Modoc Volcanic Scenic Byway leads travelers 120 miles through a volcanic area in Northeastern California unrivaled in North America for its volcanic features. The north end of the Byway sits near the California/Oregon border, travels south through Lava Beds National Monument and ends in McCloud, CA.

The Medicine Lake Highlands, located 17 miles south of the monument in the Modoc National Forest, were formed with the development of a broad shield volcano approximately 20 miles in diameter-the largest in North America. Medicine Lake is a popular camping, sightseeing, exploring, swimming, fishing, water-skiing and photography site. The lake and surrounding areas

continue to have cultural and spiritual significance to people of Modoc descent and others.

Glass Mountain, located 30 miles south of Lava Beds, is a monolith devoid of vegetation reaching to 7,622 feet, the highest elevation of any lava flow in the Medicine Lake Highlands. Formed through the accumulation of three independent lava flows, the area displays a great mass of volcanic extrusion and a wide variety of obsidian, pumice, and minerals. Visitation to the area is generally confined to the exterior because of the rough, rugged lava terrain.

Door Knob Sno-Park is located eight miles south of Lava Beds on Highway 49. The snow-park provides basic accommodations and 31 miles of groomed snow-mobile trails.

WWII Valor in the Pacific National Monument, Tule Lake Unit.

Tule Lake became part of a national monument along with other units in Hawaii and Alaska by Presidential Proclamation in December 2008. Tule Lake includes sites in the Tule Lake Basin where Japanese Americans were incarcerated during WWII. An interim visitor center has been established for the new monument at the Tulelake-Butte Valley Fairgrounds Museum. The sites may be visited on guided tours that are offered in the summer season and by request during the off seasons. Planning for the future of the new monument began in 2010.

Facilities and Asset Management

Park Infrastructure and Facilities

The monument's infrastructure is in relatively good condition. In the Indian Well area, the visitor center is newly constructed (2004) and water and sewer systems were both rehabilitated in mid-1990s. The monument electrical system which was placed underground in the mid-1980s is owned by the utility company, PacificCorp and in good condition. Employee housing is

also in good condition although the larger family size 3-bedroom houses are poorly suited to current demographics of monument staff, primarily single employees' with no children. The other employee work spaces (headquarters, maintenance shops, and fire cache) are in good condition. All office and work spaces are currently being utilized, so any new employee offices may need to be located outside of the monument.

Asset Management

The Asset Business Plan (ABP) has been developed to help national parks better understand and manage their assets. Using the data on 'industry standard assets' (includes roads, trails, campgrounds, buildings, housing, water systems, and waste water systems) from the Facility Management Software System (FMSS), the ABP is a subsection of the larger Park Asset Management Plan (PAMP). The ABP allows managers to review their inventories, conduct analyses, and document requirements for operating and sustaining their portfolio of assets. This process supports budget formulation and is the first step in determining which resources are required to bring the portfolio of assets up to an acceptable condition and properly sustain it over time.

All of the monument's built assets have been prioritized through the use of the Asset Priority Index (API). API is a key element to improving the management of a large portfolio of assets. Understanding the relative importance of assets enables leadership to make critical budgetary and programmatic decisions, putting often scarce resources to their best use. The NPS API ranks assets on a low-to-high scale ranging from 0 to 100. A lower API indicates the asset's contribution is less significant in relation to accomplishing the mission of the monument. Conversely a high API indicates that the asset contributes significantly to the mission of a national park unit.

The Facility Condition Index (FCI) is a simple measurement of a facility's relative condition at a particular point in time. The FCI uses a numeric rating system to rank assets. Dividing the collective value of all deficiencies (deferred maintenance) by the Current Replacement Value (CRV) provides the FCI. The calculated FCI is recorded within to document an asset's relative condition. Using the API and FCI together, park managers can begin to identify their highest priority

assets that are in the worst condition by plotting the API and FCI.

As of 2006, Lava Beds National Monument has a total of 183 assets, with a total monument Facility Condition Index of 0.193, and with an average Asset Priority Index value of 64.07, indicating that facilities are primarily in good condition.

Park Operations

Park Divisions and Staffing

ADMINISTRATION

The Administration Division manages and provides general oversight for all monument administrative programs including budget, finance, payroll, Government Performance and Results Act, human resources, uniforms, property, travel, safety, communications, contracting, procurement and housing. The Administration Division currently consists of 3.0 full-time equivalent staff (FTEs) including the superintendent.

