National Park Service
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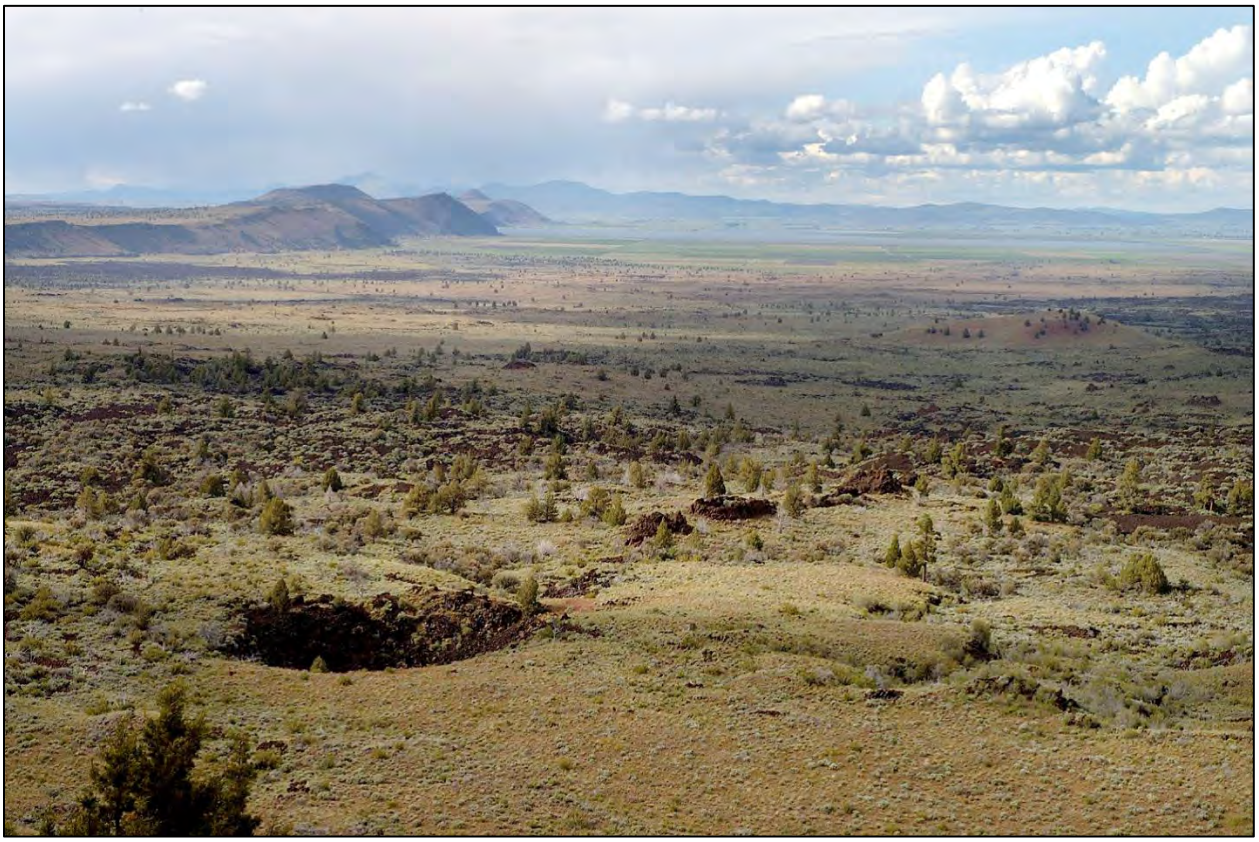
Natural Resource Stewardship and Science

Vegetation Classification and Mapping

Lava Beds National Monument

Natural Resource Report NPS/LABE/NRR—2015/1098



ON THIS PAGE
Rubber Rabbitbrush Shrubland (*Ericameria nauseosa* Shrubland) in the foreground. Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland (*Artemisia tridentata* ssp. *vaseyana - Purshia tridentata / Pseudoroegneria spicata* Shrubland) and Western Juniper / Mountain Big Sagebrush Woodland (*Juniperus occidentalis / Artemisia tridentata* ssp. *vaseyana* Woodland) are in the midground. Mt. Shasta is off in the distance.

ON THE COVER
View from Schonchin Butte looking north to the Tule Lake Basin. Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland (*Artemisia tridentata* ssp. *vaseyana - Purshia tridentata / Pseudoroegneria spicata* Shrubland) and Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland (*Juniperus occidentalis / Cercocarpus ledifolius / Pseudoroegneria spicata* Woodland) are in the foreground and midground. Photo courtesy of Lava Beds National Monument.

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Natural Resource Report NPS/LABE/NRR—2015/1098

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[3]This report is dedicated to Daniel A. Sarr (1964-2015). Daniel was the first Klamath Network Inventory and Monitoring Program Manager. He served in this capacity for 13 years and one of his many contributions was initiating vegetation inventories for park units in the Klamath Network.

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Klamath Inventory and Monitoring Network website (http://science.nature.nps.gov/im/units/klmn/index.cfm), and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

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Executive Summary

The National Park Service Vegetation Mapping Inventory Program funded an effort, beginning in 2010, to classify and map the vegetation at Lava Beds National Monument. Southern Oregon University and Klamath Network staff performed the inventory work. The Klamath Network coordinated the effort.

To classify the vegetation, we sampled 169 representative vegetation classification plots throughout the 18,936 hectare (46,792 acre) project area using traditional phytosociological methods (i.e., relevé sampling). The relevé plots were located and sampled primarily in 2010 and 2011. We identified a total of 222 vascular plant species in the relevé plots, including several species that were not previously recorded on the monument's species list. These were added to the flora of the monument by Sean B. Smith published in 2014. We classified the plot data into 24 plant associations using standard vegetation analysis methods. We provide a key to the plant associations and descriptions of each association in Appendices B and D of this report. Mapping of the vegetation polygons was completed via manual digitizing of vegetation types visible on the most recent National Agriculture Imagery Program (NAIP) and ESRI World imagery. A number of plant associations could not be consistently distinguished in the imagery. Based on our analysis, what could be distinguished accurately on the imagery, and a minimum mapping unit of 0.5 ha, we defined 15 vegetation mapping classes that were related to vegetation associations. Up to two of these vegetation classes were mapped as present in each polygon, and the percent cover that each one occupied in a polygon was coded in the database. The percent cover attribute for the primary and secondary (if present) vegetation in each polygon was estimated from photographic and field evidence. In addition, the occurrence of up to two associations and their percent cover were identified as composing the primary and secondary vegetation. We conducted map accuracy assessment in 2013 by visiting 505 stratified random accuracy assessment plots throughout the project area. The field data were compared to the vegetation map to determine accuracy. Our initial map had an overall thematic accuracy that was slightly below the 80% standard set by the National Program. To improve accuracy, we merged two vegetation types resulting in an overall thematic accuracy of 85% for the primary vegetation. Accuracy was difficult to assess for some rare types. We also assessed the accuracy of the primary association in each polygon, which was 82%.

To complete this vegetation inventory project we produced the standard deliverables as described and presented herein and saved within a geographic information (GIS) database that is distributed with this report. These are available on the NPS-National Vegetation Mapping Inventory Program website. The primary deliverables include:

- This final report, which includes plant association descriptions, the key to plant associations, description of the map classes and their photo-signatures, accuracy assessment information, project methods and results
- A GIS database containing the attributed vegetation polygons, classification plots, and accuracy assessment points

- Digital photographs characterizing the classification plots, accuracy assessment points and landscape features/objects of interest within the monument
- Metadata that is compliant with Federal Geographic Data Committee standards for all of the spatial data

Acknowledgments

We thank Kristi Mergenthaler, Thomas Hender, Katie Heard, Helen Beeson, Trevor Griffiths, and Clint Nichols for assistance in collecting field data and Lorin Groshong for GIS assistance. We also thank Sean Mohren and Allison Snyder for help with the databases. We appreciate feedback and guidance from Nancy Nordensten, Tammy Cook, and Karl Brown. Susan O'Neil developed the original proposal to fund the mapping. Julie Evens, Todd Keeler-Wolf, Diana Hickson and Chris Lea provided valuable feedback on the manuscript. We also thank Linda Mutch and Sonya Daw for copyediting and helping format the manuscript.

List of Acronyms and Abbreviations

^{o}F	Degrees Fahrenheit		m^2	square meters
^{o}C	Degrees Celsius		MYA	million years ago
cm	centimeter(s)		sp./spp.	species (singular/plural)
in	inch(es)		ssp.	subspecies
ft	foot/feet		NPS	National Park Service
km	kilometer(s)		St.	Saint
ha	hectare(s)		TURBOVEG	Dutch Software for Processing Phytosociological Data
e.g.	for example (exempli gratia)		TWINSPAN	Two-Way Indicator Species Analysis
et al.	and others (et alia)		USNVC	U.S. National Vegetation Classification
GIS	Geographic Information System		U.S.	United States of America
GPS	Global Positioning System Receiver		USGS	U.S. Geological Survey
LABE	Lava Beds National Monument		UTM	Universal Transverse Mercator
NAIP	U.S. Department of Agriculture, National Agriculture Imagery Program		NAD83	North American Datum of 1983

1 Introduction

Lava Beds National Monument encompasses an 18,936 ha (46,792 ac) area in northeastern California. The monument is known for unusual volcanic features (e.g., relatively recent lava flows) and notable history (the Modoc Indian War). Though it is less known, it also has outstanding vegetation. The purpose of this report is to describe this vegetation based on extensive field data collection and to produce a vegetation map and digital atlas based on analysis of aerial imagery.

1.1 Background (National Mapping and Data Protocols)

In 1994, the National Park Service (NPS) and U.S. Geological Survey (USGS) formed the Vegetation Mapping Inventory Program (then known as the USGS-NPS Vegetation Mapping Program). The goals of this cooperative program are to inventory and map the vegetation in U.S. National Parks. The objectives of the inventory are to provide baseline vegetation data for park resource managers, obtain vegetation data that can be examined in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 2008, Grossman et al. 1998).

At its inception, the Vegetation Mapping Inventory Program adopted the U.S. National Vegetation Classification as a basis for the definition of vegetation units. This was developed by The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI 1994, Grossman et al. 1998). This national classification was intended to be a standardized and complete taxonomic treatment of vegetation communities in the United States at eight levels of thematic resolution. The eight levels were organized in a hierarchy, with the top or upper levels comprising broadly distributed vegetation types defined by structure (physiognomy), not floristics. The lower levels are composed of more narrowly distributed types defined by floristics (alliances and associations).

The Vegetation Subcommittee of the Federal Geographic Data Committee requires that federally-funded vegetation classification studies collect data in a manner that enables crosswalking the data to the U.S. National Vegetation Classification (USNVC) and sharing among agencies (FGDC 2008). In 2008, the Federal Geographic Data Committee formally endorsed the revised version of the National Vegetation Classification Standard and the U.S. National Vegetation Classification (FGDC 2008). The review of content remains active currently, with the most recent classification treatment available online through the U.S. National Vegetation Classification and NatureServe websites.

The content of the USNVC hierarchy is currently maintained via collaboration between the Ecological Society of America, the Federal Geographic Data Committee, and NatureServe (formerly a division within The Nature Conservancy). The floristically-based alliances and associations are used as classification and mapping units by the Vegetation Mapping Inventory Program whenever feasible. The federal standard (FGDC 2008) is denoted as the National Vegetation Classification Standard (NVCS) while the classification hierarchy is referred to as the U.S. National Vegetation Classification (USNVC). The latest information is available from the U.S. National Vegetation Classification website.

Use of the USNVC as the standard vegetation classification system is central to fulfilling the goals of the Vegetation Mapping Inventory Program. This system

- is vegetation based;
- uses a systematic approach to classify vegetation along gradients of change;
- emphasizes existing, natural vegetation;
- uses a combined physiognomic-floristic hierarchy;
- identifies vegetation units based on both qualitative and quantitative data; and
- is appropriate for mapping at multiple scales.

The initial and current Vegetation Mapping Inventory Protocols and standard documents are available on the NPS-National Vegetation Mapping Inventory Program website.

The use of the national vegetation mapping protocols helps facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS. It also facilitates use of the information by other federal agencies, states, academia, and private citizens. The vegetation maps, associated classification data, and accuracy information support a wide variety of resource assessment, park management, and planning needs. In addition, the data/information can be used to provide a structure for framing and answering critical scientific questions about vegetation and species patterns and their relationship to environmental conditions and ecological processes across landscapes.

1.2 NPS Natural Resource Challenge and the Vegetation Mapping Inventory Program

The NPS initiated a program called the Natural Resource Challenge in 1999. The purpose of this ongoing program is to encourage National Parks to focus on the preservation of the nation's natural heritage through science, natural resource inventories, and expanded resource monitoring (NPS 1999). To implement the Natural Resource Challenge, NPS organized 270 parks into 32 networks to facilitate collaboration and sharing in natural resources management and to perform inventory and monitoring of natural resources. The Natural Resource Challenge identified 12 basic inventories needed to facilitate natural resources management, and vegetation mapping and inventory is one of these twelve. The Vegetation Mapping Inventory Program works closely with the networks (except those in Alaska) to inventory, map, and describe vegetation communities, and document unique plant species and associations. The vegetation inventory helps park managers conserve biodiversity; manage challenges such as exotic species, insect outbreaks, and diseases; and understand resources and processes such as wildlife habitat relationships and wildland fires.

The primary objective of the Vegetation Mapping Inventory Program is to produce high-quality, standardized maps and associated data sets of vegetation and other land cover occurring within parks. This information fills data gaps and complements a wide variety of resource assessments, park management, and conservation needs. The National Program follows well-established procedures

that are compatible with those of other agencies and organizations. The inventory uses the National Vegetation Classification Standard, a system that is integrated with the major scientific efforts in the taxonomic classification of vegetation, and is a Federal Geographic Data Compliant standard. In addition, stringent quality control procedures ensure the reliability of the vegetation data and encourage the use of resulting maps, reports, and databases. A complete vegetation mapping project for a park includes, at a minimum, the following products:

- Detailed vegetation report
- Digital vegetation map
- Map accuracy assessment data and analysis
- Vegetation classification of plot data
- Dichotomous vegetation key
- Map photointerpretation key

Maps are produced in Universal Transverse Mercator (UTM) coordinates 1983 North American Datum (NAD 83) with a 1:24,000 scale and a minimum mapping unit of 0.5 hectares (1.24 acres). The vegetation maps must meet the 2010 Federal Geographic Data Committee map accuracy standards (which specify horizontal errors of less than 12.2 meters (40.0 ft.) on the ground for 1:24,000 scale maps). The maps also must meet the minimum class accuracy goal across all vegetation and land cover classes of 80%. Digital vegetation products are accompanied by Federal Geographic Data Committee compliant metadata, which describe the content, quality, condition, and other characteristics of the spatial dataset and are critical elements that expedite the interpretation and exchange of information among users. All final Vegetation Mapping Inventory products are made available at the NPS Data Store.

1.3 Klamath Network

The Klamath Network Inventory and Monitoring Program ('Klamath Network'; Figure 1) encompasses six parks managed by the NPS in northern California and southern Oregon: Crater Lake National Park, Lassen Volcanic National Park, Lava Beds National Monument, Oregon Caves National Monument, Redwood National and State Parks, and Whiskeytown National Recreation Area. Collectively, the six parks comprise nearly 200,000 ha (494,211 acres) and range considerably in size from 1,844 to 73,775 ha (4,556 to 182,302 acres). They contain dramatic vistas, mountains, volcanoes, lakes, caves, and considerable topographic relief and biodiversity.

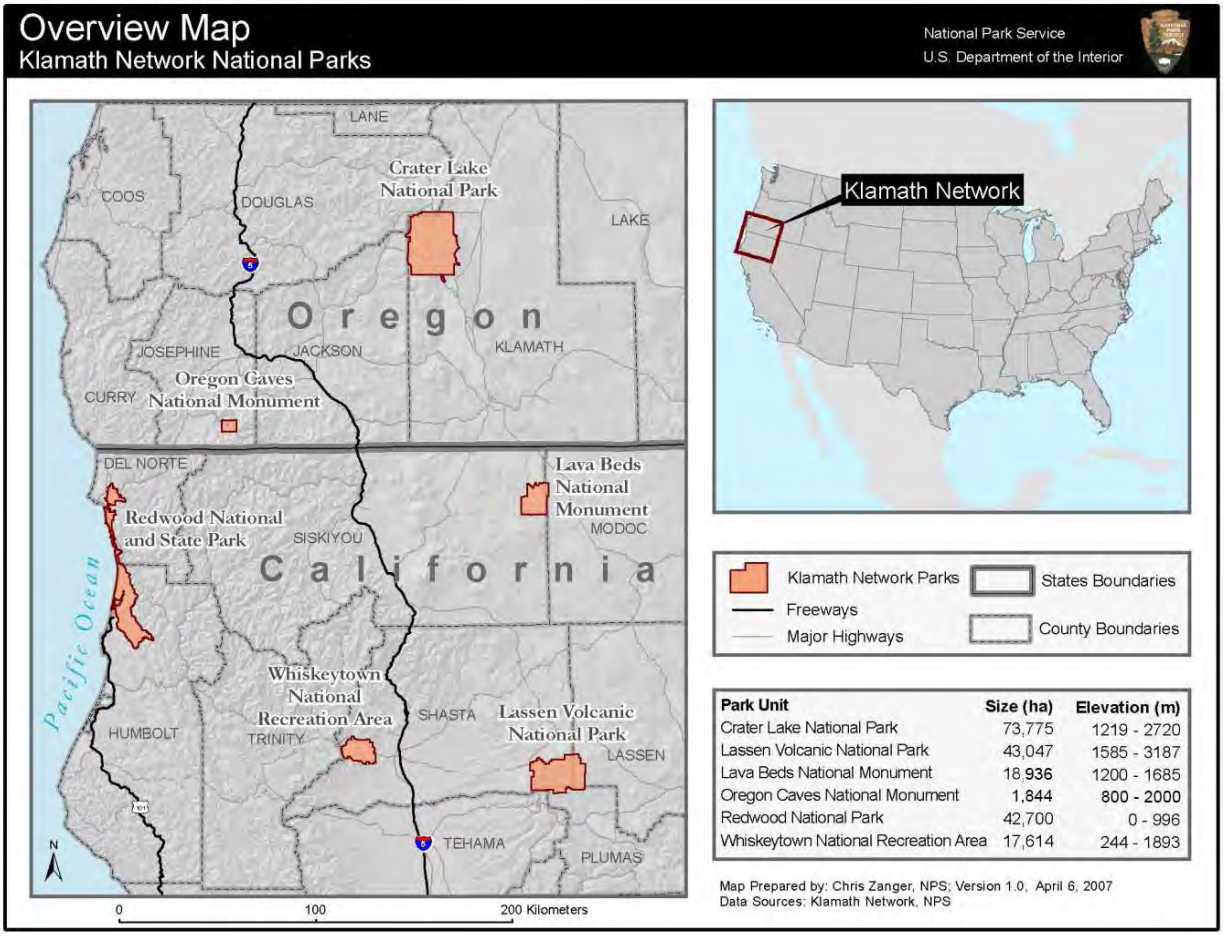

Figure 1. National Park units of the Klamath Network of southern Oregon and northern California.

1.4 Lava Beds National Monument

Lava Beds National Monument encompasses 18,936 ha (46,792 acres) in northeastern California (Figure 1). Lava Beds was designated a national monument in 1925 to showcase and protect its exceptional natural and cultural resources for future generations. In 1933, the NPS assumed management of the monument from the U.S. Forest Service.

The natural resources of the existing Lava Beds National Monument (Figures 2-3) are relatively well-known from the long history of NPS management. The following description of the natural resources of Lava Beds National Monument is excerpted from "A Flora of Lava Beds National Monument, California," by Sean Smith (Smith 2014), a coauthor of this report.

1.4.1 Location and Setting

Lava Beds is located approximately 70 km (45 mi) south-southeast of Klamath Falls, Oregon and 18 km (11 mi) south of the Oregon-California border. The northern boundary of the monument follows the historic shoreline of Tule Lake, a formerly extensive, shallow lake that has been partially drained for use in irrigation. The monument is on the Modoc Plateau, a semiarid plateau in northeastern California and southern Oregon that is east of the Cascade Range and west of the Warner Mountains,

and is considered part of the Great Basin. The topography gently rises from the northern boundary of the monument at 1,230 m (4,040 ft.), to the southern boundary at 1,372 m (4,500 ft.). Cinder cones are steep, conical volcanic features, locally called buttes, which dot the landscape and provide additional relief. Island Butte, the tallest cinder cone in the monument at 1,685 m (5,529 ft.), sits along the Southern Cascades boundary (Figure 2).

The monument is bordered by federal lands on all sides. On each side of the main monument road, which roughly bisects the monument, lie roadless areas designated in 1973 as wilderness areas (Figure 3). Combined, the Schonchin and Black Lava Flow Wildernesses total 11,355 ha (28,058 acres), 60% of the monument. To the east, west, and south are the Modoc and Klamath National Forests. The U.S. Fish and Wildlife Service Tule Lake National Wildlife Refuge oversee the agricultural lands and wetlands on the north side of the monument.

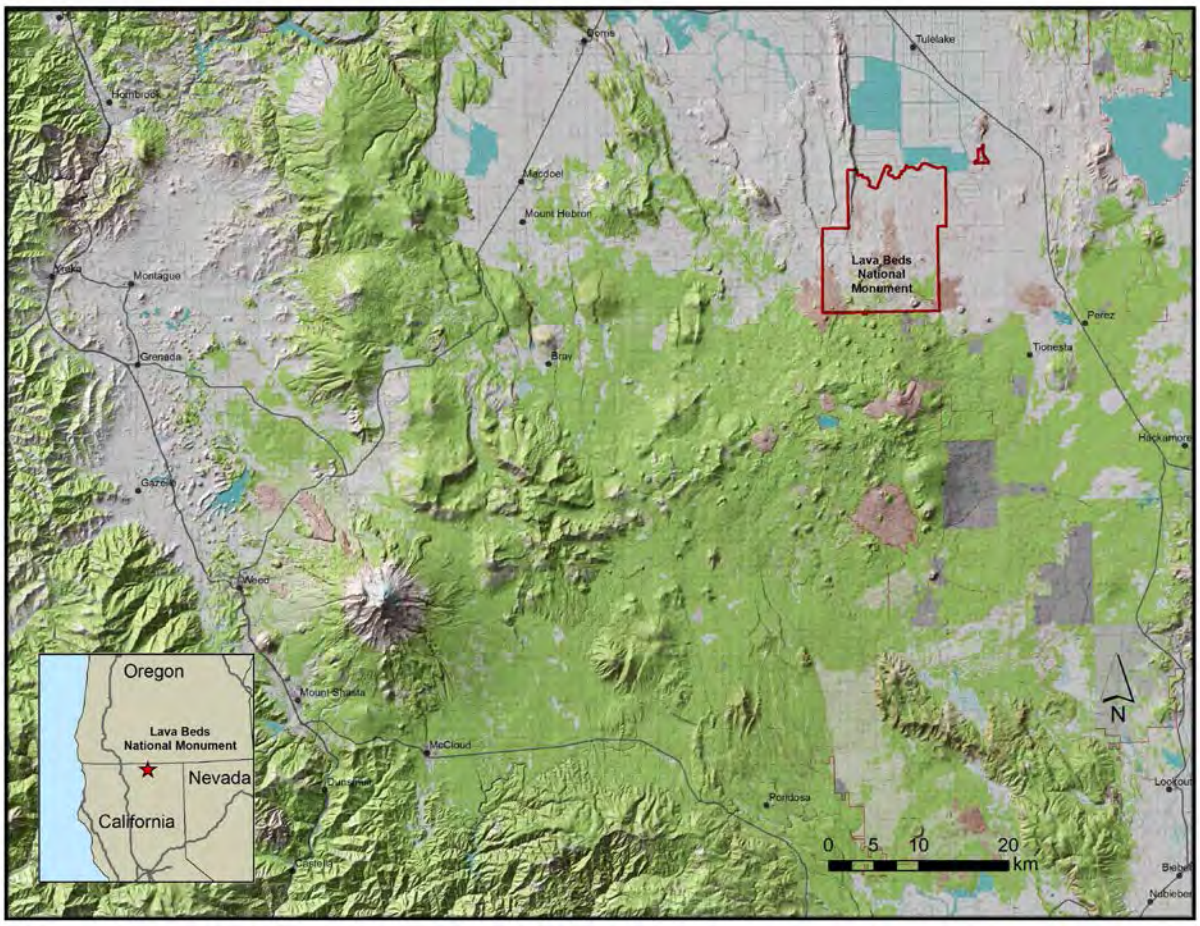

Figure 2. Lava Beds National Monument location and surrounding region.

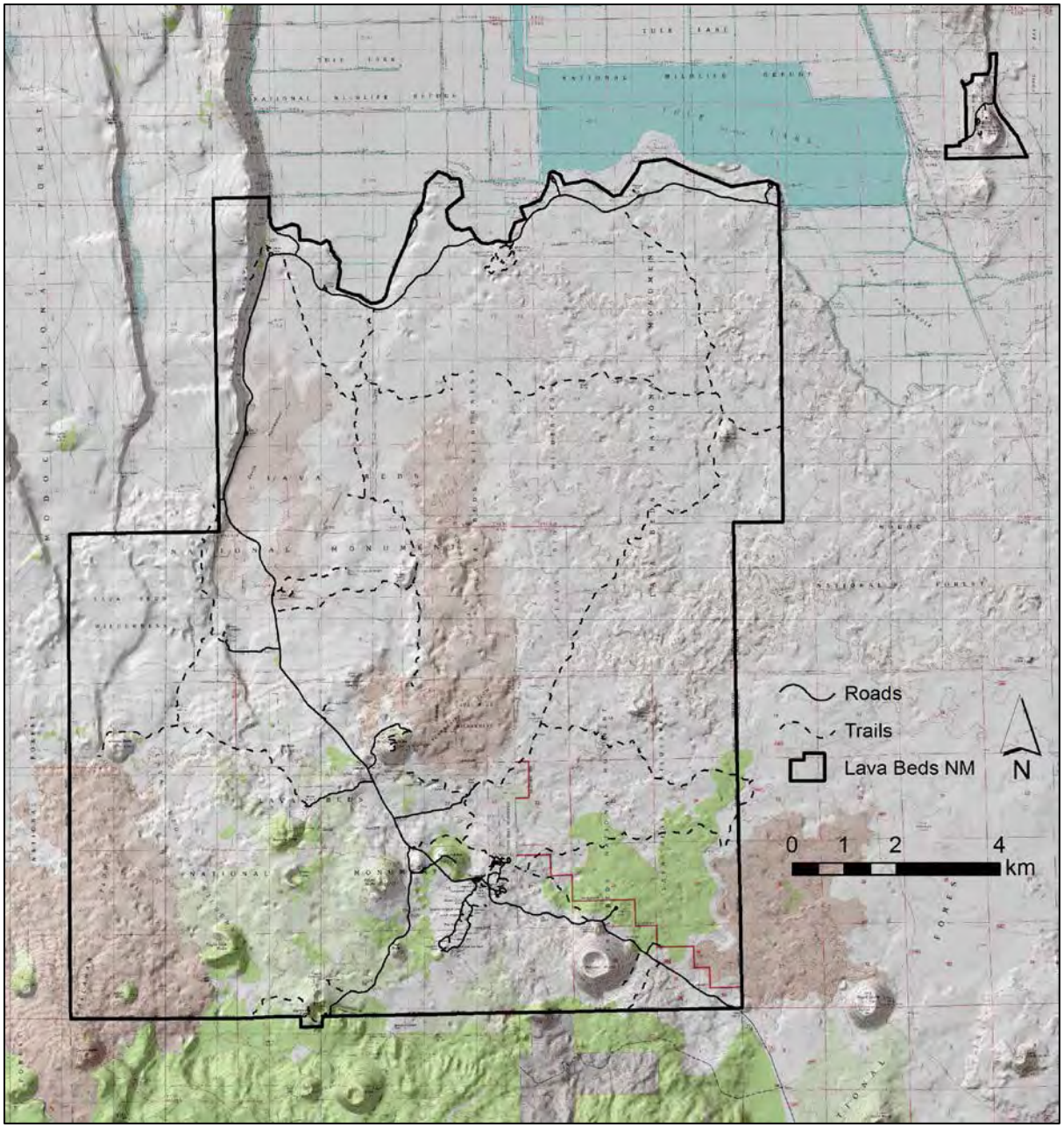

Figure 3. Lava Beds National Monument.

1.4.2 Geological and Environmental History

Exceptional geologic resources characterize Lava Beds. The geologic history has shaped the vegetation of the monument. This history is briefly described here.

The land now underlying Lava Beds emerged from the ocean near the end of the Cretaceous (65 mya) as the ancient seaway that existed began to recede.

Fossil evidence from the Alturas Formation in northeastern California supports the theory of a transition from a warm and moist, tropical climate to a semiarid, continental climate with cold

winters and hot summers by the middle to end of the Miocene (23-5.3 mya). The uplift of the Cascades and Sierra Nevada was the driving force behind the change in climate in North America. As the mountains increased in elevation, the ranges began to act as a major climatic divide, intercepting precipitation from westerly driven winter storms, and creating the rain shadow effect, now so evident at Lava Beds and throughout the Great Basin. As a result, habitats changed east of the Cascades: moist habitats became mostly eliminated from uplands (but would remain along riparian corridors) in favor of more arid woodland, chaparral, grassland, and semi-desert habitats. During the Pliocene (5.3-2.6 mya), these new Great Basin habitats were colonized by cold and/or drought tolerant species that included sagebrush (*Artemisia*), saltbush (*Atriplex*), fescue (*Festuca*), bluegrass (*Poa*), and wheatgrass (*Pseudoroegneria*) from the north; and rabbitbrush (*Ericameria*), horsebrush (*Tetradymia*), and bitterbrush (*Purshia*) from the south.

During the Miocene, the volcanic strata of the Upper Cedarville Formation, and the Modoc Plateau at large, were ruptured by block-faulting, a process creating the north-south trending ranges characteristic of the Basin and Range province (which is included in the Great Basin province). Although modest in size by Basin and Range standards, Gillem Bluff in the northwest corner of the monument represents the western edge of the Basin and Range and Great Basin provinces, and is a good example of a block-fault. Block-faulting, like flood lava flows, results from the extension of the earth's crust. The extension often causes breaks in the crust that result in vertical displacements: depressions, intervening ridges, and uplands.

A lake began to form in one such depression north of Lava Beds towards the end of the Pliocene (5.3-2.6 mya) as cooling temperatures reduced surface water evaporation and allowed rain to collect. At its largest during the Pleistocene (2.6-0.01 mya), Lake Modoc had ~644 km (400 mi) of shoreline and included eight basins. The largest remaining lakes of those that contributed to ancient and extinct Lake Modoc are Upper and Lower Klamath and Tule Lakes.

The cooling temperatures that allowed formation of Lake Modoc also caused changes in vegetation. Core samples taken in the city of Tulelake, California, north of Lava Beds, show pollen accumulation in the Tule Lake arm of Lake Modoc, and provide evidence of the climate and vegetation changed around 3 mya. At that time, the vegetation surrounding the Tule Lake arm was primarily coniferous forest dominated by pine (*Pinus*) and incense cedar (*Calocedrus*). By around 2.4 mya the amount of sagebrush pollen began to increase as advancing drought- and cold-adapted species began to dominate the area adjacent to the monument.

At about the same time, towards the middle of the Pleistocene (2.6-0.01 mya), the Medicine Lake Highland began to form. Sometime around 500,000 years ago the Medicine Lake shield volcano, an eastern finger of the main arc of Cascade volcanoes, became active and lava spilled and/or exploded onto the western portion of the Modoc Plateau. The Medicine Lake volcano grew to have the largest volume of any Cascade volcano. The monument is located on the north flank of this spreading volcano. Examples of flows from a Medicine Lake eruption 450,000 years ago can be seen at Hovey Point in the northern portion of the monument. Lava from the Medicine Lake volcano has repeatedly covered the landscape now contained within the monument, obliterating previous landscapes. Only the lavas exposed on Gillem Bluff predate the 500,000 year old Medicine Lake volcano.

Some of the monument's geologic formations include rocks from eruptions in the postglacial Holocene period (12,000 years ago to present). Two eruptive events that occurred within the monument during the Pleistocene are of particular interest because they have very different appearances and provide contrasting substrata for plant growth. The first eruptive event is the Schonchin flow, which erupted from Schonchin Butte near the middle of the monument about 65,000 years ago. This flow has a very rough, blocky surface today. The second eruptive event began at Mammoth Crater, in the southwest portion of the monument, about 36,000 years ago. Multiple vents opened during this eruption and lava was transported to distant parts of the monument through lava caves, and ultimately covered ~70% of what is now Lava Beds National Monument. The eruption created large areas of relatively smooth lava surface as it flowed from its source into Tule Lake, where it stopped. To the contemporary observer, the rugged and little vegetated Schonchin flow may appear younger than the Mammoth Crater flow, which is mostly hidden under soil, pumice, and plant life. This difference can be explained by each flow's capacity to act as a soil producing or holding substrate, especially each formation's ability to capture deposition from wind-blown silt. Evidence suggests that between 30,000 and 20,000 years ago a major arid period occurred in the Lava Beds area, possibly drying up Tule Lake, or greatly shrinking it. Winds likely transported the exposed fine lake-bottom sediments across the monument. The fine sediments that were laid down on the relatively smooth surface off the Mammoth Crater flow stayed in place, forming a shallow soil layer, conducive to plant growth. On the rugged Schonchin flow the fine sediments would have fallen or been washed by rain down into the cracks of the block lava, leaving the flow looking much as it did before the sediments were deposited: still not very hospitable to plant growth. As a result, most of the monument's vegetation grows over the relatively smooth lava of the Mammoth Crater flow.

The Mammoth Crater flow also created many of the monument's lava caves. Lava caves form in low-viscosity (fluid) basalt lava when the outer portion of a lava flow cools and hardens while the inside portion stays molten and flowing. The interior portion will eventually 'drain' leaving a tube. Occasionally the roof of a lava caves will collapse, leaving a trench filled with chunks of the former roof. Lava cave openings and collapses are among the most distinctive niche environments in the monument, and create unique habitats for plants and animals.

Most cinder cones at Lava Beds, while also formed in the Pleistocene, are older than the Mammoth Crater eruption. Cinder cones form explosively over the vents of lava flows; they often have a bowl-shaped crater at the top in which loose volcanic fragments accumulate. These volcanic fragments are glassy and vesicular with numerous gas bubbles 'frozen' into place as the erupting magma exploded into the air and then cooled quickly.

Glaciers also sculpted the landscape near Lava Beds. As the climate cooled to average temperatures lower than those of today, the glaciers advanced. Glacial and interglacial periods came and went throughout the Pleistocene. The last evidence of glaciers in the Medicine Lake highland was around 20,000 years ago. Oscillations in climate have caused rearrangements of the already existing floral elements. Cold-tolerant species responded to cold periods with range expansions; conversely, species adapted to warm, dry climates would experience range contractions during cold periods. During

warm periods the roles would be reversed, with the ranges of warm, dry-adapted species expanding and the ranges of cold, wet-adapted species contracting.

By the onset of the Holocene (<10,000 years ago), the climate had warmed, and the glaciers had retreated. Even with the overall warming trend of the Holocene, smaller scale climatic fluctuations occurred. Evidence of a smaller, less consistent snow pack during this time occurs in fossil records. For example, pollen records from Medicine Lake show that prior to 7,000 years ago pollen levels of fir (*Abies*), a wet-adapted species, were lower than present, and those of sagebrush, a dry-adapted species, were higher than present. This occurrence is likely explained by inconsistent snow pack (i.e. a more arid environment) that inhibited fir (*Abies*) growth and facilitated sagebrush growth at the lake's elevation. However after 7,000 years ago fir (*Abies*) pollen levels increased and sagebrush levels decreased, indicating a snow pack similar to current levels. By 6,000 years ago the current physiognomic structure of the Great Basin was established, but the modern grouping of Great Basin dominant woody plants would not be present until around 2,000 years ago.

By about 2,000 years ago, the vegetation and topography of Lava Beds were similar to those of present times. However, several geological events had yet to fully shape the landscape we know currently. These recent eruptions (which are part of nine eruptions to occur from the Medicine Lake volcano in the last 5,200 years) include the Callahan flow (~1,240 years ago), a rugged field of lava partially encompassed within the southwest corner of the monument. The Callahan lava flow originated from vents at or near Cinder Butte (just outside the monument to the south). Pumice from the Little Glass Mountain eruption high on the west side of Medicine Lake volcano was deposited mainly in the southwest portion of the monument (~1,000 years ago). The most recent event was the Glass Mountain eruption (~950 years ago), which spewed pumice fragments, some as large as golf balls, over much of Lava Beds. Figure 4 shows the distribution of the current geological formations.

The current geologic features of the monument include:

- the largest concentration of lava tube caves in the continental U.S., along with unique environments and cave-dependent species,
- outstanding, diverse, abundant, and well preserved lava flows, cinder cones, spatter cones, Maar volcanoes, and other volcanic features associated with the Medicine Lake shield volcano,
- wilderness in the unique volcanic landscape of the Great Basin and Cascade ecosystems, and
- native plant and animal species, their habitats, and the processes (such as fire) representative of the transition zone for Great Basin and Cascade ecosystems.

The monument has over 750 documented lava tube caves with a total of 32.5 miles of known passageways. Of these caves, 35 are documented to contain ice during most years. Ice occurs in many forms, including small pockets, stalactite/stalagmite forms, and large blocks that fill entire rooms.

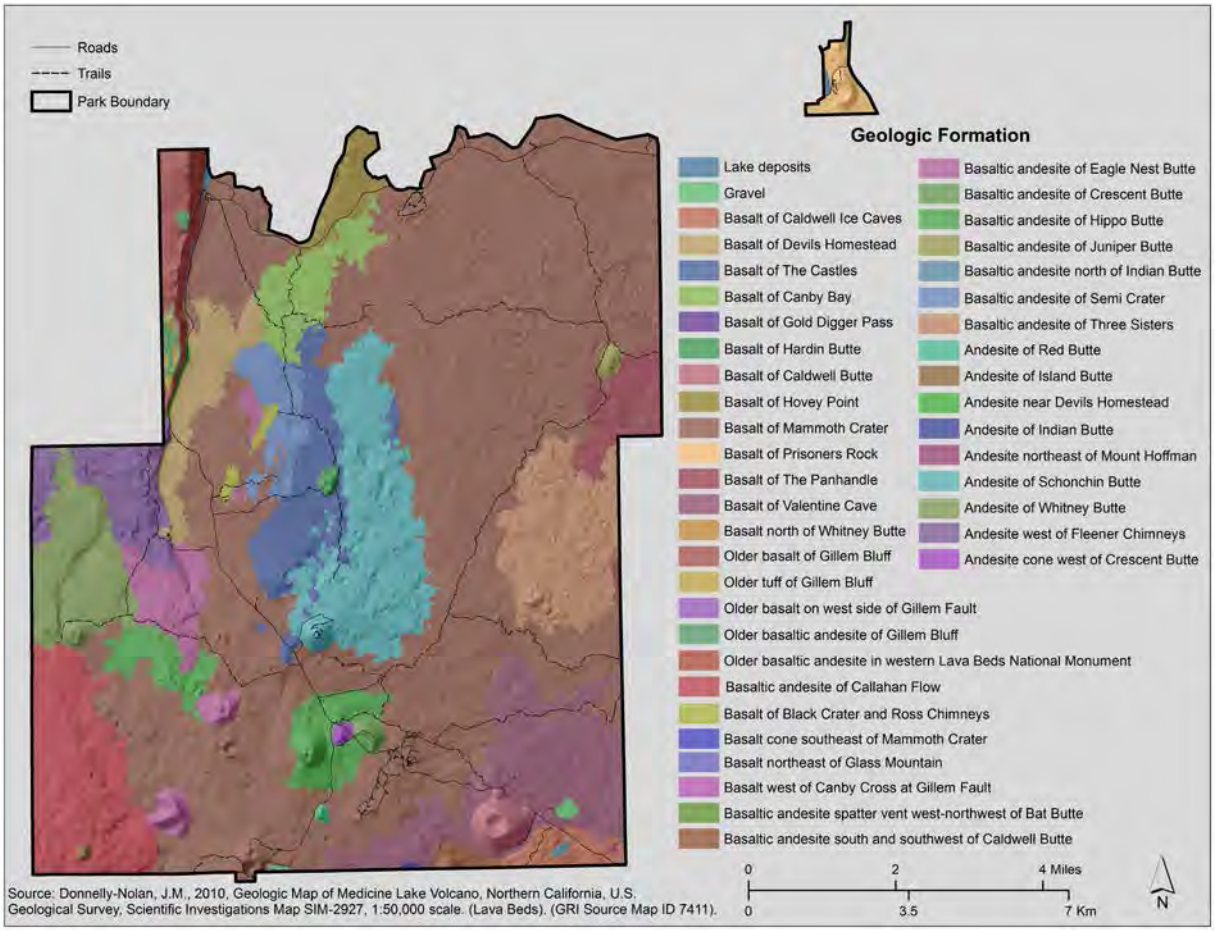

Figure 4. Geology of the Lava Beds National Monument.

1.4.3 Current Climate

Lava Beds has a climate characterized by summer drought and winter precipitation. Due to the its location on the leeward side of the Klamath and Cascade Mountains, the monument's climate is a variation of a Mediterranean climate, and accordingly has a continental, semi-arid, summer-dry climate with abundant sunshine throughout the year. At monument headquarters, precipitation averages 37 cm (14.7 in.) per year. In contrast, Crescent City, California, located on the coast almost directly to the west of the monument, receives 170 cm (67 in.) of rain per year.

Within the monument, precipitation increases with elevation. Tulelake, California, located just north of the park and at a lower elevation (1,230 m [4,035 ft.]), receives 28 cm (10.9 in.), or 9 cm (3.5 in.), less than the park headquarters, which is located at an intermediate elevation (1,450 m [4,760 ft.]). Thus, the increase in precipitation along the north-to-south elevation gradient is about 9 cm (3.5 in.) per 200 m of elevation gain. Precipitation falls primarily from October through June with a notable dry period in midsummer. The summer drought is interrupted by occasional summer thunderstorms; however, these events do little to recharge soil moisture. Snowfall averages 115 cm (45.4 in.) per year, falling primarily between November and April.

Average daily temperatures range from less than 0°C (32°F) in January to 20°C (68°F) in July. The record high is 40°C (103°F). As in most semiarid climates, day to night temperature fluctuation is large and even summer nights can be cool; the record lows for July and August are -3°C (27°F) and -1°C (30°F), respectively. Winter evenings can be bitter with a record low around -25°C (-13°F) recorded for both January and February. Frost has been recorded in every month of the year, but typically the growing season lasts from late May to September.

The rigorous high desert climate poses multiple constraints on plant establishment and growth. As in all semi-arid climates, moisture is a major limiting factor. Winter precipitation is low and soils dry rapidly in summer due to warm temperatures and low humidity. Secondary limits to plant growth include sharp temperature decreases at night, which limit vegetation growth late into the spring. Overall, moisture availability and plant moisture needs are out of phase and the majority of plant growth is limited to a relatively brief window in late spring and early summer.

1.4.4 Vegetation and Flora

Elevation-driven changes in moisture and temperature yield marked zonation in vegetation at the monument. These factors interact with substrate age and topography to produce the vegetation mosaic. Grassland and big sagebrush (*Artemisia tridentata*) communities dominate the lower elevation valleys and plateaus. With decreasing elevation from south to north, sagebrush increases in frequency while the density of western juniper (*Juniperus occidentalis),* curl-leaf mountain-mahogany (*Cercocarpus ledifolius*), and overall vegetation stature decrease. At higher elevations and more mesic sites (i.e., north facing slopes), ponderosa pine (*Pinus ponderosa* var. *ponderosa*) dominates.

Sagebrush Steppe Zone

Sagebrush steppe dominates the northern two thirds of the monument where elevations range from 1,220-1,500 m (4,000-5,000 ft). Sagebrush communities are typically co-dominated by shrubs and grasses. Grasses include both native bunchgrasses (e.g., *Elymus, Festuca, Poa*) and introduced cheatgrass (*Bromus tectorum*). Fires in recent years killed most shrubs over large areas in the northwestern quadrant of the monument. Consequently, these areas are dominated by grasses, particularly cheatgrass, and another non-native herbaceous (forb) species, herb sophia (*Descurania sophia*). This shift to grass domination may persist as Great Basin shrubs are slow to regenerate from seed and fire may recur before this can happen. Probability of fire recurrence is enhanced by cheatgrass, which has a positive feedback relationship with fire; both promoting and being promoted by fire (D'Antonio and Vitousek 1992). Over the last several decades cheatgrass has become the most widespread and abundant plant in the monument, based on 169 plots that span the range of variation in vegetation. Cheatgrass is common in all the main vegetation types, but is most common at the north end of the park.

At the lowest elevations (1,220-1,280 m) in the monument, the unburned sagebrush steppe consists of open shrublands of basin big sagebrush *(Artemisia tridentata* ssp. *tridentata*) typically on deep well-drained soils. Native bunchgrasses and cheatgrass occur in the herb layer. Common bunchgrasses include squirreltail grass (*Elymus elymoides)*, Thurber's needlegrass (*Achnatherum thurberianum*), bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata)*, Sandberg bluegrass

(*Poa secunda*), Idaho fescue (*Festuca idahoensis*), and scattered native herbs (e.g., *Agoseris* spp., *Nothocalais troximoides*, and *Astragalus* spp.). Common woody associates include the deciduous shrubs rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*) as well as antelope bitterbrush (*Purshia tridentata* var. *tridentata)* and spineless horsebrush (*Tetradymia canescens*).

At low to middle elevations (1,280-1,480 m) and on rockier soils in the monument, mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) replaces basin big sagebrush. Vegetation dominated by mountain big sagebrush often has antelope bitterbrush as a codominant shrub and bluebunch wheatgrass, Idaho fescue, and prairie junegrass (*Koeleria macrantha)* are dominant in the understory. These associations are the most mesic of the sagebrush communities (Young et al. 2007). Associated species include showy herbs such as spotted fritillary (*Fritillaria atropurpurea)*, old man's whiskers (*Geum triflorum)*, redstem springbeauty (*Claytonia rubra* ssp. *rubra)*, dwarf flax (*Hesperolinon micranthum)*, dwarf skullcap (*Scutellaria nana)*, fleabane (*Erigeron* spp.), groundsmoke (*Gayophytum* spp.), and prairie flax (*Linum lewisii* var. *lewisii*).

An association dominated by desert gooseberry (*Ribes velutinum)* and basin wildrye (*Leymus cinereus*), a very large bunchgrass, occurs in the northern part of the monument at the lowest elevations (Erhard 1979, Smith 2014), particularly on rocky sites near the former lake shore. An association dominated by basin wildrye without desert gooseberry occurs in the northern portion of the monument as well and is an indicator of pluvial lake plains (former lakebeds) (Young et al. 2007). This seasonally moist environment occurs in areas with accumulations of erosionally deposited volcanic ash (Young et al. 2007). Species associated with basin wildrye include the shrubby to small tree Pacific willow (*Salix lucida* ssp. *lasiandra*), and herbs such as longroot smartweed (*Persicaria amphibium* var. *emersum)*, and stinging nettle (*Urtica dioica* var. *holosericea*).

Perennial bunchgrass grasslands occur over portions of the monument in the sagebrush steppe zone. These grasslands are often dominated by bluebunch wheatgrass but also occur in mixed stands that include squirreltail grass, Thurber's needlegrass, Sandberg bluegrass, and, in the southwest part of the monument, Idaho fescue. These grasslands often occur where recent fire has burned off the former shrubland, woodland, grassland mosaic, but they may also be persistent on shallow soils or other substrates that have limited shrub and tree recruitment.

Shrublands dominated by rubber rabbitbrush and/or yellow rabbitbrush also occur in the northern portion of the monument where grazing, frequent fire, and the draining of Tule Lake have modified natural vegetation. Gnarled old junipers occur sporadically in the sagebrush-steppe, most often on rocky outcrops, while smaller and younger individuals can occur among sagebrush along the shrubland-woodland transition.

Juniper and Mountain-Mahogany Zone

The western juniper and curl-leaf mountain-mahogany woodland communities occupy much of the southern third of the monument, at elevations ranging from 1,310-1,615 m (4,300-5,300 ft). The woodlands represent a mid-elevation ecotone between the warmer, drier, lower elevation sagebrush

steppe vegetation and the cooler, moister, higher elevation coniferous forest vegetation. In addition to western juniper, curl-leaf mountain-mahogany, antelope bitterbrush and, to a lesser extent, mountain big sagebrush are dominant shrubs. Associated herbaceous species include western needlegrass (*Achnatherum occidentale*), bluebunch wheatgrass and the showy herbs, whitedaisy tidytips (*Layia glandulosa)*, penstemon (*Penstemon* spp.), and rock cress (*Arabis* spp.).

Mountain-mahogany communities in the monument often occur on undulating basalt with little soil development and little forb cover (Erhard 1979, Smith 2014). On deeper soils the herb layer becomes better developed. Associated species include the deciduous shrubs bitter cherry (*Prunus emarginata)* and currant (*Ribes* spp.), Sandberg bluegrass, and cheatgrass.

Although it is well distributed across the monument, western juniper is often not the most common species in many of the vegetation associations in which it occurs. However, western juniper provides the dominant cover in certain areas, such as on the gently rolling terrain of the Valentine flow in the southeast corner of the monument. Western juniper woodlands and juniper and mountain-mahogany woodlands occur as a broad frontier between the forested highlands and the sagebrush vegetation of the basin but often extend north and south into these zones on lava rock terrain with limited soils development. Juniper associations often occur on the slopes of cinder cones in the monument with mountain-mahogany as a co-dominant species at these sites.

Pine Forest Zone

Communities dominated by ponderosa pine occur in the southern portion of the monument, extending down to 1300 m (4265 ft), but mostly occurring above 1500 m (4920 ft). The shade-tolerant white fir (*Abies concolor*) and incense cedar (*Calocedrus decurrens*) occur in the understory of some stands. With the absence of fire these trees may be increasing in abundance in certain locations (Erhard 1979, Smith 2014). Antelope bitterbrush is a common shrub in ponderosa pine woodlands, along with greenleaf manzanita (*Arctostaphylos patula*) and snowbrush ceanothus (*Ceanothus velutinus*), which have fire-stimulated seed germination. These shrubs occur in relatively pure stands where, historically, stand-replacing fires allowed them to establish and/or maintain their populations. Less common are two species of currant (*Ribes roezlii* var. *roezlii* and *Ribes cereum*), and other shrubs like western chokecherry (*Prunus virginiana* var. *demissa*) and rabbitbrush (*Ericameria bloomeri)*. The dominant grasses include bunchgrasses such as bluebunch wheatgrass and Idaho fescue. Ponderosa pine stands on isolated cinder cones are mainly undisturbed, but ponderosa forests along the park's southern boundary have been profoundly altered in recent history. Railroad logging, clearing by homesteaders in the Hidden Valley area, and a major stand-replacing fire around 1915 before the monument was established had dramatic effects. Almost all the pines currently present have regrown since these events, and the ecotone between juniper woodland and ponderosa forest has shifted south and higher in elevation. Widely scattered large-diameter stumps and snags in the southern third of the park, particularly in the Valentine Flow and southeastern areas, now are surrounded by juniper and mountain-mahogany woodlands.

Lava Flows, Caves, and Cinder Cones

Because the southern slopes of cinder cones are dry, harsh environments, in places they support assemblages of locally rare species that are specialized for those conditions. These areas support

widely-spaced shrubs and subshrubs such as slender buckwheat (*Eriogonum microthecum*), purple sage (*Salvia dorrii* ssp. *dorrii* var. *incana*), and mountain monardella *(Monardella odoratissima*) along with the distinctive Sacramento waxy dogbane (*Cycladenia humilis* var. *humilis*). Associated species include the herbs, dwarf purple monkeyflower (*Mimulus nanus*), ballhead ipomopsis (*Ipomopsis congesta*) and the diminutive and state-listed rare plant, doublet *(Dimeresia howellii)*.

The lava flows in the monument are sparsely vegetated. The bare, rough, and dark volcanic rock provides scattered junipers refuge from fires, to which they are sensitive. Lava flows also feature purple sage, fernbush or desert sweet (*Chamaebatiaria millefolium*), and mountain big sagebrush. Additional shrubs in this harsh habitat are large and ancient looking mountain-mahogany as well as wax currant *(Ribes cereum)* and oceanspray *(Holodiscus discolor*). The most common forbs/subshrubs include scabland penstemon (*Penstemon deustus)* and small-leaved giant hyssop (*Agastache parviflora)*.

Cave entrances within the monument support assemblages of many of the same species discussed above, especially fernbush or desert sweet. Right next to cool cave mouths may be found locally rare or disjunct species, especially lanceleaf figwort (*Scrophularia lanceolata*), ferns such as brittle bladderfern (*Cystopteris fragilis*), and a variety of lichens and mosses (Steven Jessup, Southern Oregon University, pers. comm.). The occurrence of sword fern (*Polystichum munitum*) at some cave entrances and in some caves is highly notable because it is a species typically more common near the coast, with the nearest known neighboring population being 120 km (75 miles) west of the monument (Smith et al. 1993).

1.4.5 Fauna

Lava Beds National Monument is home to a number of large and wide ranging mammal species. Herds of mule deer (*Odocoileus hemionus*) occur throughout the monument. They are particularly abundant in late summer in the northern portions of Lava Beds. Elk (*Cervus canadensis* ssp. *nelsoni*) intermittently use the monument in the late winter and early spring. Coyotes are common residents as are bobcats. Mountain lions are known to roam the backcountry throughout the year in pursuit of prey. All of the above species, save the bobcat, are wide ranging and undoubtedly move across the national monument boundary onto adjacent public and private lands to meet their yearly life history requirements.

The monument boundary captures several major wildlife habitat types of the high desert and interior mountains that mostly parallel the vegetation "zones" described above. Each provides for a distinctive suite of associated wildlife species, however, some of these wildlife species will use two or more of these habitat/vegetation zones.

In the sagebrush steppe, several bird species are found at Lava Beds that generally do not occur in woodlands or forest. These include the western meadowlark, horned lark, sage thrasher, Brewer's sparrow, mourning dove and the northern shrike. Red-winged blackbirds from Tule Lake marshes often use the sagebrush along the northern park boundary. Large numbers of common nighthawks use the norther portion of the monument to roost and hunt over the lake at dawn and dusk. Purple martins have in the past nested and roosted near cave entrances in the middle portion of the

monument and fed over Tule Lake. A large colony of cliff swallows and a consistent nesting pair of prairie falcons occur on the steep cliff faces of the Petroglyphs Unit. There is an exceptional abundance of canyon wrens and rock wrens on the lava flows. Kangaroo rats, black-tailed jackrabbits, and California ground squirrels are some of the common mammal species in the sagebrush steppe. There is also a notable lower elevation presence of American pika (*Ochotona princeps*) in the talus around larger cave entrances.

The bird species composition shifts markedly toward the middle and higher elevations of the monument, in association with juniper and/or mountain-mahogany woodland. The mountain bluebird, scrub jay, juniper titmouse, ash-throated flycatcher, and blue-gray gnatcatcher, among other species, are common here, whereas they are typically absent from the sagebrush steppe. The lazuli bunting may be found here as well as in the sagebrush steppe while the Townsend's solitaire can be found in the woodlands as well as forested areas upslope. Woodrats, particularly their large stick nests, are conspicuous features of the woodlands.

Much of the ponderosa pine forest in the monument occurs in the transition zone between mid-elevation woodlands and the forested uplands to the south. Therefore the ponderosa pine forest shares many of the same animal species with the adjacent woodlands with a few exceptions. One of the most striking exceptions is the white-headed woodpecker, which occurs almost exclusively in the pine forest. The mountain chickadee and the olive-sided flycatcher are also more commonly found in the pine forests.

At dusk, at a few select cave entrances, in excess of one-hundred thousand bats, mostly Mexican free-tailed bats (*Tadarida brasiliensis*), fly out en masse for their nightly activities. The event happens in reverse at the pre-dawn hour. Also notable in the caves of Lava Beds are several species that live entirely within caves (i.e., troglobites). At Lava Beds, these are mostly invertebrates.

1.4.6 Natural Resource Concerns

Non-native, invasive species are a significant threat to native plant communities in virtually all natural areas, including Lava Beds National Monument. In many regions, invasive species are second only to habitat loss as a threat to native biodiversity (Wilcove et al. 1998). While many non-native, invasive species are relatively benign, impacts from a few select non-native, invasive species may include the replacement of native vegetation (Tilman 1999), the loss of rare species (King 1985), changes in ecosystem structure (Mack and D'Antonio 1998), alteration of nutrient cycles and soil chemistry (Ehrenfeld 2003), shifts in community productivity (Vitousek 1990), changes in water availability (D'Antonio and Mahall 1991), and alteration of disturbance regimes (Mack and D'Antonio 1998).

Across the Klamath Network, the number of non-native species increases sharply at lower elevations with proximity to human dominated landscapes. The Monument is much more threatened to be significantly degraded by invasive species than any other park in the Klamath Network due to its low elevation and the presence of cheatgrass (*Bromus tectorum*), an exceptionally invasive plant that can dramatically alter species composition and ecological processes.

Cheatgrass

Cheatgrass is a widespread invasive from Eurasia, occurring throughout the monument and Great Basin. It is one of the world's biggest invasive species problems (Daubenmire 1940, 1968, Mack 1981). Cheatgrass invasion in the Great Basin has been described by Aldo Leopold (1949) in *A Sand County Almanac* as a particularly significant environmental disaster that has come to be remarkably well-accepted. Thus, there can be very different levels of concern associated with cheatgrass invasion. Herein, we consider cheatgrass domination to be a serious form of degradation because it substantially alters natural conditions and perhaps ecological functions in the monument.

Cheatgrass can facilitate the conversion to grasslands from shrublands and woodlands that are not fire-adapted and which naturally burn infrequently. Cheatgrass can also dominate in ponderosa pine forests after wildfires or prescribed fires (Kerns et al. 2006). It is favored by fire (D'Antonio and Vitousek 1992) and the scale of the fires which accompanied its spread in the early 1900s was unprecedented (Billings 1990, 1994). In contrast, when the herbaceous vegetation in the sagebrush-steppe was occupied mainly by bunchgrasses, there was much less fine fuel to carry fire. Early surveys in the western Great Basin mentioned no evidence of past fire on the landscape, or cheatgrass. Cheatgrass invaded heavily grazed systems and once present, it occupied much of the open space between shrubs, greatly increasing the capacity for spreading fire.

Cheatgrass is especially prevalent after fire because fires often kill the woody vegetation and release a pulse of nutrients that increase cheatgrass growth (Billings 1990, 1994). In contrast, woody vegetation in Great Basin plant communities is very slow to redevelop after fire, and may be slower when competing with cheatgrass (Billings 1990, 1994). In addition, sagebrush is an obligate seeder; it does not re-sprout and relies on seedling regeneration (Young et al. 2007). Sagebrush accumulates no seedbank from which to germinate and grow following fire. However, following fire at higher elevations, bunchgrasses, which are also fire-associated (Wright 1982, Ellsworth and Kauffman 2010), may compete better with cheatgrass and resist its post-fire invasion (Davies et al. 2011). An increase in bunchgrass may generally be considered a positive change because native bunchgrasses do not depress diversity of other native plants to the extent that cheatgrass does, and by providing more varied vertical structure, they may support a wider variety of wildlife species.

Invasive species control efforts do not target cheatgrass because control of this species is considered futile. With no means of controlling cheatgrass, the concern for the monument is that fire will cause sagebrush-steppe and woodlands to be displaced by cheatgrass and the native vegetation won't return to its former state. Additionally concerning is the likelihood that the type conversion to cheatgrass dominated grassland will be maintained by fire. Because the shrubs regrow so slowly, even fires as infrequent as 30 to 50 years apart could maintain vegetation dominated by cheatgrass at the monument.

Other Invasive Plants

Until 1974, much of the monument was heavily grazed, which had a significant impact on the native vegetation and fragile soils, thus likely increasing the spread of invasive plants. Currently, the Lava Beds' proximity to lands disturbed by agriculture make its flora particularly vulnerable to invasive plants. Out of the total of 63 non-native plant species within the monument, 23 are considered

invasive. Invasive plants that have been subject to control efforts at Lava Beds include common mullein (*Verbascum thapsus*), horehound mint (*Marrubium vulgare*), stinging nettle (*Urtica dioica*) (found in relatively wet areas), bull thistle (*Cirsium vulgare*), and yellow sweetclover (*Melilotus officinalis*). Canada thistle (*Cirsium canadensis*) and perennial pepperweed (*Lepidium latifolium*) have not been targeted, but are incipient threats to native plant communities because they often are ecosystem transformers.

Western Juniper

Western Juniper is a native, small-statured tree whose growth conflicts with some management goals if it expands into grasslands and shrub steppe. There, it can block vistas and reduce the cover of native grasses and shrubs via shading and competition for moisture. At the same time, juniper woodlands are an important and historic native vegetation type in Lava Beds and the surrounding region, where juniper improves habitat suitability for some wildlife species and may support a diverse array of epiphytic lichens and bryophytes. The dynamics and determinants of juniper expansion or contraction are complex, as addressed in a recent review by Romme et al. (2009).

Historical Fire and Human Influences

It is helpful to consider the past fire regime at Lava Beds to understand the current condition of the monument's vegetation. However, reconstruction of intervals of past fires at a specific site is difficult or impossible, and the presettlement fire frequency, specifically in the sagebrush steppe of northeastern California, is unknown (Young et al. 2007). At a coarse landscape scale, ecologists have recognized that some stand-replacing fires have been a normal occurrence in sagebrush-dominated communities pre-dating Euro-American settlement. It also is apparent that many shrubland areas of the Great Basin lack evidence of fire and/or adaptation to rapid post-fire regeneration (Billings 1994). A recent review concluded that fires in the sagebrush steppe and juniper woodlands were infrequent on average, with interludes of up to centuries between fires. For sagebrush-steppe in general, estimates of fire frequency range from 50-240 years (Baker 2006, Mensing et al. 2006). This suggests that junipers were not excluded by fire, although they may have been excluded by climate. The historic fire frequencies described by Miller and Heyerdahl (2008) for forests in the region varied from a composite fire scar frequency of 8-9 years from 1750-1904, to 150 or more years in the last century. These estimates illustrate the wide range of natural variability that likely occurred at the monument, and how variation in fire may have occurred at relatively fine spatial scales.

Young et al. (2007) document a spike in post-settlement fire in many areas of northeastern California. Settlement burning in many areas caused a conversion of sagebrush steppe to more grass-dominated vegetation, due to the fire-sensitive nature of *Artemisia*. However, in many areas, overgrazing eliminated the bunchgrasses. Since the early 1900s, intentional fires have been greatly reduced and current conditions where fire has not occurred represent successional processes from an altered system. While some have assumed that the lack of bunchgrasses in many areas is due to lack of fire, it may be from livestock grazing. In the mid 20th century, heavy grazing left large areas of the sagebrush steppe where shrubs were not decimated by range burning, with little plant growth other than sagebrush (Young et al. 2007). The increase in shrubs may be a response to cessation of fire, but this was (at least in part) fire that was intentionally set by settlers to eliminate shrubs and promote

herbaceous vegetation for livestock (Young et al. 2007). With fires fueled by cheatgrass in recent decades, shrubs have again decreased dramatically.

Current Fire

The area burned since 1910 was calculated by Adamus et al. (2013). Overall, out of a total of 36,514 ha burned since 1910, 14,158 ha burned in lightning caused fires, 21,039 burned from human-ignited fire, and 1,316 ha burned from unknown causes of ignition. There was a large amount of wildfire (almost 20,000 ha) in the 1940s, and relatively little any other time prior to 1970. About one-third of this wildfire resulted from human ignitions. Since 1973, most fire has been from human ignitions and deliberate burning, although the lightning-ignited wildfire in 2008 known as the Jack fire did burn about 2,000 ha of sagebrush steppe.

Rotations of fire from the time period 1910-1970, in which no prescribed fires occurred, were very long for ponderosa pine forests, the vegetation which historically burned most frequently. These forests experienced almost no fire during this time period (Table 1). With the introduction of prescription burning around 1970, the amount of fire in these forests has increased considerably. The 63-year fire rotation since 1990 is still longer than the fire frequency (3-37 years from 1750-1904) recorded on ponderosa pines on three buttes by Miller and Heyerdahl (2008). It is not clear if areas off the buttes would have burned with the same frequency as areas on the buttes and whether some historic fires were the result of settlers, or were lightning ignitions.

In contrast, rotations for fire in sagebrush-steppe over the 1910-2010 time period, and for woodlands since prescription burning began in the 1970s (Table 1), are an order of magnitude shorter (i.e., more fire) than those estimated for sage-steppe or woodlands in the Great Basin prior to fire suppression (Romme et al. 2009, Baker 2006, 2011). However, for Lava Beds, Miller and Heyerdahl (2008) note that absence of large live or dead junipers is an indication that sagebrush vegetation burned frequently enough, possibly < 25 years, to have precluded juniper growth (Miller and Heyerdahl 2008). Alternatively, it could also be that the absence of old-growth junipers in sagebrush may be due to climate that was not suitable over a long-enough time span to allow for the establishment of junipers in the sagebrush areas where juniper is currently encroaching (Romme et al. 2009). In the sagebrush where live or dead old-growth junipers do occur, Miller and Heyerdahl (2008) state that fire intervals were much longer, with > 80 year fire-free periods. These periods are substantially longer than those that currently occur under the prescribed fire regime (Table 1). In woodlands, fire rotations have decreased dramatically (i.e. more fire) from 161 years during the wildfire era to only 29 years in the prescribed burning era. In the juniper woodland vegetation sampled by Miller and Heyerdahl (2008), live junipers over 250 years old may indicate that fire rotations were very long, perhaps centuries. Therefore, a substantial increase in fire during the prescribed burning era over historical levels appears to be occurring in most sagebrush areas and woodlands at the monument.

Table 1. Fire rotations in major vegetation types as calculated during different time periods at Lava Beds since 1910. Calculated in 2013 from fire history data for Lava Beds (see Adamus et al. 2013).

Vegetation	Fire rotation (years)		
	1910-1970	1971-2010	1990-2010
Forest	1772	101	63
Grassland	119	79	67
Sagebrush-steppe	33	35	29
Woodlands	161	52	28.6
All	53.1	44	32

1.5 Lava Beds National Monument Vegetation Inventory Project

The Klamath Network initiated a vegetation mapping plan for Lava Beds as part of a larger effort to complete vegetation inventory maps for all parks in the network. An initial multi-year work plan was developed for the Klamath Network by Southern Oregon University for three of the park units. These included Oregon Caves National Monument, Lava Beds National Monument, and Crater Lake National Park. Planning between the Klamath Network, the Washington Area Service Office, and Southern Oregon University project staffs was done to complete the plant community classification, digital database, and map products for a component of the Lassen Vegetation Inventory Project, as well as the inventory projects at Oregon Caves, Lava Beds, and Crater Lake. The work plan received approval from the Washington Area Service Office in 2007. When the work plan was approved and funded, the Klamath Network entered into a cooperative agreement with Southern Oregon University to complete the projects. The Southern Oregon University research team has been responsible for this project, including the following components:

- Aerial and ortho-photography;
- Classification of Lava Beds vegetation into associations;
- Dichotomous field key to vegetation associations;
- Formal description for each vegetation association;
- Ground photographs of each vegetation association and relevé (field plot);
- Field data in database format;
- Map and spatial database of Lava Beds vegetation;
- Formal description of vegetation map units in relation to associations;
- Digital and hardcopy maps of the vegetation of Lava Beds;

- Metadata for spatial databases;
- Complete accuracy assessment of spatial data.

The Southern Oregon University research team organized the data collection and image acquisition for the Lava Beds vegetation inventory (classification and mapping) project beginning in 2009.

1.6 Scope of Work

The vegetation inventory for the project occurred on an 18,936 ha (46,792 acre) area encompassing the existing Monument boundary. The inventory did not include the recently created Tule Lake Unit, WWII Valor in the Pacific National Monument that is managed by staff of Lava Beds National Monument.

2 Methods

Protocols for this project as outlined in the following sections can be found in documents for the Vegetation Mapping Inventory. In particular the following documents: TNC and ESRI (1994), Lea (2011), and Lea and Curtis (2010) provided valuable guidance.

2.1 Planning, Data Gathering and Coordination

Planning for this project was developed during a meeting held on June 12th and 13th 2006 in Redding, CA, with the following participants:

Participants	Affiliation	Phone
Leonel Arguello	NPS: Redwood National and State Parks	(707) 464-6101 x5280
Karl Brown	NPS: Vegetation Mapping Inventory Program	(970) 225-3591
Andrew Duff	Southern Oregon University	(541) 552-6253
Julie Evens	California Native Plant Society	(916) 327-0714
Todd Keeler-Wolf	California Dept. of Fish and Game	(916) 324-6857
David Larson	NPS: Lava Beds National Monument (former)	(530) 667-8106
Michael Murray	NPS: Crater Lake National Park (former)	(541) 594-3072
Dennis Odion	Southern Oregon University	(541) 552-9624
Susan O'Neil	NPS: Klamath Network (former)	(206) 220-4265
John Roth	NPS: Oregon Caves National Monument	(541) 592-2100 x230
Daniel Sarr	NPS: Klamath Network (former)	(541) 552-8575
Ken Stumpf	Geographic Resource Solutions	(707) 822-8005
Chris Wayne	NPS: Crater Lake National Park	(541) 594-3076
Russ Weatherbee	NPS: Whiskeytown National Recreation Area	(530) 242-3442
Robin Wills	NPS: Regional Fire Program	(530) 898-9826

The goals of the scoping meeting were to: (1) provide an overview of the Vegetation Mapping Inventory Program; (2) learn about the Whiskeytown National Recreation Area experience with their recently completed vegetation map; (3) discuss availability of existing data; (4) develop a plan, schedule, and list of cooperators to map the remaining park units in the Klamath Network; and (5) discuss procedural issues and data.

It was decided at this meeting that the Southern Oregon University research team would classify and map the vegetation within Lava Beds. They were to develop a detailed proposal and budget for the project at Lava Beds, as well as the projects at Crater Lake and Oregon Caves. The Klamath Network developed the detailed proposal with input from park staff and Dr. Karl Brown (Vegetation Mapping Inventory Program Manager). The final proposal was presented to the Vegetation Mapping Inventory Program in early January 2007. The proposal called for relevé sampling of vegetation types and development of a vegetation classification as per the requirements of the Vegetation Mapping Inventory Program. The vegetation would be mapped using interpretation of digital aerial photography. Additional meetings were held to discuss specific aspects of the project during the development of the proposal. The project was ultimately approved by the Vegetation Mapping Inventory Program and a task agreement was entered into with the Pacific Northwest Cooperative Ecosystem Studies Unit of the NPS with Southern Oregon University as the cooperator.

2.2 Field Surveys

The field methods that we employed in this project followed National Vegetation Classification and U.S. Geologic Survey-NPS standards (e.g., TNC and ESRI 1994), the California Native Plant Society relevé sampling protocol (CNPS 2007), as well as the relevé methods described in the Vegetation Mapping Inventory Program 12-step process. Classification plot forms and individual data/field descriptions appear in Appendix A. The relevé sampling area included all of Lava Beds National Monument (Figure 5).

Our first step was to stratify the project area into 34 separate polygons by geologic substratum and elevation, since differences in vegetation are often strongly affected by these two variables. Through reconnaissance and sampling of these stratified areas it was expected that the range of variation in the vegetation in the monument would be captured. In the spring and summer of 2010 and the spring of 2011, each of the 34 polygons that served as sampling strata were sampled following the general procedure for relevé sampling in the California Native Plant Society relevé sampling protocol (CNPS 2007) and the Vegetation Mapping Inventory Program 12-step process.

Field crews were led by Sean B. Smith, botanist with the Klamath Network and author of *A Flora of Lava Beds National Monument* (Smith 2014), and Kristi Mergenthaler, a botanist with extensive regional expertise. Both botanists had prior experience using the relevé method. All 34 separate polygons serving as our sampling strata were visited to help ensure that the variation in vegetation in the landscape would be captured. Within each of the sampling stratum, we sampled the range of variation in vegetation associations observed in the field. We assigned each classification plot to a provisional plant association and recorded the number of relevés sampled in each of these types. The sampling goal was to collect at least five relevés in every provisional association. However, some common plant associations were sampled more often and some rare associations were sampled less often. Some rare associations only occurred in one small location, suitable for one to two classification plots.

An effort was made to achieve good spatial distribution of classification plots across the landscape and to capture the full range of variation of each plant association. Once a stand of vegetation was located that appeared to contain a representative plant community, a relevé macroplot was laid out to

capture the stand characteristics. In this manner, transitional areas such as ecotones were avoided. Highly disturbed areas were also avoided unless they supported a distinct plant community. Plot size and shape requirements were consistent with Vegetation Mapping Inventory Program guidelines (TNC and ESRI 1994) and included 1,000 m^2 for forests and woodlands, 400 m^2 for shrublands, and 100 m^2 for herbaceous vegetation. Plot shapes were variable so as to avoid including ecotones when possible.

In 2010, 146 relevé plots were sampled. In 2011, 23 additional relevé plots were sampled for a total of 169. We used a Microsoft Access relational database modified from the NPS Plots v3 database for data storage and management throughout the 2010-2011 sampling efforts. We captured the cover of all species within three vertical tree strata, three vertical shrub strata, and one herbaceous stratum. The 1993 version of the Jepson Manual for California (Hickman 1993) was the primary reference used to identify plant taxa. Final taxa names conform to those in the US Department of Agriculture PLANTS database (USDA, NRCS 2014). All plot locations are shown in Figure 5.

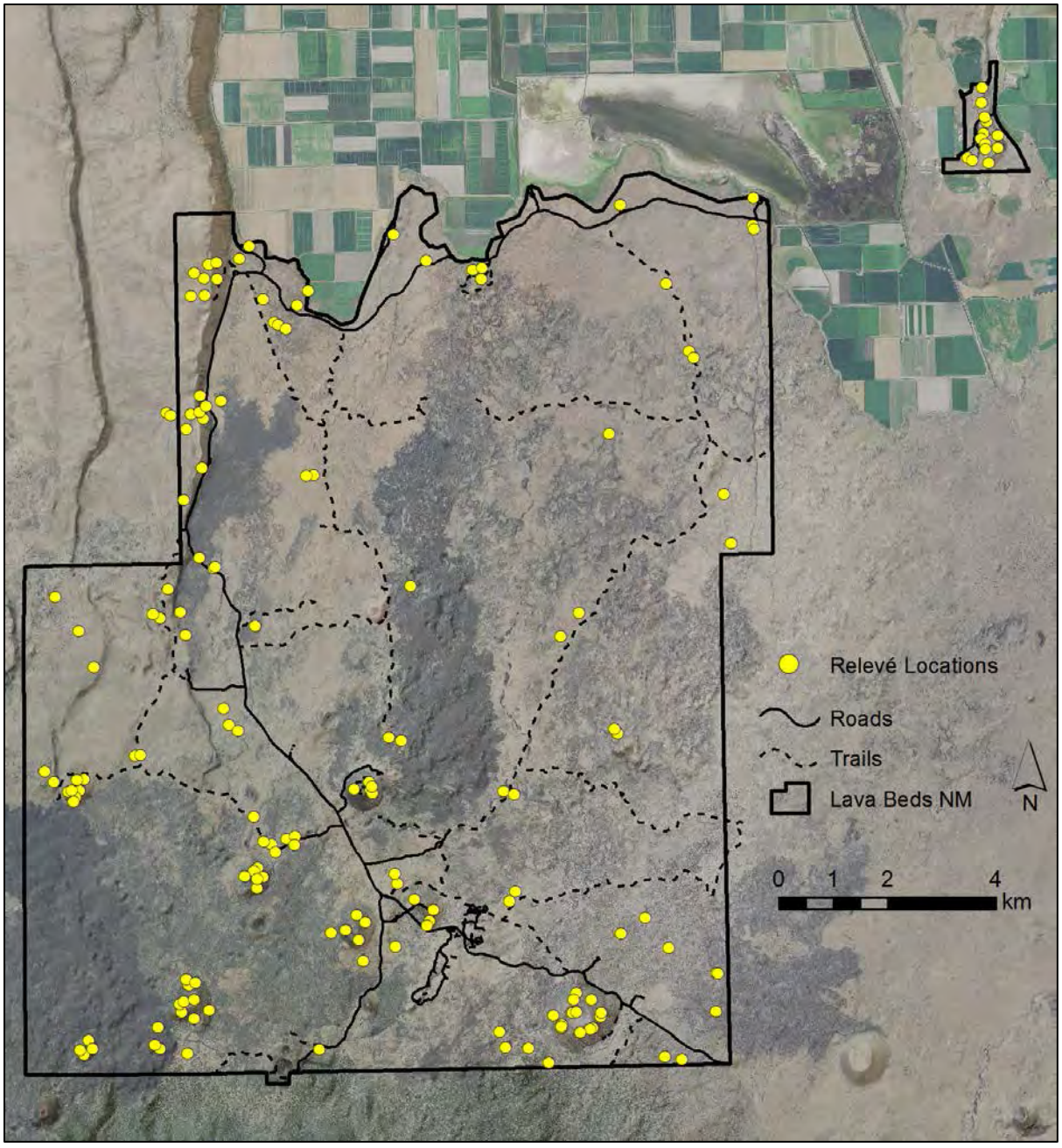

Figure 5. Locations of the 169 vegetation classification plots (relevés) at Lava Beds National Monument.

We recorded environmental data in each classification plot, including elevation, slope, aspect, landform, topographic position, soil texture and drainage, hydrologic (flooding) regime, and evidence of disturbance (wildlife or land use, fire, etc.). The unvegetated surface was recorded as percent cover of each of the following elements: bedrock, litter and duff, wood, bare soil, large rocks (>10 cm), small rocks (0.2-10 cm), sand (0.1-2 mm), lichens, mosses, and fungi. Vegetation was visually divided into strata, with the height and canopy cover of vegetation estimated for each stratum. The species representing each stratum were listed and percent canopy cover estimated using a nine-

category cover class scale (< 0.1%, 0.1-1%, 1-2%, 2-5%, 5-10%, 10-25%, 25-50%, 50-75%, and > 75%). Notes were recorded regarding non-vascular plant species and cover estimated when they comprised significant cover of the ground layer. Vascular plant species that were not identifiable in the field were collected for later identification and these specimens were destroyed in analysis or processed into the Southern Oregon University Herbarium. All vascular plants in each plot were eventually identified to species, except in a couple of instances when a grass was identified to genus (*Poa*). Non-vascular plants were not identified. We recorded location coordinates (latitude/longitude) from each plot center using a global positioning system (GPS) receiver and documented the number of satellites and error associated with the location coordinates. We recorded two photographs in opposite directions from near the center of each classification plot. All data collected in the field were entered into tablet personal computers (PCs).

2.3 Vegetation Classification

The Plots v2 and v3 databases that we populated were checked for accuracy. We ran the vegetation data through the program TURBOVEG (Hennekens 1995) to identify any problems related to species or cover values that could affect the classification. All species/strata were retained for the classification. We did not combine multiple species/strata cover values into a single value for each species. We used the software program Juice version 7.0 (Tichý 2002) to perform the initial community classification with Two-Way Indicator Species Analysis (TWINSPAN) (Hill 1979, Roleček 2009). The cover value (midpoint of the nine categories above) was used in the analysis (as opposed to presence/absence). No species were downweighted or upweighted. The TWINSPAN classification was modified by manual-sorting of some associations. Manual sorting mainly involved grouping plots based on particularly conspicuous species in the field.

The resulting associations described through the TWINSPAN classification were matched as much as possible to existing associations described in the USNVC. Associations that did not match a USNVC association were described as provisional plant associations specific to the park and as much as possible placed under an appropriate upper level group within USNVC hierarchy. Naming conventions of associations follow the format of Sawyer et al. (2009). Provisional associations were named based on one to three of the most dominant, conspicuous, and/or distinctive species in the canopy layer (i.e. herbaceous species in grasslands, shrubs in shrublands, and trees in forests). These were decided qualitatively. In most cases the dominant or diagnostic species of the upper stratum was listed first, followed by the secondary dominant regardless of stratum. If one species was strongly dominant and diagnostic, and no other species had a strong fidelity to the association, then the association was named based on a single species. If there were two or more dominant and diagnostic species, only two were used in the name, even if additional species could be used. However, in one case (Big Sagebrush - Purple Sage - Fernbush Shrubland), three species were used. This was because the association was defined as having at least two and often, but not necessarily, all three of these dominant species. In a few cases, associations were defined using a characteristic species with low or variable cover but whose constancy, presence, and conspicuousness were sufficient to define an association. The slash "/" convention in association names was used to separate species that occur in different strata. If species from only one stratum was used, then a hyphen (“-“) was used to separate important species. We present a dichotomous field key to the plant associations (Appendix B), a

classification of the associations (Appendix C), and detailed descriptions, photographs, and range maps for each association (Appendix D).

The field key was tested during the accuracy assessment phase of the project and was determined to work effectively for identifying plant associations in field conditions.

2.4 Assessing Existing Vegetation Data

A detailed vegetation map of Lava Beds was prepared by Erhard (1979). To assess whether we should use the polygons and attributes from this map, we did an accuracy assessment of the map. We calculated the percent of relevé plots that were correctly vs. incorrectly classified in the Erhard (1979) map. We found the map to be 54 percent accurate. This was far too low to use the map as a basis for our map.

Despite the limitations of the Erhard (1979) map in terms of spatial accuracy, it provides useful vegetation information if one is aware of, and takes into account, that the polygon boundaries may be inaccurate (positionally shifted). Often, the location where a polygon boundary should be is obvious on contemporary imagery.

2.5 Digital Imagery and Interpretation

The imagery having the most current and high-quality spatial and spectral resolution available was used to facilitate the vegetation classification and mapping of the monument. We used two image sources in conjunction. First, the Oregon Geographic Information Council coordinated the acquisition of the project imagery for the state of Oregon and adjacent California in the summer of 2009 through an agreement with the United States Department of Agriculture, Farm Services Agency, and National Agriculture Imagery Program (NAIP). The Oregon Geospatial Enterprise Office provided Digital Video Disks of the imagery to the Southern Oregon University research team. The imagery was projected to Universal Transverse Mercator zone 10, North American Datum (1983), with a spatial resolution of 1m (3.3 ft). The Lava Beds region imagery was then subset from the NAIP aerial orthophotography acquired for the entire state of Oregon and adjacent California. The 2009 NAIP imagery was collected with a Leica ADS40-SH51 digital camera that recorded 4-band multi-spectral (red, green, blue, and infrared wavelength) images. The Klamath Network staff did not make any additional modifications to the delivered NAIP imagery. Second, we used the ESRI world imagery in conjunction with the NAIP imagery when mapping. The world imagery and metadata are described on the ESRI World Imagery website.

Mapping was performed by Dennis Odion, and facilitated by his observations/knowledge of the vegetation which he acquired during field sampling and reconnaissance of Lava Beds, as well as past mapping of the area for the California Gap Analysis (Davis et al. 1998). The classified plot data were overlaid with the imagery to serve as an interpretive guide. Vegetation associations guided the creation of map units, which crosswalk to one or more component associations. Map units were defined by the lowest common level in the USNVC hierarchy of its component associations. Fifteen USNVC group, alliance, or association level vegetation types, and two non-natural land cover types (Anderson et al. 1976) were delineated using onscreen digitizing techniques. These 17 map units were later reduced to 15 as two map units (Mahogany-Bitterbrush and Unvegetated Rock) were

eliminated by merging them with the types with which they were most often confused. The key to the map units and the detailed descriptions of these units are provided in Appendices E and F.

Because it is often impossible to circumscribe an area of vegetation that consists entirely of a single type without significantly more detailed fieldwork and finer-detailed mapping than done for this project (e.g., smaller minimum mapping units), more than one map unit type was captured in the attributes for some vegetation map polygons (Table 2). For example, Cheatgrass Ruderal Herbaceous Vegetation and Rubber Rabbitbrush Shrubland occurring intermixed where patches of each are all less than 0.5 ha were mapped within the same polygon. In this case, the proportion of the polygon occupied by each map unit type was estimated based on evidence in the imagery, the plot data, and the Erhard (1979) map. Of the 582 polygons mapped, 517 had two map units. Further still, the percentages of up to two associations comprising the primary mapped vegetation type and up to two associations comprising the secondary mapped vegetation type (for a total of four possible associations) were also captured based on the imagery, the plot data, the Erhard (1979) map, personal knowledge of the vegetation, and relationships between the mapped vegetation types and the associations.

This approach of attributing multiple vegetation map units and associations to each vegetation map polygon provides the user with a database that can be explored and used in a variety of ways. The most simple is the production of a traditional vegetation map with each polygon representing one mapped vegetation type or a pre-defined complex of mapped vegetation types (Appendix I). Importantly, the approach described in the previous paragraph does not preclude or alter the creation of such a textbook vegetation map (mapping is still based on the identification of distinctive spatial units with a mmu of 0.5 ha). The added value is that these units can be characterized and rendered in more detail than traditional, pre-GIS approaches to mapping vegetation.

Table 2. The breakdown and description of attributes applied to vegetation map polygons in Lava Beds National Monument.

Attribute of interest	Code	Description
Area	Hectares	Polygon area in ha.
Primary vegetation	Primary_MapUnit	The dominant vegetation in each polygon distinguishable in the imagery
Primary vegetation, percent cover	Primary_MapUnit _pct	The percent cover of the dominant vegetation in each polygon (range 50-100%)
Secondary vegetation	Secondary_MapUnit	The second most dominant vegetation in each polygon distinguishable on in the imagery intermixed at a scale below the minimum mapping unit (0.5 ha)
Secondary vegetation, percent cover	Secondary_MapUnit _pct	The percent cover of the secondary vegetation in each polygon (range 10-50%)
Primary association	PrimaryAssoc1	The dominant vegetation association in the dominant mapped vegetation type (Primary_MapUnit) in each polygon
Primary association, percent cover	PrimaryAssoc1_pct	The percent cover of the dominant vegetation association in the dominant mapped vegetation type in each polygon (range 50-100%)
Secondary association of primary vegetation (if present)	PrimaryAssoc2	The secondary vegetation association in the dominant mapped vegetation type (Primary_MapUnit) in each polygon
Secondary association of primary vegetation, percent cover	PrimaryAssoc2_pct	The percent cover of the secondary vegetation association in the dominant mapped vegetation type in each polygon (range 10-50%)
Primary association of secondary vegetation (if present)	SecondAssoc1	The dominant vegetation association in the secondary mapped vegetation type (Secondary_MapUnit) in each polygon
Primary association of secondary vegetation, percent cover	SecondAssoc1_pct	The percent cover of the primary vegetation association that occurs in the secondary mapped vegetation type in each polygon (range 50-100%)
Secondary association of secondary vegetation	SecondAssoc2	The secondary vegetation association occurring in the secondary mapped vegetation type (Secondary_MapUnit) in each polygon
Secondary association of secondary vegetation, percent cover	SecondAssoc2_pct	The percent cover of the secondary vegetation association occurring in the secondary mapped vegetation type in each polygon (range 10-50%)

2.6 Accuracy Assessment

In 2013-2014, we conducted an accuracy assessment of this vegetation map/database. The accuracy assessment is a quantitative analysis of how well the vegetation map represents vegetation on the ground. Field observations are compared with the map unit assignment at the same location. Map errors occur when polygon attributes for a location differ from field observations for the same

location. Results of the accuracy assessment allow users to evaluate the likelihood that a particular vegetation assignment on the map may be something else on the ground. This information is essential to determining the utility of the vegetation mapping data for particular applications. The accuracy assessment reports the errors of omission, or the producer's accuracy, as the percentage of points that the vegetation map incorrectly classified (i.e. they were found to be different on the ground). Conversely, errors of commission are the percentage of points on the ground that fell into an incorrect map category. Our sample data design and reference data collection methodology follow the methods detailed by Lea and Curtis (2010). Several map units received more sample observations than the 30 prescribed in Lea and Curtis (2010) due to aggregation following an attempt to define finer map units.

We collected accuracy assessment data during the 2013 and 2014 field seasons, sampling 505 points throughout the Lava Beds project area. The field crew used GIS-stratified random point data uploaded into GPS units/receivers. To lay out stratified random points, a sampling frame was generated that buffered all vegetation polygon boundaries and roads by 50 m and each point from each other by 100 m. For safety reasons, the interior of recent lava flows was eliminated from the sampling frame by buffering out 200 m from the polygon boundary of Sparsely Vegetated Rock. Upon arriving at the point in the field, the decision tree (Exhibit H) in Lea and Curtis (2010) was used to determine whether the location was within a mapped vegetation type and could be used or whether the point would need to be moved to be within a homogeneous vegetation area of at least 0.5 ha, and not too close to a polygon boundary. If the point needed to be moved, it was moved according to the protocol in Lea and Curtis (2010). Once in a homogeneous unit, the field crew recorded the coordinates at the point using a GPS, as well as the GPS receiver error. They then used the dichotomous field keys to vegetation associations and to map units produced from the vegetation classification (Appendices B & E) to determine the vegetation association and the primary map unit where the point was located. If no homogeneous area of vegetation could be obtained by moving the point 100-200 m, and two vegetation map units were present within the 0.5 ha (1.24 ac) area around the point, then both of these map units were recorded in order of relative abundance and the relative abundance was estimated. In addition, the cover of the most dominant species of trees, shrubs, and herbaceous vegetation was recorded (up to 5 species in each stratum). The slope and aspect was also measured and recorded at each plot and two digital photographs were acquired (see data form in Appendix A).

The coordinates collected using GPS receivers at each of the 505 accuracy assessment locations (Figure 6) were uploaded and merged with the vegetation map. Where the distance from the point to a polygon boundary was less than the GPS receiver error (mostly 7 m (23 ft) or less), the point was either dropped, or it was included when it could be determined unequivocally from the field data which map unit the point actually fell within. Eleven points were dropped from the analysis because they were within 4 m of a polygon or park boundary.

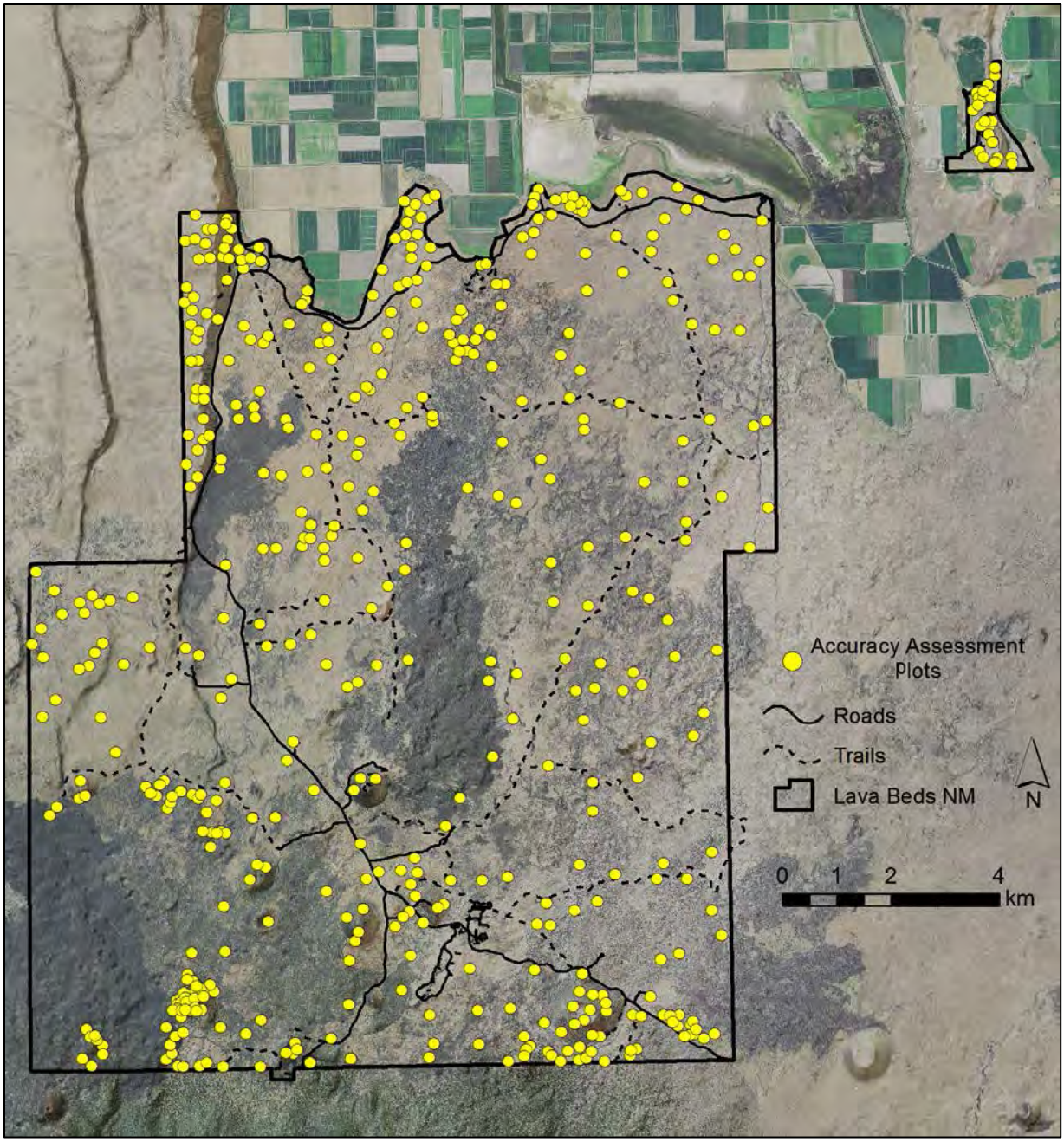

Figure 6. Location of 505 Accuracy Assessment Plots at Lava Beds National Monument. Eleven points were dropped because they were within 4 m of a polygon or park boundary.