RESOURCE MANAGEMENT

The Resource Management Division manages the monument's natural, cultural, historical and archeological resources and is responsible for planning and implementing short-term and long-term projects to enhance these resources. Resource Management staff monitor wildlife, nonnative populations, ice levels in caves, and air quality. Provides information technology, geographic information systems, photography and telephone support for the monument.

The Fire Management Program provides overall direction, with scientific and specialized expertise, for the monuments' fire management program, which includes managing both prescribed and wildland fire. Fire management staff develop, plan, integrate and apply fire science methods and practices into the total program, both at the planning and operational levels. Lava Beds National Monument is unusual in that it also hosts a NPS/U.S. Forest Service (Modoc National Forest) interagency wildland fire engine and crew. In addition to the interagency engine, there is a high degree of shared fire staff resources with the

U.S. Forest Service, U.S. Fish and Wildlife Service, and other National Park units in Northern California and Southern Oregon.

Currently, the Fire Management Division consists of six FTE including the Fire Management Officer (FMO) which also serves as the FMO for Oregon Caves National Monument. These positions are not funded out of the monument's base budget.

Currently the Resource Management Division consists of 3.85 FTE of which three are permanent employees and the remainder are seasonal, term or student intern/volunteer employees.

FACILITIES MANAGEMENT (MAINTENANCE)

The Facilities Management Division manages the day-to-day maintenance needs of the monument, serving both employee and visitor facilities. This division is responsible for planning, formulating, implementing, and tracking maintenance projects, as well as develop-

TABLE 15: MONUMENT FUNDING

MONUMENT FUNDING	
Fiscal Year (FY)	Monument Funding (ONPS)
FY2009	\$1,922,000 plus an additional \$300,000 for fire program base positions.*
FY2008	\$1,701,000
FY2007	\$1,578,000
FY2006	\$1,505,000
FY2005	\$1,450,000
FY2004	\$1,120,000
FY2003	\$1,117,000
FY2002	\$1,122,000
FY2001	\$1,085,000
FY2000	\$1,048,000
FY1999	\$1,021,000
FY1998	\$939,000
FY1997	\$886,000
FY1996	\$682,000
*Does not include project funding which can range from several hundred thousand to several million dollars per year.	
Source: All figures derived from the SALT table in FFS 2009	

ing long range planning budgets for Cyclic Maintenance Repair/Rehabilitation and Construction Programs.

Currently the Maintenance Division consists of 7.09 FTE, of which three are permanent, full time employees. Three are permanent, less than full time employees. Additional seasonal employees are hired each year with project funds.

RESOURCE PROTECTION AND VISITOR SERVICES

The Resource Protection and Visitor Services Division provide law enforcement services, (including all emergency services such as search and rescue and emergency medicine) education and interpretation, and fee collection. Currently, the division consists of 7.35 FTE, two of which are permanent full time, and another five which are permanent less than full time. The remainder of the staff are filled by term, seasonal, and student intern/volunteer positions. The Resource Protection and Visitor Services Division is responsible for planning, managing and coordinating interpretive programs and other forms of outreach and providing search and rescue operations as needed. The division also plans for long-term interpretive and law enforcement projects, provides for visitor and employee safety, and manages the structural fire prevention program.

SUPERINTENDENT

Provides on-site management, planning, program direction and operation of resource and visitor protection, interpretation, maintenance, cultural and natural resource management. The superintendent oversees the overall operation of the monument by setting goals and priorities and establishing guidelines. One person fills the superintendent's position.

Currently Lava Beds staff are providing staffing for the new WWII Valor in the Pacific National Monument, Tule Lake Unit. A nominal amount of additional funding in FY2009 and 2010 facilitated the hire of one seasonal interpreter. Starting in FY2012, it is hoped that the new monument will have its own base budget of approximately \$250,000 and will be able to hire two to three permanent staff. The Lava Beds Superintendent and Division Chiefs likely will continue to co-manage the new monument for the foreseeable (next 5+ years) future.

Carbon Footprint

The monument's carbon emissions were analyzed in 2008, based on 2007 data. The Climate Leadership in Parks (CLIP) tool, software developed jointly by the Environmental Protection Agency and the NPS, was used to calculate the monument's greenhouse gas emissions. Most of the information needed to perform the calculations was taken from 2007 reports and records. These items included the amount of electricity purchased, sewage pumped, waste sent to the landfill, and fuels consumed. Additional motor vehicle data was derived from a combination of 2007 road counter data and visitor use surveys. The findings show that motor vehicle use is the largest contributor to greenhouse gases (68%), with purchased electricity accounting for approximately 22% of total greenhouse gases. In comparison, emissions resulting from solid waste disposal, refrigeration, wastewater, sewage, propane, and heating oil were negligible.

The monument used 2,129 gallons of heating oil and diesel, 1,402 gallons of propane, 249,540 kWh of electricity, and 6,260 gallons of gasoline in 2007. Additionally, 24 tons of solid waste were generated and 10,140 gallons of sewage were pumped. An estimate of visitor vehicle miles was derived from visitor use survey data and road counters, with the conclusion that visitors drove approximately 883,000 miles on monument roads in 2007.

Monument activities, including both operations and visitor use, were found to result in the gross (excluding carbon sinks) emission of 182.4 metric tons of carbon equivalent (MTCE) in 2007. Seventy MTCE were attributed directly to monument operations, with the remainder (113 MTCE) attributable to visitor vehicle use. By contrast, the state of California reported 483.87 million metric tons of carbon dioxide equivalent (MTCO₂E) in 2006. Using a conversion ratio of 3.67 MTCO₂E to 1 MTCE, Lava Beds National Monument contributes about 0.0001% of California's gross emissions through its operational activities and visitor vehicle use on the 46,560 acre monument (about 0.05% of California). This inventory, however, did not account for emissions resulting from visitor travel outside of the monument's boundaries, a number which would presumably raise the monument's total emissions due to the fact that the majority of visitors travel 100- to 400 miles or more to reach the monument.

Although the monument’s share of carbon emissions may be negligible when compared to state and regional emissions, the cumulative nature of countless small carbon sources and the expectation of National Park Service leadership on environmental issues justify significant actions to mitigate emissions from monument activities.

Regional Socioeconomics

Location

Lava Beds National Monument spans two California counties, Modoc County and Siskiyou County. Klamath County, Oregon is approximately 12 miles north of the monument. Local population centers include the small towns of Tulelake, Merrill, and Alturas. The nearest city is Klamath Falls, Oregon. These communities serve as gateways to the monument, providing a variety of goods and services for visitors. Any socioeconomic impacts from the action alternatives would have the most impact on these counties and communities. Such impacts become insignificant in areas farther from the monument.

Much of the land in the Klamath Basin is federal, with national forest lands predominating. Substantial acreages are also administered by the U.S. Fish and Wildlife Service, Bureau of Land Management (BLM), and Bureau of Reclamation (BOR). The monument is largely adjoined by lands administered by these federal agencies. Private lands adjoin the monument on the northeast and south boundaries of the main unit, and on the west and north sides of Petroglyph Point. U.S. Forest Service and BLM-administered lands are managed for multiple uses, including forest products, mineral resources, grazing, and recreation. The U.S. Fish and Wildlife Service manages the Klamath Basin National Wildlife Refuges as an important link in western waterfowl migration routes. Private and leased public lands in the vicinity of the monument are used primarily for irrigated agriculture, with water supplied by the BOR’s Klamath Project.

Access to the monument from the north and east is provided by good state highways, and from the south and west via slow speed rural or U.S. Forest Service roads. The Modoc Volcanic Scenic Byway, which incorporates some of these roads, functions as a tourism route through the area. The nearest commercial airport and AMTRAK rail service is in Klamath Falls, Oregon.

Demographics

The three counties in the affected region for socioeconomics are predominantly rural. This three-county area had a combined population of more than 117,000 persons in the year 2000 (see table 16: Population). Local population centers include the small towns of Tulelake, Merrill and Alturas. The largest city is Klamath Falls with a regional population of 19,462 in 2000. The population centers listed in the table account for nearly 21% of the area’s residents.