We chose a binary accuracy assessment: either right or wrong (per Lea and Curtis 2010). However, our accuracy assessment methods were complicated somewhat by our attribution of multiple map units to a polygon. Our accuracy assessment of map units is based on comparison of the primary vegetation type in the map with the vegetation confirmed at a location on the ground. If the primary vegetation type in the map and vegetation confirmed on the ground were the same, this was considered correct, and vice versa if these were different. In addition, where the map indicated that

the primary vegetation type and secondary vegetation type were equally abundant (a 50/50 mix), then we compared the vegetation confirmed on the ground with both the primary and secondary vegetation types of the map polygon. In these cases, which were fairly uncommon, we considered the polygon correctly labeled if the field vegetation corresponded to either the primary or secondary vegetation types in the map polygon. In the accuracy assessment for the associations, we considered a polygon correctly labeled if it corresponded to the most abundant association. Also, if two associations were equally abundant and one matched the vegetation map, it was considered correct.

3 Results

3.1 Vegetation Classification

The 169 relevé plots were classified into 24 plant associations that are listed in Table 3, and described in detail in Appendix D. We documented 224 plant taxa. These are listed in Appendix G, which also describes the frequency with which each species was encountered in the relevé plots.

The most common herbaceous association was the Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation (mapped over 15.6% of the monument) (Table 3). The most common shrub association, and most common association overall, was the Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland (mapped over 28.8% of the monument). The most common woodland association was Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland (mapped over 11.3% of the monument).

Table 3. List of plant associations and area mapped within the Lava Beds National Monument project area and the United States National Vegetation Classification (USNVC) association they represent, if one exists. N/A is used where there is no USNVC association. Area was calculated based on the percentage of the association found in both primary and secondary vegetation types. Pavement and buildings were not included. The percent of the monument was calculated as the area each association occupied divided by the total area of the monument (18,925 ha)*.

Plant Association Common Name	Plant Association Scientific Name	USNVC Association	USNVC/Park Association Code	Area (ha)	Percent of Monument (%)
Herbaceous Vegetation					
1. Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional]	*Lomatium macrocarpum - Poa secunda* Herbaceous Vegetation [Provisional]	N/A	NPSLABE001	33.3	0.2
2. Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation	*Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation	Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation	CEGL001677	2,957.0	15.6
3. Basin Wildrye Herbaceous Vegetation	*Leymus cinereus* Herbaceous Vegetation	Basin Wildrye Herbaceous Vegetation	CEGL001479	28.6	0.2
4. Needle and Thread Great Basin Herbaceous Vegetation	*Hesperostipa comata* Great Basin Herbaceous Vegetation	Needle-and-Thread Great Basin Herbaceous Vegetation	CEGL001705	0.1	<0.1
5. Cheatgrass Ruderal Herbaceous Vegetation	*Bromus tectorum* Ruderal Herbaceous Vegetation	Cheatgrass Ruderal Herbaceous Vegetation	CEGL003019	945.5	5.0
6. Squirreltail Herbaceous Vegetation [Provisional]	*Elymus elymoides* Herbaceous Vegetation [Provisional]	N/A	NPSLABE002	142.4	0.8

Table 3. List of plant associations for the Lava Beds National Monument project area (*continued*).

Plant Association Common Name	Plant Association Scientific Name	USNVC Association	USNVC/Park Association Code	Area (ha)	Percent of Monument (%)
Shrubland					
7. Chokecherry - Mixed Shrub Talus Shrubland	*Prunus virginiana* - Mixed Shrub Talus Shrubland	Chokecherry Mixed Shrub Talus Shrubland	CEGL005444	1.6	<0.1
8. Greenleaf Manzanita - Sierran Chaparral Shrubland	*Arctostaphylos patula* Sierran Chaparral Shrubland	Greenleaf Manzanita - Sierran Chaparral Shrubland	CEGL005820	14.9	0.1
9. Oceanspray - Desert Gooseberry Shrubland [Provisional]	*Holodiscus discolor – Ribes velutinum* shrubland [Provisional]	N/A	NPSLABE003	0.0	0.0
10. Rubber Rabbitbrush Shrubland	*Ericameria nauseosa* Shrubland	Rubber Rabbitbrush Shrubland	CEGL002713	897.3	4.7
11. Yellow Rabbitbrush Shrub Herbaceous Vegetation	*Chrysothamnus viscidiflorus* Shrub Herbaceous Vegetation	Yellow Rabbitbrush Shrub Herbaceous Vegetation	CEGL002530	7.9	<0.1
12. Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]	*Artemisia tridentata - Salvia dorrii - Chamaebatiaria millefolium* Shrubland [Provisional]	N/A	NPSLABE004	1,579.9	8.3
13. Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	*Artemisia tridentata* ssp. *tridentata / Pseudoroegneria spicata* Shrub Herbaceous Vegetation	(Basin Big Sagebrush, Foothill Big Sagebrush) / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	CEGL001018	1,081.5	5.7

Table 3. List of plant associations for the Lava Beds National Monument project area (*continued*).

Plant Association Common Name	Plant Association Scientific Name	USNVC Association	USNVC/Park Association Code	Area (ha)	Percent of Monument (%)
14. Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland	*Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland	Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland	CEGL001032	5,447.8	28.8
15. Antelope Bitterbrush - Purple Sage Shrubland [Provisional]	*Purshia tridentata – Salvia dorrii* Shrubland [Provisional]	N/A	NPSLABE005	14.6	0.1
16. Fernbush - Wax Currant Shrubland [Provisional]	*Chamaebatiaria millefolium* - *Ribes cereum* Shrubland [Provisional]	N/A	NPSLABE006	597.9	3.2
17. Desert Gooseberry / Basin Wildrye Shrubland [Provisional]	*Ribes velutinum* / *Leymus cinereus* Shrubland [Provisional]	N/A	NPSLABE007	40.9	0.2
Woodland					
18. Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland	*Pinus ponderosa* / *Arctostaphylos patula* - *Purshia tridentata* Woodland	Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland	CEGL000063	168.2	0.9
19. Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland	*Juniperus occidentalis* / *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Woodland	Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland	CEGL000725	2,142.3	11.3

Table 3. List of plant associations for the Lava Beds National Monument project area (*continued*).

Plant Association Common Name	Plant Association Scientific Name	USNVC Association	USNVC/Park Association Code	Area (ha)	Percent of Monument (%)
20. Western Juniper / Mountain Big Sagebrush Woodland	*Juniperus occidentalis* / *Artemisia tridentata* ssp. *vaseyana* Woodland	Western Juniper / Mountain Big Sagebrush Woodland	CEGL000723	306.9	1.6
21. Curl-leaf Mountain- Mahogany / Mountain Big Sagebrush Woodland	*Cercocarpus ledifolius* / *Artemisia tridentata* ssp. *vaseyana* Woodland	Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland	CEGL001022	794.0	4.2
22. White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland	*Abies concolor* - *Pinus ponderosa* / *Purshia tridentata* Woodland	White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland	CEGL000259	6.9	<0.1
23. Pacific Willow - Basin Wildrye Woodland [Provisional]	*Salix lucida* ssp. *lasiandra* - *Leymus cinereus* Woodland [Provisional]	N/A	NPSLABE008	0.3	<0.1
Other					
24. Sparsely Vegetated Rock [Provisional]	N/A	N/A	NPSLABE009	1,715.3	9.1
Total*				18,925	100

*Does not include paved and developed areas (10.4 ha) and irrigated agriculture (0.7 ha).

3.2 Digital Imagery and Interpretation

3.2.1 Vegetation Map

We originally mapped 15 vegetation types (i.e., map units). However, two mapped vegetation types (Mahogany-Bitterbrush and Unvegetated Rock) were eliminated by merging them with the types with which they were most often confused. The final 15 map units (includes two non-natural cover types) and their relation to the classified vegetation associations are shown in Table 4. The final Lava Beds vegetation map showing the primary map unit in each polygon is presented in Appendix I. The vegetation map consists of 582 polygons comprising an area of 18,936 ha (46,792 ac) (Table 5). This includes a small area (10.4 ha) of non-vegetation, which was paved and/or developed. Sixty-five polygons were 100% dominated by one mapped vegetation type. The remaining polygons contained two mapped vegetation types. Of these polygons:

(1) 80 were interpreted to be 90% dominated by the primary map unit;
(2) 110 were interpreted to be 80% dominated by the primary map unit;
(3) 126 were interpreted to be 70% dominated by the primary map unit;
(4) 10 were interpreted to be 60% dominated by the primary map unit;
(5) 101 polygons were interpreted to have had a 50/50 split between two map units.

Polygons were not split when patches of secondary map units making up the polygon were smaller than 0.5 ha.

The most common vegetation in the Lava Beds project area was Mountain Big Sagebrush - Antelope Bitterbrush Shrubland (Table 5), occupying about 35% of the Lava Beds. Juniper - Mountain-mahogany Woodland, the second most common mapped vegetation type, occupied about 19% of the monument. Maps showing the distribution of each map unit are presented in Appendix G.

Table 4. Map unit - vegetation association crosswalk. An = sign is used when the map unit and classified vegetation are equivalent. A > sign is used when associations are subsumed within a map unit.

Map Unit Code	Map Unit Name Abbreviated	Map Unit Common Name	Map Unit Scientific Name		Vegetation Classification Common Name	Vegetation Classification Scientific Name	Vegetation Code
NPSLABE010	Perennial Grassland	Perennial Grassland	Perennial Grassland	>	Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional]	*Lomatium macrocarpum* - *Poa secunda* Herbaceous Vegetation [Provisional]	NPSLABE001
				>	Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation	*Pseudoroegneria spicata* - *Poa secunda* Herbaceous Vegetation	CEGL001677
				>	Basin Wildrye Herbaceous Vegetation	*Leymus cinereus* Herbaceous Vegetation	CEGL001479
				>	Needle and Thread Grass Great Basin Herbaceous Vegetation	*Hesperostipa comata* Great Basin Herbaceous Vegetation	CEGL001705
				>	Squirreltail Herbaceous Vegetation [Provisional]	*Elymus elymoides* Herbaceous Vegetation [Provisional]	NPSLABE002
CEGL003019	Cheatgrass Ruderal Herbaceous Vegetation	Cheatgrass Ruderal Herbaceous Vegetation	*Bromus tectorum* Ruderal Herbaceous Vegetation	=	Cheatgrass Ruderal Herbaceous Vegetation	*Bromus tectorum* Ruderal Herbaceous Vegetation	CEGL003019
CEGL005444	Chokecherry Shrubland	Chokecherry - Mixed Shrub Talus Shrubland	*Prunus virginiana* - Mixed Shrub Talus Shrubland	=	Chokecherry - Mixed Shrub Talus Shrubland	*Prunus virginiana* - Mixed Shrub Talus Shrubland	CEGL005444
CEGL005820	Greenleaf Manzanita Shrubland	Greenleaf Manzanita Sierran Chaparral Shrubland	*Arctostaphylos patula* Sierran Chaparral Shrubland	=	Greenleaf Manzanita Sierran Chaparral Shrubland	*Arctostaphylos patula* Sierran Chaparral Shrubland	CEGL005820

Table 4. Map unit vegetation association crosswalk (*continued*).

Map Unit Code	Map Unit Name Abbreviated	Map Unit Common Name	Map Unit Scientific Name		Vegetation Classification Common Name	Vegetation Classification Scientific Name	Vegetation Code
G310	Rubber Rabbitbrush Shrubland	Yellow Rabbitbrush - Rubber Rabbitbrush – Winterfat Shrubland Group	*Chrysothamnus viscidiflorus* - *Ericameria nauseosa* - *Krascheninnikovia lanata* Shrubland Group	=	Yellow Rabbitbrush - Rubber Rabbitbrush – Winterfat Shrubland Group	*Chrysothamnus viscidiflorus* - *Ericameria nauseosa* - *Krascheninnikovia lanata* Shrubland Group	G310
				>	Rubber Rabbitbrush Shrubland	*Ericameria nauseosa Shrubland*	CEGL002713
				>	Yellow Rabbitbrush Shrub Herbaceous Vegetation	*Chrysothamnus viscidiflorus* Shrub Herbaceous Vegetation	CEGL002530
NPSLABE004	Big Sagebrush - Purple Sage - Fernbush Shrubland	Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]	*Artemisia tridentata – Salvia dorrii – Chamaebatiaria millefolium* Shrubland [Provisional]	>	Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]	*Artemisia tridentata – Salvia dorrii – Chamaebatiaria millefolium* Shrubland [Provisional]	NPSLABE004
				>	Antelope Bitterbrush - Purple Sage Shrubland [Provisional]	*Purshia tridentata – Salvia dorrii* Shrubland [Provisional]	NPSLABE005
				>	Fernbush - Wax Currant Shrubland [Provisional]	*Chamaebatiaria millefolium* - *Ribes cereum* Shrubland [Provisional]	NPSLABE006
CEGL001018	Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland	Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	*Artemisia tridentata* ssp. *tridentata* / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation	=	(Basin Big Sagebrush, Foothill Big Sagebrush) / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	*Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation	CEGL001018
CEGL001032	Mountain Big Sagebrush - Antelope Bitterbrush Shrubland	Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland	*Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland	=	Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland	*Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland	CEGL001032
CEGL000063	Ponderosa Pine Woodland	Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland	*Pinus ponderosa* / *Arctostaphylos patula* - *Purshia tridentata* Woodland	=	Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland	*Pinus ponderosa* / *Arctostaphylos patula* - *Purshia tridentata* Woodland	CEGL000063

Table 4. Map unit vegetation association crosswalk (*continued*).

Map Unit Code	Map Unit Name Abbreviated	Map Unit Common Name	Map Unit Scientific Name		Vegetation Classification Common Name	Vegetation Classification Scientific Name	Vegetation Code
G248	Juniper-Mountain-mahogany Woodland	Western Juniper Woodland & Savanna Group & Curl-leaf Mountain-mahogany Scrub & Woodland Group	*Juniperus occidentalis* Woodland & Savanna Group & *Cercocarpus ledifolius* Scrub & Woodland Group	=	Western Juniper Woodland & Savanna Group	*Juniperus occidentalis* Woodland & Savanna Group	G248
				=	Curl-leaf Mountain-mahogany Scrub & Woodland Group	*Cercocarpus ledifolius* Scrub & Woodland Group	G249
				>	Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland	*Juniperus occidentalis* / *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Woodland	CEGL000725
				>	Western Juniper / Mountain Big Sagebrush Woodland	*Juniperus occidentalis* / *Artemisia tridentata* ssp. *vaseyana* Woodland	CEGL000723
				>	Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland	*Cercocarpus ledifolius* / *Artemisia tridentata* ssp. *vaseyana* Woodland	CEGL001022
CEGL000259	White Fir - Ponderosa Pine Woodland	White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland	*Abies concolor - Pinus ponderosa* / *Purshia tridentata* Woodland	=	White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland	*Abies concolor - Pinus ponderosa / Purshia tridentata* Woodland	CEGL000259
NPSLABE008	Pacific Willow / Basin Wildrye Woodland	Pacific Willow / Basin Wildrye Woodland [Provisional]	*Salix lucida* ssp. *lasiandra* / *Leymus cinereus* Woodland [Provisional]	=	Pacific Willow / Basin Wildrye Woodland [Provisional]	*Salix lucida* ssp. *lasiandra / Leymus cinereus* Woodland [Provisional]	NPSLABE008
NPSLABE009	Sparsely Vegetated Rock	Sparsely Vegetated Rock [Provisional]	Sparsely Vegetated Rock [Provisional]	=	Sparsely Vegetated Rock [Provisional]	Sparsely Vegetated Rock [Provisional]	NPSLABE009
LULC16	Pavement - Developed	Mixed Urban or Built-up Land	Mixed Urban or Built-up Land	=	Mixed Urban or Built-up Land	Mixed Urban or Built-up Land	LULC16
LULC21	Irrigated Agriculture	Cropland and Pasture	Cropland and Pasture	=	Cropland and Pasture	Cropland and Pasture	LULC21

Table 5. Area of each vegetation map unit mapped as the primary and secondary vegetation at Lava Beds National Monument.

Vegetation Map Unit	Status in Polygon		Total Area (ha)	% of Total Project Area
	Primary (ha)	Secondary (ha)		
1. Perennial Grassland	1506.6	199.5	1706.1	9.01
2. Cheatgrass Ruderal Herbaceous Vegetation	504.2	214.3	718.5	3.79
3. Chokecherry Shrubland	0.0	1.6	1.6	0.01
4. Greenleaf Manzanita Shrubland	6.6	10.6	17.2	0.09
5. Rubber Rabbitbrush Shrubland	132.8	967.0	1099.8	5.81
6. Big Sagebrush – Purple Sage – Fernbush Shrubland	783.7	1306.9	2090.6	11.04
7. Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland	818.6	214.0	1032.6	5.45
8. Mountain Big Sagebrush - Antelope Bitterbrush Shrubland	6026.1	1153.1	7179.2	37.91
9. Ponderosa Pine Woodland	146.1	27.6	173.7	0.92
10. Juniper - Mountain-mahogany Woodland	2176.9	832.8	3009.7	15.89
11. White Fir - Ponderosa Pine Woodland	3.9	3.0	6.9	0.04
12. Pacific Willow / Basin Wildrye Woodland	0.3	0.0	0.3	0.00
13. Sparsely Vegetated Rock	1692.9	196.8	1889.7	9.98
14. Pavement - Developed	9.6	0.0	9.6	0.05
15. Irrigated Agriculture	0.7	0.0	0.7	0.00
Total	13,809.13	5,127.11	18,936.2	100

3.3 Accuracy Assessment

Appendix H presents the contingency table, or confusion matrix, showing concordance between the vegetation map (the primary vegetation) and field data, including the errors of omission and commission in the map. Map accuracy was improved considerably after we merged two map unit classes that we originally tried to distinguish. These map units were: 1) Mahogany – Bitterbrush, which had only 9 AA plots due to rarity, and only 27% producer's accuracy and 41% user's accuracy. It was therefore merged with Juniper - Mountain-mahogany Woodland, with which was the only type in which it was confused; and 2) Unvegetated Rock. Most unvegetated rock AA plots (9 of 11) were found in Sparsely Vegetated Rock vegetation and none were found in Unvegetated Rock. Therefore, these two similar types were merged (safety and access concerns precluded more sampling of unvegetated rock). The overall map accuracy prior to these changes was slightly less than 80%. Following these changes it was 85.3%. The lowest accuracy occurred in mapped vegetation types that were so rare in the field that they could not accommodate an accuracy assessment plot (Pacific Willow / Basin Wildrye Woodland and Chokecherry Shrubland). Greenleaf

Manzanita Shrubland was rare as well (17.2 ha), and had two of three field plots that agreed with the map. In contrast, the most abundant vegetation types mapped had high accuracy, and this was based on a large number of accuracy assessment plots: Juniper - Mountain-mahogany Woodland (98.6%), Mountain Big Sagebrush - Antelope Bitterbrush Shrubland (88%) and Perennial Grassland (83%).

The accuracy of associations was 81.4% overall (Appendix H). There were some rare types in which no accuracy assessment plots were located, such as Needle and Thread Great Basin Herbaceous Vegetation, Oceanspray - Desert Gooseberry Shrubland, and Pacific Willow / Basin Wildrye Woodland. The more abundant types had high accuracy, such as Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland (97%), Mountain Big Sagebrush - Antelope Bitterbrush Shrubland (87%), and Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation (92%).

4 Discussion

The Lava Beds vegetation classification and mapping effort should provide a broad context for interpreting the vegetation resources and a baseline for future research at the monument. This project provides the most detailed study to date of the distribution and diversity of plant associations in Lava Beds. As with previous studies in the region, the vegetation inventory within Lava Beds demonstrates the floristic diversity of the park. This section provides a discussion of the project limitations; possibilities for improving the classification and map accuracy; and the study's implications for natural resource management, interpretive goals, and future research.

4.1 Vegetation Classification

The vegetation of Lava Beds was sampled and classified into 24 associations that were mapped in 13 vegetation map units; the accuracy assessment rate was 85 % and the field work documented the occurrence of 224 vascular plant taxa.

As with any broad inventory effort, this study would be improved with additional and more targeted sampling. The vegetation data presented in this project should therefore be considered a baseline upon which to build. Additional sampling would improve both the classification and the vegetation map.

The 13 vegetation map units can be shown along a hypothetical north-south elevational gradient at Lava Beds (Figure 7). Mountain Big Sagebrush – Antelope Bitterbrush Shrubland and Juniper Mountain-mahogany Woodland occupy very broad elevation zones, explaining their dominance in the monument. Conversely, White Fir - Ponderosa Pine Woodland and to a lesser degree Ponderosa Pine Woodland only occur on the north-facing sides of buttes and at the highest elevations in the monument (>1300m). Cheatgrass Ruderal Herbaceous Vegetation occurs primarily at the lowest elevation, but this is in part due to the Jack Fire, which, in 2008, caused a type conversion from shrubland to grassland dominated in part by the annual cheatgrass (*Bromus tectorum*) over a large portion of the north end of the monument. Cheatgrass Ruderal Herbaceous Vegetation could establish over a much broader area of the monument following fire.

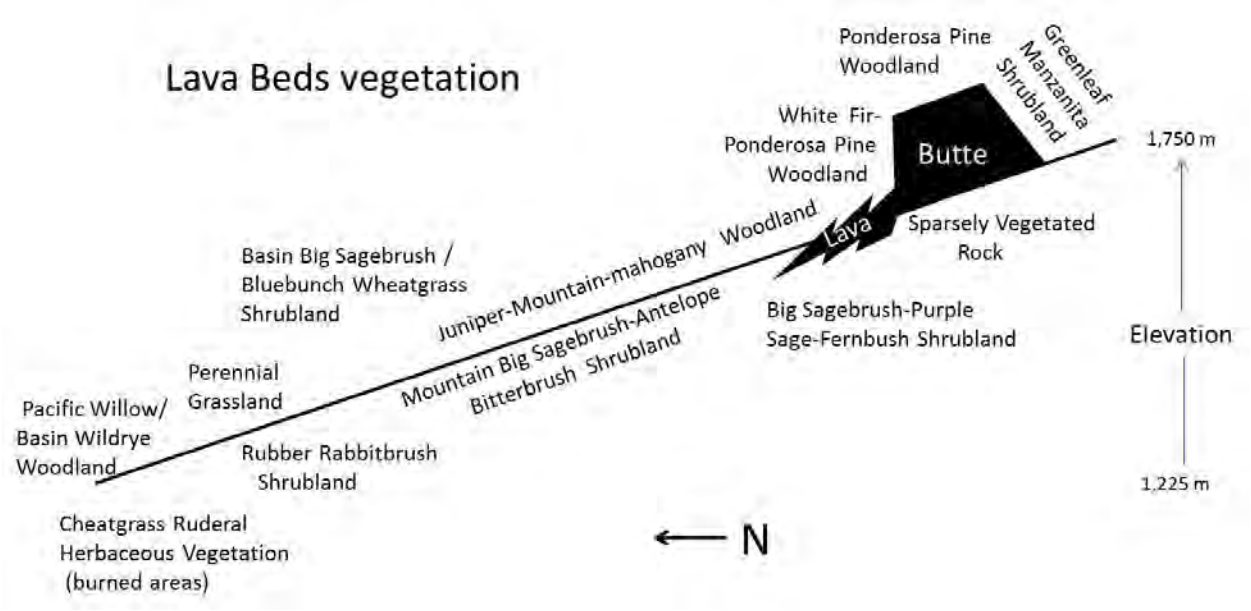

Figure 7. Vegetation of Lava Beds National Monument in relation to elevation. The lower elevations are at the north end of the park and the higher elevations are to the south.

4.2 Accuracy Assessment

The accuracy assessment for primary map units was relatively high 85%. This was, in part, due to the relatively small number of vegetation types mapped (13). We originally mapped more vegetation types (15), but the accuracy fell below the desired 80% with this many types. Mapping 13 vegetation types was probably the best compromise between map unit diversity and accuracy. There were three map units that were abundant whose accuracy was lower than 80%: Cheatgrass Ruderal Herbaceous Vegetation (75.4%), Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland (74.1%), and Big Sagebrush - Purple Sage - Fernbush Shrubland (75.2%). We chose not to merge these types because they are important to managers, and the accuracy was close to 80%. All the other types we mapped had high accuracy.

4.3 Natural Resource Concerns

Vegetation structure, function, and composition can be altered by many activities (e.g., fire management) or from extrinsic factors (e.g., off-site pollution, climate change, invasive species). These affect the structure of the habitat, particularly the disturbance regimes, as well as the landscape patterns that create habitat for a wide variety of species. There are several vegetation related issues of concern at the monument.

4.3.1 Bunchgrasses

Bunchgrasses are native vegetation that has declined in many parts of the Great Basin. Lava Beds is a remaining stronghold for bunchgrasses. Little is known about the long-term dynamics between bunchgrasses and cheatgrass, and in particular, the long-term recruitment and mortality rates of the bunchgrasses and the impacts of climate change. Because bunchgrasses have been displaced much more by cheatgrass at lower elevations at Lava Beds, it is likely that bunchgrasses will be more

negatively affected in drier environments in general. This is consistent with the susceptibility of Great Basin vegetation to invasion by cheatgrass being higher at lower elevations where bunchgrasses are less common (Chambers et al. 2007).

4.3.2 Invasive Non-Native Species

The vegetation database contains information on the presence and absence of all non-native invasive species encountered in the classification and accuracy assessment plots. These data will be very useful as a baseline from which to evaluate changes in the future. In addition, the data could be used to model the types of environments susceptible to invasion. Such modeling is described in the Klamath Network's invasive species protocol (Odion et al. 2010).

4.3.3 Wildlife Habitat

Although this study did not emphasize sampling of detailed wildlife habitat or structural parameters, the delineation of 13 vegetation map units should aid in analyses of broad patterns in vegetation structural types for use in wildlife monitoring. This project should help inform modeling and mapping efforts for wildlife habitat/use. At a minimum, the data presented herein should crosswalk to National Gap Analysis Program analysis efforts for focal species (Davis et al. 1998) and the Atlas of Oregon Wildlife (Csuti et al. 2001).

Although quantitative data are lacking, it is apparent that a decline in sagebrush cover in the monument has occurred where the Jack Fire burned and juniper has encroached over the last century. Future loss of fire-sensitive sagebrush cover is a strong possibility because fires are inevitable, and fires (whether prescription or wild) are followed by invading cheatgrass, especially at lower elevations. The vegetation map can help document changes in sagebrush steppe extent. It can also be used to identify areas to attempt to protect from fire in the interest of protecting mature sagebrush.

The nearest remaining sage grouse active lek (breeding site) and known rearing areas are located around Clear Lake National Wildlife Refuge, about 15 miles east of the monument. In 2008, the grouse population there was estimated at fewer than 50 individuals and was not considered viable (Horney 2008). A recovery plan for grouse in this area and extending westward to Lava Beds and beyond was drafted by resource agencies, including the National Park Service. The monument comprises about 18% of the approximately 254,000 acres covered by the plan (Horney 2008). Re-introducing the grouse to Lava Beds is being actively considered, and Monument personnel are selectively reducing juniper cover in an effort to enhance future habitat for this species.

4.3.4 Juniper

The density and canopy cover of juniper has increased substantially during the past 150 years in many juniper and piñon woodlands of the western Great Basin, but have not changed or have declined in others (Romme et al. 2009). The dynamic may be influenced by cheatgrass invasion or climate change. This is important because juniper growth may be lessened or reversed even without juniper control efforts. Mechanisms for the increasing density of juniper are not well understood in most situations and may include recovery from past disturbances, natural ongoing expansion, recovery from livestock grazing, fire exclusion, and effects of climatic variability and rising carbon dioxide (CO_2) (Romme et al. 2009). Monitoring the general distribution of juniper using the

vegetation map may help sort out the factors most associated with juniper growth and increase and assist park efforts to manage the species.

4.4 Natural Resource Interpretation

This study will also serve as a valuable resource for individuals wanting to quickly gain a comprehensive introduction to the vegetation of the monument and surrounding vicinity. It provides an in-depth resource for interpretive staff to develop communication programs that describe the complex vegetation mosaic within the monument. In particular, the vegetation association descriptions (Appendix D) and the key to the associations (Appendix B) provide valuable tools to effectively communicate both vegetation classification and distribution patterns. These resources can be used in conjunction with the vegetation map and the vegetation/elevation profile shown in Figure 7. The map can be customized in a wide variety of ways, depending on the user's needs.

This study can also be used in conjunction with the newly published *A Flora of Lava Beds National Monument* (Smith 2014). Printed copies of the vegetation map to keep with the Flora would provide a useful, efficient reference. The map and accompanying data could also be accessed on smart phones and tablet PCs in the field where phone service is available.

4.5 Research Opportunities

The vegetation map and database provide opportunities for research on vegetation-environment relations. The spatial data can be overlaid with the recent geology map (see Figure 4) to provide an additional environmental descriptor for each plot location. Ordination techniques relating plot data to environmental data could be applied to pursue vegetation-environment relations. In addition, species richness data could be analyzed for patterns related to vegetation association, elevation, disturbance, and other variables. The map data are also useful for wildlife habitat modeling, fire modeling, and as a guide for rare plant surveys, wildlife habitat structural analyses, and inventorying areas that likely contain invasive exotic species. Complex interactions between environmental data and the mapped vegetation could be examined and yield important information about vegetation composition, structure, and function and how these elements are affected by elevation, soil, slope, aspect, and disturbance. Lastly, the map can be used for detection of vegetation change at some future time. Vegetation that is mapped in the future can be quantitatively contrasted with the map presented here.

5 Literature Cited

(Note: some references are from the appendices that follow this bibliography)

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Appendix A. Field Data Forms and Instructions

Instructions for Lava Beds Vegetation Mapping Field Form

Survey Date — date the survey was taken; year, month, day.

Polygon Code — Code indicating the vegetation polygon where the plot was taken.

Plot Code — Code indicating the specific plot within the vegetation polygon. This field will begin with either 9999 or 8888 and increment upward.

Surveyors — Names (and addresses, if appropriate) of surveyors, principle surveyor listed first.

Latitude N Use UTM coordinates from GPS

Longitude E Use UTM coordinates from GPS

GPS Error — enter the error inherent in the GPS type/model used.

Plot Length and Plot Width — enter width and length dimensions for rectangular (or square) plots, or radius length for circular plots. Choose the appropriate plot size based on the following:

Forest:	1000 m^2
Shrubland:	400 m^2
Grassland/Meadow	100 m^2

ENVIRONMENTAL DESCRIPTION

Elevation — elevation of the plot (meters above mean sea level).

Slope — measure slope degrees using a clinometer.

Aspect — enter slope aspect; use a compass (be sure to correct for the magnetic declination).

Topographic Position — Topographic position of the plot. NOTE: A comprehensive list of topographic positions is being developed. The list below provides an example of the topographic positions that might be included.

Vegetation Mapping Definitions

Plot Size

Forest:	1000 m^2
Shrubland:	400 m^2
Grassland/Meadow	100 m^2

Topographic Position

INTERFLUVE (crest, summit, ridge): Linear top of ridge, hill, or mountain; the elevated area between two fluves (drainageways) that sheds water to the drainageways.

HIGH SLOPE (shoulder slope, upper slope, convex creep slope): Geomorphic component that forms the uppermost inclined surface at the top of a slope. Comprises the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.

HIGH LEVEL (mesa): Level top of plateau.

MIDSLOPE (transportational midslope, middle slope): Intermediate slope position.

BACKSLOPE (dipslope): Subset of midslopes that are steep, linear, and may include cliff segments (fall faces).

STEP IN SLOPE (ledge, terracette): Nearly level shelf interrupting a steep slope, rock wall, or cliff face.

LOWSLOPE (lower slope, foot slope, colluvial footslope): Inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between midslope or backslope, and toeslope.

TOESLOPE (alluvial toeslope): Outermost gently inclined surface at base of a slope. In profile, commonly gentle and linear and characterized by alluvial deposition.

LOW LEVEL (terrace): Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

CHANNEL WALL (bank): Sloping side of a channel.

CHANNEL BED (narrow valley bottom, gully arroyo): Bed of single or braided watercourse commonly barren of vegetation and formed of modern alluvium.

BASIN FLOOR (depression): Nearly level to gently sloping, bottom surface of a basin.

Soil Texture Key

A1 Soil does not remain in a ball when squeezed.....sand

A2 Soil remains in a ball when squeezed.....B

B1 Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. Soil makes no ribbon.....loamy sand

B2 Soil makes a ribbon; may be very short.....C

C1 Ribbon extends less than 1 inch before breaking.....D

C2 Ribbon extends 1 inch or more before breaking.....E

D1 Add excess water to small amount of soil; soil feels at least slightly gritty.....loam or sandy loam

D2 Soil feels smooth.....silt loam

E1 Soil makes a ribbon that breaks when 1-2 inches long; cracks if bent into a ring.....F

E2 Soil makes a ribbon 2+ inches long; does not crack when bent into a ring.....G

F1 Add excess water to small amount of soil; soil feels at least slightly gritty.....sandy clay loam or clay loam

F2 Soil feels smooth.....silty loam or silt

G1 Add excess water to a small amount of soil; soil feels at least slightly gritty.....sandy clay or clay

G2 Soil feels smooth.....silty clay

Strata/Lifeform, Height, Cover, Diagnostic Species — Visually divide the community into vegetation layers (strata). Indicate the average height of the stratum in the first column, and average percent cover (using the cover scale below) of the whole stratum in the second column. Trees are defined as single-stemmed woody plants, generally 5m in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally known to be diagnostic of a particular vegetation type are present, list them. Leave blank if the diagnostics are not known.

Vegetation Strata

T1 (20-35 m) = Emergent Tree

T2 (10-20 m) = Tree Canopy

T3 (5-10 m) = Tree Subcanopy

S1 (2-5 m) = Tall Shrub

S2 (1-2 m) = Short Shrub

S3 (.5-1 m) = Dwarf Shrub

H (<.5 m) = Herbaceous

Physiognomic Class

FOREST — Trees usually over 5m tall with crowns interlocking (generally forming 60-100% cover). Shrubs, herbs and nonvascular plants may be present at any cover value.

WOODLAND — Open stands of trees usually over 5m tall with crowns not usually touching (generally forming 25-60% cover). Shrubs, herbs, and nonvascular plants may be present at any cover value.

SPARSE WOODLAND — Trees usually over 5m tall with widely spaced crowns (generally forming 10-25% canopy cover. Shrubs, herbs, and non-vascular plants may be present with any cover value.

SHRUBLAND — Shrubs and/or small trees usually 0.5-5.0 meters tall with individuals or clumps not touching to interlocking (generally forming >25% canopy cover). Trees may be present, but with cover 10% or less. Herbs and nonvascular plants may be present at any cover value.

SPARSE SHRUBLAND — Shrubs and/or small trees usually 0.5-5m tall with individuals or clumps widely spaced (generally forming 10-25% canopy cover. Trees may be present, but with cover 10% or less. Herbs and nonvascular plants may be present at any cover value.

DWARF SHRUBLAND — Low growing shrubs and/or dwarf trees are usually under 0.5m tall (though known dwarf forms between 0.5 and 1m can be included), individuals or clumps not touching to interlocking (generally forming >25% cover). Trees and shrubs greater than 0.5m may be

present but cover with canopy cover 10% or less. Herbs and nonvascular plants may be present at any cover value.

SPARSE DWARF SHRUBLAND — Low growing shrubs and/or dwarf trees usually under 0.5m (though known dwarf forms between 0.5m and 1m can be included) with individuals or clumps widely spaced (generally with 10-25% cover). Trees and shrubs greater than 0.5m may be present, but with cover 10% or less. Herbs and nonvascular plants may be present at any cover value.

HERBACEOUS — Graminoids and/or forbs (including ferns) generally forming >10% cover. Trees, shrubs, and dwarf shrubs may be present, but with cover 10% or less. Nonvascular may be present at any cover value.

SPARSE VASCULAR VEGETATION/NON-VASCULAR — Vascular vegetation is scattered or nearly absent. The cover of each vascular lifeform (tree, shrub, dwarf shrub, herb) is at most 10%; in some cases the total cover of vascular vegetation may exceed 10%. Cover of nonvascular plants (mosses and lichens) may be absent to continuous.

Non-Vegetative Cover

Bedrock- solid rock surface

Litter and Duff- Litter is the top layer of the forest, shrubland, or grassland floor, directly above the duff layer, including freshly fallen leaves, needles, bark flakes, cone scales, fruits (including acorns and cones), dead matted grass and other vegetative parts that are little altered in structure by decomposition. Does not include twigs and larger stems.

Small rocks - <6 inches diameter

Large rocks- >6 inches diameter

Wood- includes twigs and larger material

Bare soil-does not include duff if exposed

Sand- see soil texture key

Water—standing water

Other—describe what it is.

Species/Percent Cover
Start with the uppermost stratum, list all the species present and the percent cover (using the scale provided below) of each species in the stratum. For the tallest stratum, list the estimated average DBH for trees above 10cm diameter.

Cover Scale for Species Percent Cover

1=trace	2=a few (<1%)
3=1-2%	4=2-5%
5=5-10%	6=10-25%
7=25-50%	8=50-75%
9=75-100%	

Lava Beds 2010 Vegetation Mapping Data Sheet

Survey Date _____

Plot Code_____Park Code LABE _____Polygon code_____

Surveyors_____

Latitude___ ___ ___ ___ ___ ___ Longitude___ ___ ___ ___ ___ ___ ___ GPS Error_____

Directions to Plot

Plot representativeness:_____
Plot length_____ Plot width_____ Plot diameter (circular plots)_____

Photographer_____Photograph #_____

This photographs shows the habitat types at site: LABE_____

Photographer_____Photograph #_____

This photographs shows the habitat types at site: LABE_____

Photographer_____Photograph #_____

Photographer_____Photograph #_____

Topographic position (circle one)

INTERFLUVE = (crest, summit, ridge)	LOWSLOPE =(lower slope, foot slope, colluvial footslope)
HIGH SLOPE = (shoulder slope, upper slope, convex slope)	TOESLOPE = (alluvial toeslope)
HIGH LEVEL = (mesa)	LOW LEVEL = (terrace)
MIDSLOPE = (intermediate slope position)	CHANNEL WALL = (bank)
BACKSLOPE = (dipslope)	CHANNEL BED = (narrow valley bottom, gully arroyo)
STEP IN SLOPE (ledge, terracette)	BASIN FLOOR (depression)

Elevation _____Slope (deg) _____Aspect_____

Soil Texture___ sand ___ sandy loam ___ loam ___ silt loam ___ clay loam ___ clay ___ peat ___ muck

Non-vegetated surface: %bedrock___ %litter/duff____ %small rocks____ %large rocks____ %wood____ % bare soil____ %sand____ %water___% other_____describe:_____

Physiognomic class

Forest ____Woodland____Sparse Woodland____Shrubland_____Sparse Shrubland____Dwarf Shrubland ____

Sparse Dwarf Shrubland___Herbaceous Vegetation ____Sparse Vascular Vegetation____

Species/percent cover: starting with the uppermost stratum, list all species and % cover for each in the stratum. For forests and woodlands, the estimated average DBH of trees in the tallest stratum. Cover values are: 1=trace, 2=a few (<1%), 3=1-2%, 4=2-5%, 5=5-10%, 6=10-25%, 7=25-50%, 8=50-75%, 9=75-100%.

Disturbance notes (e.g., logging)

Strata	Height	%Cover
T1 Emergent		
T2 Canopy		
T3 Sub canopy (>5m)		
S1 Tall Shrub (2-5 m)		
S2 Short Shrub (<2m)		
S3 Dwarf Shrub (<0.5m)		
H Herbaceous		
N Non-vascular		
V Vine		

Accuracy Assessment Data Sheets

LABE AA 2013 - Name_____Date_____

Waypoint number_LABE_____

Coordinates: X_____Y_____

Elevation_____m

Plot offset?_____GPS Error_____Plot Size_____Plot Shape_____

Slope_____Aspect_____Photo 1_____Photo 2_____

Primary vegetation type in key _____%_____

Secondary vegetation type in key _____%_____

Vegetation description if not in key _____

Dominant Trees (0-5) _____

Dominant Shrubs (0-5) _____

Dominant Herbs (0-5) _____

LABE AA 2013 - Name_____Date_____

Waypoint number_LABE_____

Coordinates: X_____Y_____

Elevation_____m

Plot offset?_____GPS Error_____Plot Size_____Plot Shape_____

Slope_____Aspect_____Photo 1_____Photo 2_____

Primary vegetation class in key_____%_____

Secondary vegetation class in key_____%_____

Vegetation description if not in key_____

Dominant Trees (0-5) _____

Dominant Shrubs (0-5) _____

Dominant Herbs (0-5) _____

Appendix B. Key to Vegetation Associations

Natural Vegetation (key to groups adapted from A Manual of California Vegetation Sawyer et al. 2009)

1. Lacking vegetation entirely, or with very sparse vegetation, often isolated small individuals of *Cercocarpus ledifolius, Juniperus occidentalis, Chamaebatiaria millefolium,* or *Salvia dorrii* in rock crevices (<< 5% cover of vascular plants over any area of 0.5 ha or more). ……..… **Sparsely Vegetated Rock**

2. Non-woody herbaceous vegetation dominant throughout stand. When total vegetation cover is less than about 20%, shrubs, sub-shrubs, and/or trees may be present but are less than 2-5% cover and are not evenly distributed across stand. When total vegetation cover is greater than about 20%, the layer of shrubs, sub-shrubs, and trees, if present, are of a lower cover than herbs and typically less than 10%. When cover of herbs is greater than 60%, the cover of low shrubs, which are lower than herbs, can be as high as 20-25%. Go to..... **Herbaceous Vegetation**

3. Woody shrubs and sub-shrubs conspicuous throughout stand. Shrubs are at least 10% cover. When total vegetation cover is greater than 20%, the tree layer, if present, is generally less than 15% cover, while herbaceous species may total higher cover than shrubs. In areas where vegetation is less than 20% total cover, shrubs may cover less than 10%, but are evenly distributed across the stand. Go to ……..…… **Shrubland**

4. Trees evenly distributed and conspicuous throughout stand. In areas where vegetation cover is greater than about 20%, tree canopy may be as low as 10% over denser layers of shrubs and herbaceous species. In areas where vegetation is less than 20% total cover, trees may cover less than 10% (as low as about 8%) but are evenly distributed across stand. Go to …….…….……..... **Forests and Woodland**

Herbaceous Vegetation

1. Total combined cover of native bunchgrasses excluding *Poa secunda* < 10%. *Poa secunda* may be present >10%.

2. *Leymus cinereus* present >1% and evenly distributed through stand.

3. *Ribes velutinum* present, generally common. Substrate mostly rock.……..…… ……..... **DESERT GOOSEBERRY / BASIN WILDRYE SHRUBLAND [Provisional]** (***Ribes velutinum / Leymus cinereus*** **Shrubland [Provisional]**)

3.' *Ribes velutinum* absent or rare. Substrate mostly soil. …….. ……..…….. **BASIN WILDRYE HERBACEOUS VEGETATION** **(*Leymus cinereus* Herbaceous Vegetation)**

2.' *Leymus cinereus* absent or cover <1% and/or not evenly distributed through stand.

4. *Lomatium macrocarpum* abundant, cover > 5%. *Poa secunda* present, often abundant. Total vegetation cover generally sparse. ……..…

BIGSEED BISCUITROOT - SANDBERG BLUEGRASS HERBACEOUS VEGETATION [Provisional]
(*Lomatium macrocarpum - Poa secunda* Herbaceous Vegetation)

4.' Not as above. *Bromus tectorum* is abundant. Non-native *Descurainia sophia* and/or *Erodium cicutarium* abundant. *Lomatium macrocarpum* generally absent or rare. ……
…….. **CHEATGRASS RUDERAL HERBACEOUS VEGETATION**
(*Bromus tectorum* Ruderal Herbaceous Vegetation)

1.' Total combined cover of native bunchgrasses excluding *Poa secunda* > 10% and/or *Leymus cinereus* present > 5%.

5. *Leymus cinereus* present >1% and evenly distributed through stand.

6. *Ribes velutinum* present, generally common. Substrate mostly rock. …….
…… **DESERT GOOSEBERRY / BASIN WILDRYE SHRUBLAND [Provisional]**
(*Ribes velutinum / Leymus cinereus* Shrubland [Provisional])

6.' *Ribes velutinum* absent or rare. Substrate mostly soil. ……..
…….. **BASIN WILDRYE HERBACEOUS VEGETATION**
(*Leymus cinereus* Herbaceous Vegetation)

5.' *Leymus cinereus* absent or cover < 1% and/or not evenly distributed through stand.

7. *Hesperostipa comata* the dominant cover. No other native bunchgrass species with higher cover than *Hesperostipa comata*.……..……
…….. **NEEDLE AND THREAD GRASS GREAT BASIN HERBACEOUS VEGETATION**
(*Hesperostipa comata* Great Basin Herbaceous Vegetation)

7.' *Hesperostipa comata* not the dominant native bunchgrass cover.

8. *Elymus elymoides* the dominant cover. No other native bunchgrass species with higher cover than *Elymus elymoides*. …..…**SQUIRRELTAIL HERBACEOUS VEGETATION [Provisional]**
(*Elymus elymoides* Herbaceous Vegetation [Provisional])

8.' *Pseudoroegneria spicata* the dominant cover or co-dominant with *Achnatherum thurberianum*. *Pseudoroegneria spicata* present with at least 5% cover. *Achnatherum thurberianum* may be more abundant than *Pseudoroegneria spicata* ……..
BLUEBUNCH WHEATGRASS - SANDBERG BLUEGRASS HERBACEOUS VEGETATION
(*Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation)

Shrubland

1. *Cercocarpus ledifolius* cover > 5%. If *Cercocarpus ledifolius* cover is < 5%, no other shrub species has greater cover ……..
……**CURL-LEAF MOUNTAIN-MAHOGANY - MOUNTAIN BIG SAGEBRUSH WOODLAND**
(*Cercocarpus ledifolius / Artemisia tridentata* ssp. *vaseyana* Woodland)

1'. *Cercocarpus ledifolius* is not the dominant or co-dominant shrub, cover generally < 2%. If *Cercocarpus ledifolius* cover is between 2% and 5%, other individual shrub species have greater cover.