The 2000 Modoc County population was 9,449, while Siskiyou County had a population of 44,301, most of which is located to the west of the monument along the Interstate 5 corridor. Modoc County’s population declined 2.4% between 1990 and 2000, while Siskiyou

TABLE 16: POPULATION

POPULATION			
Counties/Cities	1990	2000	% change 1990 to 2000
Modoc County, CA	9,678	9,449	-2.4%
Tulelake	1,010	1,020	1.0%
Alturas	3,231	2,892	-10.5%
Siskiyou County, CA	43,531	44,301	1.8%
Klamath County, OR	57,702	63,775	10.5%
Klamath Falls	17,737	19,462	9.7%
Merrill	837	897	7.2%
Three-County Area	110,911	117,525	6.0%
California	29,760,021	33,871,648	13.8%
Oregon	2,842,321	3,421,399	20.4%
Source: United States Census Bureau, 1990;2000			

TABLE 17: POPULATION PROJECTIONS

POPULATION PROJECTIONS					
Counties	2000	2005	2010	2020	% change 2005-2020
Modoc County, CA	9,449	9,894	9,285	9,285	-6.2%
Siskiyou County, CA	44,301	45,789	45,611	45,862	0.2%
Klamath County, OR	63,775	65,330	66,968	70,595	8.1%
Three-County Area	117,525	121,013	121,864	125,742	3.9%
California**	33,871,648	36,038,859	38,067,134	42,206,743	17.1%
Oregon**	3,421,399	3,596,083	3,790,996	4,260,393	18.4%
Sources:					
U.S. Census Bureau, 2000; California Department of Finance, 2006; California Department of Finance, 2004; Klamath County Population Projections, Oregon Office of Economic Analysis, Department of Administrative Services, 2004					

County grew 1.8%. The California counties together grew at a much lower rate than California as a whole during the decade of the 1990s (1% compared to 13.8% for the state of California). Population in Klamath County, Oregon increased 10.5% between 1990 and 2000, largely due to in migration.

In future years, the population of Modoc, Siskiyou, and Klamath Counties is expected to grow at a much lower rate than California and Oregon. Modoc County population is projected to decline 6.2% by the year 2020, one of the only counties in California where a decline in population is expected. Siskiyou County is projected to grow less than 0.5% by the year 2020, a rate much lower than the 17% increase projected for California. Of the three counties, the most growth is projected for Klamath, 8.1% by 2020. However, this rate is still much lower than the overall projection for Oregon, 20.1% by the year 2020.

ETHNICITY

The largest race/ethnic group in the affected area is White (87%). Hispanic or Latino is the second largest race/ethnic group in the affected area (9,403 persons in 2000). These individuals comprise 8% of the area’s population compared to 32% for the state of California and 8% for the state of Oregon. Native Americans were the second largest race/ethnic group in the affected area (4,796 persons in 2000).

These individuals comprise 4% of the area’s population compared to 0.53% for the state of California and 1.17% for the state of Oregon (U.S. Census Bureau 2000).

INCOME

In 2004, California’s per capita personal income (PCPI) was \$35,248, about 107% of the national average. Modoc County had the lowest per capita personal income, \$25,085, at 72% of the state average for California. Klamath County had a PCPI of \$24,917, less

TABLE 18: PER CAPITA PERSONAL INCOME

PER CAPITA PERSONAL INCOME				
Area	1994 \$	2004 \$	% of State Average, 2004	State Rank, 2004
Modoc County	\$17,919	\$25,085	71	44th out of 58
Siskiyou County	\$17,731	\$25,521	72	45th out of 58
Klamath County	\$16,660	\$24,917	82	26th out of 36
California	\$23,203	\$35,278	100	
Oregon	\$21,060	\$30,823	100	
United States	\$22,172	\$33,090		
Source: Bureau of Economic Analysis, U.S. Department of Commerce, 2007				

than 82% of the state average for Oregon. The total personal income for the three-county region was more than \$36 billion in the year 2000. This figure represents only a small percentage of the total personal income for California and Oregon (U.S. Department of Commerce 2007).

EMPLOYMENT

Major components of the local economy include timber harvest and processing, livestock production, irrigated farming, public land management, and services. Commercial services including gas, groceries, restaurants, motels, and RV parks located in communities near the monument. The affected region had more than 47,000 jobs in 2000. Educational, health and social services, manufacturing, and agriculture were the sectors employing the most workers in the three counties.