2. *Prunus virginiana* present. Combined cover of *Prunus virginiana* and *Symphoricarpos rotundifolius* greater than the cover of any other individual shrub species present. ……..…
……**CHOKECHERRY - MIXED SHRUB TALUS SHRUBLAND SHRUBLAND**
(*Prunus virginiana* - Mixed Shrub Talus Shrubland)

2.' *Prunus virginiana* absent or rare. If present, combined cover of *Prunus virginiana* and *Symphoricarpos rotundifolius* is less than the combined cover of any other individual shrub species present.

3. *Ribes velutinum* is the dominant or co-dominant shrub and *Leymus cinereus* is present. Where *Ribes velutinum* is the dominant shrub *Leymus cinereus* may be absent or present at very low cover. ……..…… **DESERT GOOSEBERRY / BASIN WILDRYE SHRUBLAND [Provisional]**
(*Ribes velutinum / Leymus cinereus* Shrubland [Provisional])

3.' Not as above.

4. *Chamaebatiaria millefolium* and/or *Salvia dorrii* present, combined cover > 1%.

5. *Artemisia tridentata* ssp. absent or << the combined cover of *Chamaebatiaria millefolium* and *Salvia dorrii.*

6. *Purshia tridentata* absent or rare. If present then << the combined cover of *Chamaebatiaria millefolium* and *Ribes cereum. Chamaebatiaria millefolium* is always present. ……..…… **FERNBUSH - WAX CURRANT SHRUBLAND [Provisional]**
(*Chamaebatiaria millefolium - Ribes cereum* Shrubland [Provisional])

6.' *Purshia tridentata* is the dominant shrub and *Salvia dorrii* is present or *Salvia dorrii* is the dominant shrub and *Purshia tridentata* is present. *Chamaebatiaria millefolium* absent or rare (<< 1%). ……..……
……**ANTELOPE BITTERBRUSH - PURPLE SAGE SHRUBLAND [Provisional]**
(*Purshia tridentata – Salvia dorrii* Shrubland [Provisional])

5.' *Artemisia tridentata* ssp. dominant or co-dominant and *Chamaebatiaria millefolium* and/or *Salvia dorrii* present > 1%. ……...
…..… **BIG SAGEBRUSH - PURPLE SAGE - FERNBUSH SHRUBLAND [Provisional]**
(*Artemisia tridentata – Salvia dorrii – Chamaebatiaria millefolium* Shrubland [Provisional])

4.' *Chamaebatiaria millefolium* and *Salvia dorrii* absent or rare, combined cover < 1%.

7. *Holodiscus discolor* present, cover greater than the cover of all other shrub species present. ……..... **OCEANSPRAY - DESERT GOOSEBERRY SHRUBLAND [Provisional]**
(*Holodiscus discolor - Ribes velutinum* Shrubland [Provisional])

7.' Not as above.

8. Shrub layer dominated by *Artemisia tridentata* ssp., *Purshia tridentata, Chrysothamnus viscidiflorus,* or *Ericameria nauseosa.*

9. *Artemisia tridentata* ssp. is the dominant shrub. *Purshia tridentata* often present and/or co-dominant. *Chrysothamnus viscidiflorus* and/or *Ericameria nauseosa* generally absent, but if present, their individual covers are < the cover of *Artemisia tridentata* ssp.

10. *Artemisia tridentata* ssp. *tridentata* is the dominant shrub. …….
BASIN BIG SAGEBRUSH / BLUEBUNCH WHEATGRASS SHRUB HERBACEOUS VEGETATION
(*Artemisia tridentata* ssp. *tridentata* / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation)

10.' *Artemisia tridentata* ssp. *vaseyana* is the dominant shrub. *Purshia tridentata* is co-dominant and sometimes dominant. …… **MOUNTAIN BIG SAGEBRUSH - ANTELOPE BITTERBRUSH / BLUEBUNCH WHEATGRASS SHRUBLAND**
(*Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland)

9.' Shrub layer dominated by *Chrysothamnus viscidiflorus* or *Ericameria nauseosa*. If the individual or combined covers of *Chrysothamnus viscidiflorus* and *Ericameria nauseosa* ≈ the cover of *Artemisia tridentata* ssp., go to 9.

11. *Ericameria nauseosa* is the dominant shrub, generally > 5% cover. No other shrub species with greater cover. …… **RUBBER RABBITBRUSH SHRUBLAND**
(*Ericameria nauseosa* Shrubland)

11.' *Chrysothamnus viscidiflorus* is the dominant shrub, generally > 5%. No other shrub species with greater cover. …… **YELLOW RABBITBRUSH SHRUB HERBACEOUS VEGETATION**
(*Chrysothamnus viscidiflorus* Shrub Herbaceous Vegetation)

8.' *Arctostaphylos patula* is the dominant shrub, often co-dominant with *Ceanothus velutinus*. …**GREENLEAF MANZANITA SIERRAN CHAPARRAL SHRUBLAND**
(*Arctostaphylos patula* Sierran Chaparral Shrubland)

Forest and Woodland

1. Overstory dominated by *Pinus ponderosa* var. *ponderosa*, cover > 5%.

2. *Abies concolor* present, cover generally > 2%. …… **WHITE FIR - PONDEROSA PINE / ANTELOPE BITTERBRUSH WOODLAND**
(*Abies concolor* - *Pinus ponderosa* / *Purshia tridentata* Woodland)

2.' *Abies concolor* absent or cover generally < 2% …… **PONDEROSA PINE / GREENLEAF MANZANITA - ANTELOPE BITTERBRUSH WOODLAND**
(*Pinus ponderosa* / *Arctostaphylos patula* - *Purshia tridentata* Woodland)

1.' Overstory not dominated by *Pinus ponderosa*, cover < 5%.

3. Overstory dominated by *Juniperus occidentalis.*

4. *Cercocarpus ledifolius* present, cover generally > 2%. ..... **WESTERN JUNIPER / CURL-LEAF MOUNTAIN-MAHOGANY / BLUEBUNCH WHEATGRASS WOODLAND**
(*Juniperus occidentalis* / *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Woodland)

4.' *Cercocarpus ledifolius* absent. If present, cover generally < 2%..... **WESTERN JUNIPER / MOUNTAIN BIG SAGEBRUSH WOODLAND**
(*Juniperus occidentalis* / *Artemisia tridentata* ssp. *vaseyana* Woodland)

3.' Overstory dominated by *Salix lucida. Juniperus occidentalis* absent or rare…… **PACIFIC WILLOW / BASIN WILDRYE WOODLAND [Provisional]**
(*Salix lucida* / *Leymus cinereus* Woodland [Provisional])

Appendix C. Classification of Vegetation of Lava Beds National Monument Based on the National Vegetation Classification Hierarchy

Classification Version May 5, 2015

1. Mesomorphic Tree Vegetation Class
  1.B Temperate & Boreal Forest & Woodland Subclass
    1.B.2 Cool Temperate Forest & Woodland Formation
      1.B.2.Nb Rocky Mountain Cool Temperate Forest Division
        M501 *Pinus ponderosa* var. *ponderosa* - *Pseudotsuga menziesii* - *Pinus flexilis* Central Rocky Mountain Dry Forest Macrogroup
          G213 *Pinus ponderosa* var. *ponderosa* Central Rocky Mountain Woodland & Savanna Group
            A3446 *Pinus ponderosa* / Shrub Understory Central Rocky Mountain Woodland Alliance
              Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland (CEGL000063)
              Pinus ponderosa / *Arctostaphylos patula* - *Purshia tridentata* Woodland

      1.B.2.Nc Western North American Cool Temperate Woodland & Scrub Division
        M026 *Pinus monophylla* - *Juniperus osteosperma* - *Juniperus occidentalis* Intermountain Woodland Macrogroup
          G248 *Juniperus occidentalis* Woodland & Savanna Group
            A3499 *Juniperus occidentalis* / Shrub Understory Woodland Alliance
              Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland (CEGL000725)
              Juniperus occidentalis / *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Woodland

              Western Juniper / Mountain Big Sagebrush Woodland (CEGL000723)
              Juniperus occidentalis / *Artemisia tridentata* ssp. *vaseyana* Woodland

          G249 *Cercocarpus ledifolius* Scrub & Woodland Group
            A0586 *Cercocarpus ledifolius* / Shrub Understory Woodland Alliance
              Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland (CEGL001022)
              Cercocarpus ledifolius / *Artemisia tridentata* ssp. *vaseyana* Woodland

      1.B.2.Nd Vancouverian Cool Temperate Forest Division
        1.B.2.Nd.2 - M023 *Calocedrus decurrens* - *Pinus jeffreyi* - *Abies concolor* var. *lowiana* Forest Macrogroup
          G344 *Calocedrus decurrens* - *Pinus lambertiana* - *Abies concolor* Forest & Woodland Group
            A3677 *Abies concolor* - *Pinus ponderosa* Eastern Sierran Forest & Woodland Alliance
              White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland (CEGL000259)
              Abies concolor - *Pinus ponderosa* / *Purshia tridentata* Woodland

2. Mesomorphic Shrub & Herb Vegetation Class
2.B Temperate & Boreal Grassland & Shrubland Subclass
2.B.2 Temperate Grassland & Shrubland Formation
2.B.2.Na Western North American Grassland & Shrubland Division
M049 *Quercus gambelii - Cercocarpus montanus - Purshia* spp. Southern Rocky Mountain Montane Shrubland Macrogroup
G277 *Quercus gambelii - Amelanchier* spp. *- Prunus virginiana* Southern Rocky Mountain Montane Shrubland Group
A3736 *Fraxinus anomala - Rhus trilobata - Fendlera rupicola* Talus & Rock Outcrop Shrubland Alliance
Chokecherry - Mixed Shrub Talus Shrubland (CEGL005444)
Prunus virginiana - Mixed Shrub Talus Shrubland

M048 *Amelanchier alnifolia* / *Festuca idahoensis - Pseudoroegneria spicata* Central Rocky Mountain Montane & Foothill Grassland & Shrubland Macrogroup
G273 *Festuca campestris - Festuca idahoensis - Pseudoroegneria spicata* Central Rocky Mountain Foothill Grassland Group
A3987 *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Dry Grassland Alliance
Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional]
Lomatium macrocarpum - Poa secunda Herbaceous Vegetation [Provisional]

Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation (CEGL001677)
Pseudoroegneria spicata - Poa secunda Herbaceous Vegetation

2.B.2.Nd Western North American Interior Sclerophyllous Chaparral Division
M094 *Arctostaphylos patula - Ceanothus velutinus - Quercus vacciniifolia* Montane Chaparral Macrogroup
G282 *Arctostaphylos patula - Arctostaphylos nevadensis - Ceanothus velutinus* Montane Sclerophyll Scrub Group
A0788 *Arctostaphylos patula - Arctostaphylos nevadensis* Shrubland Alliance
Greenleaf Manzanita Sierran Chaparral Shrubland (CEGL005820)
Arctostaphylos patula Sierran Chaparral Shrubland

A3918 *Prunus emarginata - Holodiscus discolor* Shrubland Alliance
Oceanspray - Desert Gooseberry Shrubland [Provisional]
Holodiscus discolor - Ribes velutinum Shrubland [Provisional]

2.C Shrub & Herb Wetland Subclass
2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation
2.C.4.Nb *Alnus viridis* ssp. *sinuata - Salix* spp. / *Carex* spp. *- Blennosperma nanum – Poa pratensis* Western North American Freshwater Shrubland, Wet Meadow & Marsh Division
M075 Western North American Montane to Alpine Wet Shrubland & Wet Meadow Macrogroup
G527 *Salix* spp. *- Alnus* spp. *- Betula occidentalis* Riparian & Seep Shrubland Group
A3769 *Salix boothii - Salix geyeriana - Salix lutea* Montane Shrubland Alliance
Pacific Willow / Basin Wildrye Woodland [Provisional]
Salix lucida ssp. *lasiandra* / *Leymus cinereus* Woodland [Provisional]

2.C.5 Salt Marsh Formation
2.C.5.Nd *Sarcobatus vermiculatus - Allenrolfea occidentalis – Schoenoplectus americanus* North American Interior Brackish Marsh Division
M082 Warm & Cool Desert Alkali-Saline Wetland Macrogroup
G538 *Distichlis spicata - Puccinellia lemmonii - Salicornia* spp. Alkaline-Saline Herbaceous Wetland & Playa Group
A1329 *Leymus cinereus - Leymus triticoides* Herbaceous Alliance
Basin Wildrye Herbaceous Vegetation (CEGL001479)
Leymus cinereus Herbaceous Vegetation

3. Xeromorphic Woodland, Scrub & Herb Vegetation Class
3.B Cool Semi-Desert Scrub & Grassland Subclass
3.B.1 Cool Semi-Desert Scrub & Grassland Formation
3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
M171 *Chrysothamnus viscidiflorus - Coleogyne ramosissima* / *Achnatherum hymenoides* Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup
G311 *Pleuraphis jamesii - Achnatherum hymenoides - Hesperostipa comata* Semi-Desert Grassland Group
A1270 *Hesperostipa comata* Bunch Herbaceous Alliance
Needle and Thread Grass Great Basin Herbaceous Vegetation (CEGL001705)
Hesperostipa comata Great Basin Herbaceous Vegetation

G310 *Chrysothamnus viscidiflorus - Ericameria nauseosa – Krascheninnikovia lanata* Shrubland Group
A3196 *Ericameria nauseosa* Shrubland & Shrub Herbaceous Alliance
Rubber Rabbitbrush Shrubland (CEGL002713)
Ericameria nauseosa Shrubland

A3195 *Chrysothamnus viscidiflorus* Shrubland & Shrub Herbaceous Alliance
Yellow Rabbitbrush Shrub Herbaceous Vegetation (CEGL002530)
Chrysothamnus viscidiflorus Shrub Herbaceous Vegetation

M169 *Artemisia tridentata - Artemisia tripartita* ssp. *tripartita - Purshia tridentata* Great Basin & Intermountain Shrubland & Steppe Macrogroup
Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]
Artemisia tridentata – Salvia dorrii – Chamaebatiaria millefolium Shrubland [Provisional]

G302 *Artemisia tridentata - Artemisia tripartita - Purshia tridentata* Big Sagebrush Steppe Group
A3183 *Artemisia tridentata* ssp. *tridentata - Artemisia tridentata* ssp. *xericensis* Mesic Shrubland & Steppe Alliance

Artemisia tridentata (ssp. *tridentata*, ssp. *xericensis*) / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001018)
=
Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation (CEGL001018**)**
Artemisia tridentata ssp. *tridentata* / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation

G304 *Artemisia tridentata* ssp. *spiciformis* - *Artemisia tridentata* ssp. *vaseyana* – *Artemisia cana* ssp. *viscidula* Tall Shrubland & Steppe Group

A3208 *Artemisia tridentata* ssp. *vaseyana* - Mixed Shrubland Alliance

Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland (CEGL001032)

Artemisia tridentata ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland

M118 *Atriplex* spp. - *Ephedra* spp. - *Eriogonum* spp. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation Macrogroup

Antelope Bitterbrush - Purple Sage Shrubland [Provisional]

Purshia tridentata – Salvia dorrii Shrubland [Provisional]

M499 *Agropyron cristatum* - *Bromus tectorum* - *Sisymbrium altissimum* Western North American Ruderal Semi-Desert Scrub & Grassland Macrogroup

G600 Great Basin & Intermountain Ruderal Dry Shrubland & Grassland Group

A1814 *Bromus tectorum* - *Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance

Cheatgrass Ruderal Herbaceous Vegetation (CEGL003019)

Bromus tectorum Ruderal Herbaceous Vegetation

6. Cryptogam - Open Mesomorphic Vegetation Class

6.B Temperate & Boreal Open Rock Vegetation Subclass

6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation

6.B.1.Nb Western North American Temperate Cliff, Scree & Rock Vegetation Division

M6887 Western North American Temperate Cliff, Scree & Rock Vegetation Macrogroup

Sparsely Vegetated Rock [Provisional]

<u>Not classified in the USNVC database</u>

Squirreltail Herbaceous Vegetation [Provisional]

Elymus elymoides Herbaceous Vegetation [Provisional]

Fernbush - Wax Currant Shrubland [Provisional]

Chamaebatiaria millefolium - *Ribes cereum* Shrubland [Provisional]

Desert Gooseberry / Basin Wildrye Shrubland [Provisional]

Ribes velutinum / *Leymus cinereus* Shrubland [Provisional]

Appendix D. Vegetation Association Descriptions

U.S. NATIONAL VEGETATION CLASSIFICATION

Lava Beds National Monument
January 2014

By Dominic A. DiPaolo, Southern Oregon University

Contents

HERBACEOUS VEGETATION

1. *Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional]*

Lomatium macrocarpum - *Poa secunda* Herbaceous Vegetation [Provisional]

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.B Temperate & Boreal Grassland & Shrubland Subclass
Formation: 2.B.2 Temperate Grassland & Shrubland Formation
Division: 2.B.2.Na Western North American Grassland & Shrubland Division
Macrogroup: 2.B.2.Na.2 - M048 *Amelanchier alnifolia* / *Festuca idahoensis - Pseudoroegneria spicata* Central Rocky Mountain Montane & Foothill Grassland & Shrubland Macrogroup
Group: 2.B.2.Na.2.c - G273 *Festuca campestris - Festuca idahoensis - Pseudoroegneria spic*ata Central Rocky Mountain Foothill Grassland Group
Alliance: A3987 *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Dry Grassland Alliance
Association: Provisional vegetation association.

NPS Identifier: NPSLABE001

LOCAL INFORMATION

Environmental Description: This association is characterized from only one sample plot and is known only to occur within the monument on Gillem Bluff. It occurs at middle elevations (1376 m) within the monument on gentle, southwest facing slopes. Topographic position is on a summit. Soils are loamy sand, shallow, and are rapidly drained.

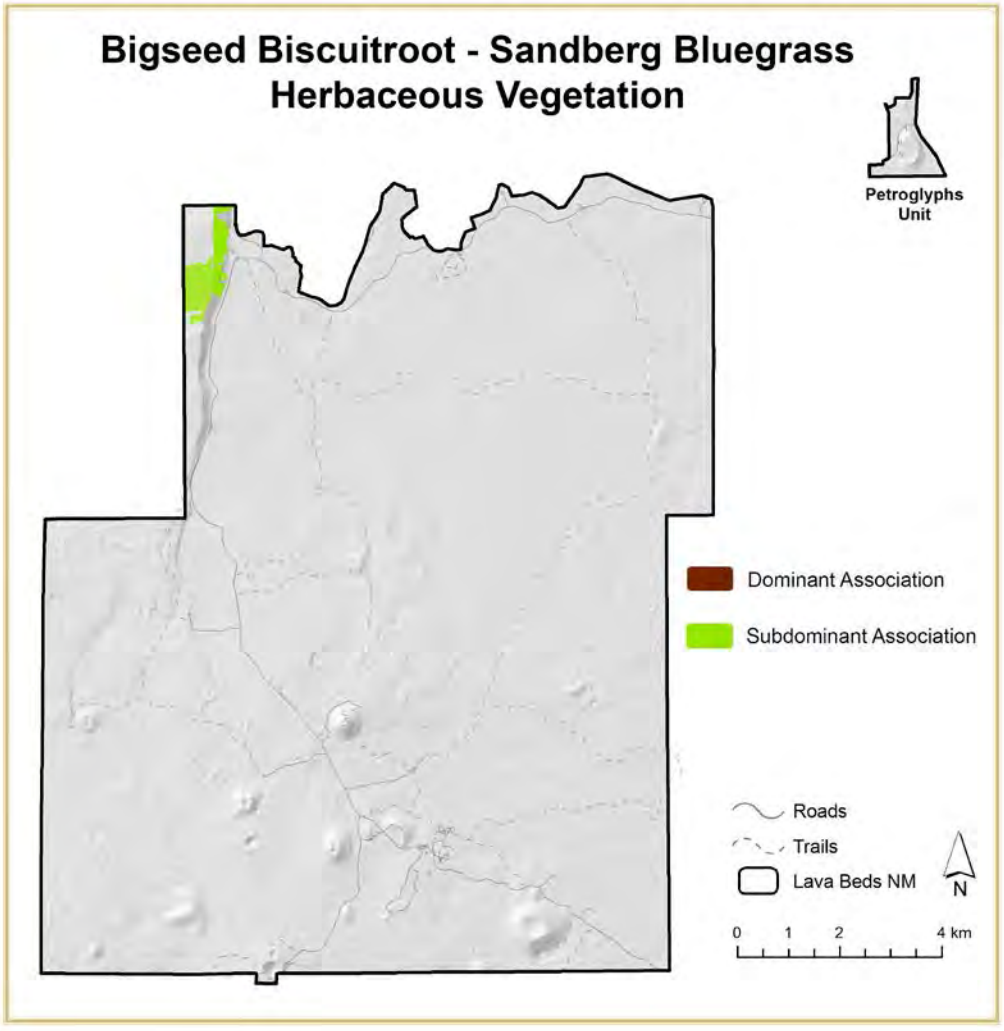
Vegetation Description: This grassland/herb association is composed of a generally sparse vegetation cover dominated by the perennial herb bigseed biscuitroot (*Lomatium macrocarpum*) at low to moderate cover. Sandberg bluegrass (*Poa secunda*) is present at low cover but is evenly distributed throughout the stand. Other perennial herbs and grasses present include low pussytoes (*Antennaria dimorpha*), wallflower phoenicaulis (*Phoenicaulis cheiranthoides*), Thurber's needlegrass (*Achnatherum thurberianum*), and squirreltail (*Elymus elymoides*).

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Herb	Perennial herb	*Lomatium macrocarpum* (bigseed biscuitroot)	100	5 - 10	7.5
		Antennaria dimorpha (low pussytoes)	100	2 - 5	3.5
	Graminoid	*Achnatherum thurberianum* (Thurber's needlegrass)	100	2 - 5	3.5
		Bromus tectorum (cheatgrass)	100	1 - 2	1.5
		Elymus elymoides (squirreltail)	100	1 - 2	1.5
		Poa secunda (Sandberg bluegrass)	100	0.1 - 1	0.5

Diagnostic Species: *Lomatium macrocarpum* at relatively high cover.
Constant Species: Not applicable.
Other Noteworthy Species: *Phoenicaulis cheiranthoides.*
Species Richness of Sample Plot: 16.
Local Range: Gillem Bluff.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional] is a dominant or subdominant association.

Classification Comments: This Lava Beds provisional vegetation association is similar to associations described under the *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Dry Grassland Alliance (Code: A3987) in the USNVC. This Lava Beds provisional vegetation association was classified under the *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Dry Grassland Alliance because at least one of these three grasses are diagnostic species, it occurs on shallow lithosol soils, and it is sparsely vegetated. However, *Poa secunda* is described as a community dominant in the USNVC alliance description but it is not the community dominant in this vegetation

association. Furthermore, the alliance description does not mention *Lomatium macrocarpum* as a dominant or co-dominant species while it is a community dominant in this provisional vegetation association.

This vegetation association is also similar to the *Pseudoroegneria spicata – Poa secunda* Lithosolic Herbaceous Vegetation (Code: CEGL001678) in the *Pseudoroegneria spicata - Festuca idahoensis - Opuntia polyacantha* Dry Canyon Slope Grassland Alliance (Code: A3976) in the USNVC except that *Pseudoroegneria spicata* is not dominant in the Lava Beds provisional association and *Lomatium macrocarpum* is not present in the USNVC association. Further inquiry should be taken to reveal whether this Lava Beds provisional association should be placed under the *Pseudoroegneria spicata - Festuca idahoensis - Opuntia polyacantha* Dry Canyon Slope Grassland Alliance. This provisional vegetation association is also similar to associations classified under the *Eriogonum* spp. / *Poa secunda* Dwarf-shrub Herbaceous Alliance (Code: A1568).

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Number of Plots: 1. Relevé 16.
Lava Beds National Monument Inventory Notes: None.

Above: **Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional]** (*Lomatium macrocarpum - Poa secunda* Herbaceous Vegetation [Provisional]).

2. *Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation*

Pseudoroegneria spicata - Poa secunda Herbaceous Vegetation

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.B Temperate & Boreal Grassland & Shrubland Subclass
Formation: 2.B.2 Temperate Grassland & Shrubland Formation
Division: 2.B.2.Na Western North American Grassland & Shrubland Division
Macrogroup: 2.B.2.Na.2 - M048 *Amelanchier alnifolia* / *Festuca idahoensis - Pseudoroegneria spicata* Central Rocky Mountain Montane & Foothill Grassland & Shrubland Macrogroup
Group: 2.B.2.Na.2.c - G273 *Festuca campestris - Festuca idahoensis - Pseudoroegneria spicata* Central Rocky Mountain Foothill Grassland Group
Alliance: A3987 *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Dry Grassland Alliance
Association: *Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation

Translated Name: Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation

USNVC Identifier: CEGL001677

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at lower to middle elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions include low slope, midslope, high slope, and on summits. Soils are sandy loam, loamy sand, and silt loam. Soil drainage is well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1369	17	82	3
Range	1315 – 1483	0 - 35	0 - 230	0.1 - 10

Vegetation Description: This grassland association is dominated by the perennial bunchgrass bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) at moderate to high cover, along with other perennial bunchgrasses, including Thurber's needlegrass (*Achnatherum thurberianum*) and/or Idaho fescue (*Festuca idahoensis*) at low to moderate cover. Thurber's needlegrass and/or Idaho fescue can occur at a higher cover than bluebunch wheatgrass in some stands. Idaho fescue can often be absent from some stands in the monument as Idaho fescue is not evenly distributed through the park. The non-native annual species cheatgrass (*Bromus tectorum*) is often present at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Herb	Graminoid	*Pseudoroegneria spicata* ssp. *spicata* (bluebunch wheatgrass)	100	5-50	24.6
		Bromus tectorum (cheatgrass)	100	0.1-50	13
		Festuca idahoensis (Idaho fescue)	57.1	0-25	3.2
		Achnatherum thurberianum (Thurber's needlegrass)	85.7	0-5	1.3

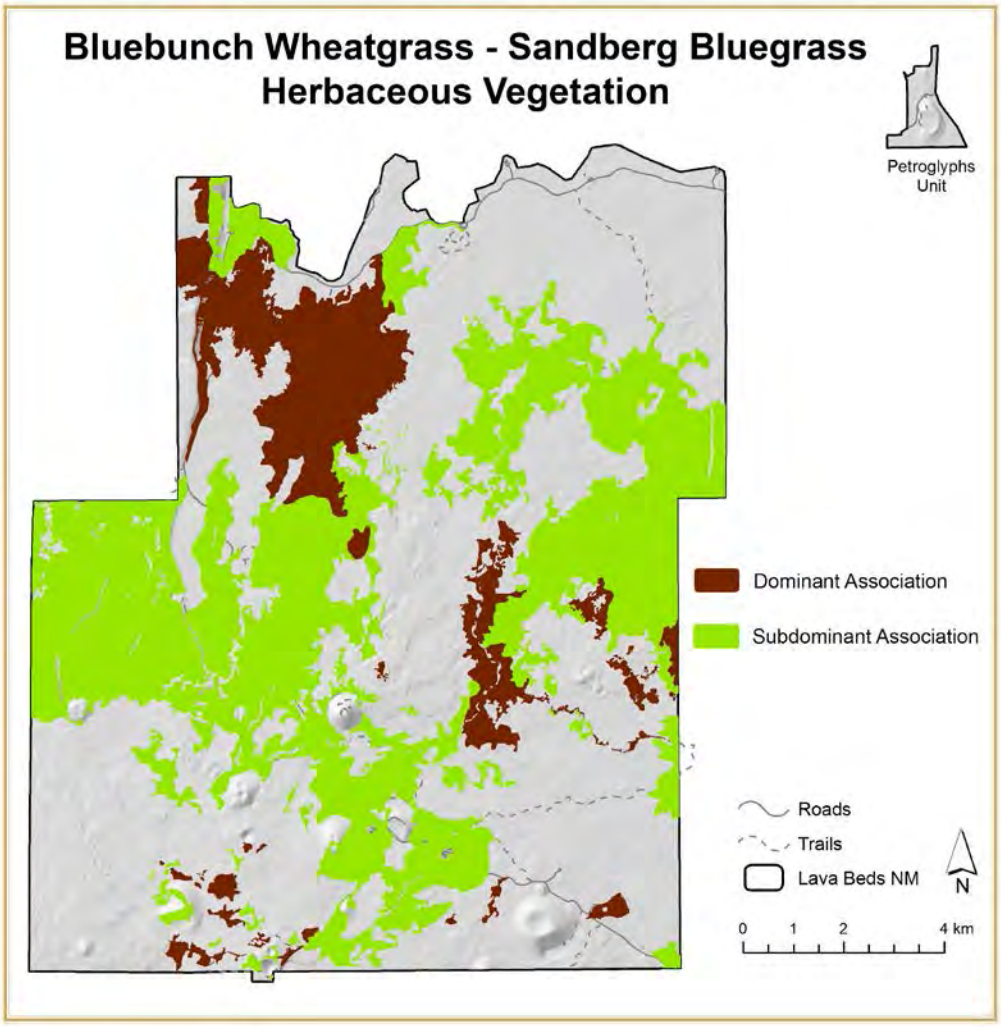
Species Richness:

Plot Species Richness Average	25.9
Plot Species Richness Range	9 - 41
Total Species Richness (all Plots)	79

Diagnostic Species: *Pseudoroegneria spicata* ssp. *spicata* at high cover.
Constant Species: *Pseudoroegneria spicata* ssp. *spicata*, *Bromus tectorum.*
Other Noteworthy Species: None.
Number of Plots: 7. Relevés 17, 18, 21, 35, 43, 47, 64.

Local Range: Throughout the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation (Code: CEGL001677) defined by the USNVC and placed in the *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Dry Grassland Alliance (Code: A3987) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association occurs at lower montane to subalpine elevations throughout much of the Rocky Mountains and intermountain northwestern United State and adjacent Canada, and east on to the northwestern Great Plains. Sites usually are ridges and slopes, sometimes alluvial fans, scree slopes, sloped rocky cliff faces, and bedrock outcrops of any aspect, although southerly and westerly aspects are most common in the northwestern part (British Columbia, Washington, Idaho) and northern part (Montana) of the geographic range. In Wyoming and Colorado, many of the sites supporting this association are windswept slopes and ridges. This association grows over a very broad elevational range, from 213 to 854 m (700-2800 feet) in the northwestern part of the range, 915 to 2288 m (3000-7500 feet) in the north-central part, and 2867 to 3050 m (9400-10,000 feet) in central Colorado. Stands of this association occupy loamy, rocky, often shallow soils on slopes and ridges, generally around the edges of basins and in the foothills of the mountains. Stands grow on well-drained, often shallow, and frequently gravelly or rocky soils generally of loam, clay loam, silt loam, or sandy loam textural classes.

Vegetation Description: Throughout its geographic range this is a bunch grassland with minor cover of forbs and, often, sparse shrubs. *Pseudoroegneria spicata* dominates or codominates the vegetation; *Poa secunda* and *Koeleria macrantha* usually are present in substantial amounts, and Festuca idahoensis is absent or present in very small amounts. The common shrubs are *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Chrysothamnus viscidiflorus*, and *Artemisia tridentata* (subspecies unknown). Associated forbs are highly variable, given the broad geographic and elevational range. This association was at one time common throughout its wide geographic range, but much of it in Washington and Oregon has been converted to agricultural fields. In many of the remaining stands, the cover of *Pseudoroegneria spicata* has decreased and the cover of *Hesperostipa comata* (= *Stipa comata*) and shrubs have increased, and exotics (especially *Bromus tectorum*, *Tragopogon* spp., and *Alyssum* spp.) have become common members of the vegetation; these changes are attributed in large part to livestock grazing.

DISTRIBUTION

Range: This grassland association occurs in the intermountain northwestern U.S. and adjacent Canada, and extends east into the Rocky Mountains from northern Colorado to northern Montana and east on to the northwestern Great Plains.
States/Provinces: BC? CO, ID, MT, NV, OR, UT, WA, WY.
Nations: CA?, U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest and Klamath National Forest), USFWS Tule Lake National Wildlife Refuge). Widespread association, presumed on public lands elsewhere in the northwestern U.S.

CONSERVATION STATUS

Rank: G4 - Apparently Secure (01Feb1996)
Reason: Information not available.

Global Description Author(s): J. Coles, mod. K.A. Schulz
Global Description References: J. Coles, mod. K.A. Schulz. 2008. *Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation [06May2008]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation (*Pseudoroegneria spicata* - *Poa secunda* Herbaceous Vegetation).

3. *Basin Wildrye Herbaceous Vegetation*

Leymus cinereus Herbaceous Vegetation

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.C Shrub & Herb Wetland Subclass
Formation: 2.C.5 Salt Marsh Formation
Division: 2.C.5.Nd *Sarcobatus vermiculatus - Allenrolfea occidentalis - Schoenoplectus americanus* North American Interior Brackish Marsh Division
Macrogroup: 2.C.5.Nd.1 - M082 Warm & Cool Desert Alkali-Saline Wetland Macrogroup
Group: 2.C.5.Nd.1.a - G538 *Distichlis spicata - Puccinellia lemmonii - Salicornia* spp. Alkaline-Saline Herbaceous Wetland & Playa Group
Alliance: A1329 *Leymus cinereus - Leymus triticoides* Herbaceous Alliance
Association: *Leymus cinereus* Herbaceous Vegetation

Translated Name: Basin Wildrye Herbaceous Vegetation

USNVC Identifier: CEGL001479

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at lower elevations within the monument on gentle, north facing slopes. Topographic position is low level. Soils are silt loam and loamy sand. Soil drainage is well drained to rapidly drained. This vegetation association typically occurs on former lakebed soils of the historic Tule Lake. However, it may also occur just upslope and to the south from the old lakeshore on deeper soils that have developed in depressions between rocky hills and lava flow formations.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1241	3	355	28
Range	1237 - 1245	0 - 5	350 - 0	5 - 50

Vegetation Description: This grassland association is comprised of basin wildrye (*Leymus cinereus*) at moderate cover. The non-native annual grass cheatgrass (*Bromus tectorum*) is present at moderate to high cover. The non-native annual forb herb sophia (*Descurainia sophia*) is present at low to high cover. This grassland association represents large stands of basin wildrye among more widespread vegetation associations.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	5 - 75	35
		Leymus cinereus (basin wildrye)	100	10 - 25	17.5
	Annual herb	*Descurainia sophia* (herb sophia)	100	1 - 25	9.5
		Sisymbrium altissimum (tall tumblemustard)	100	0 - 2	0.8
		Holostium umbellatum (jagged chickweed)	100	0 - 0.1	0.05

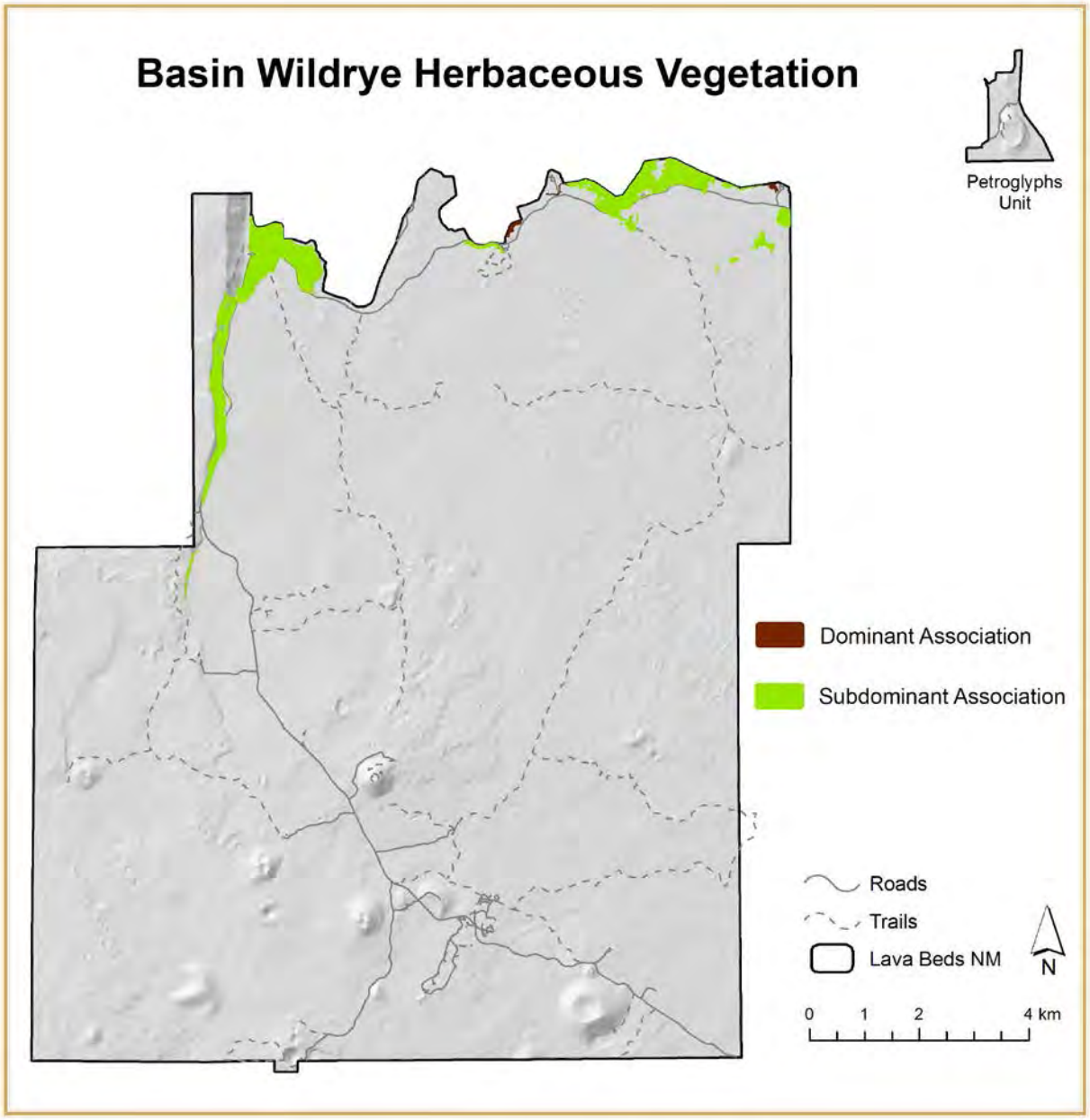
Species Richness:

Plot Species Richness Average	17
Plot Species Richness Range	11 - 23
Total Species Richness (all Plots)	29

Diagnostic Species: *Leymus cinereus.*
Constant Species: *Bromus tectorum*, *Descurainia sophia, Holostium umbellatum, Leymus cinereus, Sisymbrium altissimum.*
Other Noteworthy Species: None.
Number of Plots: 2. Relevés 5, 39.

Local Range: The northern one-fourth of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Basin Wildrye Herbaceous Vegetation is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Leymus cinereus* Herbaceous Vegetation (Code: CEGL001479) defined by the USNVC and placed in the *Leymus cinereus* - *Leymus triticoides* Herbaceous Alliance (Code: A1329) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association is found along lower elevation riparian corridors and some moderately alkaline valley bottomlands from Colorado to the Pacific Coast states. Elevations range between 305 and 780 m (1000-2550 feet) in northeastern and central Oregon, between 915 and 1525 m (3000-5000 feet) in the Great Basin, and from 1830 to 2450 m (6000-8036 feet) in western Colorado and southwestern Wyoming. Generally, stands tend to be patchy and grow on mesic sites with more soil moisture than is available to the surrounding vegetation, including mesic swales and seeps (Thilenius et al. 1995), foothill ravines (Knight et al. 1976), moist bottomlands (Stoddart 1941), along streams (Mueggler and Stewart 1980), and on gentle slopes in canyon bottoms in Oregon. Sites are flat to steep and occur on all aspects.

Soils are rapidly drained, often with a shallow water table. Soil texture is variable and ranges from silty clays to deep loamy sands. Parent materials are alluvium or colluvium derived from a variety of parent materials, including sandstone, shale, and volcanic rocks. Upland (i.e., non-riparian) stands of basin wildrye may grow on finer-textured soils than does the surrounding shrub-steppe vegetation (Knight et al. 1976), or the soils may be of the same texture but deeper due to badger digging (Walker and Brotherson 1982). Riparian stands have been described as growing on saline-alkaline soils (Mueggler and Stewart 1980), deep, rich soils free from high quantities of alkali (Aldous and Shantz 1924), and heavy soils (Stoddart 1941).

Vegetation Description: The vegetation is characterized by a tall (over 1.5 m), moderately dense to more typically dense grassland dominated by high cover (30-95%) of *Leymus cinereus (= Elymus cinereus*). Other plants are found mainly between the clumps of *Leymus cinereus* or on the edges of the dense stands. Scattered shrubs may be present, including *Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa (= Chrysothamnus nauseosus), Rhus trilobata, Ribes* spp., *Rosa* spp., and *Symphoricarpos oreophilus*. Associated species occurring at lower cover include graminoids such as *Achnatherum hymenoides, Achnatherum lettermanii, Carex douglasii, Elymus glaucus, Hesperostipa comata, Juncus balticus, Pascopyrum smithii*, and introduced species *Bromus tectorum* and *Poa pratensis*, and forbs such as *Achillea millefolium, Agastache urticifolia, Castilleja* spp., *Iris missouriensis, Potentilla gracilis* var. *flabelliformis (= Potentilla flabelliformis), Rumex crispus, Sidalcea oregana, Stephanomeria minor*, and *Vicia americana*. *Claytonia perfoliata (= Montia perfoliata)* is always associated in northwestern Oregon, while more alkaline forbs (*Suaeda* spp.) are more important in northern Great Basin valleys.

Walker and Brotherson (1982) describe a process by which stands of *Leymus cinereus* are established and maintained in a matrix of sagebrush-steppe on sites disturbed by badger digging. If badgers abandon a site, the *Leymus cinereus* is gradually replaced by shrubs and lower grasses from the surrounding vegetation matrix, and this replacement may be hastened by livestock grazing on the young *Leymus cinereus* shoots. Other references to *Leymus cinereus* stands do not describe this dependence on disturbance.

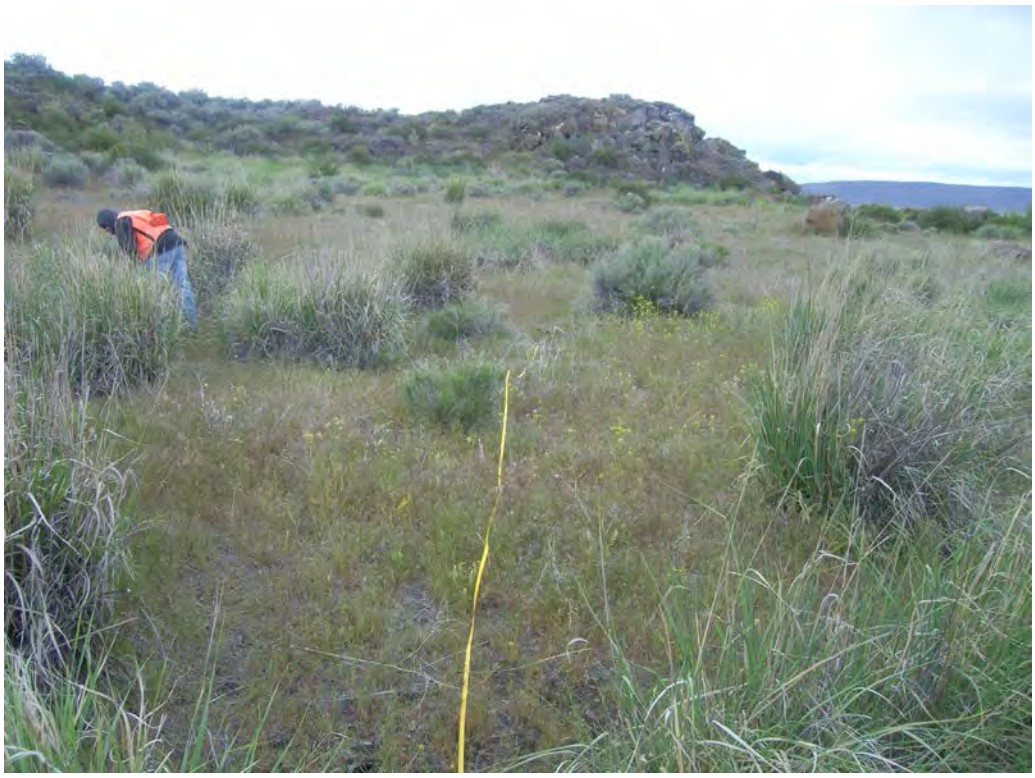
DISTRIBUTION
Range: This type is found mainly in the Great Basin and the Intermountain Region, and just reaches the western part of the Northern Great Plains.
States/Provinces: CA, CO, ID, MT, NV, OR, UT, WA, WY.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest), USFWS (Tule Lake National Wildlife Refuge).

CONSERVATION STATUS
Rank: G2 - Imperiled. (29Mar1999)
Reason: This is a very widespread community, being found in many western states, but is badly degraded everywhere. It has declined markedly throughout its range, and probably represents two or more separate community types. This type was formerly very abundant in interior valleys. Early settlers described the very tall grasslands (up to their horses' backs) in many areas. Most of these sites have been converted to agriculture. Even as described here as a broad association floristically and geographically - the size and quality of most occurrences should make it a G2. More knowledge of its distribution is needed, but it should remain a priority for conservation. Most sites are threatened by livestock grazing, agriculture, altered stream hydrology, and altered fire regime.

Global Description Author(s): G.P. Jones and M.P. Murray, mod. K.A. Schulz
Global Description References: G.P. Jones and M.P. Murray, mod. K.A. Schulz. 2008. *Leymus cinereus* Herbaceous Vegetation [17Jan2008]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).



Above: **Basin Wildrye Herbaceous Vegetation** (*Leymus cinereus* Herbaceous Vegetation).