Modoc County's primary industries are government, retail trade, and services. Government, the largest industry, accounts for almost 45% of all employment in the county. Wholesale and retail trade employment accounts for 19% of total employment. The share of employment in services is 14%. Agricultural production and agricultural services are also important to the county and account for close to 10% of the total. The top agricultural products and commodities include alfalfa, cattle and calves, pasture and range, potatoes, and hay (California Department of Transportation 2002).

In Modoc County the only industries that experienced growth from 2001 to 2005 were agriculture and government. Agriculture grew 27.6%. The agriculture industry had an estimated value of \$71 million dollars in 2004 (California Employment Development Department 2006).

Historically, Siskiyou County jobs were concentrated in the timber industry. In recent years this sector has been subject to significant consolidation. Today the majority of jobs are found in government, services, retail trade, and the farm sector. In 2002, government accounted for the largest share of jobs with over 27% of total employment. The majority of government jobs are in the local government sector. Services contributed 23% of the total, and retail trade made up 24% of all jobs. Within retail trade, most of the jobs are associated with restau-

TABLE 19: UNEMPLOYMENT RATES

UNEMPLOYMENT RATES		
Area	1996	2005
Modoc County	12.2	7.9
Siskiyou County	13.7	8.9
Klamath County	8.3	7.6
Three-County Area	10.6	8.1
California	7.3	5.4
Oregon	5.6	6.1
National	5.4	5.1
Source: U.S. Department of Labor, 2007		

rants and food stores (California Department of Transportation 2002).

Although construction and government jobs received growth in Siskiyou County from 2001-2005, most other industries recorded job declines during those years. Mining and natural resources experienced no changes, while the accommodation component of the hospitality industry gained 130 jobs over the years 2001-2005 (California Employment Development Department 2007).

Job growth in Klamath County is expected to increase about 14% between 2004 and 2014 due to an employment sector shift from the manufacturing and wood products to services. This increase in job growth is slightly lower than the projected increase for Oregon (Oregon Employment Department 2007).

TABLE 20: PERCENT OF PEOPLE LIVING IN POVERTY

PERCENT OF PEOPLE IN POVERTY		
Area	1989	1999
Modoc County	15.0	21.5
Siskiyou County	14.0	18.6
Klamath County	16.7	16.8
Three-County Area	15.5	17.8
California	12.5	14.2
Oregon	12.4	11.6
National	13.1	12.4
Source: United States Census Bureau, 1990;2000		

UNEMPLOYMENT

The unemployment rates in the regional counties have been notably higher than both the state and national rates for the selected years (See table 19: Unemployment Rates). However, unemployment rates steadily declined for all three counties over the past ten years. The unemployment rate for the three-county area meant that one out of 13 people in the labor force were unemployed in 1999. Unemployment in Klamath County remains high relative to the rest of the state due to slower population growth and highly seasonal employment for large job sectors such as agriculture and manufacturing (Oregon Employment Department 2007).

POVERTY

The national average for persons living in poverty in 1999 was 12% (see table 20, Percent of People in Poverty). The poverty rates for California and Oregon were slightly lower than the national rate. For 1989 and 1999, the poverty rates in the three counties were all higher than the state rates. Combined, the three counties had a poverty rate of 17.8% in 1999; this figure represented more than 20,000 people living in poverty.

REGIONAL TOURISM

Tourism spending in the three-county area is relatively small compared to total state expenditures for Califor-

nia and Oregon. Total travel spending in Modoc County for 2004 was \$19.8 million compared with \$82 billion for the State of California. Siskiyou County fared better with total travel spending of \$151 million for 2004. In 2004, the combined travel spending for Modoc and Siskiyou counties accounted for less than 1% of the total travel spending for California. Klamath County, the economic hub of the region, received \$114 million in travel spending in 2004, approximately 1.6% of the total travel spending in Oregon (Dean Runyan and Associates 2007).

For the region, the tourism industry provides a total of 4,620 jobs. Total direct employment increased 17% from 1992 to 2004 in Siskiyou County, while Modoc County saw an increase of only 3%. Klamath County saw the greatest increase in direct employment from tourism. Between 1992 and 2004 tourism jobs grew by 29% (Dean Runyan and Associates 2007).

The socioeconomic impact of Lava Beds National Monument on local and regional economies is substantial. The National Park Service uses a Money Generation Model to estimate the contribution of visitor and monument payroll spending to gateway communities within a 50 mile radius of a national park unit. A 2007 analysis shows that national parks and other units within the U.S. National Park System generate an average of four dollars for state and local economies in return for every one tax dollar invested in each national park's annual budget. Using this estimate, Lava Beds National Monument generates around \$6,200,000 manifest in local and state tax revenue, jobs, and direct purchases by visitors on lodging, food, transportation, souvenirs, etc. in the areas around the monument. In

TABLE 21: REGIONAL TOURISM

REGIONAL TOURISM						
2004	Destination Spending (Millions)	Total Travel Spending (Millions)	Employment (Jobs)	Earnings (Millions)	Tax Receipts (Millions)	% of Total Travel Spending for State
Modoc County	13.3	19.8	300.0	6.2	1.1	0.01%
Siskiyou County	95.8	151.3	2,560.0	53.3	15.1	0.16%
Klamath County	56.2	113.9	1,760.0	32.0	4.3	1.6%
California	45.8	81,900.0	912,000.0	26,500.0	9,300.0	
Oregon	6,290	6,903	87,200	1,727	617	

Source: Dean Runyan and Associates, 2007

some years this can be substantially more (e.g. 2009) in which funding for projects was up substantially.

KLAMATH BASIN WILDLIFE REFUGES VISITATION

North and east of the monument is the Klamath Basin complex of national wildlife refuges managed by the U.S. Fish and Wildlife Service. The entire complex encompasses 192,322 acres. Tule Lake National Wildlife Refuge, directly adjacent to the northern boundary of the monument, has the highest number of visitors for the six refuges. This area encompasses 39,116 acres. Most recreational use is associated with wildlife observation. The refuge has a 14-mile auto tour, a 2-mile canoe tour, attracts birders, waterfowl hunters, and photographers.

In 1995, The Tule Lake National Wildlife Refuge logged 196,544 visitors. Almost all of the visitors engaged in wildlife observation activities. Visitation is spread out throughout the year, with the highest levels of use in the spring and the fall. Refuge managers estimate that 80% of non-consumptive users (those other than hunters) and 95% of hunters come from outside the local area (more than 30 miles distant).

Lower Klamath National Wildlife Refuge recreational visitation totaled 164,000 for the same year. The vast majority of these visitors engaged in wildlife observation, while about 10,200 visitors hunted. For 2008, the visitation count for the Hill Road Visitor Center was 10,413. For the past 5 years, the numbers range from 10,319 to 11,273. Tule Lake and Lower Klamath National Wildlife Refuges receive approximately 40,000 visitors per year.

Total visitation spending for the Tule Lake National Wildlife Refuge in 1995 was \$683,600. This value was generated in the three-county area by refuge visitor spending. The refuge also generated a total of 19 jobs (Laughland and Caudill 1997).

MODOC NATIONAL FOREST VISITATION

Land to the west, south and east of the monument is managed by the Forest Service as part of the Modoc National Forest. The Modoc National Forest consists of 1,979,407 acres of which 1,654,392 acres are administered directly by the U.S. Forest Service. In 2000, the Modoc National Forest received approximately 146,155 visitors. The primary activities of the visitors included fishing, viewing scenery, and driving for pleasure on forest roads. Facilities used the most include developed

campgrounds, swimming areas and trails. Use of the scenic byway ranked fourth. Of those surveyed, 6% of Modoc National Forest visitors were visiting the forest as their primary destination. Most were visiting the forest as part of visits to other local destinations (USFS 2001).

WWII VALOR IN THE PACIFIC NATIONAL MONUMENT, TULE LAKE UNIT VISITATION

In its first year of operation, the Tule Lake Unit maintained a temporary visitor center inside the Tulelake - Butte Valley Fairgrounds from Memorial Day through Labor Day. During this time the visitor center received 633 visitors. Tours were offered regularly on the weekend and by request during the week. In total, 51 formal tours were provided for a total of 1,236 visitors. Visitation was limited by the lack of a website, which was not yet activated, and highway signs not being installed until after the summer season. The dedication for the unit was held in conjunction with the Tule Lake Pilgrimage, and had 700 in attendance. Of those in attendance, over 160 had been interned at Tule Lake or one of the other nine centers. In addition, three education programs were provided to 48 students.