4. *Needle and Thread Grass Great Basin Herbaceous Vegetation*

Hesperostipa comata Great Basin Herbaceous Vegetation

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.1 - M171 *Chrysothamnus viscidiflorus - Coleogyne ramosissima* / *Achnatherum hymenoides* Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup
Group: 3.B.1.Ne.1.c - G311 *Pleuraphis jamesii - Achnatherum hymenoides - Hesperostipa comata* Semi-Desert Grassland Group
Alliance: A1270 *Hesperostipa comata* Bunch Herbaceous Alliance
Association: *Hesperostipa comata* Great Basin Herbaceous Vegetation

Translated Name: Needle-and-Thread Great Basin Herbaceous Vegetation

USNVC Identifier: CEGL001705

LOCAL INFORMATION

Environmental Description: This vegetation association is uncommon in the monument and occurs in relatively small patches among more widespread vegetation associations. It occurs at lower elevations within the monument on gentle slopes. Aspects are variable. Topographic positions include toe slopes, basin floor and on summits. Soil is sandy loam and rapidly draining.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1266	3	346	4
Range	1248 – 1282	0 - 7	0 - 198	1 - 10

Vegetation Description: This grassland association is dominated by the perennial bunchgrass needle and thread grass (*Hesperostipa comata* ssp. *comata*) at moderate to high cover in relatively pure stands. Other perennial bunchgrasses may be present but at low cover. The non-native annual grass cheatgrass (*Bromus tectorum*) is present at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Herb	Graminoid	*Hesperostipa comata* ssp. *comata* (needle and thread grass)	100	10 - 75	39.2
		Bromus tectorum (cheatgrass)	100	1 - 25	7.5
	Annual herb	*Tragopogon dubius* (yellow salsify)	66.7	0 - 0.1	0.03

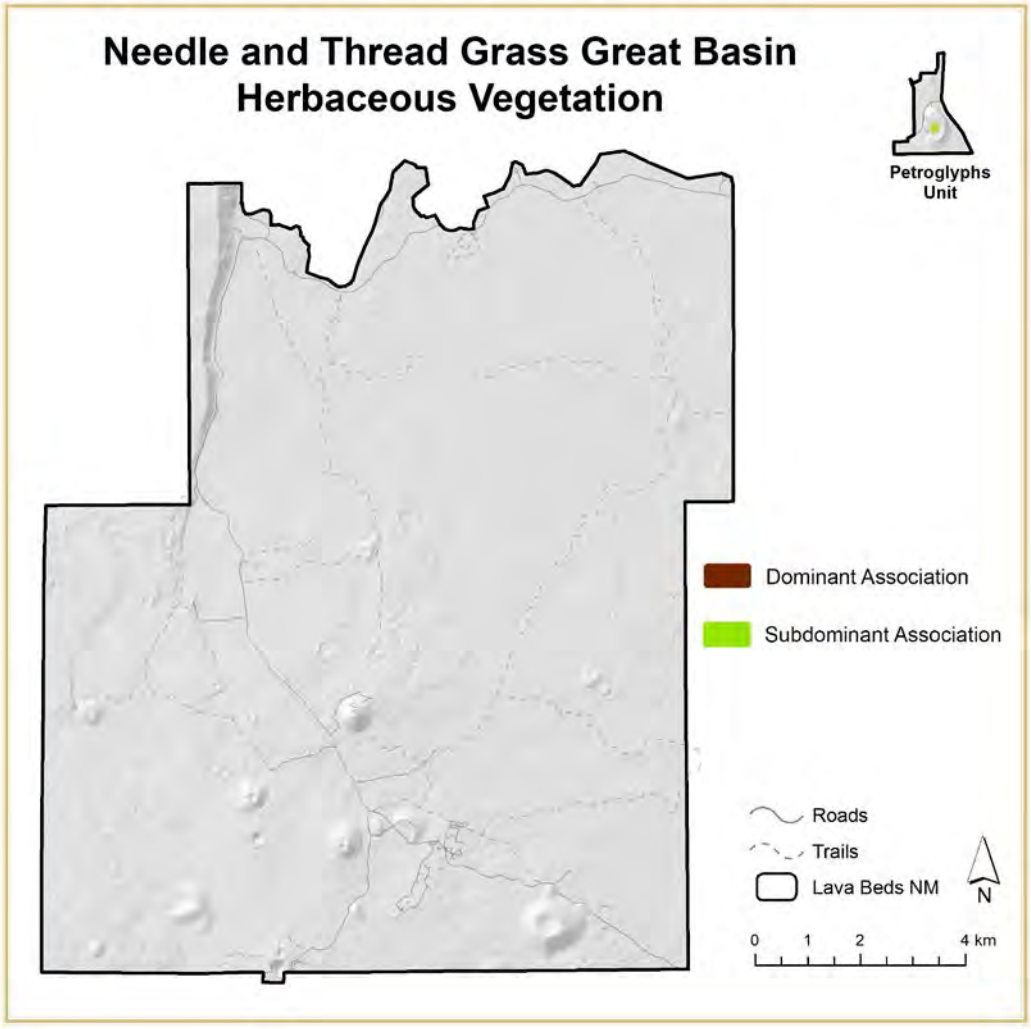
Species Richness:

Plot Species Richness Average	10
Plot Species Richness Range	9 - 11
Total Species Richness (all Plots)	22

Diagnostic Species: *Hesperostipa comata* ssp. *comata.*
Constant Species: *Hesperostipa comata* ssp. *comata, Bromus tectorum.*
Other Noteworthy Species: None.
Number of Plots: 3. Relevés 28, 49, 91.

Local Range: Northwest corner of the monument, the Petroglyphs unit, and Big Sand Butte on the Modoc National Forest.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Needle and Thread Great Basin Herbaceous Vegetation is a dominant or subdominant association (in the Petroglyphs Unit).

Classification Comments: This association is equivalent to the *Hesperostipa comata* Great Basin Herbaceous Vegetation (Code: CEGL001705) defined by the USNVC and placed in the *Hesperostipa comata* Bunch Herbaceous Alliance (Code: A1270) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This semi-arid grassland occurs on the Great Basin and Colorado Plateau and high plateaus of southern Utah, east into the western slope of the southern Rocky Mountains. Stands are found a variety of sites, such as on point bars, stream terraces, in sand-filled potholes in slickrock washes, on plains, valleys, canyon floors, gentle hillslopes, knolls and bluffs, mesatops, and plateau parks. Sites are generally flat to gently sloping, but occasionally are steep (to 53% slope). Elevation ranges from 1250-2683 m. The unvegetated surface has moderate to high cover of bare soil with sparse to moderate cover of litter. Biological soil crusts are often present with low cover. Soils are variable and include sand, cobbles, sandy, silt and clay loams and silty clay. Common parent materials are sandstones and shale that have been eroded and redistributed in alluvial and eolian deposits, but include Tertiary volcanic rocks. Fires may be important in maintaining these grasslands by reducing woody cover, but burning during the growing season could also damage *Hesperostipa comata* plants.

Vegetation Description: The vegetation is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the medium-tall, cool-season bunchgrass *Hesperostipa comata*, but it may also include stands with less than 10% total vegetation cover. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, Koeleria macrantha, Leymus salinus, Pleuraphis jamesii, Poa fendleriana*, or *Sporobolus cryptandrus*, may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated forbs include *Balsamorhiza sagittata, Hymenopappus filifolius, Machaeranthera canescens, Sphaeralcea coccinea, Vicia americana*, and species of *Antennaria, Astragalus, Cryptantha, Eriogonum, Gilia*, and *Lappula*. Scattered shrubs and dwarf-shrubs may present with less than 5% total cover. Common species include *Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha*, and *Symphoricarpos oreophilus*. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Some stands have high cover of biological soil crusts.

These grasslands are dominated by relatively deep-rooted grasses that use soil moisture below 0.5 m during the typically dry summers. The coarse-textured soils allow for rapid infiltration and storage of winter and summer precipitation (Kleiner 1968, Daubenmire 1970, Kleiner and Harper 1977, Thilenius et al. 1995). However, during the severe drought of 2002, there was widespread die-off of *Hesperostipa comata* throughout the northern Colorado Plateau (J. Coles, pers. obs. 2005). Fires when the grasses are dormant may be important in maintaining these grasslands by reducing woody cover. However, burning during the growing season generally kills or severely damages *Hesperostipa comata* plants. After fire, regeneration of this non-rhizomatous bunchgrass is by seed and may take many years to reach pre-fire densities (FEIS 1998).

GLOBAL DISTRIBUTION

Range: This grassland is found on the west slope of the Colorado Rocky Mountains, on the Colorado Plateau and in the Great Basin in Colorado and Utah, and probably occurs in adjacent states.
States/Provinces: AZ, CO, NV, UT, WY.
Nations: U.S.

Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest) Widespread association, presumed on public lands elsewhere in the Great Basin.

CONSERVATION STATUS
Rank: G3 - Vulnerable (23Feb1994).
Reason: Information not available.

Global Description Author(s): K.A. Schulz, mod. J. Coles.
Global Description References: K.A. Schulz, mod. J. Coles. 2009. *Hesperostipa comata* Great Basin Herbaceous Vegetation [24Feb2009]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Needle and Thread Great Basin Herbaceous Vegetation** (*Hesperostipa comata* Great Basin Herbaceous Vegetation).

5. *Cheatgrass Ruderal Herbaceous Vegetation*

Bromus tectorum Ruderal Herbaceous Vegetation

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.90 - M499 *Agropyron cristatum - Bromus tectorum - Sisymbrium altissimum* Western North American Ruderal Semi-Desert Scrub & Grassland Macrogroup
Group: 3.B.1.Ne.90.a - G600 Great Basin & Intermountain Ruderal Dry Shrubland & Grassland Group
Alliance: A1814 *Bromus tectorum - Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance
Association: *Bromus tectorum* Ruderal Herbaceous Vegetation

Translated Name: Cheatgrass Ruderal Herbaceous Vegetation

USNVC Identifier: CEGL003019

LOCAL INFORMATION

Environmental Description: This association occurs at lower elevations within the monument on moderate to gentle slopes and on flat ground. Aspects are variable. Topographic positions include low slope, low level, bench, and basin floor. Soils include sandy loam, loamy sand, and silt loam. Soil drainage is moderately well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1252	3	8	23
Range	1229 - 1270	0 - 14	120 - 0	1 - 90

Vegetation Description: This grassland association is dominated by a dense cover of non-native annual grasses and forbs including cheatgrass (*Bromus tectorum*) as the most dominant grass and herb sophia (*Descurainia sophia*) as the most common forb. Their cover ranges from low to high. Redstem stork's bill (*Erodium cicutarium*) is often present at low to moderate cover. This association often, but not exclusively, occupies shrubland that has recently experienced a stand replacement disturbance and also occurs on land that was previously cultivated and/or overgrazed. Much of the extent of this association within the monument is within the fire perimeter of the Jack fire that burned in the summer of 2008. The dominance by the short-lived annual species cheatgrass and herb sophia, the very low abundance of woody shrubs or perennial grasses and forbs, and the common presence of charred shrub snags indicate a stand replacement fire in the recent past and may represent a type conversion and/or successional re-initiation from shrubland or perennial grassland associations to this recently disturbed annual grassland association. Though infrequent, the native perennial grasses Sandberg bluegrass (*Poa secunda*) and squirreltail (*Elymus elymoides*) may be present and common in stands of this association.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	0 - 75	42.2
		Elymus elymoides (squirreltail)	100	0 - 10	1.4
	Annual herb	*Descurainia sophia* (herb sophia)	66.7	0 - 95	16.2
		Erodium cicutarium (redstem stork's bill)	55.6	0 - 50	4.4
		Sisymbrium altissimum (tall tumblemustard)	77.8	0 - 5	0.6

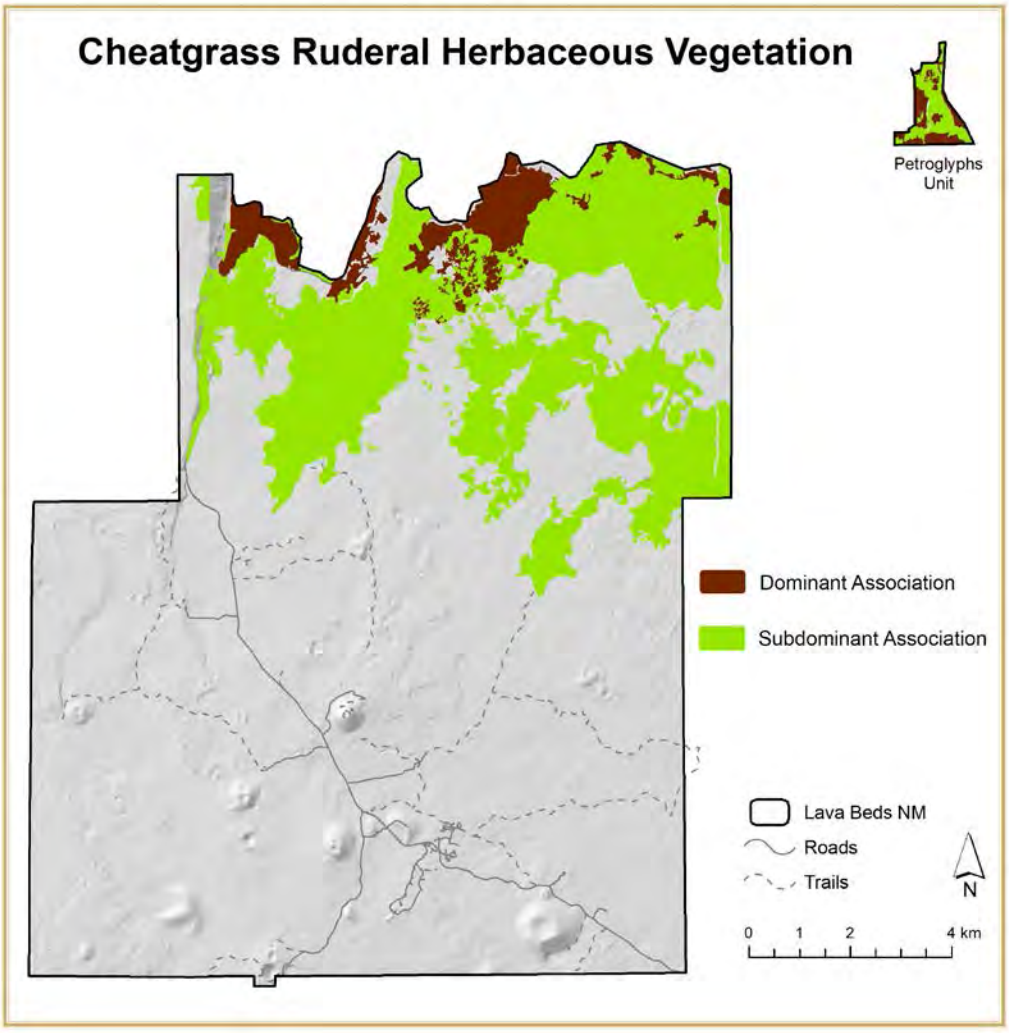
Species Richness:

Plot Species Richness Average	10
Plot Species Richness Range	4 - 18
Total Species Richness (all Plots)	30

Diagnostic Species: *Descurainia sophia, Erodium cicutarium.*
Constant Species: *Bromus tectorum*
Other Noteworthy Species: None.

Local Range: The Petroglyphs unit; the northern one-third of the monument, particularly on the former lakebed of Tule Lake and within the perimeter of the 2008 Jack fire. Widespread elsewhere in the southern Klamath Basin.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Cheatgrass Ruderal Herbaceous Vegetation is a dominant or subdominant association.

Classification Comments: This association is equivalent to *Bromus tectorum* Ruderal Herbaceous Vegetation (Code: CEGL003019) defined by the USNVC and placed in the *Bromus tectorum* - *Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance (Code: A1814) of the revised USNVC hierarchy.

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Number of Plots: 9. Relevés 1, 2, 3, 27, 37, 38, 58, 92, 158.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the Intermountain and southwestern U.S. Elevation ranges from sea level to 2200 m. Stands occur after disturbance of a natural shrub- or grass-dominated community that results in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*, although invasion of undisturbed sites has also been reported (e.g., Evans et al. 2001). At Wind Cave National Park in South Dakota, weedy non-native graminoid vegetation occurs on recently disturbed areas, most commonly along roads. Small stands also occur in prairie dog towns (H. Marriott pers. comm. 1999). In the Great Basin, *Bromus tectorum* grasslands have invaded large areas of burned-over sagebrush steppe. *Bromus tectorum* increases the fire frequency of steppe communities, which eventually eliminates sagebrush (FEIS 2001).

Vegetation Description: *Bromus tectorum* typically dominates the community with over 80-90% of the total vegetation cover, making it difficult to determine what natural community was formerly present. This vegetation also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species such as *Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, or *Bromus rubens*. It is distinct from the annual *Bromus* communities found along the Pacific Coast typical of the Mediterranean or maritime climates.

Bromus tectorum is an annual grass able to germinate in cool temperatures and complete its lifecycle in the spring before drying out mid-summer. Its fine structure makes it extremely flammable when dry, and it will increase the fire frequency of a site (FEIS 2001). Frequent fires favor *Bromus tectorum* because they eliminate competing perennial vegetation, but do not kill all the *Bromus tectorum* seeds, which survive in the unburned organic material (FEIS 2001). This altered ecological process has promoted the spread of *Bromus tectorum* and other exotic annual bromes at the expense of sagebrush shrublands in large parts of the western U.S. (Young and Evans 1973, 1978, Daubenmire 1975).

T. Naumann (pers. comm. 2005) reported successful restoration of cheatgrass-invaded systems by the use of prescribed fire, timed and controlled so as to destroy the seeds of *Bromus tectorum* while stimulating growth in remnant native warm-season grasses. She also reported that prescribed fire was least successful in areas of shallow soils, presumably because native grasses cannot develop sufficient root mass to compete with cheatgrass. Work by Redente and others (e.g., Redente et al. 1992) indicates that, under some circumstances, native grass and shrub species can regain competitive advantage over annuals such as *Bromus tectorum* if a source of carbon, such as sugar or sawdust, is added to the system. Amending the soil with carbon increases the activity of soil microbes and results in the reduction of plant-available nitrogen.

This type is most common where disturbances have eliminated or largely set back the native vegetation. Where the brome grasses are invading native vegetation, the types may still be tracked as native types, since the native species may still persist. A recent study (Karl et al. 1999) found that, despite strong seed and seedling production by the exotic brome grasses (*Bromus japonicus, Bromus tectorum*), the large amount of herbaceous biomass produced by the two vegetatively propagating native grasses *Bouteloua gracilis* and *Pascopyrum smithii* suggests that these native grasses may well maintain their ecological importance in the stands.

Evans et al. (2001) studied the invasion by cheatgrass of an undisturbed native grassland in Canyonlands National Park (Virginia Park). Their study showed that *Bromus* may cause a short-term decrease in nitrogen loss by decreasing substrate availability and denitrification enzyme activity, but in the long term, nitrogen loss is likely to be greater in invaded sites because of increased fire frequency and greater nitrogen volatilization during fire. A study by Englund (2004) at the same site showed decreasing levels of soil organic carbon as *Bromus tectorum*, with its shallow root systems, replaced perennial grasses with their more massive root systems.

In Nevada, Beatley (1976) found dense stands of the introduced winter annual grass *Bromus tectorum* growing in disturbed *Artemisia* shrublands. *Bromus rubens* is more common in lower elevation sites, and *Bromus tectorum* is most common in higher elevation sagebrush and pinyon-juniper communities.

DISTRIBUTION
Range: This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S.
States/Provinces: AZ, CA, CO, ID, NV, SD, UT, WA.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest and Klamath National Forest), USFWS Tule Lake National Wildlife Refuge). Widespread association, presumed on public lands elsewhere in the northwestern U.S.

CONSERVATION STATUS
Rank: GNA (01Dec1997)
Reason: GNA – Not Applicable.

Global Description Author(s): D. Faber-Langendoen, mod. K. Schulz and J. Coles.
Global Description References: D. Faber-Langendoen, mod. K. Schulz and J. Coles. 2008. *Bromus tectorum* Ruderal Herbaceous Vegetation [06May2008]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Cheatgrass Ruderal Herbaceous Vegetation** (*Bromus tectorum* Ruderal Herbaceous Vegetation).

6. *Squirreltail Herbaceous Vegetation [Provisional]*

Elymus elymoides Herbaceous Vegetation [Provisional]

USNVC Classification: Provisional vegetation association not classified in the USNVC hierarchy.

NPS Unique Identifier: NPSLABE002

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at lower elevations within the monument on very gentle slopes. Topographic positions are low level and on summits. Soils are silt loam and sandy loam. Soil drainage is moderately well drained. This vegetation association typically occurs on deeper soils near the former lakeshore of the historic Tule Lake but may also occur further upslope and to the south of the former lakeshore.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1298	0	0	8
Range	1238 – 1357	0	0	1 - 15

Vegetation Description: This grassland association is dominated by the perennial bunchgrass squirreltail (*Elymus elymoides*) at moderate to high cover in relatively pure stands. The non-native annual grass cheatgrass (*Bromus tectorum*) is present at low to moderate cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Herb	Graminoid	*Elymus elymoides* (squirreltail)	100	10 - 50	27.5
		Bromus tectorum (cheatgrass)	100	0.1 - 5	2
	Annual herb	*Tragopogon dubius* (yellow salsify)	100	0 - 0.1	0.03

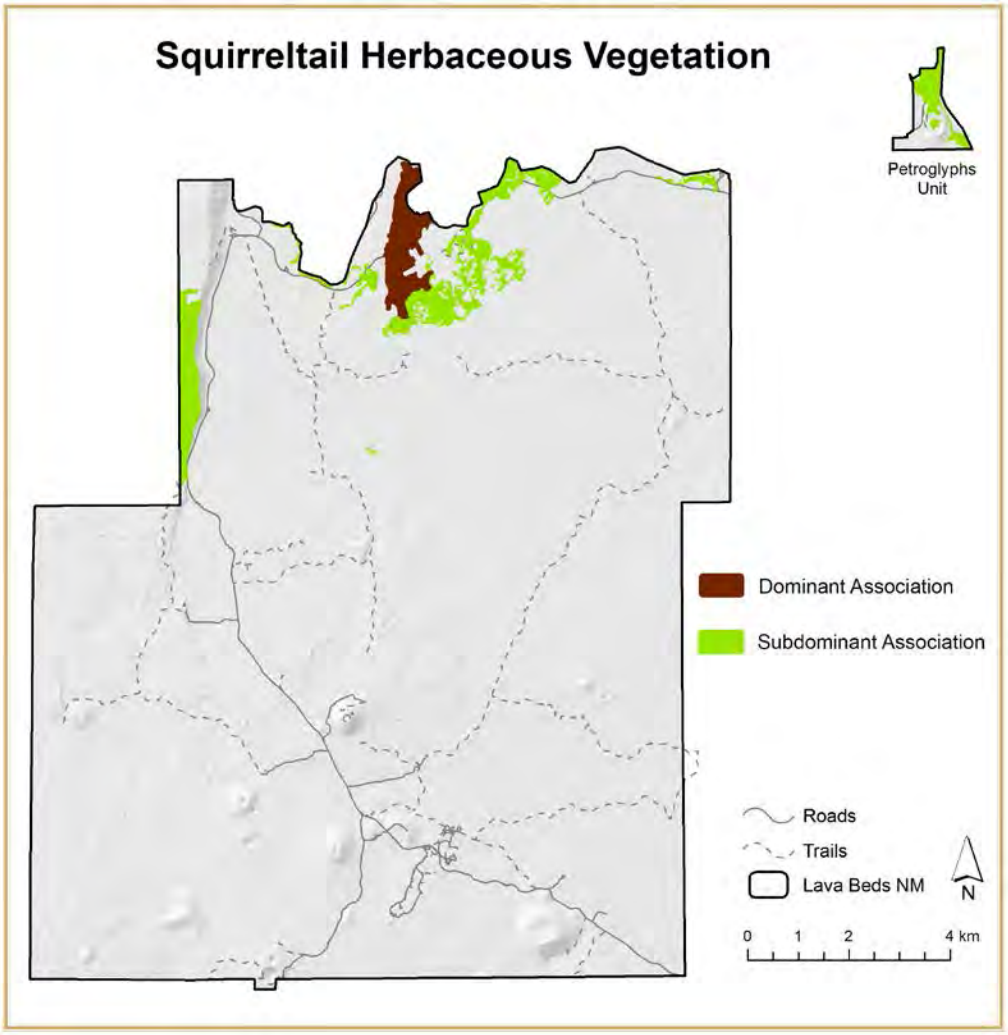
Species Richness:

Plot Species Richness Average	9
Plot Species Richness Range	6 - 12
Total Species Richness (all Plots)	15

Diagnostic Species: *Elymus elymoides* as the sole dominant bunchgrass species.
Constant Species: *Elymus elymoides, Bromus tectorum, Tragopogon dubius.*
Other Noteworthy Species: None.
Number of Plots: 2. Relevés 13, 20.

Local Range: Along the northern boundary of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Squirreltail Herbaceous Vegetation [Provisional] is the dominant association or is a subdominant association.

Classification Comments: Similar stands with *Elymus elymoides* dominant or co-dominant with non-native grasses have been documented in cismontane California, including the North Coast Ranges and southern Sierra Nevada Foothills (J. Evens, pers. comm.). Further inquiry is needed to reveal the proper alliance placement for this association from the monument.
Other Comments: *Poa secunda* is sometimes present and abundant in stands of this association.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

Above: **Squirreltail Herbaceous Vegetation [Provisional]** (*Elymus elymoides* Herbaceous Vegetation [Provisional]).

SHRUB VEGETATION

7. *Chokecherry - Mixed Shrub Talus Shrubland*

Prunus virginiana - Mixed Shrub Talus Shrubland

Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.B Temperate & Boreal Grassland & Shrubland Subclass
Formation: 2.B.2 Temperate Grassland & Shrubland Formation
Division: 2.B.2.Na Western North American Grassland & Shrubland Division
Macrogroup: 2.B.2.Na.1 - M049 *Quercus gambelii - Cercocarpus montanus - Purshia* spp. Southern Rocky Mountain Montane Shrubland Macrogroup
Group: 2.B.2.Na.1.a - G277 *Quercus gambelii - Amelanchier* spp. - *Prunus virginiana* Southern Rocky Mountain Montane Shrubland Group
Alliance: A3736 *Fraxinus anomala - Rhus trilobata - Fendlera rupicola* Talus & Rock Outcrop Shrubland Alliance
Association: *Prunus virginiana* - Mixed Shrub Talus Shrubland

Translated Name: Chokecherry - Mixed Shrub Talus Shrubland

USNVC Identifier: CEGL005444

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at lower to middle elevations within the monument on steep, northeast to southeast facing slopes. Topographic positions include bench, low slope, and high slope. Soils are clay loam, sandy loam, and rock. Soil drainage is rapidly drained. This vegetation association typically occurs on large accumulations of scree on or at the base of cliffs and on old lava flow formations.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1389	21	53	3
Range	1295 - 1491	14 - 29	15 - 110	1 - 4

Vegetation Description: This small patch shrubland association is co-dominated by the shrub chokecherry (*Prunus virginiana*) at moderate to high cover and roundleaf snowberry (*Symphoricarpos rotundifolius*) at low to high cover. Herbaceous cover is often sparse. The non-native annual grass cheatgrass (*Bromus tectorum*) is sometimes present at low to moderate cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Prunus virginiana* (chokecherry)	100	2 - 25	10.3
		Symphoricarpos rotundifolius (roundleaf snowberry)	66.7	0 - 50	13
	Broad-leaved evergreen shrub	*Cercocarpus ledifolius* var. *intercedens* (curl-leaf mountain-mahogany)	66.7	0 - 2	1
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	0 - 5	1.4
	Annual herb	*Epilobium brachycarpum* (tall annual willowherb)	100	0 - 1	0.2

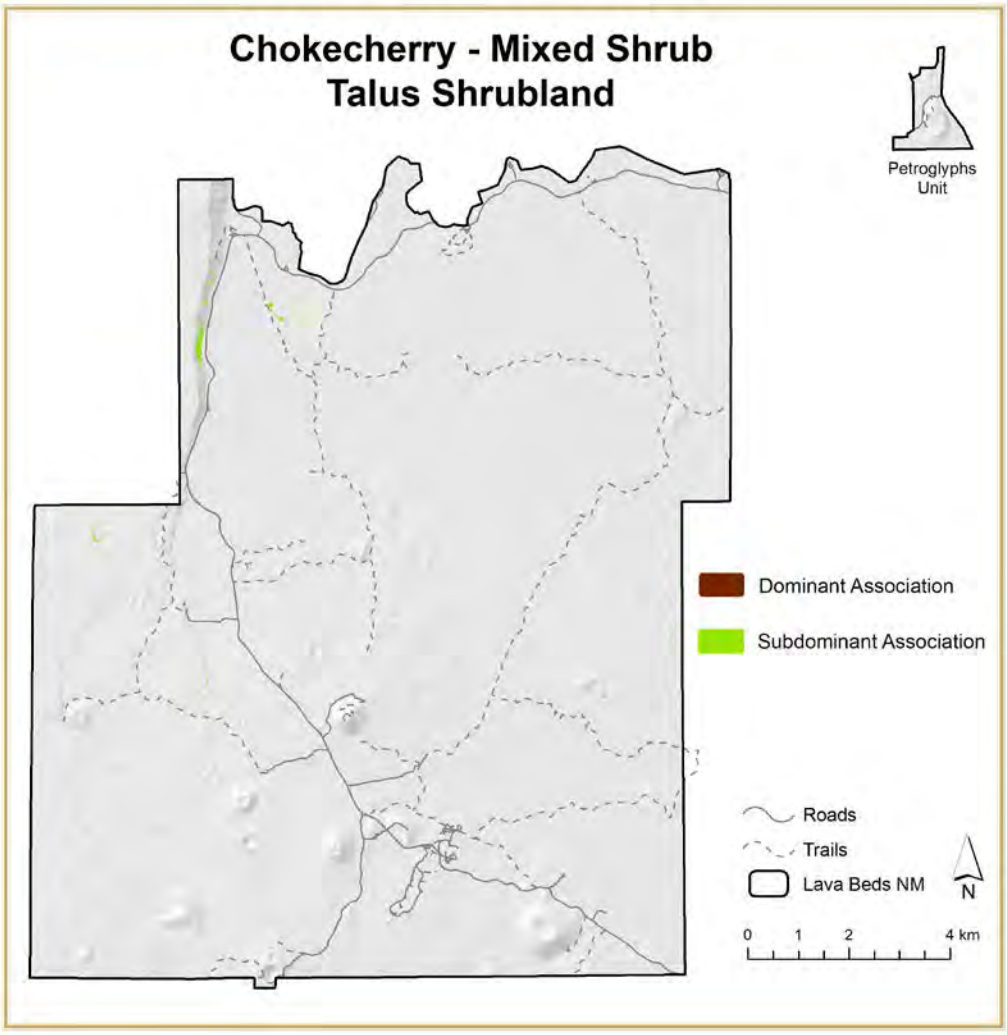
Species Richness:

Plot Species Richness Average	29.7
Plot Species Richness Range	17 - 41
Total Species Richness (all Plots)	65

Diagnostic Species: *Prunus virginiana.*
Constant Species: *Prunus virginiana, Bromus tectorum, Epilobium brachycarpum.*
Other Noteworthy Species: None.
Number of Plots: 3. Relevés 33, 61, 141.

Local Range: On Gillem Bluff and its east facing slope. On rocky substrata in the southern ¼ of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Chokecherry - Mixed Shrub Talus Shrubland is the dominant association or is a subdominant association.

Classification Comments: This association is possibly related to the following associations within the recently redefined alliances by the USNVC: the *Cercocarpus ledifolius / Symphoricarpos rotundifolius* Woodland (Code: CEGL008637) within the *Cercocarpus ledifolius* / Shrub Understory Woodland Alliance (Code: A0586), *Prunus virginiana* - (*Prunus americana*) Shrubland (Code: CEGL001108) within the *Rhus trilobata - Crataegus rivularis - Forestiera pubescens* Shrubland Alliance (Code: A3799), and the *Prunus virginiana* Great Plains Shrubland (Code: CEGL005453) within the *Prunus virginiana - Symphoricarpos occidentalis - Amelanchier alnifolia* Great Plains Shrub Alliance (Code: A4036). Further inquiry should be taken to reveal the proper alliance placement for this association from the monument.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Information not available.

Vegetation Description: Information not available.

DISTRIBUTION

Range: Information not available.
States/Provinces: NV.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest).

Global Description Author(s): Information not available.
Global Description References: *Prunus virginiana* - Mixed Shrub Talus Shrubland. No Date. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/21/2015).

Above: **Chokecherry - Mixed Shrub Talus Shrubland** (*Prunus virginiana* - Mixed Shrub Talus Shrubland).

8. *Greenleaf Manzanita Sierran Chaparral Shrubland*

Arctostaphylos patula Sierran Chaparral Shrubland

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.B Temperate & Boreal Grassland & Shrubland Subclass
Formation: 2.B.2 Temperate Grassland & Shrubland Formation
Division: 2.B.2.Nd Western North American Interior Sclerophyllous Chaparral Division
Macrogroup: 2.B.2.Nd.1 - M094 *Arctostaphylos patula - Ceanothus velutinus - Quercus vacciniifolia* Montane Chaparral Macrogroup
Group: 2.B.2.Nd.1.a - G282 *Arctostaphylos patula - Arctostaphylos nevadensis - Ceanothus velutinus* Montane Sclerophyll Scrub Group
Alliance: A0788 *Arctostaphylos patula - Arctostaphylos nevadensis* Shrubland Alliance
Association: *Arctostaphylos patula* Sierran Chaparral Shrubland

Translated Name: Greenleaf Manzanita Sierran Chaparral Shrubland

USNVC Identifier: CEGL005820

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at high elevations within the monument on steep north facing slopes. Topographic position is high slope. Soils are loamy sand, and sandy loam. Soil drainage is rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1648	16	336	0.1
Range	1631 - 1665	15 - 17	310 - 1	0.1

Vegetation Description: This shrubland association is dominated by greenleaf manzanita (*Arctostaphylos patula*) at moderate to high cover, often occurring in dense stands. Snowbrush ceanothus (*Ceanothus velutinus*) is present and sometimes co-dominant at moderate cover. The perennial bunchgrass bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) is present at low to high cover. The sub-shrub sulphur-flower buckwheat (*Eriogonum polyanthum*) and the perennial herb wavyleaf Indian paintbrush (*Castilleja applegatei* ssp. *pinetorum*) are present at low to moderate cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Juniperus occidentalis* var. *occidentalis* (western juniper)	100	0 - 2	0.8
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Arctostaphylos patula* (greenleaf manzanita)	100	5 - 50	24
		Ceanothus velutinus (snowbrush ceanothus)	100	2 - 10	6.5
Herb	Graminoid	*Pseudoroegneria spicata* ssp. *spicata* (bluebunch wheatgrass)	50	0 - 50	18.8
	Sub-shrub	*Eriogonum polyanthum* (sulphur-flower buckwheat)	100	0.1 - 5	2
	Perennial herb	*Castilleja applegatei* ssp. *pinetorum* (wavyleaf Indian paintbrush)	100	1 - 5	2.5
		Penstemon humilis (low beardtongue)	100	0.1 - 1	0.5

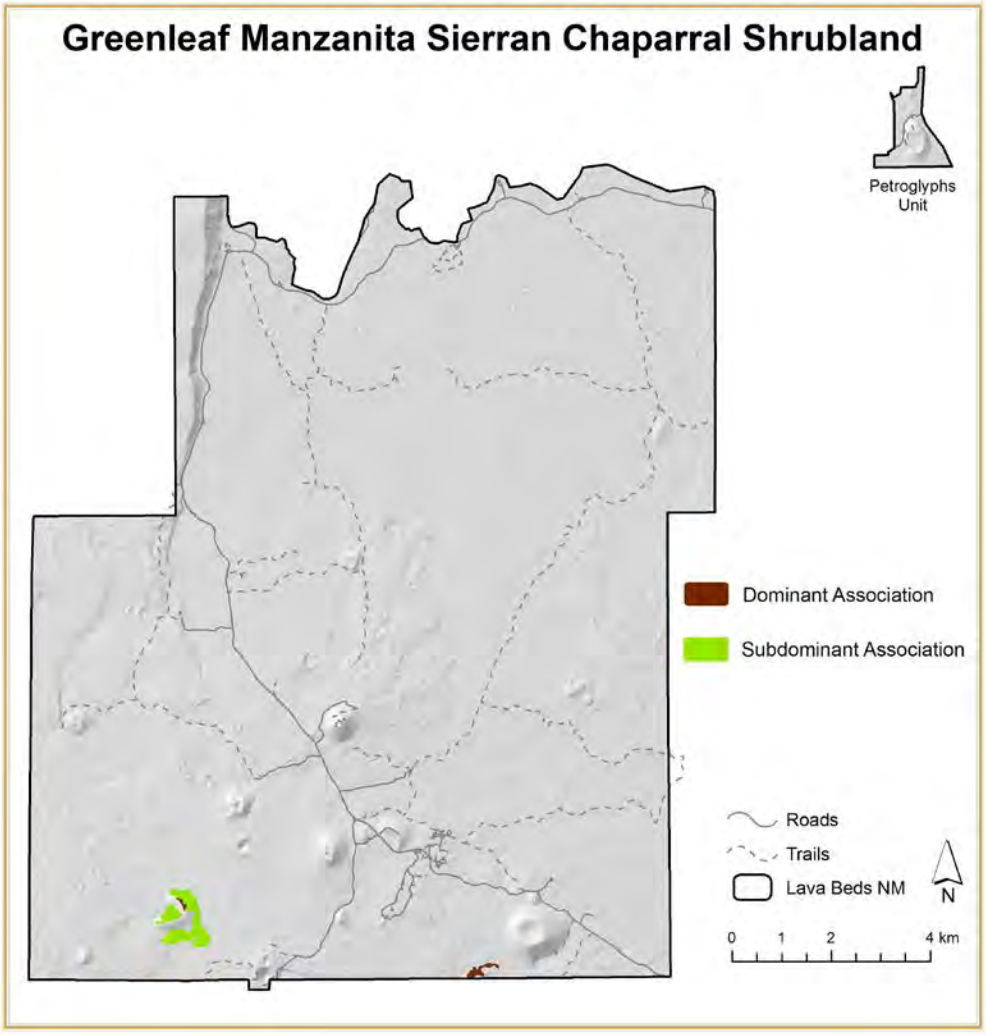
Species Richness:

Plot Species Richness Average	37
Plot Species Richness Range	31 - 43
Total Species Richness (all Plots)	52

Diagnostic Species: *Arctostaphylos patula, Ceanothus velutinus.*
Constant Species: *Juniperus occidentalis* var. *occidentalis, Arctostaphylos patula, Ceanothus velutinus, Eriogonum polyanthum, Castilleja applegatei* ssp. *pinetorum.*
Other Noteworthy Species: None.
Number of Plots: 2. Relevés 108, 109.

Local Range: Eagle Nest Butte. This association may occur in small patches on buttes elsewhere in the southern portion of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Greenleaf Manzanita Sierran Chaparral Shrubland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Arctostaphylos patula* Sierran Chaparral Shrubland (Code: CEGL005820) defined by the USNVC and placed in the *Arctostaphylos patula - Arctostaphylos nevadensis* Shrubland Alliance (Code: A0788) of the revised USNVC hierarchy.

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This shrubland association is currently only known from Yosemite National Park in California, and the following description is based on occurrences there. Additional information will be added as it becomes available. It is likely that this association ranges throughout the Sierra Nevada and perhaps elsewhere in montane California. Stands are found at low to mid elevations (1495-2530 m [4900-8300 feet]) on mid to high portions of slopes with all aspects. The slopes tend to be linear and moderately steep to abrupt (10-70 degrees). This association is found on moderately deep to deep soils and occasionally on shallow soils. Soils are poorly drained to well-drained with textures ranging from stony and gravelly to loam from sedimentary and granitic parent materials. Although fires in this type can be small due to resistance to ignition, they can support catastrophic fires once they get started. The unvegetated surface is made up of litter, wood and bare soil. Disturbance in the form of invasion by exotics, logging, improper burning regime, and road and trail construction occur in low to high intensity. Most stands are the result of fire or other natural or unnatural process. Many stands could support conifer woodland or forest with long intervals between fires or other disturbance processes.

Vegetation Description: This association forms open to moderately dense stands dominated by *Arctostaphylos patula*. Often found in this association are *Abies concolor*, *Calocedrus decurrens*, *Quercus kelloggii*, and *Chamaebatia foliolosa*. Occasionally, *Pinus jeffreyi*, *Quercus kelloggii*, and *Apocynum androsaemifolium* are present. A variety of other species present in this association may include *Carex multicaulis*, *Ceanothus parvifolius*, *Ceanothus cordulatus*, *Chamaesyce serpyllifolia*, *Lupinus breweri*, and *Prunus emarginata*. Stands of this association are variable in their disturbance regimes. Some are clearly seral to forest types, and others are edaphically controlled, probably persisting from 50 to more than 100 years at least without being invaded by conifers.

DISTRIBUTION

Range: This association is only known from Yosemite National Park in California. Information about its global characteristics is not available without additional inventory. It is likely that this association ranges throughout the Sierra Nevada and perhaps elsewhere in montane California.
States/Provinces: CA.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest and Klamath National Forest).

CONSERVATION STATUS

Rank: G5 - Secure. (11Feb2003)
Reason: Probably a widespread seral association of the mountains of California.

Global Description Author(s): T. Keeler-Wolf.
Global Description References: T. Keeler-Wolf. 2010. *Arctostaphylos patula* Sierran Chaparral Shrubland [06May2010]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Greenleaf Manzanita Sierran Chaparral Shrubland** (*Arctostaphylos patula* Sierran Chaparral Shrubland).

9. *Oceanspray - Desert Gooseberry Shrubland [Provisional]*

Holodiscus discolor - Ribes velutinum Shrubland [Provisional]

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.B Temperate & Boreal Grassland & Shrubland Subclass
Formation: 2.B.2 Temperate Grassland & Shrubland Formation
Division: 2.B.2.Nd Western North American Interior Sclerophyllous Chaparral Division
Macrogroup: 2.B.2.Nd.1- M094 *Arctostaphylos patula - Ceanothus velutinus - Quercus vacciniifolia* Montane Chaparral Macrogroup
Group: 2.B.2.Nd.1.a - G282 *Arctostaphylos patula - Arctostaphylos nevadensis - Ceanothus velutinus* Montane Sclerophyll Scrub Group
Alliance: A3918 *Prunus emarginata - Holodiscus discolor* Shrubland Alliance
Association: Provisional vegetation association.

NPS Unique Identifier: NPSLABE003

LOCAL INFORMATION

Environmental Description: This vegetation association is described from only one sample plot. It occurs at middle elevations within the monument on a steep south facing slope. Topographic position is high slope. Soils are rock. Soil drainage is rapidly drained. This vegetation association is expected to occur elsewhere in the monument on areas of exposed rock on lava flows, in and around collapsed lava caves, or on large accumulations of scree on cliffs.

Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
1387	21	140	1

Vegetation Description: This shrubland association is dominated by oceanspray (*Holodiscus discolor*) at moderate to high cover. The shrubs mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and desert gooseberry (*Ribes velutinum*) are present at moderate cover. The perennial bunchgrass Sandberg bluegrass (*Poa secunda*) is present at low cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush)	100	2 - 5	3.5
	Broad-leaved deciduous shrub	*Holodiscus discolor* (oceanspray)	100	10 - 25	17.5
		Ribes velutinum (desert gooseberry)	100	2 - 5	3.5
Herb	Graminoid	*Poa secunda* (Sandberg bluegrass)	100	1 - 2	1.5

Diagnostic Species: *Holodiscus discolor.*
Constant Species: Not applicable.
Other Noteworthy Species: None.
Species Richness of Sample Plot: 19

Number of Plots: 1. Relevé 129.
Local Range: At middle elevations within the monument.

Local Range Map: Not available for this association. Occurrence is too limited to show at the spatial scale of the monument.

Classification Comments: This provisional vegetation association is classified under the *Prunus emarginata - Holodiscus discolor* Shrubland Alliance (Code: A3918) defined by the USNVC.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

Above: **Oceanspray - Desert Gooseberry Shrubland [Provisional]** (*Holodiscus discolor - Ribes velutinum* Shrubland [Provisional]).

10. Rubber Rabbitbrush Shrubland

Ericameria nauseosa Shrubland

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.1 - M171 *Chrysothamnus viscidiflorus - Coleogyne ramosissima* / *Achnatherum hymenoides* Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup
Group: 3.B.1.Ne.1.d - G310 *Chrysothamnus viscidiflorus - Ericameria nauseosa - Krascheninnikovia lanata* Shrubland Group
Alliance: A3196 *Ericameria nauseosa* Shrubland & Shrub Herbaceous Alliance
Association: *Ericameria nauseosa* Shrubland

Translated Name: Rubber Rabbitbrush Shrubland

USNVC Identifier: CEGL002713

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at low to middle elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions include basin floor, midslope, high slope, backslope, summit, and bench. Soils are loam, loamy sand, sandy loam, and sand. Soil drainage is rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1305	7	321	0.5
Range	1237 - 1380	0 - 22	0 - 340	0 - 2

Vegetation Description: This shrubland association is dominated by rubber rabbitbrush (*Ericameria nauseosa*) at moderate to high cover. The non-native annual grass cheatgrass (*Bromus tectorum*) is present at low to high cover. This association often occurs as an early to mid-successional condition in sagebrush (*Artemisia tridentata* ssp.) associations that have been disturbed by fire.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Ericameria nauseosa* (rubber rabbitbrush)	100	5 - 50	15.5
		Chrysothamnus viscidiflorus ssp. *viscidiflorus* (yellow rabbitbrush)	6.7	0 - 5	1.1
		Artemisia tridentata ssp. *tridentata* (basin big sagebrush)	33.3	0 - 2	0.4
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	0.1 - 50	8.7
	Annual herb	*Sisymbrium altissimum* (tall tumble mustard)	100	0 - 25	2.1

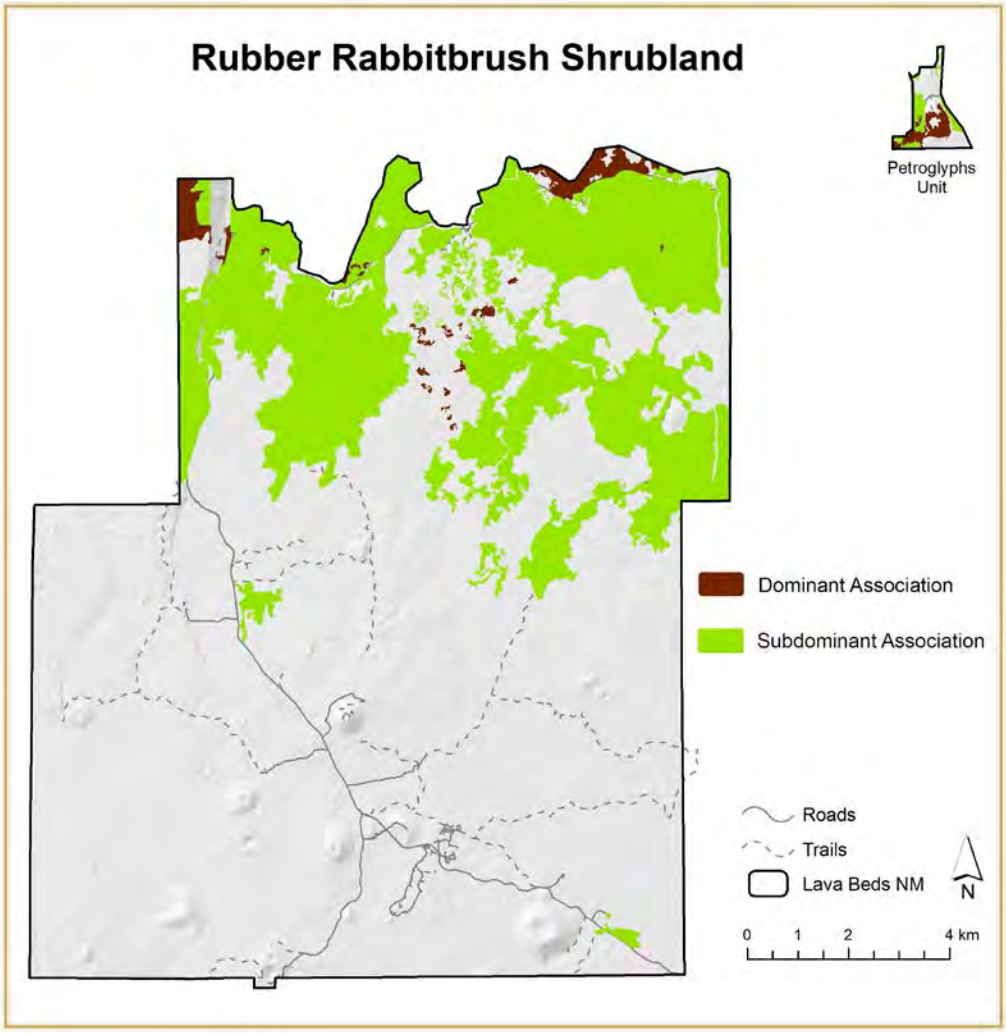
Species Richness:

Plot Species Richness Average	16.9
Plot Species Richness Range	9 - 26
Total Species Richness (all Plots)	60

Diagnostic Species: *Ericameria nauseosa* at high cover.
Constant Species: *Ericameria nauseosa, Bromus tectorum, Sisymbrium altissimum.*
Other Noteworthy Species: None.
Number of Plots: 9. Relevés 24, 26, 32, 36, 42, 56, 57, 59, 60.

Local Range: Petroglyphs unit. Gillem Bluff. The northern one-half of the monument. A widespread association that occurs throughout the Klamath Basin.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Rubber Rabbitbrush Shrubland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Ericameria nauseosa* Shrubland (Code: CEGL002713) defined by the USNVC and placed in the *Ericameria nauseosa* Shrubland & Shrub Herbaceous Alliance (Code: A3196) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This is a broadly defined, semi-arid upland shrubland association currently described from western Colorado, Nevada, and Utah and is likely more widespread. Elevations range from 1191-2420 m (3900-8000 feet). Stands occur on flat to gently sloping (<8%), dry alluvial terraces above ephemeral washes or perennial stream and river channels or may form a band in the alluvial flats above playas. Substrates are deep, moderately well- to well-drained silty clay loam to sandy loam soils derived from stratified alluvium. Sand or other coarse-textured material may underlay finer-textured layers (Bundy et al. 1996). The ground surface has moderate to high cover of bare soil.

Vegetation Description: This vegetation is characterized by a moderately dense to dense (40-70% cover) shrub canopy dominated by *Ericameria nauseosa* shrubs 0.5-3 m tall, with a relatively sparse herbaceous layer. Some stands have low diversity, others have additional associated short and dwarf-shrubs such as *Artemisia frigida, Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Psorothamnus polydenius, Rosa woodsii, Sarcobatus vermiculatus*, and *Tetradymia tetrameres*. The sparse herbaceous layer is a mixture of grasses and forbs. Grass cover is generally low and may include native species such as *Achnatherum lettermanii, Achnatherum hymenoides, Distichlis spicata, Pseudoroegneria spicata, Sporobolus airoides*, and *Elymus elymoides*. Non-native grasses include *Bromus tectorum* and *Poa pratensis*. Common forbs may include the native species *Erigeron flagellaris, Tragopogon dubius, Achillea millefolium, Agoseris glauca, Potentilla crinita, Artemisia ludoviciana, Eriogonum hookeri, Rumex salicifolius*, and *Verbesina encelioides*.

Ericameria nauseosa is considered a shrub of depleted range and disturbed areas (McArthur et al. 1977). It is a fire-adapted species that is typically unharmed or enhanced by fire and is often one of the first species to colonize burned areas by sprouting from adventitious buds from its stems and root crown or from off-site seed (FEIS 2006). Stands appear to be dependent on disturbance, such as receding lakebed, past prairie dog use, abandoned agriculture or heavy grazing, which favors *Ericameria nauseosa* (USFS 1937).

DISTRIBUTION

Range: This is a broadly defined upland shrubland association currently described from western Colorado, Utah and Nevada, but it likely occurs more widely in the western U.S.
States/Provinces: AZ, CA, CO, NV, UT.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest). USFWS (Tule Lake National Wildlife Refuge). Widespread association, presumed on public lands elsewhere in the northwestern U.S.

CONSERVATION STATUS

Rank: G5 – Secure.
Reason: Information not available.

Global Description Author(s): K.A. Schulz, mod. G. Kittel.
Global Description References: K.A. Schulz, mod. G. Kittel. 2011. *Ericameria nauseosa* Shrubland [19Feb2011]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Rubber Rabbitbrush Shrubland** (*Ericameria nauseosa* Shrubland).

11. Yellow Rabbitbrush Shrub Herbaceous Vegetation

Chrysothamnus viscidiflorus Shrub Herbaceous Vegetation

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.1 - M171 *Chrysothamnus viscidiflorus - Coleogyne ramosissima* / *Achnatherum hymenoides* Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup
Group: 3.B.1.Ne.1.d - G310 *Chrysothamnus viscidiflorus - Ericameria nauseosa - Krascheninnikovia lanata* Shrubland Group
Alliance: A3195 *Chrysothamnus viscidiflorus* Shrubland & Shrub Herbaceous Alliance
Association: *Chrysothamnus viscidiflorus* Shrub Herbaceous Vegetation

Translated Name: Yellow Rabbitbrush Shrub Herbaceous Vegetation

USNVC Identifier: CEGL002530

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at low to high elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions include basin floor, low slope, high level, and high slope. Soils are loam, sandy loam, and sand. Soil drainage is well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1452	9	1	5
Range	1248 - 1552	0 - 20	0 - 290	0.1 - 10

Vegetation Description: This shrubland association is dominated by yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) at moderate to high cover. The non-native annual grass cheatgrass (*Bromus tectorum*) is present at low to moderate cover. This association often occurs as an early to mid-successional condition in sagebrush (*Artemisia tridentata* ssp.) associations that have been disturbed by fire and/or as shrub stands developing in the Cheatgrass Ruderal Herbaceous Vegetation (*Bromus tectorum* Ruderal Herbaceous Vegetation).

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Chrysothamnus viscidiflorus* ssp. *viscidiflorus* (yellow rabbitbrush)	100	5 - 50	20.1
		Purshia tridentata (antelope bitterbrush)	100	0 - 2	1.14
Herb	Graminoid	*Festuca idahoensis* (Idaho fescue)	75	0 - 50	9.8
		Bromus tectorum (cheatgrass)	100	1 - 10	3.5
		Achnatherum occidentale ssp. *californicum* (California needlegrass)	75	0 - 5	2.1
		Poa secunda (Sandberg bluegrass)	100	0 - 5	1

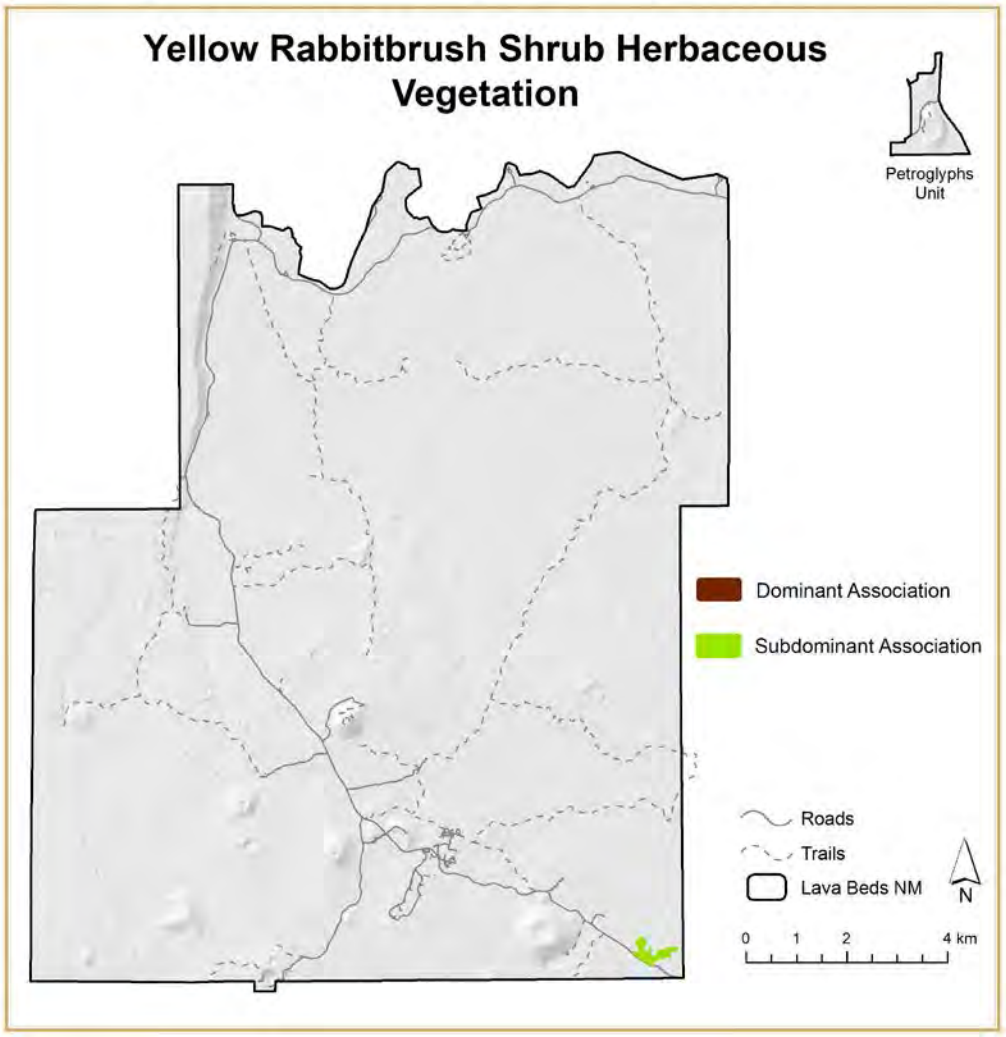
Species Richness:

Plot Species Richness Average	36
Plot Species Richness Range	33 - 39
Total Species Richness (all Plots)	83

Diagnostic Species: *Chrysothamnus viscidiflorus* ssp. *viscidiflorus* at high cover.
Constant Species: *Bromus tectorum, Chrysothamnus viscidiflorus* ssp. *viscidiflorus, Poa secunda*, *Purshia tridentata.*
Other Noteworthy Species: None.
Number of Plots: 4. Relevés 67, 70, 113, 160.

Local Range: Throughout the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Yellow Rabbitbrush Shrub Herbaceous Vegetation is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Chrysothamnus viscidiflorus* Shrub Herbaceous Vegetation (Code: CEGL002530) defined by the USNVC and placed in the *Ericameria nauseosa* Shrubland & Shrub Herbaceous Alliance (Code: A3195) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This steppe community and open shrubland has been sampled on lower slopes of the Grand Teton National Park, Wyoming, between 2012 and 2326 m elevation and in northern Utah on the banks of a gully near 1400 m elevation and is reported from the southern San Luis Valley of Colorado. Sites range from gentle to moderately steep (4 and 55%) with variable aspects. Some sites are highly disturbed by gully erosion. Soils include deep well-drained, fine-textured alluvium soils such as silty clay loams. Ground surface is variable and has low to high cover of gravel, bare soil, litter and duff.

Vegetation Description: This association is characterized by an open to moderately dense shrub layer ranging from 3-20% shrub cover of *Chrysothamnus viscidiflorus*. Other shrubs may be present with low cover, such as *Artemisia tridentata* ssp*. tridentata*, *Atriplex canescens*, *Ericameria nauseosa*, *Gutierrezia sarothrae*, and *Tetradymia canescens*. The herbaceous layer is mainly a mixture of grasses, including *Hesperostipa comata*, *Koeleria macrantha*, *Poa secunda*, *Pseudoroegneria spicata*, and introduced annuals *Bromus briziformis* and *Bromus tectorum*. *Leymus cinereus* is present in mesic gully bottoms in Utah. Forb species are present with low cover and include *Antennaria lanata*, *Astragalus kentrophyta*, *Antennaria microphylla*, *Astragalus bisulcatus*, *Castilleja applegatei*, *Castilleja flava*, *Castilleja sulphurea*, *Cirsium undulatum*, *Cryptantha humilis*, *Leptodactylon pungens*, and *Leptodactylon watsonii*. Colorado stand information will be added at a later date.

DISTRIBUTION

Range: This association occurs in Wyoming, Colorado and Utah, and is likely more widespread in the western U.S.
States/Provinces: CA, CO, NV, UT, WY.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest). USFWS (Tule Lake National Wildlife Refuge). Widespread association, presumed on public lands elsewhere in the northwestern U.S.

CONSERVATION STATUS

Rank: GNR – Not Yet Ranked.
Reason: Information not available.

Global Description Author(s): G. Kittel, mod. K.A. Schulz.
Global Description References: G. Kittel, mod. K.A. Schulz. 2012. *Chrysothamnus viscidiflorus* Shrub Herbaceous Vegetation [06Apr2012]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Yellow Rabbitbrush Shrub Herbaceous Vegetation** (*Chrysothamnus viscidiflorus* Shrub Herbaceous Vegetation).

12. Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]

Artemisia tridentata - Salvia dorrii - Chamaebatiaria millefolium Shrubland [Provisional]

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.3 - M169 *Artemisia tridentata - Artemisia tripartita* ssp. *tripartita - Purshia tridentata* Great Basin & Intermountain Shrubland & Steppe Macrogroup

Association: Provisional vegetation association.

NPS Unique Identifier: NPSLABE004

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at low to high elevations within the monument on very gentle to steep slopes. Aspects are variable. Topographic positions are basin floor, low level, midslope and bench. Soils are sand, loamy sand, silt loam, clay loam, and rock. Soil drainage is well drained to rapidly drained. This vegetation association typically occurs on large areas of exposed rock on lava flows, in and around collapsed lava caves, and on large accumulations of scree at the base of cliffs and older lava flow formations.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1326	15	1	2
Range	1247 - 1555	0 - 55	0 - 295	0.5 - 5

Vegetation Description: This shrubland association is dominated by either basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) or mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) at moderate to high cover. The shrubs purple sage (*Salvia dorrii*), antelope bitterbrush (*Purshia tridentata* var. *tridentata*), and fernbush or desert sweet (*Chamaebatiaria millefolium*) are often codominant at low to moderate cover. The perennial bunchgrass bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) can be present at low to high cover. The perennial herbs scabland penstemon (*Penstemon deustus* var. *pedicellatus*) and granite prickly phlox (*Leptodactylon pungens*) are sometimes present at low cover to moderate cover. Plot data for this association lack mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), however, this species was observed in stands of this vegetation association visited elsewhere in the monument.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *tridentata* (basin big sagebrush)	100	10 - 50	22.2
		Salvia dorrii (purple sage)	66.7	0 – 10	2.9
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	83.3	0 – 10	2.5
	Broad-leaved deciduous shrub	*Chamaebatiaria millefolium* (fernbush)	83.3	0 - 5	1.3
		Ribes cereum (wax currant)	100	0 – 5	1.3
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	0 - 10	2.5
		Pseudoroegneria spicata ssp. *spicata* (bluebunch wheatgrass)	66.7	0 - 25	3.7
	Perennial herb	*Penstemon deustus* var. *pedicellatus* (scabland penstemon)	66.7	0 – 5	0.9
		Leptodactylon pungens (granite prickly phlox)	83.3	0 – 2	0.7

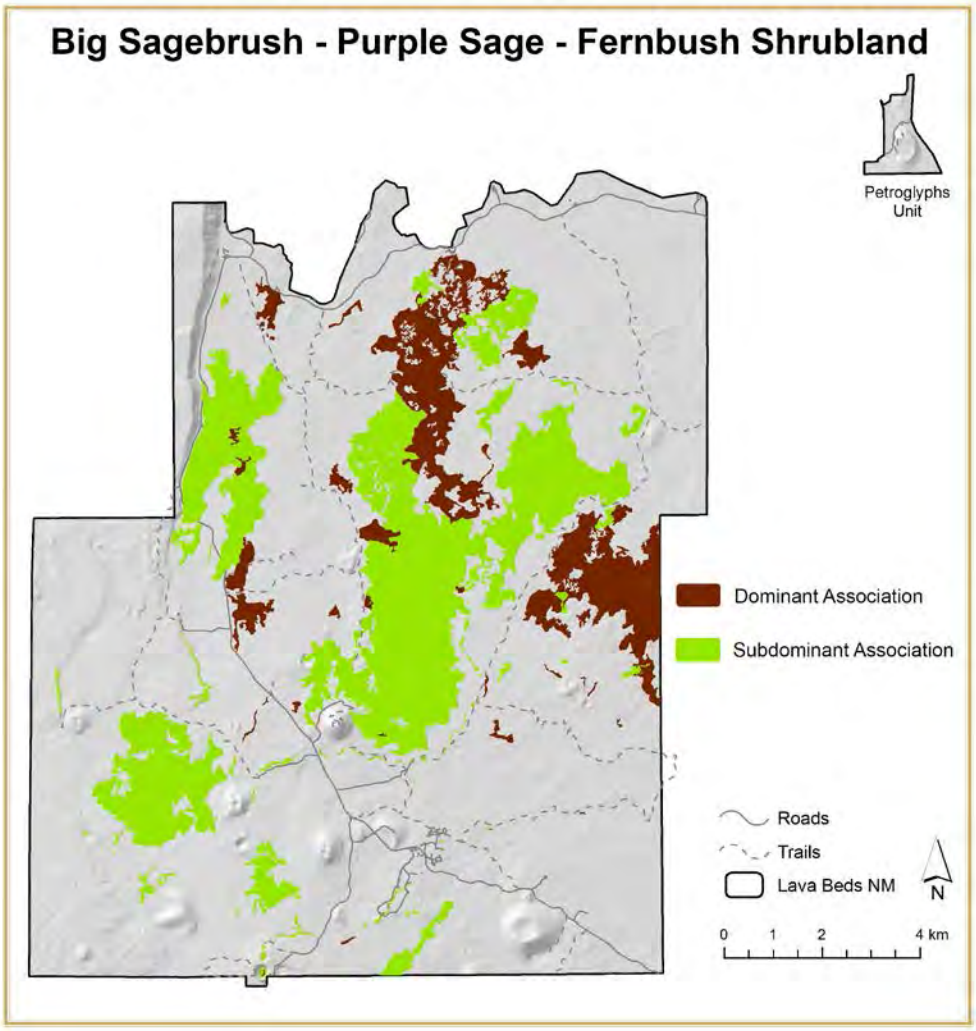
Species Richness:

Plot Species Richness Average	24.8
Plot Species Richness Range	16 - 32
Total Species Richness (all Plots)	68

Diagnostic Species: *Chamaebatiaria millefolium, Artemisia tridentata* ssp. *tridentata*
Constant Species: *Artemisia tridentata* ssp. *tridentata, Bromus tectorum, Ribes cereum*
Other Noteworthy Species: None.
Number of Plots: 6. Relevés 8, 15, 40, 50, 125, 145.

Local Range: On sparsely vegetated lava flows, lava rock formations, and collapsed lava caves throughout the central portion of the monument, but also likely to occur on similar substrates in the extreme north and south of the monument. Found on Schonchin Butte.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional] is the dominant association or is a subdominant association.

Classification Comments: This provisional vegetation association could possibly be placed in the *Artemisia tridentata* - Mixed Shrub Dry Shrubland Alliance (Code: A3198). Further inquiry should be taken to reveal the proper alliance and upper level USNVC placement for this association from the monument.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

Above: **Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]** (*Artemisia tridentata - Salvia dorrii - Chamaebatiaria millefolium* Shrubland [Provisional]).

13. Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation

Artemisia tridentata ssp. *tridentata* / Bluebunch Wheatgrass Shrub Herbaceous Vegetation

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.3 - M169 *Artemisia tridentata - Artemisia tripartita* ssp. *tripartita - Purshia tridentata* Great Basin & Intermountain Shrubland & Steppe Macrogroup
Group: 3.B.1.Ne.3.b - G302 *Artemisia tridentata - Artemisia tripartita - Purshia tridentata* Big Sagebrush Steppe Group
Alliance: A3183 *Artemisia tridentata* ssp. *tridentata - Artemisia tridentata* ssp. *xericensis* Mesic Shrubland & Steppe Alliance
Association: *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation

Translated Name: (Basin Big Sagebrush, Foothill Big Sagebrush) / Bluebunch Wheatgrass Shrub Herbaceous Vegetation

USNVC Identifier: CEGL001018

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at low to middle elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions include basin floor, low level, low slope, midslope, high slope and toe slope. Soils are loamy sand, sandy loam, sand, rock and sand, and silt loam. Soil drainage is well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1307	4	5	10
Range	1239 - 1487	0 - 26	0 - 305	1 - 30

Vegetation Description: This shrubland association is dominated by basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) at moderate to high cover. The shrubs antelope bitterbrush (*Purshia tridentata* var. *tridentata*) and yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) are often present at low to moderate cover. The non-native annual grass cheatgrass (*Bromus tectorum*) is present at low to high cover. The perennial bunchgrasses Thurber's needlegrass (*Achnatherum thurberianum*), Sandberg bluegrass (*Poa secunda*), and squirreltail (*Elymus elymoides*) are present at low to moderate cover. Moving upslope from the basin floor to the foothills of the Medicine Lake Highlands, basin big sagebrush gives way to mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) in a broad zone of intergradation at the lower end of the middle elevations within the monument. The two subspecies often co-occur and possibly hybridize in this intergradation zone.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *tridentata* (basin big sagebrush)	100	2 - 50	18.9
		Chrysothamnus viscidiflorus ssp. *viscidiflorus* (yellow rabbitbrush)	76.4	0 - 10	1.8
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	52.9	0 - 25	3.7
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	0.1 - 50	11.8
		Achnatherum thurberianum (Thurber's needlegrass)	70.5	0 - 10	2.2
		Poa secunda (Sandberg bluegrass)	88.2	0 - 10	1.7
		Elymus elymoides (squirreltail)	76.4	0 - 10	1.2
	Annual herb	*Phacelia linearis* (threadleaf phacelia)	88.2	0 - 2	0.4

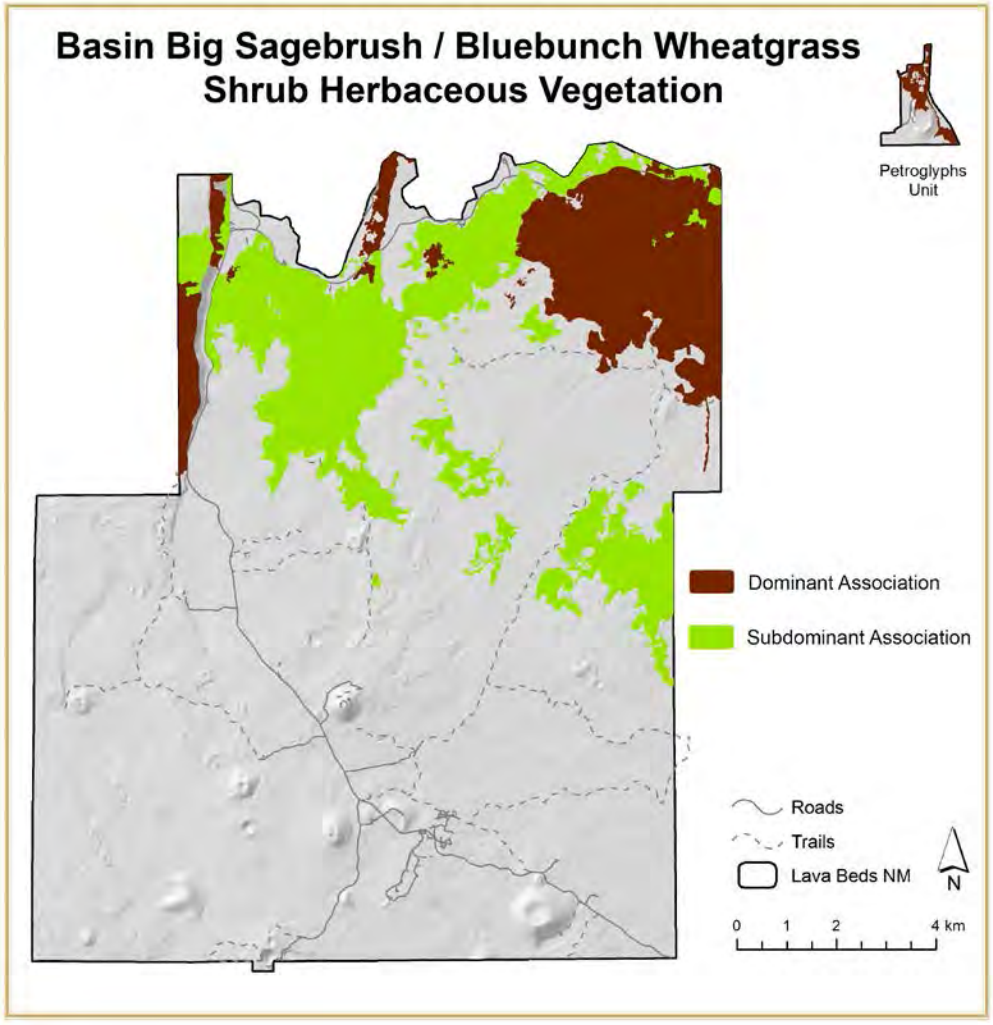
Species Richness:

Plot Species Richness Average	20.6
Plot Species Richness Range	4 - 34
Total Species Richness (all Plots)	88

Diagnostic Species: *Artemisia tridentata* ssp. *tridentata.*
Constant Species: *Artemisia tridentata* ssp. *tridentata, Bromus tectorum.*
Other Noteworthy Species: None.
Number of Plots: 17. Relevés 11, 23, 117, 120, 121, 123, 124, 126, 127, 134, 136, 157, 159, 161, 162, 163, 166.

Local Range: Petroglyphs unit. The northern one-third of the monument. A widespread association that occurs at lower elevations throughout the southern Klamath Basin.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation (Code: CEGL001018) defined by the USNVC and placed in the *Artemisia tridentata* ssp. *tridentata* - *Artemisia tridentata* ssp. *xericensis* Mesic Shrubland & Steppe Alliance (Code: A3183) of the revised USNVC hierarchy.

Degraded stands of this association with a high cover of *Bromus tectorum* could possibly be split out and placed in their own association equivalent to the *Artemisia tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Ruderal Shrubland (Code: CEGL002699) under the *Artemisia tridentata* ssp. *tridentata* - *Artemisia tridentata* ssp. *xericensis* Dry Shrubland Alliance (Code: A3194). Further inquiry should be taken to determine whether such a distinction is warranted.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This tall-shrub big sagebrush association is found on deep soils in basins and foothills of the Idaho, Montana and Wyoming Rocky Mountains west to eastern Washington, eastern Oregon, and northeastern California. Stands of this association grow on moderately deep to deep soils of alluvial fans and higher stream terraces (Tweit and Houston 1980) and on slopes (Mueggler and Stewart 1980), as well swales and draws in intermountain basins and in the foothills of the surrounding mountains. Occasional stands in mountains occur on shallow, rocky soils. Judging from information about the similar *Artemisia tridentata* ssp. *tridentata* / *P. spicata - Stipa thurberiana* Association (Hironaka et al. 1983), these soils are deeper and contain more moisture than the soils supporting *Artemisia tridentata* ssp. *wyomingensis* associations.

Vegetation Description: *Artemisia tridentata ssp. tridentata* dominates the shrub layer, which may contain *Chrysothamnus* spp. and *Artemisia tridentata ssp. wyomingensis*. Shrub cover generally ranges from 10-25%, but may exceed 25% in some stands. *Pseudoroegneria spicata* dominates the understory in good condition stands, which may also contain a variety of other graminoids and forbs. *Bromus tectorum* is common in degraded stands. The species composition of this type is very similar to *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrubland (CEGL001009) (which grows on shallower, drier soils), but *Artemisia tridentata ssp. tridentata* dominates the overstory in this association. Stands of this type occupy deeper soils than do stands of the shorter *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrubland (CEGL001009), which may form the surrounding matrix vegetation.

DISTRIBUTION

Range: This association at one time extended from the northeastern corner of California, eastern Oregon, and eastern Washington on the west to northwestern Wyoming on the east, and as far south as northeastern Nevada. It has been reported from southwestern Montana. It may also occur in northern Utah and perhaps in northwestern Colorado, although it apparently has not been found in vegetation surveys of northwestern Colorado.
States/Provinces: CA, CO?, ID, MT, NV, OR, UT, WA, WY.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest), USFWS Tule Lake National Wildlife Refuge).

CONSERVATION STATUS

Rank: G1 - Critically Imperiled. (31Jan2007)
Reason: The number of viable occurrences and area of occupancy of the association have declined severely since the time of European settlement. Remaining occurrences are mostly in relatively poor condition due to the combined and cumulative effects of livestock grazing, exotic species introductions, and altered fire disturbance regimes. As early as 1983, Hironaka et al. (1983) noted that the habitat type supporting this association in Idaho "has been drastically reduced" by cultivation of the floodplains where it used to occur, and that only a few stands remain. In Oregon and Washington, this association was probably much more common before settlement than it is now, and most stands have been destroyed by conversion to agriculture, prolonged heavy grazing, and inundation. This association is also assumed to have declined in area in California. In northwestern Wyoming, the area occupied by this association may have declined little, but stands there are

restricted to specialized sites and apparently are small, so that geographic area probably has always contained only a small proportion of the original extent of the association.

Global Description Author(s): G.P. Jones, mod. K.A. Schulz.
Global Description References: G.P. Jones, mod. K.A. Schulz. 2008. *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation [06May2008]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: August 13, 2015).

Above: **Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation** (*Artemisia tridentata ssp. tridentata / Bluebunch Wheatgrass* Shrub Herbaceous Vegetation).

14. Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland

Artemisia tridentata ssp. *vaseyana - Purshia tridentata* / *Pseudoroegneria spicata* Shrubland

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.3 - M169 *Artemisia tridentata - Artemisia tripartita* ssp. *tripartita - Purshia tridentata* Great Basin & Intermountain Shrubland & Steppe Macrogroup
Group: 3.B.1.Ne.3.c - G304 *Artemisia tridentata* ssp. *spiciformis - Artemisia tridentata* ssp. *vaseyana - Artemisia cana* ssp. *viscidula* Tall Shrubland & Steppe Group
Alliance: A3208 *Artemisia tridentata* ssp. *vaseyana* - Mixed Shrubland Alliance
Association: *Artemisia tridentata* ssp. *vaseyana - Purshia tridentata* / *Pseudoroegneria spicata* Shrubland

Translated Name: Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland

USNVC Identifier: CEGL001032

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at middle to high elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions include low level, low slope, midslope, and bench. Soils are loam, loamy sand, sandy loam, sand, rock and sand, and silt loam. Soil drainage is well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1416	8	9	2
Range	1330 - 1589	0 - 35	0 - 350	0.1 - 10

Vegetation Description: This shrubland association is dominated by mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) at moderate to high cover co-dominant with antelope bitterbrush (*Purshia tridentata* var. *tridentata*) at low to moderate cover. The perennial bunchgrasses bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) and Idaho fescue (*Festuca idahoensis*) are often present at low to high cover. Thurber's needlegrass (*Achnatherum thurberianum*), Sandberg bluegrass (*Poa secunda*) are present at low to moderate cover. Moving upslope from the basin floor to the foothills of the Medicine Lake Highlands, basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) gives way to mountain big sagebrush in a broad zone of intergradation at the lower end of the middle elevations within the monument. The two subspecies of sagebrush often co-occur and possibly hybridize in this zone of intergradation.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush)	100	2 - 50	16.4
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	100	0.1 - 25	9.8
		Chrysothamnus viscidiflorus ssp. *viscidiflorus* (yellow rabbitbrush)	83.3	0 - 5	0.8
Herb	Graminoid	*Pseudoroegneria spicata* ssp. *spicata* (bluebunch wheatgrass)	72.2	0 - 50	8.5
		Festuca idahoensis (Idaho fescue)	61.1	0 - 25	3
		Achnatherum thurberianum (Thurber's needlegrass)	72.2	0 - 10	2
		Poa secunda (Sandberg bluegrass)	83.3	0 - 10	1.9
	Perennial herb	*Crepis acuminata* (tapertip hawksbeard)	83.3	0 - 2	0.4
	Annual herb	*Phacelia linearis* (threadleaf phacelia)	83.3	0 - 1	0.1
	Subshrub	*Phlox diffusa* (spreading phlox)	66.7	0 - 5	0.8

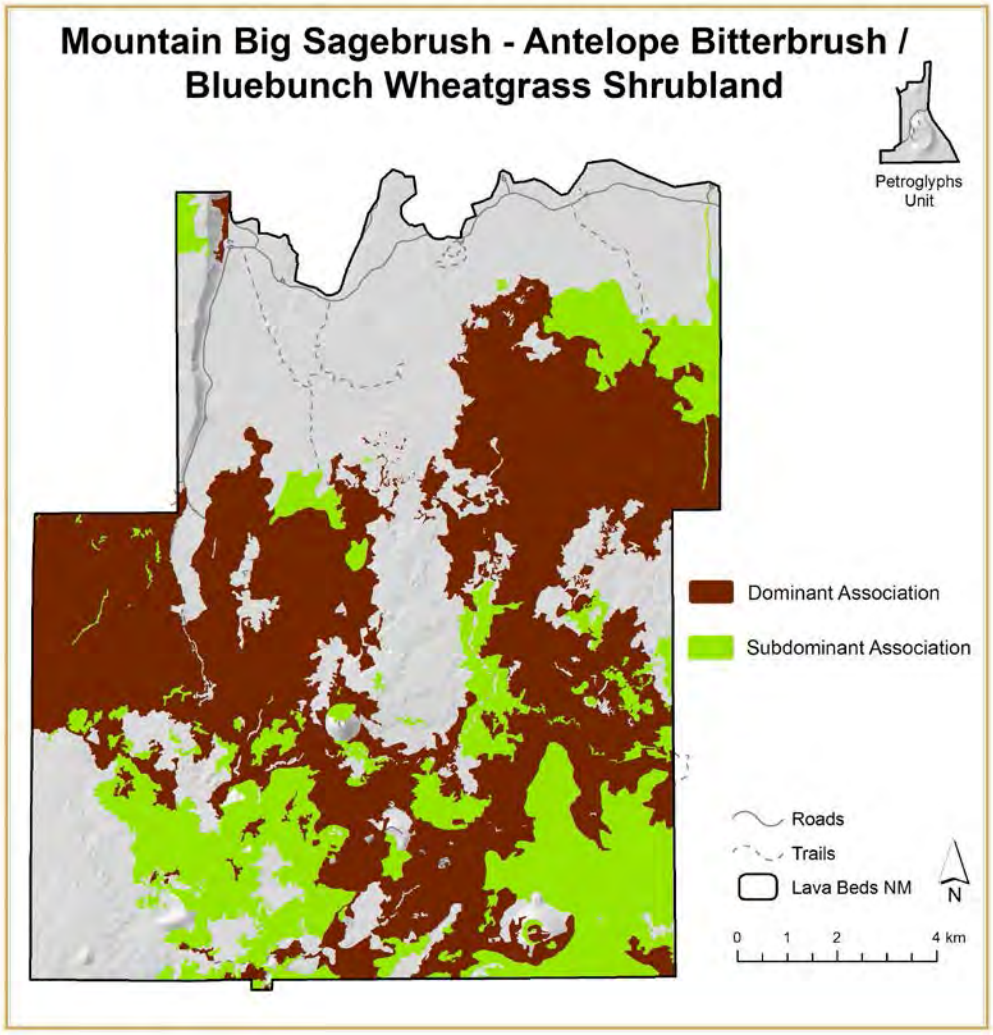
Species Richness:

Plot Species Richness Average	31.7
Plot Species Richness Range	24 - 48
Total Species Richness (all Plots)	114

Diagnostic Species: *Artemisia tridentata* ssp. *vaseyana, Purshia tridentata* var. *tridentata.*
Constant Species: *Artemisia tridentata* ssp. *vaseyana, Purshia tridentata* var. *tridentata.*
Other Noteworthy Species: None.
Number of Plots: 18. Relevés 31, 34, 45, 62, 68, 72, 74, 79, 82, 83, 84, 87, 94, 95, 96, 149, 154, 165.

Local Range: Throughout the southern three-fourths of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland Association (Code: CEGL001032) defined by the USNVC and placed in the *Artemisia tridentata* ssp. *vaseyana* - Mixed Shrubland Alliance (Code: A3208) of the revised USNVC hierarchy.

This local association also appears to be similar to the USNVC association *Artemisia tridentata* ssp. *vaseyana* / *Pseudoroegneria spicata* Shrubland (Code: CEGL001030) within the *Artemisia tridentata* ssp. *spiciformis* - *Artemisia tridentata* ssp. *vaseyana* Shrubland & Steppe Alliance (Code: A3207). Further inquiry should establish whether this Lava Beds park association should be placed under the above USNVC association.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION
Environmental Description: Information not available.
Vegetation Description: Information not available.

DISTRIBUTION
Range: Information not available.
States/Provinces: ID, NV, WY.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest and Klamath National Forest). Widespread association, presumed on public lands elsewhere in the northwestern U.S.

CONSERVATION STATUS
Rank: G5 - Secure (14May1999)
Reason: Information not available.

Global Description Author(s): Information not available.
Global Description References: *Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland. No Date. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: August 13, 2015).

Above: **Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland** (*Artemisia tridentata ssp. vaseyana - Purshia tridentata / Pseudoroegneria spicata* Shrubland).

15. *Antelope Bitterbrush - Purple Sage Shrubland [Provisional]*

Purshia tridentata - Salvia dorrii Shrubland [Provisional]

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.6 - M118 *Atriplex* spp. - *Ephedra* spp. - *Eriogonum* spp. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation Macrogroup

Association: Provisional vegetation association.

NPS Unique Identifier: NPSLABE005

LOCAL INFORMATION

Environmental Description: This vegetation association typically occurs on loose pumice slopes of buttes found through the southern half of the monument. It occurs at middle to high elevations within the monument on steep slopes. Aspects are generally southeast to southwest. Topographic positions are midslope to high slope. Soils are loamy sand, sand, and rock. Soil drainage is rapidly drained. Patches are usually small in area.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1516	29	162	0.3
Range	1349 - 1643	25 - 34	96 - 280	0.1 – 1

Vegetation Description: This shrubland association is dominated by the shrub antelope bitterbrush (*Purshia tridentata* var. *tridentata*) at low to moderate cover. The shrub purple sage (*Salvia dorrii*) is often co-dominant at low to moderate cover. The non-native annual grass cheatgrass (*Bromus tectorum*) is sometimes present at low to high cover. The perennial herb narrowleaf wirelettuce (*Stephanomeria minor*) is present at low cover and evenly distributed across the stands.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Purshia tridentata* var. *tridentata* (antelope bitterbrush)	100	0.1 – 25	7.7
		Salvia dorrii (purple sage)	80	0 -10	4.1
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	0.1 - 50	8.7
	Perennial herb	*Stephanomeria minor* (narrowleaf wirelettuce)	100	0.1 - 2	0.6

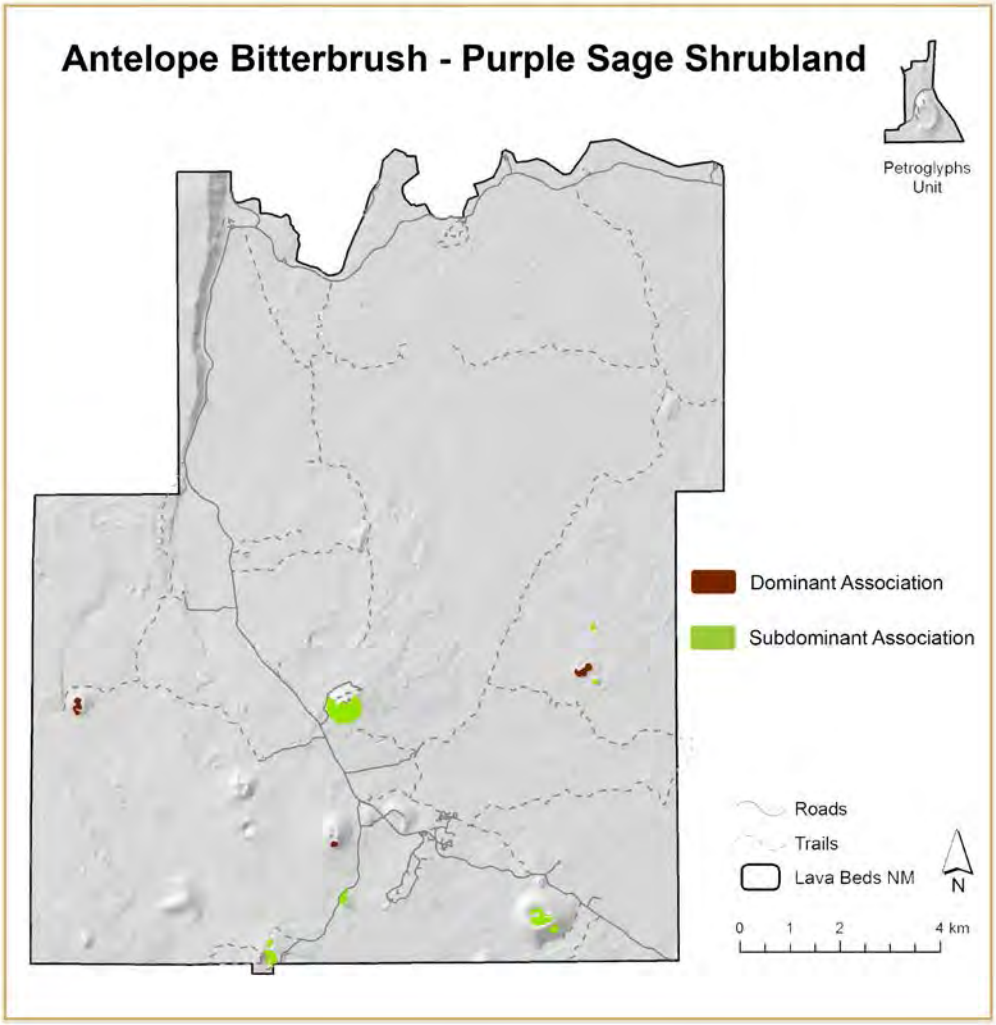
Species Richness:

Plot Species Richness Average	29
Plot Species Richness Range	21 - 41
Total Species Richness (all Plots)	72

Diagnostic Species: *Salvia dorrii.*
Constant Species: *Purshia tridentata* var. *tridentata*, *Bromus tectorum, Stephanomeria minor.*
Other Noteworthy Species: None.
Number of Plots: 5. Relevés 22, 71, 77, 98, 101.

Local Range: On generally south-facing loose pumice slopes of buttes found through the southern half of the monument. On the east face of Gillem Bluff.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Antelope Bitterbrush - Purple Sage Shrubland [Provisional] is the dominant association or is a subdominant association.

Classification Comments: This provisional vegetation association is classified under the *Atriplex* spp. - *Ephedra* spp. - *Eriogonum* spp. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation Macrogroup (Code: M118) defined by the USNVC. This provisional vegetation association is possibly similar to the *Salvia dorrii* / *Pseudoroegneria spicata* Dwarf-shrubland (Code: CEGL001453) under the *Salvia dorrii* Dwarf-shrubland Alliance (Code: A1129), however, this USNVC association is not considered equivalent because of the high cover of *Purshia tridentata* var. *tridentata* in this provisional vegetation association. Further inquiry should be taken to reveal the proper equivalent USNVC association for this association from the monument.

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

Above: **Antelope Bitterbrush - Purple Sage Shrubland [Provisional]** (*Purshia tridentata - Salvia dorrii* Shrubland [Provisional]).

16. Fernbush - Wax Currant Shrubland [Provisional]

Chamaebatiaria millefolium - Ribes cereum Shrubland [Provisional]

USNVC Classification: Provisional vegetation association not classified in the USNVC hierarchy.

NPS Unique Identifier: NPSLABE006

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at middle elevations within the monument on very gentle to steep slopes. Aspects are variable. Topographic positions include midslope, high slope, toe slope, and channel wall. Soils are rock and rapidly drained. This vegetation association typically occurs on large areas of exposed rock on lava flows, in and around collapsed lava caves, and on large piles of scree at the base of cliffs and older lava flow formations.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1443	18	16	3
Range	1318 - 1496	0 - 47	0 - 98	1 - 5

Vegetation Description: This shrubland association is dominated by fernbush (*Chamaebatiaria millefolium*) at low to moderate cover. Also present are the shrubs purple sage (*Salvia dorrii*), wax currant (*Ribes cereum*), and rubber rabbitbrush (*Ericameria nauseosa*) at low to moderate cover. Overall vegetation cover is sparse due to the coarseness of rock fragments present and the lack of soil development.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Chamaebatiaria millefolium* (fernbush)	100	0.1 - 25	5.5
		Ribes cereum (wax currant)	80	0 - 10	3.6
	Broad-leaved evergreen shrub	*Ericameria nauseosa* (rubber rabbitbrush)	100	0.1 - 10	3.3
		Salvia dorrii (purple sage)	80	0 - 5	1.8
Herb	Graminoid	*Poa secunda* (Sandberg bluegrass)	100	0 - 1	0.1

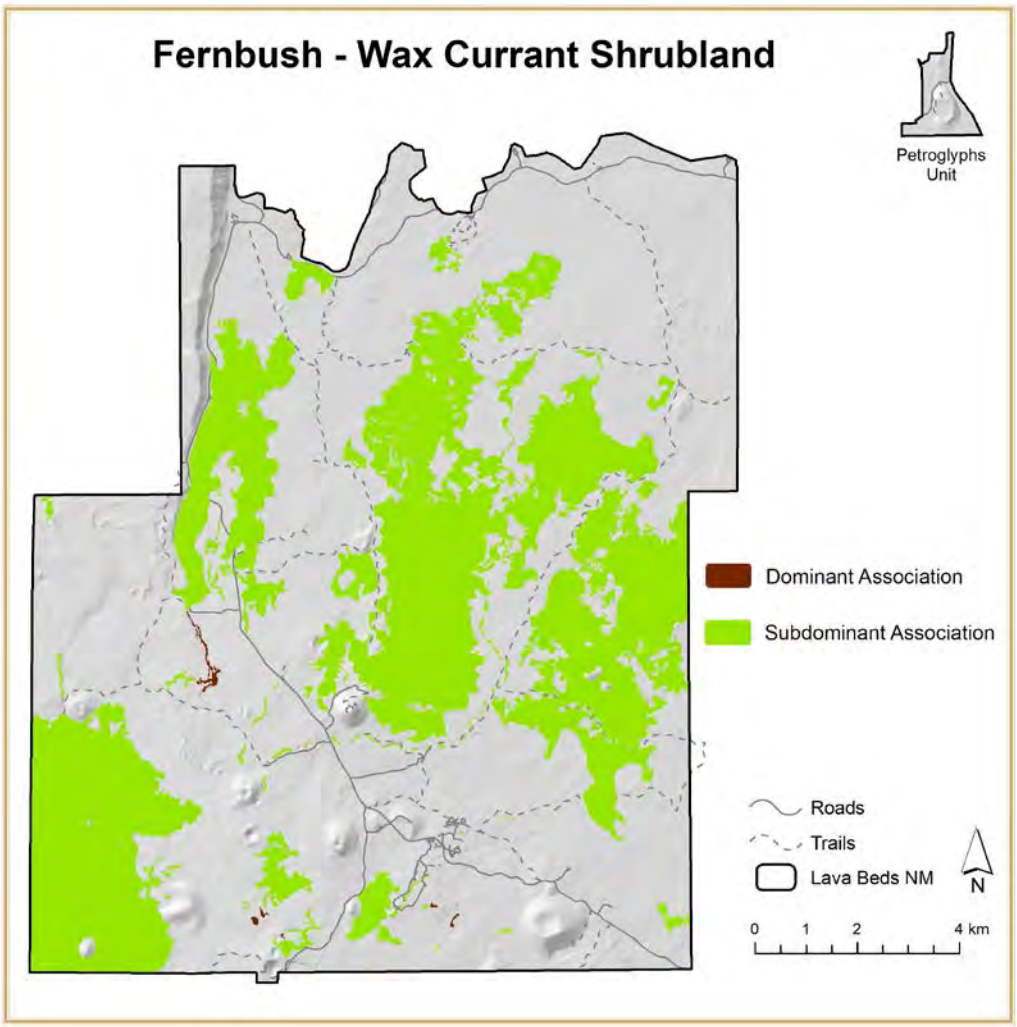
Species Richness:

Plot Species Richness Average	18
Plot Species Richness Range	12 - 30
Total Species Richness (all Plots)	44

Diagnostic Species: *Chamaebatiaria millefolium.*
Constant Species: *Chamaebatiaria millefolium, Ericameria nauseosa, Poa secunda.*
Other Noteworthy Species: None.
Number of Plots: 5. Relevés 10, 55, 131, 132, 169.

Local Range: On sparsely vegetated lava flows and collapsed lava caves throughout the central portion of the monument, but also likely to occur on similar substrates in the extreme north and south of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Fernbush - Wax Currant Shrubland [Provisional] is the dominant association or is a subdominant association.

Classification Comments: A related association from the monument is *Artemisia tridentata - Salvia dorrii - Chamaebatiaria millefolium* Shrubland, which likely would be placed in the *Artemisia tridentata* - Mixed Shrub Dry Shrubland Alliance (Code: A3198). Further inquiry should be taken to reveal the proper alliance and upper level USNVC placement for this association from the monument.

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

Above: **Fernbush - Wax Currant Shrubland [Provisional]** (*Chamaebatiaria millefolium - Ribes cereum* Shrubland [Provisional]).

17. Desert Gooseberry / Basin Wildrye Shrubland [Provisional]

Ribes velutinum / Leymus cinereus Shrubland [Provisional]

USNVC Classification: Provisional vegetation association not classified in the USNVC hierarchy.

NPS Unique Identifier: NPSLABE007

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at lower elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions include basin floor, low slopes, benches on slopes, high slopes, and on summits. Soils are sandy loam, loamy sand, loam, and rock. Soil drainage is well drained to rapidly drained. This vegetation association can typically be found on the low rocky rises that constitute much of the former lakeshore of Tule Lake. However, it may also occur on old, vegetated lava flow formations upslope and to the south from the old lakeshore and near the base of cliffs and scree on the east facing slope of Gillem Bluff.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1261	21	57	4
Range	1234 - 1245	0 - 65	0 - 180	0 - 15

Vegetation Description: This shrubland association is composed of desert gooseberry (*Ribes velutinum*) at low to moderate cover co-occurring with basin wildrye (*Leymus cinereus*) at low to moderate cover. The non-native annual grass cheatgrass (*Bromus tectorum*) and the forb tall tumblemustard (*Sisymbrium altissimum*) are present at low to high cover. The native annual herb western tansymustard (*Descurainia pinnata* ssp. *halictorum*) may be present at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Ribes velutinum* (desert gooseberry)	100	0 - 25	4.5
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	100	2 - 25	9.1
		Leymus cinereus (basin wildrye)	100	0.1 - 10	5.3
	Annual herb	*Sisymbrium altissimum* (tall tumblemustard)	100	0 - 50	9.4
		Descurainia pinnata ssp. *halictorum* (western tansymustard)	80	0 - 50	8.2

Species Richness:

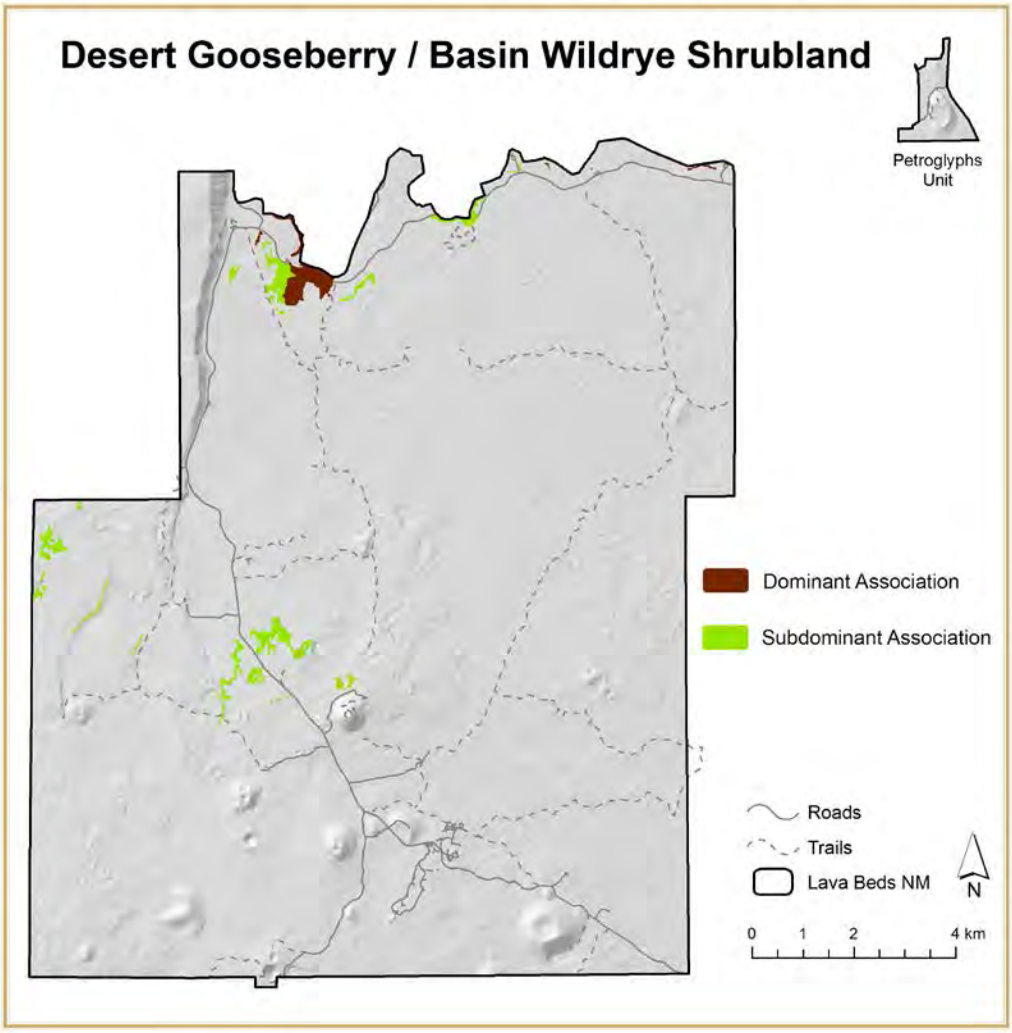
Plot Species Richness Average	21.4
Plot Species Richness Range	13 - 40
Total Species Richness (all Plots)	60

Diagnostic Species: *Leymus cinereus.*
Constant Species: *Ribes velutinum, Leymus cinereus, Bromus tectorum, Sisymbrium altissimum.*
Other Noteworthy Species: None.

Number of Plots: 5. Relevés 4, 14, 48, 119, 122.

Local Range: The northern one-fourth of the monument, especially along the former lakeshore of Tule Lake and around Hovey Point. On the east facing slope of Gillem Bluff.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Desert Gooseberry / Basin Wildrye Shrubland [Provisional] is the dominant association or is a subdominant association.

Classification Comments: This provisional vegetation association is potentially similar, but not related to the *Ribes cereum* / *Leymus ambiguus* Shrubland (Code: CEGL001124) within the *Purshia tridentata* - *Ribes cereum* Shrubland Alliance (Code: A3731). Further inquiry should be taken to reveal the proper alliance and upper level USNVC placement for this association from the monument.

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

Above: **Desert Gooseberry / Basin Wildrye Shrubland [Provisional]** (*Ribes velutinum / Leymus cinereus* Shrubland [Provisional]).

WOODLAND VEGETATION

18. Ponderosa Pine / Greenleaf Manzanita – Antelope Bitterbrush Woodland

Pinus ponderosa / *Arctostaphylos patula* - *Purshia tridentata* Woodland

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nb Rocky Mountain Cool Temperate Forest Division
Macrogroup: 1.B.2.Nb.2- M501 *Pinus ponderosa* var. *ponderosa* - *Pseudotsuga menziesii* - *Pinus flexilis* Central Rocky Mountain Dry Forest Macrogroup
Group: 1.B.2.Nb.2.a - G213 *Pinus ponderosa* var. *ponderosa* Central Rocky Mountain Woodland & Savanna Group
Alliance: A3446 *Pinus ponderosa* / Shrub Understory Central Rocky Mountain Woodland Alliance
Association: *Pinus ponderosa* / *Arctostaphylos patula* - *Purshia tridentata* Woodland

Translated Name: Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

USNVC Identifier: CEGL000063

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at middle to high elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions are low level, low slope, midslope, and high slope. Soils are loamy sand, sandy loam and sand. Soil drainage is well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1530	17	36	47
Range	1346 - 1655	4 - 33	30 - 354	25 - 90

Vegetation Description: This forest and woodland association is dominated by ponderosa pine (*Pinus ponderosa* var. *ponderosa*) at moderate to high cover. Stands range from scattered open grown trees to denser stands. Snowbrush ceanothus (*Ceanothus velutinus*), greenleaf manzanita (*Arctostaphylos patula*), and *Purshia tridentata* var. *tridentata* (antelope bitterbrush) are often present in the shrub layer at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pinus ponderosa* (ponderosa pine)	100	10 - 75	33
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Arctostaphylos patula* (greenleaf manzanita)	55.6	0 - 50	6.4
		Ceanothus velutinus (snowbrush ceanothus)	55.6	0 - 25	3.7
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	100	0 - 5	1.9
	Broad-leaved deciduous shrub	*Ribes cereum* (wax currant)	66.7	0 - 2	0.6
Herb	Graminoid	*Elymus elymoides* (squirreltail)	100	0 - 10	1.4
		Carex rossii (Ross' sedge)	77.8	0 - 1	0.1
	Annual herb	*Collinsia parviflora* (maiden blue eyed Mary)	100	0 - 1	0.1

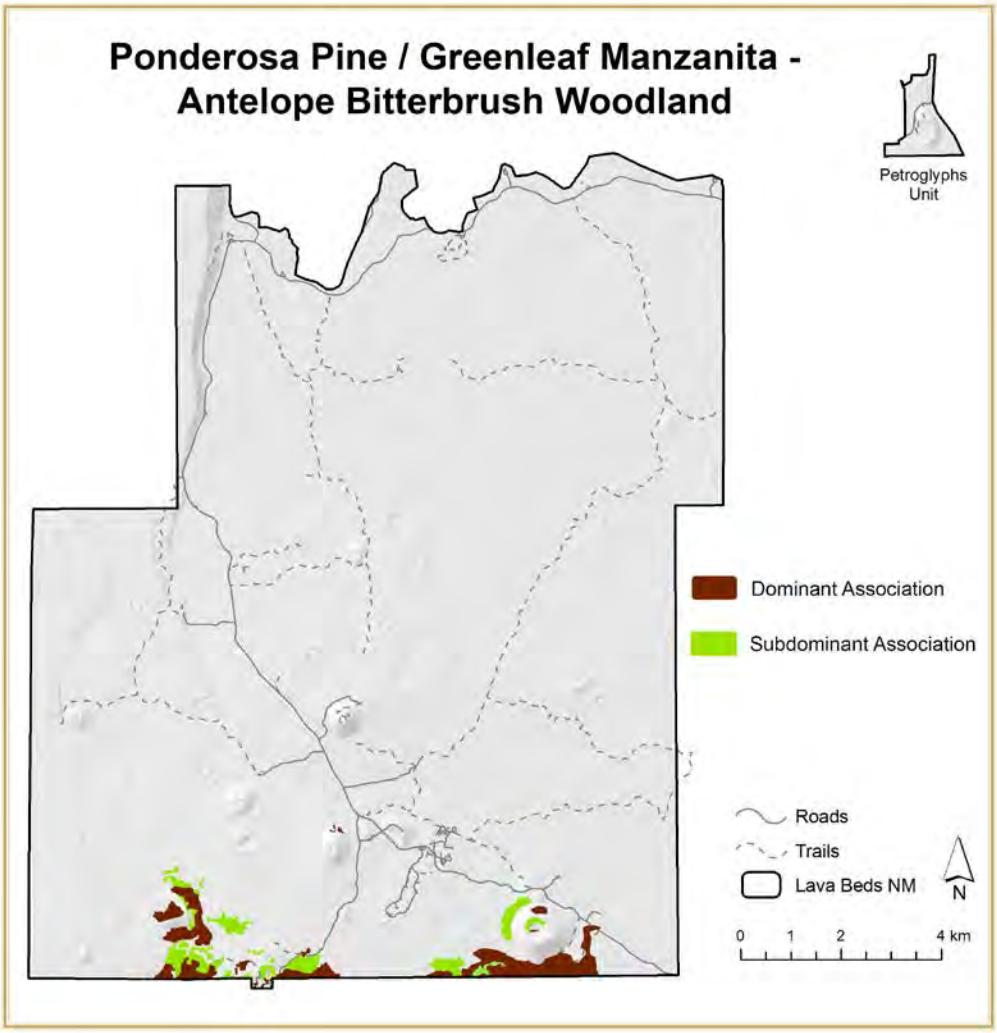
Species Richness:

Plot Species Richness Average	32
Plot Species Richness Range	17 - 40
Total Species Richness (all Plots)	91

Diagnostic Species: *Pinus ponderosa* var. *ponderosa.*
Constant Species: *Pinus ponderosa* var. *ponderosa, Purshia tridentata* var. *tridentata, Elymus elymoides, Collinsia parviflora.*
Other Noteworthy Species: None.
Number of Plots: 9. Relevés 90, 97, 107, 114, 115, 116, 140, 143, 155.

Local Range: The extreme southern portion of the monument. South of the monument in the Modoc National Forest.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Pinus ponderosa* / *Arctostaphylos patula* - *Purshia tridentata* Woodland (Code: CEGL000063) defined by the USNVC and placed in the *Pinus ponderosa* / Shrub Understory Central Rocky Mountain Woodland Alliance (Code: A3446) of the revised USNVC hierarchy.

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This forest association is common in the eastern Cascades of Oregon and California. It is found at elevations between 915 and 1980 m (3000-6500 feet) on all aspects of variable steepness. Soils are derived from basalt, ash, and cinders but vary in water-holding capacity.

Vegetation Description: The overstory is typically a semi-open canopy (5-48% cover) of *Pinus ponderosa* var. *ponderosa)*. Other trees may occur but are always subdominant and include *Abies concolor* and *Pinus contorta*. The shrub layer is codominated by *Arctostaphylos patula*, *Purshia tridentata*, and *Ceanothus velutinus* with occasional *Ericameria bloomeri*. The herb layer usually supports at least one grass species, such as *Festuca idahoensis*, *Achnatherum occidentale* ssp. *occidentale* (= *Stipa occidentalis*), and *Elymus elymoides* ssp. *elymoides* (= *Sitanion hystrix*). Many different forbs can be found, although none have high cover. In natural condition, this community is associated with periodic non-stand-replacing fire.

Characteristic Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is common in the eastern Cascades from central Oregon to northern California.
States/Provinces: CA, OR.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest and Klamath National Forest).

CONSERVATION STATUS

Rank: G3 - Vulnerable (09Nov2000)
Reason: This association is widespread with many occurrences of good quality. However, it has dramatically declined over the last 70 years. It continues to be threatened in the long term by fire suppression which allows *Pinus ponderosa* to be replaced by *Abies concolor*. The resulting increased tree canopy shades out shrubs and grasses. Over grazing by domestic livestock has altered the condition of the understory grasses in many communities, and intense logging of the large pine, while generally selective in nature, has dramatically reduced the area of old-growth stands.

Global Description Author(s): M.P. Murray.
Global Description References: M.P. Murray. 1997. *Pinus ponderosa* / *Arctostaphylos patula - Purshia tridentata* Woodland [26Nov1997]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland** (*Pinus ponderosa / Arctostaphylos patula - Purshia tridentata* Woodland).

19. Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland

Juniperus occidentalis / Cercocarpus ledifolius / Pseudoroegneria spicata Woodland

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nc Western North American Cool Temperate Woodland & Scrub Division
Macrogroup: 1.B.2.Nc.1 - M026 *Pinus monophylla - Juniperus osteosperma - Juniperus occidentalis* Intermountain Woodland Macrogroup
Group: 1.B.2.Nc.1.b - G248 *Juniperus occidentalis* Woodland & Savanna Group
Alliance: A3499 *Juniperus occidentalis* / Shrub Understory Woodland Alliance
Association: *Juniperus occidentalis* / *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Woodland

Translated Name: Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland

USNVC Identifier: CEGL000725

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at middle to high elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions are basin floor, low slope, midslope, high slope, and toe slope. Soils are loamy sand, sandy loam, clay loam, rock, and sand. Soil drainage is well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1516	16	2	6
Range	1331 - 1672	0 - 38	0 - 300	0.1 - 25

Vegetation Description: This woodland association is dominated by western juniper (*Juniperus occidentalis* var. *occidentalis*) at moderate to high cover with curl-leaf mountain-mahogany (*Cercocarpus ledifolius* var. *intercedens*) present and often co-dominant at low to high cover. Antelope bitterbrush (*Purshia tridentata* var. *tridentata*) is often present at low to moderate cover. The perennial bunchgrasses bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) and Idaho fescue (*Festuca idahoensis*) are sometimes present at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Juniperus occidentalis* var. *occidentalis* (western juniper)	100	2 - 50	17.1
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Cercocarpus ledifolius* var. *intercedens* (curl-leaf mountain-mahogany)	100	0.1 - 50	18.9
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	81.8	0 - 10	2.1
	Broad-leaved deciduous shrub	*Ribes velutinum* (desert gooseberry)	90.9	0 - 5	1
Herb	Sub-shrub	*Eriogonum polyanthum* (sulphur-flower buckwheat)	86.3	0 - 5	1
	Perennial herb	*Phacelia ramosissima* var. *ramosissima* (branching phacelia)	68.1	0 - 25	1.1
	Graminoid	*Festuca idahoensis* (Idaho fescue)	36.3	0 - 50	3.6
		Pseudoroegneria spicata ssp. *spicata* (bluebunch wheatgrass)	54.5	0 - 25	1.9
		Bromus tectorum (cheatgrass)	86.3	0 - 25	1.2

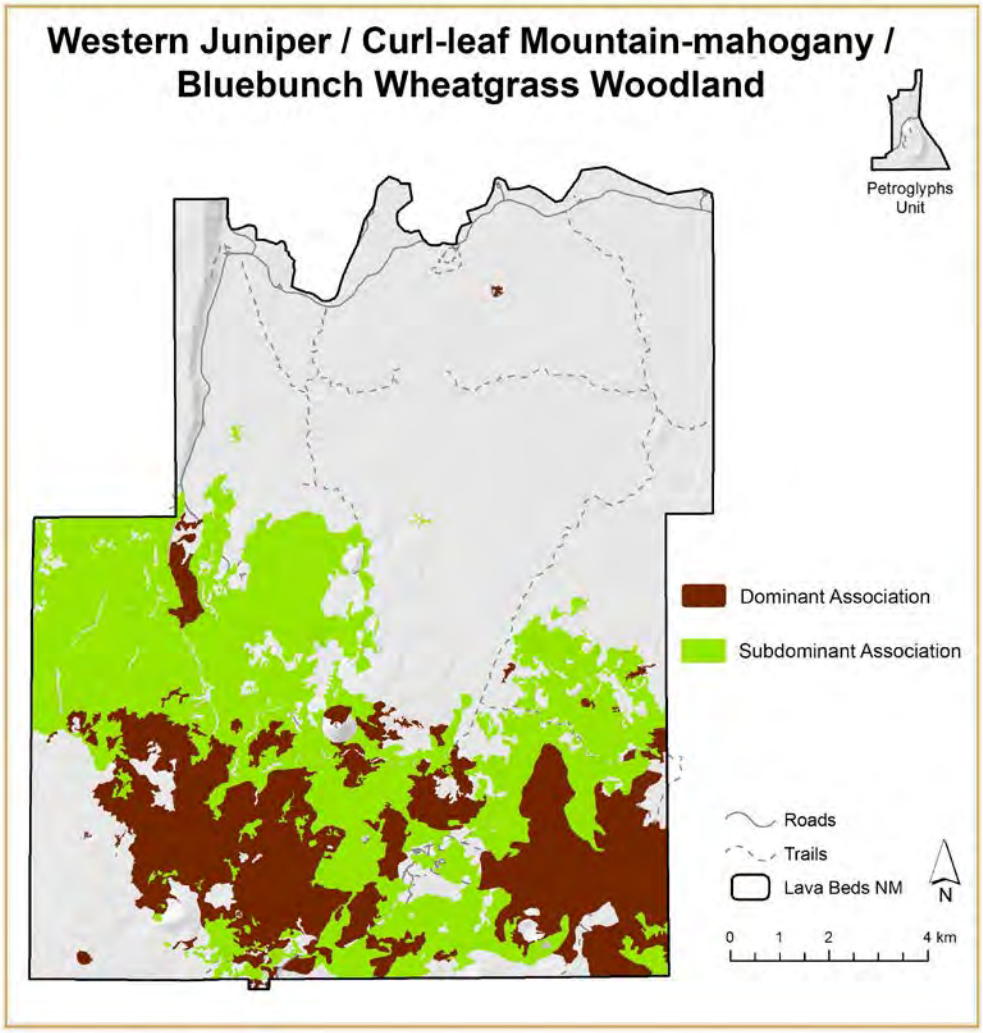
Species Richness:

Plot Species Richness Average	30.6
Plot Species Richness Range	18 - 40
Total Species Richness (all Plots)	118

Diagnostic Species: *Juniperus occidentalis* var. *occidentalis, Cercocarpus ledifolius* var. *intercedens.*
Constant Species: *Juniperus occidentalis* var. *occidentalis, Cercocarpus ledifolius* var. *intercedens.*
Other Noteworthy Species: None.
Number of Plots: 22. Relevés 9, 44, 46, 52, 63, 75, 76, 80, 81, 86, 104, 105, 110, 111, 135, 137, 139, 142, 144, 146, 167, 168.

Local Range: Throughout the southern one-half of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Juniperus occidentalis* / *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Woodland (Code: CEGL000725) defined by the USNVC and placed in the *Juniperus occidentalis* / Shrub Understory Woodland Alliance (Code: A3499) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Information not available.

Vegetation Description: Information not available.

DISTRIBUTION

Range: Information not available.
States/Provinces: CA, NV?, OR.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest).

CONSERVATION STATUS

Rank: G4 - Apparently Secure. (01Feb1996)
Reason: Information not available.

Global Description Author(s): Information not available.
Global Description References: *Juniperus occidentalis* / *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Woodland. No Date. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland** (*Juniperus occidentalis / Cercocarpus ledifolius / Pseudoroegneria spicata* Woodland).

20. Western Juniper / Mountain Big Sagebrush Woodland

Juniperus occidentalis / Artemisia tridentata ssp. *vaseyana* Woodland

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nc Western North American Cool Temperate Woodland & Scrub Division
Macrogroup: 1.B.2.Nc.1 - M026 *Pinus monophylla - Juniperus osteosperma - Juniperus occidentalis* Intermountain Woodland Macrogroup
Group: 1.B.2.Nc.1.b - G248 *Juniperus occidentalis* Woodland & Savanna Group
Alliance: A3499 *Juniperus occidentalis* / Shrub Understory Woodland Alliance
Association: *Juniperus occidentalis* / *Artemisia tridentata* ssp. *vaseyana* Woodland

Translated Name: Western Juniper / Mountain Big Sagebrush Woodland

USNVC Identifier: CEGL000723

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at middle to high elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions are low level, midslope, high slope, and on summits. Soils are loamy sand, sandy loam, silt loam, and sand. Soil drainage is well drained to rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1407	6	234	5
Range	1354 - 1507	0 - 22	0 - 260	0.1 - 15

Vegetation Description: This woodland association is dominated by western juniper (*Juniperus occidentalis* var. *occidentalis*) at moderate to high cover. The shrub mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) is often present at low to high cover. Antelope bitterbrush (*Purshia tridentata* var. *tridentata*) is often present at low to moderate cover. Stands range from denser stands to scattered open grown western juniper trees among common shrub associations or on large areas of exposed rock or pumice. The perennial bunchgrasses bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*), Thurber's needlegrass (*Achnatherum thurberianum*) and Idaho fescue (*Festuca idahoensis*) are sometimes present at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Juniperus occidentalis* var. *occidentalis* (western juniper)	100	5 - 25	11.9
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush)	83.3	0 - 50	11.2
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	83.3	0 - 10	1.8
Herb	Graminoid	*Pseudoroegneria spicata* ssp. *spicata* (bluebunch wheatgrass)	83.3	0 - 50	7.2
		Achnatherum thurberianum (Thurber's needlegrass)	100	0 - 25	5.4
		Bromus tectorum (cheatgrass)	100	0 - 5	1.4
		Festuca idahoensis (Idaho fescue)	66.7	0 - 10	2.5
		Poa secunda (Sandberg bluegrass)	100	0 - 10	2.3

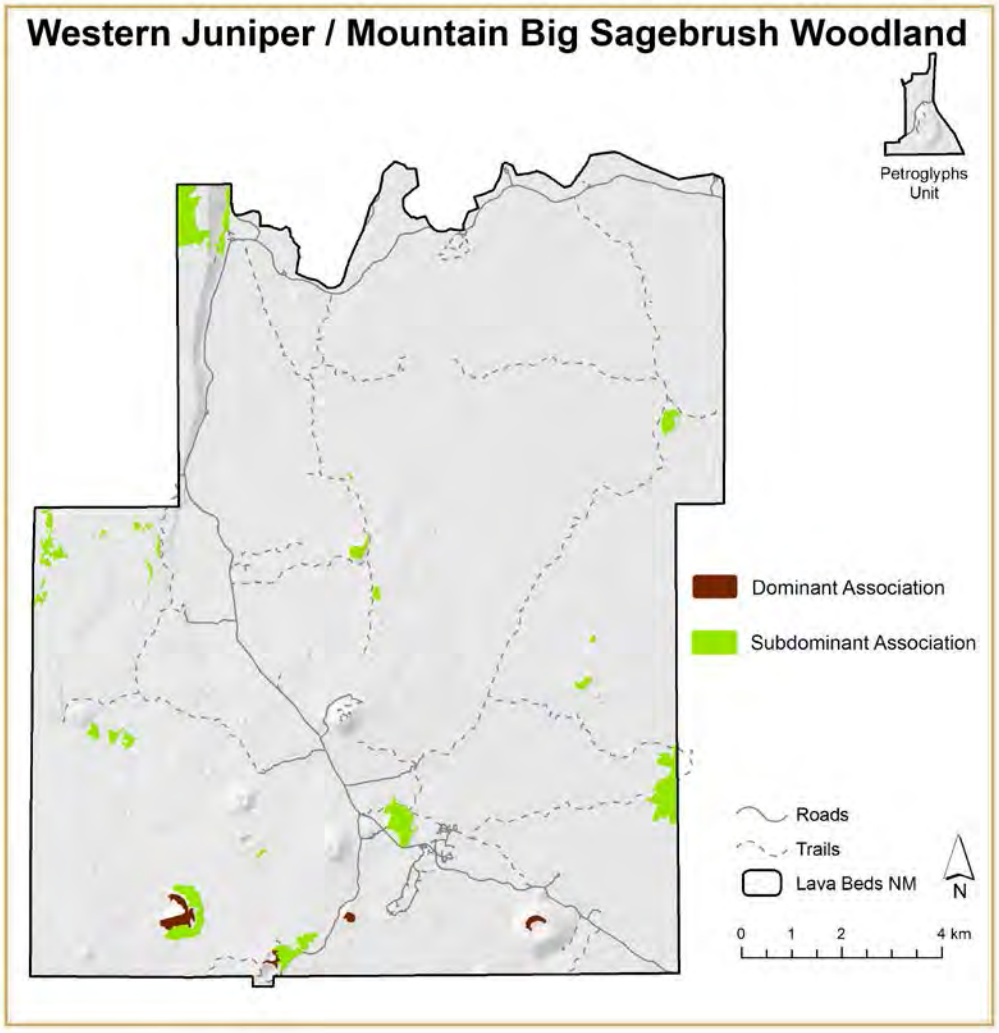
Species Richness:

Plot Species Richness Average	30.3
Plot Species Richness Range	22 - 37
Total Species Richness (all Plots)	86

Diagnostic Species: *Juniperus occidentalis* var. *occidentalis* as the sole dominant arboreal woody species.
Constant Species: *Juniperus occidentalis* var. *occidentalis, Achnatherum thurberianum, Bromus tectorum, Poa secunda.*
Other Noteworthy Species: None.
Number of Plots: 6. Relevés 19, 41, 51, 128, 130, 164.

Local Range: Throughout the southern one-half of the monument. Gillem Bluff.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Western Juniper / Mountain Big Sagebrush Woodland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Juniperus occidentalis* / *Artemisia tridentata* ssp. *vaseyana* Woodland (Code: CEGL000723) defined by the USNVC and placed in the *Juniperus occidentalis* / Shrub Understory Woodland Alliance (Code: A3499) of the revised USNVC hierarchy.

Occasional across the monument are western juniper woodlands with no shrub cover and instead have a savanna -like appearance with scattered juniper trees over an herbaceous layer dominated by bluebunch wheatgrass and other common bunchgrasses. These stands are comparable to the USNVC association *Juniperus occidentalis* / *Pseudoroegneria spicata* Wooded Herbaceous Vegetation (Code: CEGL001728), however, they were not delineated in this classification. As such stands were not sampled adequately to justify separation and these stands are included with juniper woodlands with a strong shrub component.

Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION
Environmental Description: Information not available.

Vegetation Description: Information not available.

DISTRIBUTION
Range: Information not available.
States/Provinces: CA, OR, ID, WY.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest and Klamath National Forest), USFWS (Tule Lake National Wildlife Refuge). Widespread association, presumed on public lands elsewhere in the northwestern U.S.

CONSERVATION STATUS
Rank: G4 - Apparently Secure (01Feb1996).
Reason: Information not available.

Global Description Author(s): Information not available.
Global Description References: *Juniperus occidentalis* / *Artemisia tridentata* ssp. *vaseyana* Woodland. No Date. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Western Juniper / Mountain Big Sagebrush Woodland** (*Juniperus occidentalis / Artemisia tridentata ssp. vaseyana* Woodland).

21. Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland

Cercocarpus ledifolius / *Artemisia tridentata* ssp. *vaseyana* Woodland

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nc Western North American Cool Temperate Woodland & Scrub Division
Macrogroup: 1.B.2.Nc.1 - M026 *Pinus monophylla - Juniperus osteosperma - Juniperus occidentalis* Intermountain Woodland Macrogroup
Group: 1.B.2.Nc.1.d - G249 *Cercocarpus ledifolius* Scrub & Woodland Group
Alliance: A0586 *Cercocarpus ledifolius* / Shrub Understory Woodland Alliance
Association: *Cercocarpus ledifolius* / *Artemisia tridentata* ssp. *vaseyana* Woodland

Translated Name: Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland

USNVC Identifier: CEGL001022

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at middle to higher elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions include low level, low slope, midslope, high slope, basin floor, bench, and on summits. Soils are sand, loam, loamy sand, sandy loam, and rock. Soil drainage is well drained or rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1513	17	338	4
Range	1318 - 1653	0 - 30	0 - 350	0 - 20

Vegetation Description: This shrubland association is dominated by the shrub curl-leaf mountain-mahogany (*Cercocarpus ledifolius* var. *intercedens*) at moderate to high cover. Antelope bitterbrush (*Purshia tridentata* var. *tridentata*) is often present at low to moderate cover. Other commonly occurring shrubs may be present, including rubber rabbitbrush (*Ericameria nauseosa*), desert gooseberry (*Ribes velutinum*), and mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), at low to moderate cover. The perennial grasses Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) are often present at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Juniperus occidentalis* var. *occidentalis* (western juniper)	81.8	0 - 5	1.7
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Cercocarpus ledifolius* var. *intercedens* (curl-leaf mountain-mahogany)	100	2 - 75	16.3
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	90.9	0 - 10	1.7
		Ericameria nauseosa (rubber rabbitbrush)	63.6	0 - 5	0.5
	Broad-leaved deciduous shrub	*Ribes velutinum* (desert gooseberry)	81.8	0 - 25	1.7
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	86.3	0 - 25	2
		Festuca idahoensis (Idaho fescue)	36.3	0 - 50	5.8
	Perennial herb	*Phacelia heterophylla* ssp. *virgata* (varileaf phacelia)	59.1	0 - 2	0.3

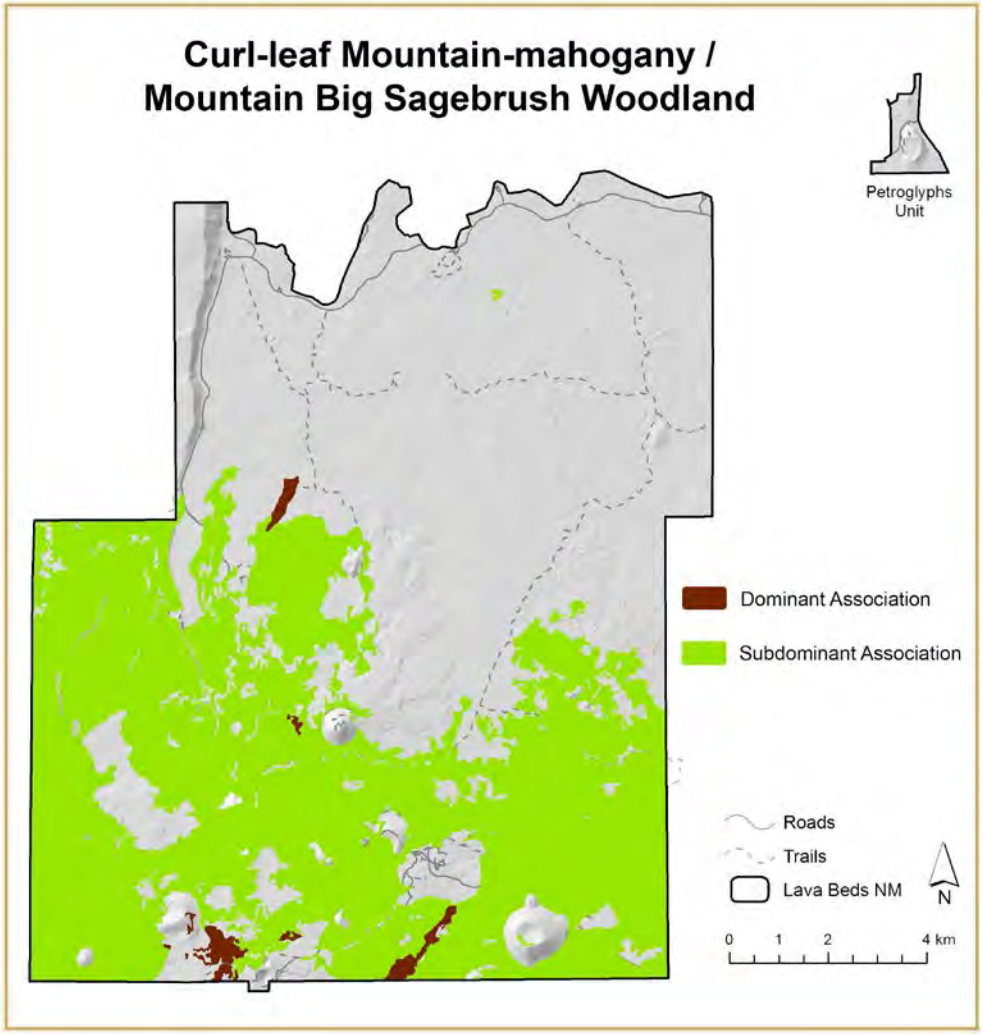
Species Richness:

Plot Species Richness Average	30.1
Plot Species Richness Range	10 - 45
Total Species Richness (all Plots)	127

Diagnostic Species: *Cercocarpus ledifolius* var. *intercedens.*
Constant Species: *Cercocarpus ledifolius* var. *intercedens.*
Other Noteworthy Species: None.
Number of Plots: 22. Relevés 30, 54, 65, 66, 69, 73, 78, 85, 88, 89, 93, 99, 100, 102, 103, 133, 138, 147, 148, 151, 152, 153.

Local Range: Throughout the southern one-half of the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Cercocarpus ledifolius* / *Artemisia tridentata* ssp. *vaseyana* Woodland (Code: CEGL001022) defined by the USNVC and placed in the *Cercocarpus ledifolius* / Shrub Understory Woodland Alliance (Code: A0586) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association is documented in southeastern Oregon and southern Utah and possibly occurs in the Owyhee Uplands of Idaho, in scattered mountain ranges in the northern Great Basin region of Nevada and California, and the Colorado Plateau of western Colorado. Sites are well-drained loams or loamy sands over basalt, sandstone or rhyolite. Elevations range from 1600-1950 m (5250-6400 feet) in Oregon and around 2750 m (9025 feet) in Utah and Colorado. Aspects are variable with slopes ranging from 0-60%.

Vegetation Description: This association is variable in its appearance. The canopy may be open to moderately closed, with a sparse to dense shrub understory. The canopy typically is dominated by *Cercocarpus ledifolius* var. *ledifolius*, which averages 50% cover but may have as much as 80% cover or as little as 20%. Common shrubs include *Artemisia tridentata* ssp. *vaseyana* or (less commonly) *Artemisia tridentata* ssp. *wyomingensis*, *Amelanchier alnifolia*, *Cercocarpus montanus*, *Paxistima myrsinites*, *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Symphoricarpos oreophilus*, and *Chrysothamnus viscidiflorus*. *Elymus elymoides* (= *Sitanion hystrix*) and *Achnatherum lemmonii* (= *Stipa lemmonii*) are the most common grasses, but *Festuca idahoensis*, *Poa fendleriana*, *Pseudoroegneria spicata*, and *Poa secunda* may also be present. Stands may have emergent trees of *Pseudotsuga menziesii* that range in height from 15-20 m tall and provide less than 5% cover. Sampled stands tend to be mature, with arboreal forms of *Cercocarpus ledifolius*. Younger stands may take the form of a dense mountain shrubland with a mixed canopy of sagebrush and mountain-mahogany. This is one of the drier *Cercocarpus ledifolius* woodlands.

DISTRIBUTION

Range: This association is possibly widely distributed in the northern Great Basin, Colorado Plateau and the Owyhee Uplands, although currently it is documented only in Oregon, Colorado and southern Utah.
States/Provinces: CA?, CO, ID?, NV, OR, UT.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest).

CONSERVATION STATUS

Rank: G3 - Vulnerable. (15Nov1999)
Reason: Although this type may be regionally widespread, its occurrences are small and fragmented. Overgrazing and fire suppression have changed the nature of most stands, and even the "protected" sites are grazed by cattle. Cattle and heavy wildlife (elk) grazing have degraded most sites, leading to very high *Artemisia tridentata* ssp. *vaseyana* cover and lower cover of *Cercocarpus ledifolius* and bunch grasses. While the *Cercocarpus* has spread out from its naturally protected habitats, stands have smaller plants and different associated species.

Global Description Author(s): M.P. Murray, mod. J. Coles.
Global Description References: M.P. Murray, mod. J. Coles. 2006. *Cercocarpus ledifolius* / *Artemisia tridentata* ssp. *vaseyana* Woodland [06Jun2006]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland** (*Cercocarpus ledifolius / Artemisia tridentata ssp. vaseyana* Woodland).

22. White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland

Abies concolor - Pinus ponderosa / *Purshia tridentata* Woodland

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nd Vancouverian Cool Temperate Forest Division
Macrogroup: 1.B.2.Nd.2 - M023 *Calocedrus decurrens - Pinus jeffreyi - Abies concolor* var. *lowiana* Forest Macrogroup
Group: 1.B.2.Nd.2.a - G344 *Calocedrus decurrens - Pinus lambertiana - Abies concolor* Forest & Woodland Group
Alliance: A3677 *Abies concolor - Pinus ponderosa* Eastern Sierran Forest & Woodland Alliance
Association: *Abies concolor - Pinus ponderosa* / *Purshia tridentata* Woodland

Translated Name: White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland

USNVC Identifier: CEGL000259

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at high elevations within the monument on steep, generally north facing slopes. Topographic positions are low slope to high slope. Soils are loamy sand, and sandy loam. Soil drainage is well drained and rapidly drained.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1616	23	14	72
Range	1597 - 1649	19 - 25	340 - 33	65 - 80

Vegetation Description: This forest association is dominated by ponderosa pine (*Pinus ponderosa* var. *ponderosa*) at moderate to high cover with white fir (*Abies concolor*) present and often co-dominant at low to high cover. Snowbrush ceanothus (*Ceanothus velutinus*) and greenleaf manzanita (*Arctostaphylos patula*) are present at low to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pinus ponderosa* var. *ponderosa* (ponderosa pine)	100	10 - 50	34.1
		Abies concolor (white fir)	100	2 - 25	8.6
Shrub/sapling (short and tall)	Broad-leaved evergreen shrub	*Ceanothus velutinus* (snowbush ceanothus)	66.7	0 - 25	6.4
		Arctostaphylos patula (greenleaf manzanita)	100	1 - 10	3.5
		Purshia tridentata var. *tridentata* (antelope bitterbrush)	100	0.1 - 2	1
	Broad-leaved deciduous shrub	*Ribes roezlii* var. *roezlii* (Sierra gooseberry)	100	0 - 1	0.4
Herb	Graminoid	*Elymus elymoides* (squirreltail)	100	0 - 1	0.4
	Perennial herb	*Heuchera cylindrica* var. *alpina* (alpine alumroot)	100	0 - 1	0.2

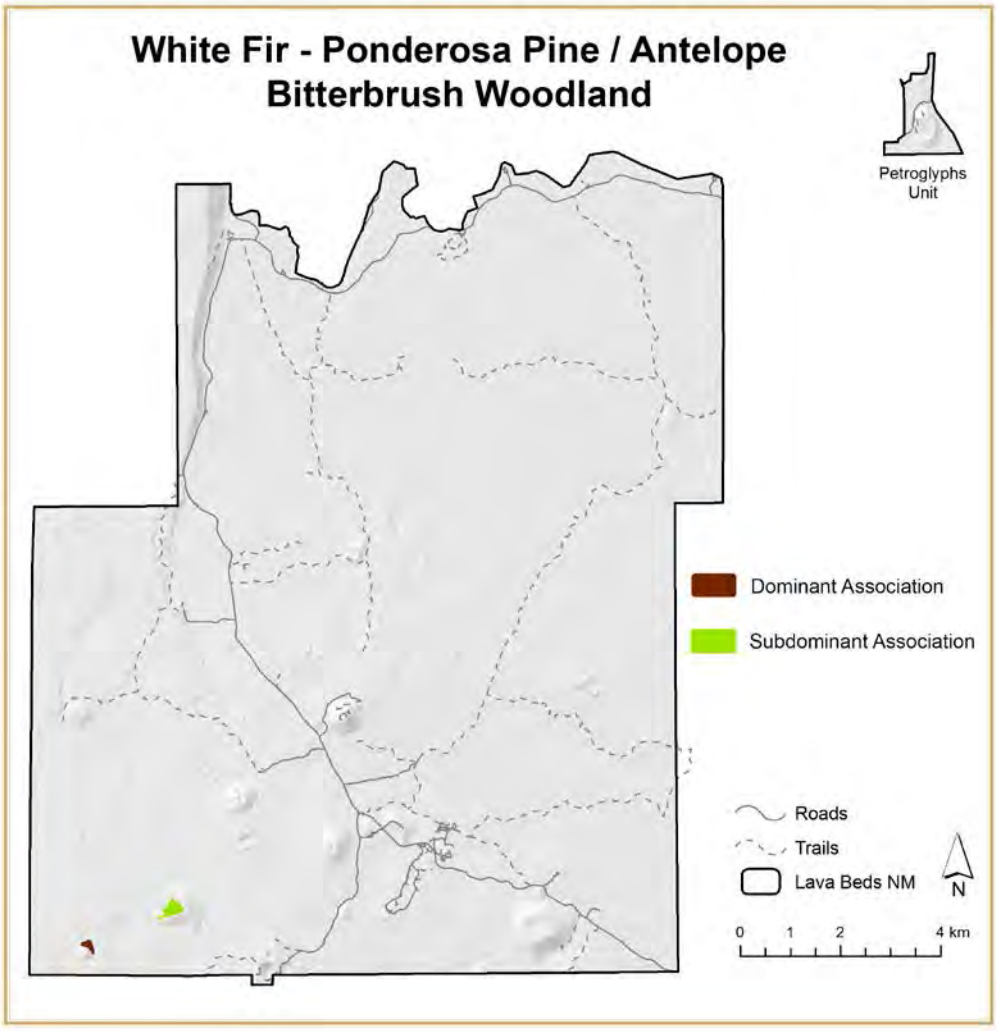
Species Richness:

Plot Species Richness Average	32.7
Plot Species Richness Range	26 - 39
Total Species Richness (all Plots)	58

Diagnostic Species: *Abies concolor.*
Constant Species: *Abies concolor, Pinus ponderosa* var. *ponderosa, Arctostaphylos patula, Purshia tridentata* var. *tridentata, Ribes roezlii* var. *roezlii, Heuchera cylindrica* var. *alpina, Elymus elymoides.*
Other Noteworthy Species: None.
Number of Plots: 3. Relevés 106, 112, 156.

Local Range: Eagle Nest Butte. Island Butte. South of the monument in the Medicine Lake Highlands.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument the White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland is the dominant association or is a subdominant association.

Classification Comments: This association is equivalent to the *Abies concolor - Pinus ponderosa* / *Purshia tridentata* Woodland (Code: CEGL000259) defined by the USNVC and placed in the *Abies concolor - Pinus ponderosa* Eastern Sierran Forest & Woodland Alliance (Code: A3677) of the revised USNVC hierarchy.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This woodland community is found in the East Cascade region of central and southern Oregon and extreme northern California. Typical elevations are between 1250-1800 m (4100-5886 feet). It occurs on a high variety of slopes and aspects with coarse sand and loamy sand soils.

Vegetation Description: *Pinus ponderosa* generally dominates south aspects while *Abies concolor* prevails on north aspects and higher elevations. *Purshia tridentata* is most common at lower slopes. At the upper elevations within its range, *Arctostaphylos patula* or *Ceanothus velutinus* may dominate. Common herbs include *Chamerion angustifolium* (= *Epilobium angustifolium*), *Apocynum androsaemifolium* (= ssp. *pumilum*), *Carex rossii*, and *Elymus elymoides* ssp. *elymoides* (= *Sitanion hystrix*). This association becomes increasingly dominated by *Abies concolor* in the absence of fire, which typically kills the younger fire-sensitive firs.

DISTRIBUTION

Range: This association is found from the Deschutes National Forest of central Oregon southward to the Lassen National Forest of California. A latitudinal range between 350 and 450 miles.
States/Provinces: CA, OR.
Nations: U.S.
Federal Lands: NPS (Lava Beds National Monument), USFS (Modoc National Forest and Klamath National Forest).

CONSERVATION STATUS

Rank: G3 - Vulnerable (06Nov2000)
Reason: Although this woodland community is wide-ranging and abundant, it is threatened with fire suppression and logging. Logging has traditionally removed the large older trees, especially *Pinus ponderosa*, which changes the canopy structure and makes the stand even more liable to stand-replacement fires. Fire suppression has been ubiquitous, and if it remains so, occurrences will be under an increasing threat of stand-replacing fires where significant undergrowth of *Abies concolor* creates ladder fuels. Furthermore, as tree canopy cover increases in the absence of fire, the shrub species will decrease. Careful prescribed burning and thinning may reduce the threat of stand-replacing fire.

Global Description Author(s): M.P. Murray.
Global Description References: M.P. Murray. 1997. *Abies concolor - Pinus ponderosa* / *Purshia tridentata* Woodland [26Nov1997]. United States National Vegetation Classification. Federal Geographic Data Committee, Washington, D.C.

Available: http://usnvc.org/explore-classification (Accessed 09/17/2015).

Additional global information from: NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 25, 2015).

Above: **White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland** (*Abies concolor - Pinus ponderosa / Purshia tridentata* Woodland).

23. Pacific Willow / Basin Wildrye Woodland [Provisional]

Salix lucida ssp. *lasiandra / Leymus cinereus* Woodland [Provisional]

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.C Shrub & Herb Wetland Subclass
Formation: 2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation
Division: 2.C.4.Nb *Alnus viridis* ssp. *sinuata* - *Salix* spp. / *Carex* spp. - *Blennosperma nanum* - *Poa pratensis* Western North American Freshwater Shrubland, Wet Meadow & Marsh Division
Macrogroup: 2.C.4.Nb.2 - M075 Western North American Montane to Alpine Wet Shrubland & Wet Meadow Macrogroup
Group: 2.C.4.Nb.2.d - G527 *Salix* spp. - *Alnus* spp. - *Betula occidentalis* Riparian & Seep Shrubland Group
Alliance: A3769 *Salix boothii - Salix geyeriana - Salix lutea* Montane Shrubland Alliance
Association: Provisional vegetation association.

NPS Unique Identifier: NPSLABE008

LOCAL INFORMATION

Environmental Description: This vegetation association is described from only one sample plot. It occurs at low elevations within the monument on gentle slopes along the former lakeshore of Tule Lake. Topographic position is low level. Soils are loamy sand. Soil drainage is moderately well drained.

Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
1243	0	280	15

Vegetation Description: This vegetation association is dominated by Pacific willow (*Salix lucida* ssp. *lasiandra*) and the perennial bunchgrass basin wildrye (*Leymus cinereus*) at high cover. The shrubs desert gooseberry (*Ribes velutinum*), yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*), and Saskatoon serviceberry (*Amelanchier alnifolia* var. *semiintegrifolia*) are present at moderate to high cover.

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Salix lucida* ssp. *lasiandra* (Pacific willow)	100	25 - 50	37.5
		Ribes velutinum (desert gooseberry)	100	5 - 10	7.5
		Amelanchier alnifolia var. *semiintegrifolia* (Saskatoon serviceberry)	100	2 - 5	3.5
	Broad-leaved evergreen shrub	*Chrysothamnus viscidiflorus* ssp. *viscidiflorus* (yellow rabbitbrush)	100	10 - 25	17.5
Herb	Graminoid	*Leymus cinereus* (basin wildrye)	100	25 - 50	37.5
	Annual herb	*Sisymbrium altissimum* (tall tumblemustard)	100	2 - 5	3.5
		Descurainia sophia (herb sophia)	100	1 - 2	1.5

Diagnostic Species: *Salix lucida* ssp. *lasiandra.*
Constant Species: Not applicable.
Other Noteworthy Species: None.
Species Richness of Sample Plot: 15
Number of Plots: 1. Relevé 6.

Local Range: Along the northern boundary of the monument on the former lakeshore of the historic Tule Lake.

Local Range Map: Not available for this association. Occurrence is too limited to show at the spatial scale of the monument. Refer to Appendix E in this report and the range map for the mapped location of the Pacific willow / Basin wildrye Woodland [Provisional] in Lava Beds National Monument.

Classification Comments: This provisional vegetation association is classified under the *Salix boothii - Salix geyeriana - Salix lutea* Montane Shrubland Alliance (Code: A3769) defined by the USNVC. This local association is similar to the USNVC associations *Salix lucida ssp. caudata* Shrubland (Code: CEGL001215) and *Salix lucida ssp. caudata / Rosa woodsii* Shrubland (Code: CEGL002621) under the *Salix boothii - Salix geyeriana - Salix lutea* Montane Shrubland Alliance (Code: A3769). However, since the principle species differ in subspecies, neither USNVC association was considered analogous to the local association.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.

Above: **Pacific Willow / Basin Wildrye Woodland [Provisional]** (*Salix lucida* ssp*. lasiandra* / *Leymus cinereus* Woodland [Provisional]).

OTHER

24. Sparsely Vegetated Rock [Provisional]

USNVC Classification:
Class: 6 Cryptogam - Open Mesomorphic Vegetation Class
Subclass: 6.B Temperate & Boreal Open Rock Vegetation Subclass
Formation: 6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation
Division: 6.B.1.Nb Western North American Temperate Cliff, Scree & Rock Vegetation Division
Macrogroup: 6.B.1.Nb.1 – M6887 Western North American Temperate Cliff, Scree & Rock Vegetation Macrogroup
Association: Provisional vegetation association.

NPS Unique Identifier: NPSLABE009

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at low to high elevations within the monument on gentle to steep slopes. Aspects are variable. Topographic positions are basin floor, low slope, high slope, toe slope, and bench. Soils are rock. Soil drainage is well drained to rapidly drained. This association typically occurs on younger lava flows.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1426	12	352	0.1
Range	1247 - 1614	0 - 60	190 - 0	0 - 0.5

Vegetation Description: This association is defined by its extremely sparse vegetation cover or near complete absence of vegetation. Scattered individuals or small patches of shrubs include curl-leaf mountain-mahogany (*Cercocarpus ledifolius* var. *intercedens*), purple sage (*Salvia dorrii*), rubber rabbitbrush (*Ericameria nauseosa*), and/or fernbush or desert sweet (*Chamaebatiaria millefolium*).

Most Abundant Species:

Stratum	Lifeform	Species	Constancy (%)	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Cercocarpus ledifolius* var. *intercedens* (curl-leaf mountain-mahogany)	71.4	0 - 2	0.7
		Salvia dorrii (purple sage)	57.1	0 - 2	0.3
		Ericameria nauseosa (rubber rabbitbrush)	57.1	0 - 1	0.2
	Broad-leaved deciduous shrub	*Chamaebatiaria millefolium* (fernbush)	71.4	0 - 1	0.3
Herb	Graminoid	*Bromus tectorum* (cheatgrass)	71.4	0 - 5	0.5
		Poa secunda (Sandburg bluegrass)	57.1	0 - 1	0.2

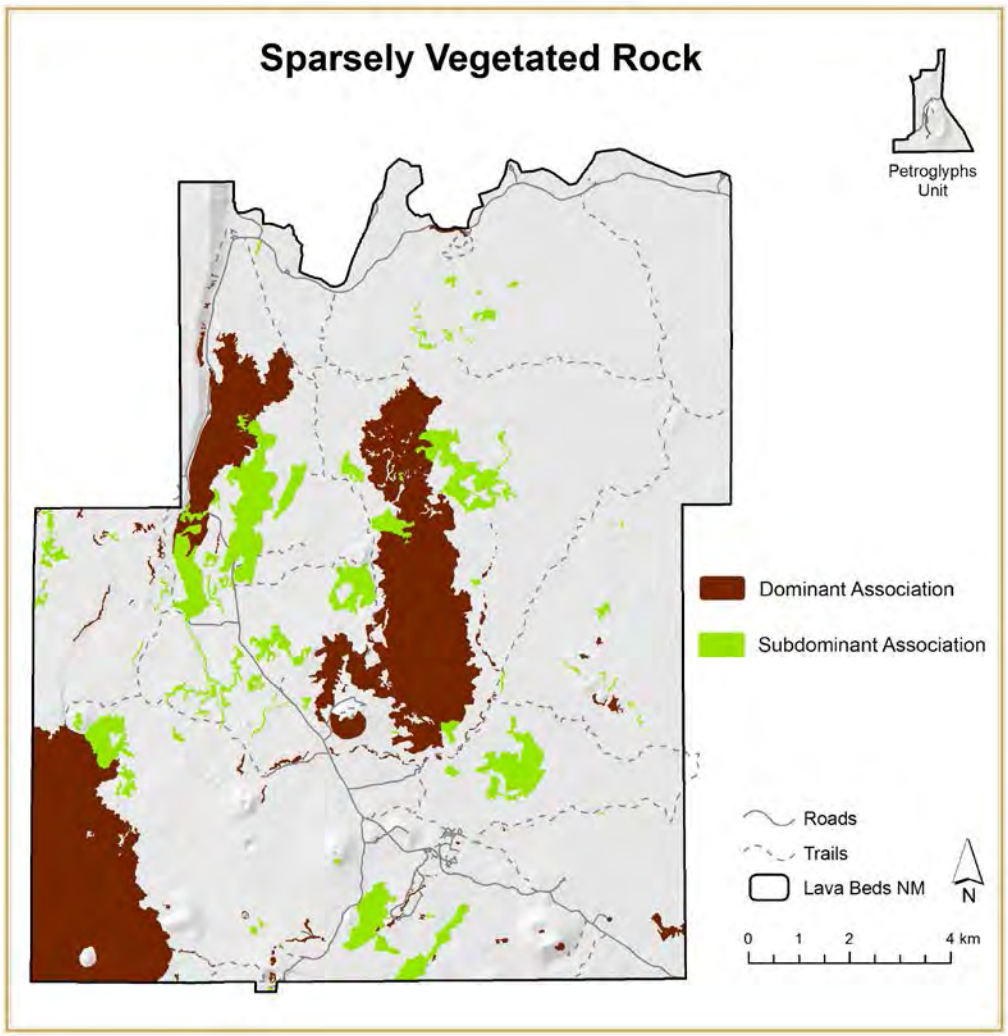
Species Richness:

Plot Species Richness Average	18.4
Plot Species Richness Range	3 - 30
Total Species Richness (all Plots)	60

Diagnostic Species: None.
Constant Species: None.
Other Noteworthy Species: None.
Number of Plots: 7. Relevés 7, 12, 25, 29, 53, 118, 150.

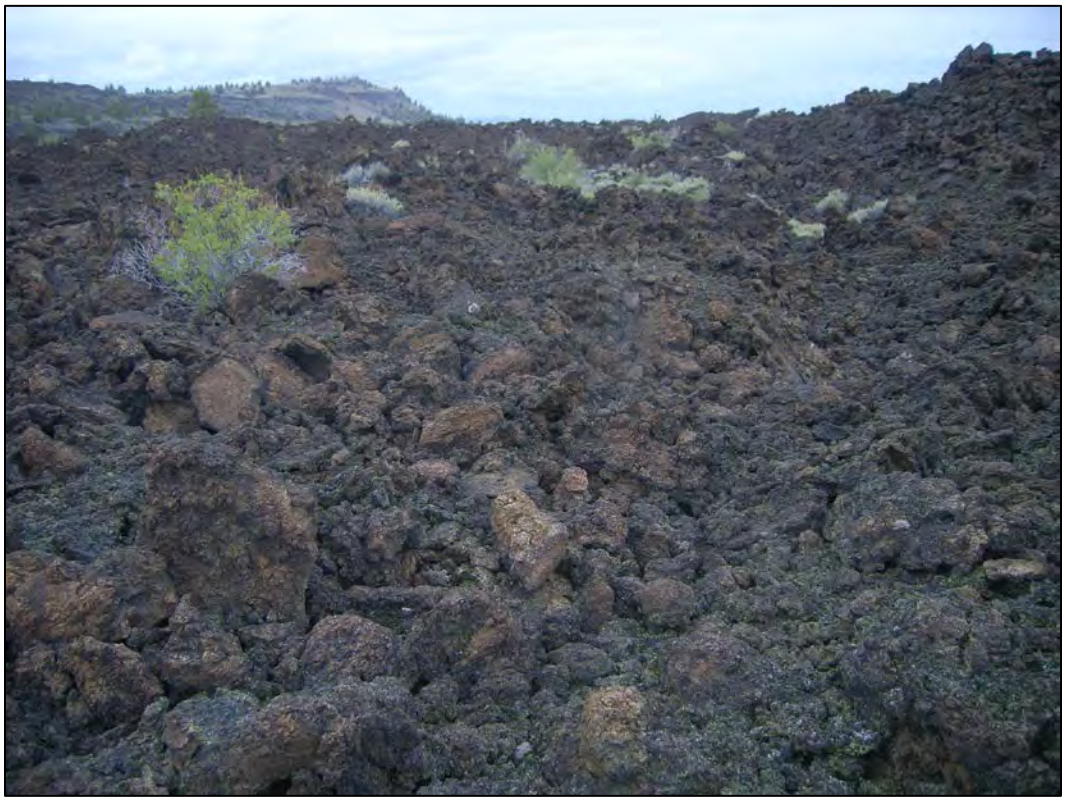
Local Range: Recent lava flows, collapsed lava caves, and scree and pumice slopes throughout the monument.

Local Range Map:



Above: Range map showing where at Lava Beds National Monument Sparsely Vegetated Rock [Provisional] is the dominant association or is a subdominant association.

Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo, D. C. Odion, T. Griffiths.
Lava Beds National Monument Inventory Notes: None.



Above: **Sparsely Vegetated Rock [Provisional]** with occasional shrubs at Lava Beds National Monument. Vegetation is often lacking.

Appendix E. Key to Map Units

***If no map unit can be identified, indicate no map unit.**

1. Lacking vegetation entirely, or with very sparse vegetation, often isolated small individuals of *Cercocarpus ledifolius, Juniperus occidentalis, Chamaebatiaria millefolium,* or *Salvia dorrii* in rock crevices (<< 5% cover of vascular plants over any area of 0.5 ha or more).
…….……..…….…… **Sparsely Vegetated Rock**

1' Vegetation cover > 5%.

2. Shrub and/or tree cover < 10%. Dominant vegetation is grassland (or herbaceous and grassland species, e.g. *Descurainia sophia*), often due to fire.

3. Perennial grasses < 10% cover, annual species more common. ……..……
……..……. **Cheatgrass Ruderal Herbaceous Vegetation**

3' Perennial grasses > 10 % or annual species rare. ……..…… **Perennial Grassland**

2' Shrub and/or tree cover > 10%.

4. Shrub (not woodland or forest) associations present (including Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland and Chokecherry - Mixed Shrub Talus Shrubland).

5. *Cercocarpus ledifolius* present >5%. Curl-leaf Mountain-mahogany - Antelope Bitterbrush shrubland or Western Juniper / Curl-leaf Mountain-mahogany Woodland the dominant vegetation associations. ..……..……... **Juniper - Mountain-mahogany Woodland**

5' *Cercocarpus ledifolius* absent or rare (does not define the dominant vegetation association present).

6. *Chamaebatiaria millefolium* or *Salvia dorrii* present. Combined cover ≥ 1%. Dominant association is Big Sagebrush - Purple Sage - Fernbush Shrubland, Fernbush - Wax Currant Shrubland, or Antelope Bitterbrush - Purple Sage Shrubland.
……..…… **Big Sagebrush - Purple Sage - Fernbush Shrubland**

6' *Chamaebatiaria millefolium* or *Salvia dorrii* both absent, or combined cover < 1%.

7. Dominant association is Chokecherry - Mixed Shrub Talus Shrubland.
…… **Chokecherry Shrubland**

7' Chokecherry - Mixed Shrub Talus Shrubland is not the dominant associations present.

8. *Ericameria nauseosa* and/or *Chrysothamnus viscidiflorus* the dominant shrub species present (>5% cover). ……..……. **Rubber Rabbitbrush Shrubland**

8' Shrub vegetation not dominated by *Ericameria nauseosa* and/or *Chrysothamnus viscidiflorus.*

9. *Artemisia tridentata* is present, usually dominant.

10. *Artemisia tridentata* ssp. *tridentata* is present in the vegetation,

> *Artemisia tridentata* ssp. *vaseyana*. Dominant association is Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation, Desert Gooseberry / Basin Wildrye Shrubland or Oceanspray - Desert Gooseberry Shrubland. …… **Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland**

10' *Artemisia tridentata* ssp. *vaseyana* is present in vegetation and dominant, > *Artemisia tridentata* ssp. *tridentata*. Dominant association is Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland, Desert Gooseberry / Basin Wildrye Shrubland or Oceanspray - Desert Gooseberry Shrubland. …… **Mountain Big Sagebrush - Antelope Bitterbrush Shrubland**

9' Dominant association not dominated by *Artemisia tridentata.*

11. Dominant association is Greenleaf Manzanita Sierran Chaparral Shrubland. …….. **Greenleaf Manzanita Shrubland**

11' Not dominated by *Arctostaphylos patula* or *Ceanothus velutinus.* …… **No Map Unit**

4' Woodland associations present (including Pacific Willow / Basin Wildrye Woodland).

12. Dominant association is Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland or Western Juniper / Mountain Big Sagebrush Woodland. …….. **Juniper - Mountain-mahogany Woodland**

12' Dominant association is Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland, White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland, or Pacific Willow / Basin Wildrye Woodland.

13. *Pinus ponderosa* var. *ponderosa* is common, *Salix lucida* is absent.

14. *Abies concolor* is absent or rare. …….. **Ponderosa Pine Woodland**

14' *Abies concolor* is common, White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland is the dominant association present. ……..**White Fir - Ponderosa Pine Woodland**

13' *Pinus ponderosa* var. *ponderosa* absent, *Salix lucida* dominant. …… **Pacific Willow / Basin Wildrye Woodland**

Appendix F. Photo-Interpretation Mapping Conventions and Visual Key

This appendix describes the vegetation classes mapped for the Lava Beds National Monument Vegetation Inventory (Classification and Mapping) Project. These classes are defined mainly by vegetation structure (physiognomy). Unlike the vegetation associations, which were defined by vegetation species composition, the map classes were recognizable and mappable on air photo imagery. This report has a key to these vegetation map classes in Appendix E. Here, for each mapped vegetation class we provide:

- A brief description of the vegetation, including the U.S. National Vegetation Classification (USNVC) associations that characterize each vegetation class (if published by NatureServe or others), and the associations we classified that characterize the vegetation class;
- The cumulative aerial extent of each vegetation where mapped as a primary vegetation and/or a secondary vegetation;
- A range map for each vegetation class, indicating areas where it was the primary vegetation, or the secondary vegetation; and
- An image illustrating the photo-signature for the vegetation class, followed by a description of mapping considerations;
- A representative ground photograph/image for each map unit.

The vegetation classes mapped were the following:

1. Physiognomic classes as seen on the digital aerial photos (NAIP 2009 imagery) and informed by existing relevé plots;

2. Vegetation types that could not be separated on imagery, but were separated by elevation based on plot sampling and the map by Erhard (1979). These elevation definitions were described for each physiognomic vegetation class described below in the sections on photo-signature and mapping considerations;

The vegetation described in this section reflects the classification designed specifically for this project. For more information on the development of the mapping scheme for Lava Beds National Monument please reference the Digital Imagery and Interpretation subsection of the Methods section of this report and the digital information (i.e. lookup tables, metadata) included on the project DVD.

The descriptions provided below follow the physiognomic grouping of each map unit starting with herbaceous classes and then moving to shrub and woodland classes.

A. Herbaceous Vegetation

1. Perennial Grassland

Mapping Classification Common Name: Perennial Grassland

Mapping Classification Scientific Name: N/A

Map Code: NPSLABE010

Common Species: Bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*), Sandberg bluegrass (*Poa secunda*), cheatgrass (*Bromus tectorum*), squirreltail (*Elymus elymoides*), bigseed biscuitroot (*Lomatium macrocarpum*), Idaho fescue (*Festuca idahoensis*), Thurber's needlegrass (*Achnatherum thurberianum*), needle and thread grass *(Hesperostipa comata* ssp. *comata*)

USNVC Classification:
This type does not crosswalk to a single USNVC type.

Associations dominating the map unit:

- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation
- Squirreltail Herbaceous Vegetation [Provisional]
- Needle and Thread Great Basin Herbaceous Vegetation
- Basin Wildrye Herbaceous Vegetation
- Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional]
- Desert Gooseberry / Basin Wildrye Shrubland [Provisional]

Associations that may be present but not dominant in the map unit:

- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation (in polygons where it does not dominate)
- Squirreltail Herbaceous Vegetation [Provisional] (in polygons where it does not dominate)
- Needle and Thread Great Basin Herbaceous Vegetation (in polygons where it does not dominate)
- Basin Wildrye Herbaceous Vegetation (in polygons where it does not dominate)
- Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional] (in polygons where it does not dominate)
- Desert Gooseberry / Basin Wildrye Shrubland [Provisional]
- Cheatgrass Ruderal Herbaceous Vegetation
- Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation
- Rubber Rabbitbrush Shrubland
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Fernbush - Wax Currant Shrubland [Provisional]
- Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland
- Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland
- Western Juniper / Mountain Big Sagebrush Woodland

- White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland
- Sparsely Vegetated Rock [Provisional]

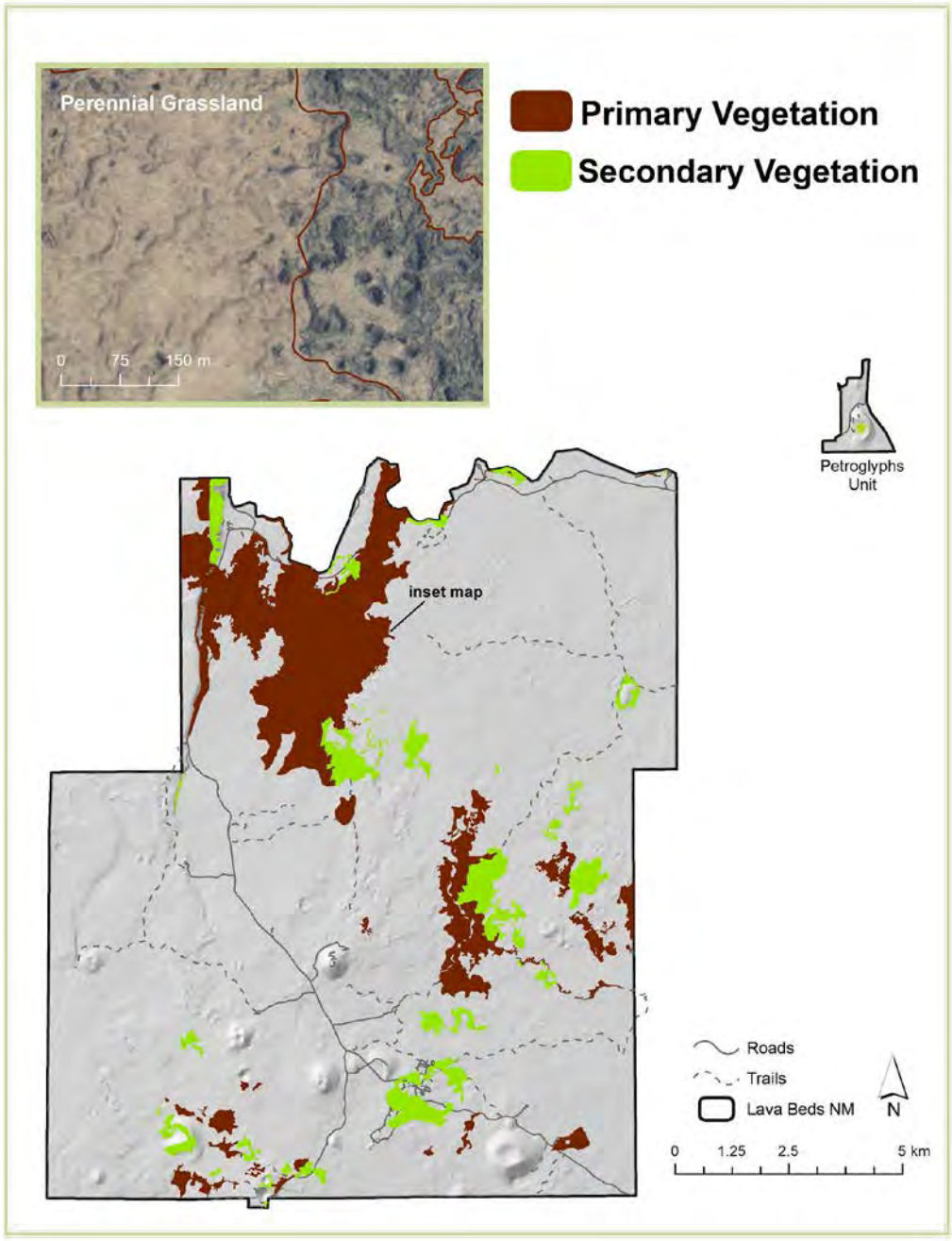
Cumulative area occupied (ha)*	
Primary vegetation	1506.6
Secondary vegetation	195.5
Total	1706.1
Percentage of Monument	9.0

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1230-1605 m

Description: This vegetation consists of grassland dominated by perennial, tussock-forming bunchgrasses and the annual cheatgrass (*Bromus tectorum*). Different bunchgrass species dominate in different areas, accounting for the several different classified associations listed above that may be present in Perennial Grassland at a given location (the associations are each described in the association descriptions). Although perennial grasses define and dominate this formation, the annual cheatgrass (*Bromus tectorum*) is almost always present. Shrubs such as basin big sagebrush (*Artemisia tridentata ssp. tridentata*), mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), and rubber rabbitbrush (*Ericameria nauseosa*) are also commonly present, but are widely scattered and account for little cover (<5%).

Range and Distribution: Perennial Grassland occurs throughout Lava Beds in a variety of settings, often where soils qualitatively appear to have relatively high clay content, but also in recently burned areas at middle and higher elevations in the monument. Perennial Grassland is particularly abundant on Gillem Bluff in the northwestern portion of the park.



Above: Photo signature and range map for Perennial Grassland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Like Cheatgrass Ruderal Herbaceous Vegetation, Perennial Grassland has a smooth, tawny appearance on the imagery. Perennial Grassland was separated from Cheatgrass Ruderal Herbaceous Vegetation based on ancillary information: either relevé data or the previous vegetation map by Erhard (1979). The abundance of shrubs (>5% cover), which are visible because they create a rough texture on the imagery, distinguishes shrub vegetation types from Perennial Grassland.

Representative Ground Photo:

Above: Perennial Grassland on Gillem Bluff at Lava Beds National Monument.

Above: Perennial Grassland dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) at Lava Beds National Monument.

2. Cheatgrass Ruderal Herbaceous Vegetation

Mapping Classification Common Name: Cheatgrass Ruderal Herbaceous Vegetation

Mapping Classification Scientific Name: *Bromus tectorum* Ruderal Herbaceous Vegetation

Map Code: CEGL003019

Common Species: cheatgrass (*Bromus tectorum*), rubber rabbitbrush (*Ericameria nauseosa*), squirreltail (*Elymus elymoides*), herb sophia (*Descurainia sophia*), redstem stork's bill (*Erodium cicutarium*), tall tumble mustard (*Sisymbrium altissimum*)

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.90 - M499 *Agropyron cristatum - Bromus tectorum - Sisymbrium altissimum* Western North American Ruderal Semi-Desert Scrub & Grassland Macrogroup
Group: 3.B.1.Ne.90.a - G600 Great Basin & Intermountain Ruderal Dry Shrubland & Grassland Group
Alliance: A1814 *Bromus tectorum - Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance
Association: *Bromus tectorum* Ruderal Herbaceous Vegetation

Translated Name: Cheatgrass Ruderal Herbaceous Vegetation

Associations that may dominate the map unit:
- Cheatgrass Ruderal Herbaceous Vegetation
- Squirreltail Herbaceous Vegetation [Provisional]
- Basin Wildrye Herbaceous Vegetation

Associations that may be present but not dominant in the map unit:
- Squirreltail Herbaceous Vegetation [Provisional] (in polygons where it does not dominate)
- Basin Wildrye Herbaceous Vegetation (in polygons where it does not dominate)
- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation
- Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation
- Rubber Rabbitbrush Shrubland
- Sparsely Vegetated Rock [Provisional]

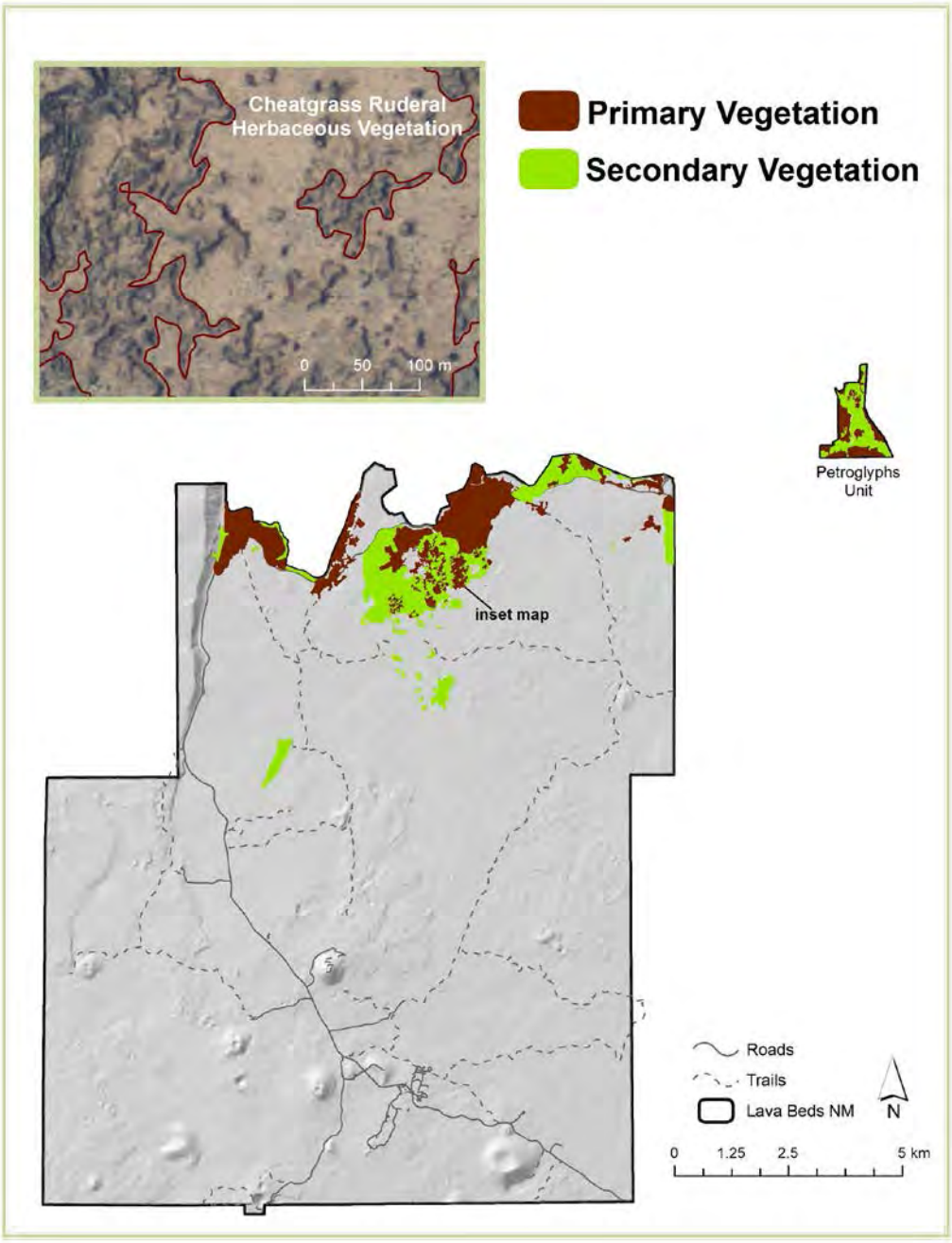
Cumulative area occupied (ha)*	
Primary vegetation	504.2
Secondary vegetation	214.3
Total	**718.5**
Percentage of Monument	**3.8**

*Calculated as the sum of the total area of all polygons in which this vegetation class was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1225-1520 m

Description: This vegetation consists of grassland dominated by a dense cover of the annual species cheatgrass (*Bromus tectorum*) and herb sophia (*Descurainia sophia*). Another annual species, redstem stork's bill (*Erodium cicutarium*) is often present at low to moderate cover. The Cheatgrass Ruderal Herbaceous Vegetation formation often, but not exclusively, occupies former shrubland that has recently burned. Fire is generally lethal to dominant shrubs like big sagebrush (*Artemisia tridentata*). Rubber rabbitbrush (*Ericameria nauseosa*) is the shrub that often colonizes these burns, but it and other shrubs may recruit slowly. Hence, burned sagebrush steppe vegetation remains dominated by Cheatgrass Ruderal Herbaceous Vegetation for many years after a fire. Perennial grasses are also favored by fire and are often common components of burned and unburned Cheatgrass Ruderal Herbaceous Vegetation, particularly squirreltail (*Elymus elymoides*) and Sandberg bluegrass (*Poa secunda*). Cheatgrass Ruderal Herbaceous Vegetation also occurs on land that was previously cultivated and/or heavily grazed. The dominance by the short-lived annual species cheatgrass and herb sophia, the very low abundance of woody shrubs or perennial grasses and forbs, and the common presence of charred shrub snags indicate that a type conversion has occurred. The cheatgrass is very fire prone and the recurrence of fire will promote the presence of more cheatgrass.

Range and Distribution: Cheatgrass Ruderal Herbaceous Vegetation occurs mainly at the north end of the monument, particularly in the area burned in the Jack fire in the summer of 2008. Large parts of the Jack fire area are not Cheatgrass Ruderal Herbaceous Vegetation, thus, previous disturbances may have predisposed the areas that do support Cheatgrass Ruderal Herbaceous Vegetation as a result of the Jack Fire to invasion by the non-native annuals. Cheatgrass Ruderal Herbaceous Vegetation is also common in the petroglyphs portion of the park.



Above: Photo signature and range map for Cheatgrass Ruderal Herbaceous Vegetation in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Cheatgrass Ruderal Herbaceous Vegetation is characterized on the 2009 NAIP imagery by a smooth texture and distinctive, tawny brown color. The previously mapped boundary of the 2008 Jack fire was also used in delineating Cheatgrass Ruderal Herbaceous Vegetation.

Representative Ground Photo:

Above: Cheatgrass Ruderal Herbaceous Vegetation dominated by cheatgrass (*Bromus tectorum*) and herb sophia (*Descurania sophia*) at the northern end of Lava Beds National Monument. The pink flowers are redstem stork's bill (*Erodium cicutarium*).

B. Shrub Vegetation

3. Chokecherry Shrubland

Mapping Classification Common Name: Chokecherry - Mixed Shrub Talus Shrubland

Mapping Classification Scientific Name: *Prunus virginiana* - Mixed Shrub Talus Shrubland

Map Code: CEGL005444

Common Species: chokecherry **(***Prunus virginiana*), roundleaf snowberry (*Symphoricarpos rotundifolius*), curl-leaf mountain-mahogany (*Cercocarpus ledifolius* var. *intercedens*), cheatgrass (*Bromus tectorum*), tall annual willowherb (*Epilobium brachycarpum*)

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.B Temperate & Boreal Grassland & Shrubland Subclass
Formation: 2.B.2 Temperate Grassland & Shrubland Formation
Division: 2.B.2.Na Western North American Grassland & Shrubland Division
Macrogroup: 2.B.2.Na.1 - M049 *Quercus gambelii - Cercocarpus montanus - Purshia* spp. Southern Rocky Mountain Montane Shrubland Macrogroup
Group: 2.B.2.Na.1.a - G277 *Quercus gambelii - Amelanchier* spp. - *Prunus virginiana* Southern Rocky Mountain Montane Shrubland Group
Alliance: A3736 *Fraxinus anomala - Rhus trilobata - Fendlera rupicola* Talus & Rock Outcrop Shrubland Alliance
Association: *Prunus virginiana* - Mixed Shrub Talus Shrubland

Translated Name: Chokecherry - Mixed Shrub Talus Shrubland

Associations that may dominate the map unit:
- Chokecherry - Mixed Shrub Talus Shrubland

Associations that may be present but not dominant in the map unit:
- None

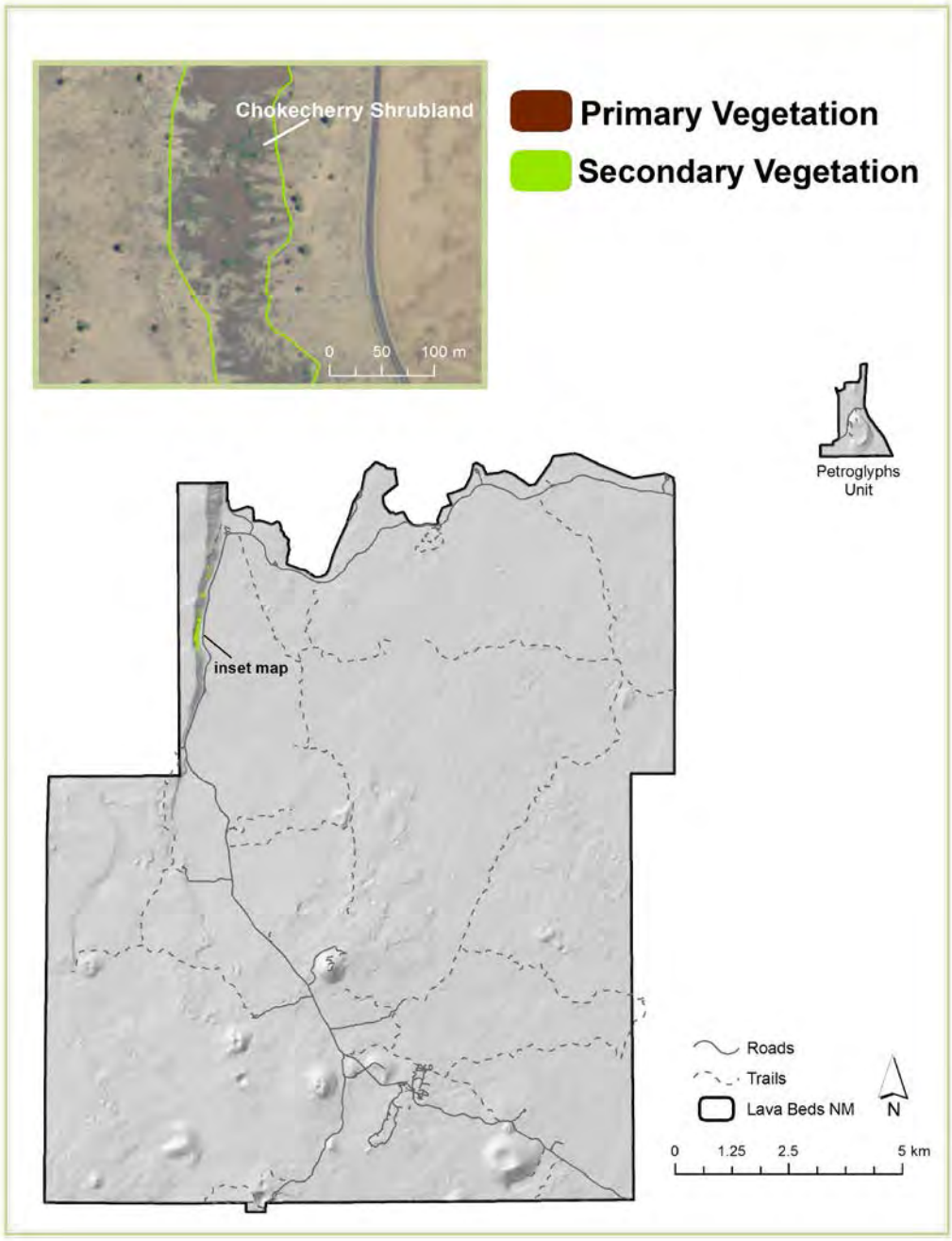
Cumulative area occupied (ha)*	
Primary vegetation	0
Secondary vegetation	1.6
Total	**1.6**
Percent of Monument	**0.01**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1235-1250 m

Description: This shrub vegetation is co-dominated by chokecherry (*Prunus virginiana*), averaging about 10% cover, and roundleaf snowberry (*Symphoricarpos rotundifolius*) averaging about 13% cover. Herbaceous cover is often sparse because this vegetation occurs in rocky areas, such as talus slopes. The non-native annual grass cheatgrass (*Bromus tectorum*) is sometimes present at low to moderate cover. Shrub cover ranges from total coverage (>90%) to more open stands of 10-20% canopy cover, with the higher values tending to occur in sites located in basin bottoms and on lowermost slopes, and the lower values on higher slopes.

Range and Distribution: Chokecherry Shrubland occurs in mappable (>0.5 ha) areas along the talus slopes that drop away from Gillem Bluff.



Above: Photo signature and range map for Chokecherry Shrubland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: The rocky talus slope where this vegetation is found is discernable on the imagery. Knowledge of the vegetation on the ground acquired from fieldwork aided in the identification of Chokecherry Shrubland as a sub-dominant vegetation in this area.

Representative Ground Photo:

Above: Chokecherry Shrubland at the northwestern end of Lava Beds National Monument.

4. Greenleaf Manzanita Shrubland

Mapping Classification Common Name: Greenleaf Manzanita Sierran Chaparral Shrubland

Mapping Classification Scientific Name: *Arctostaphylos patula* Sierran Chaparral Shrubland

Map Code: CEGL005820

Common Species: Greenleaf manzanita **(***Arctostaphylos patula*), snowbrush ceanothus (*Ceanothus velutinus*), western juniper (*Juniperus occidentalis* var. *occidentalis*), bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*), sulphur-flower buckwheat (*Eriogonum polyanthum*), wavyleaf Indian paintbrush (*Castilleja applegatei* ssp. *pinetorum*), low beardtongue (*Penstemon humilis*).

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.B Temperate & Boreal Grassland & Shrubland Subclass
Formation: 2.B.2 Temperate Grassland & Shrubland Formation
Division: 2.B.2.Nd Western North American Interior Sclerophyllous Chaparral Division
Macrogroup: 2.B.2.Nd.1 - M094 *Arctostaphylos patula - Ceanothus velutinus - Quercus vacciniifolia* Montane Chaparral Macrogroup
Group: 2.B.2.Nd.1.a - G282 *Arctostaphylos patula - Arctostaphylos nevadensis - Ceanothus velutinus* Montane Sclerophyll Scrub Group
Alliance: A0788 *Arctostaphylos patula - Arctostaphylos nevadensis* Shrubland Alliance
Association: *Arctostaphylos patula* Sierran Chaparral Shrubland

Translated Name: Greenleaf Manzanita Sierran Chaparral Shrubland

Associations that may dominate the map unit:
- Greenleaf Manzanita Sierran Chaparral Shrubland

Associations that may be present but not dominant in the map unit:
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

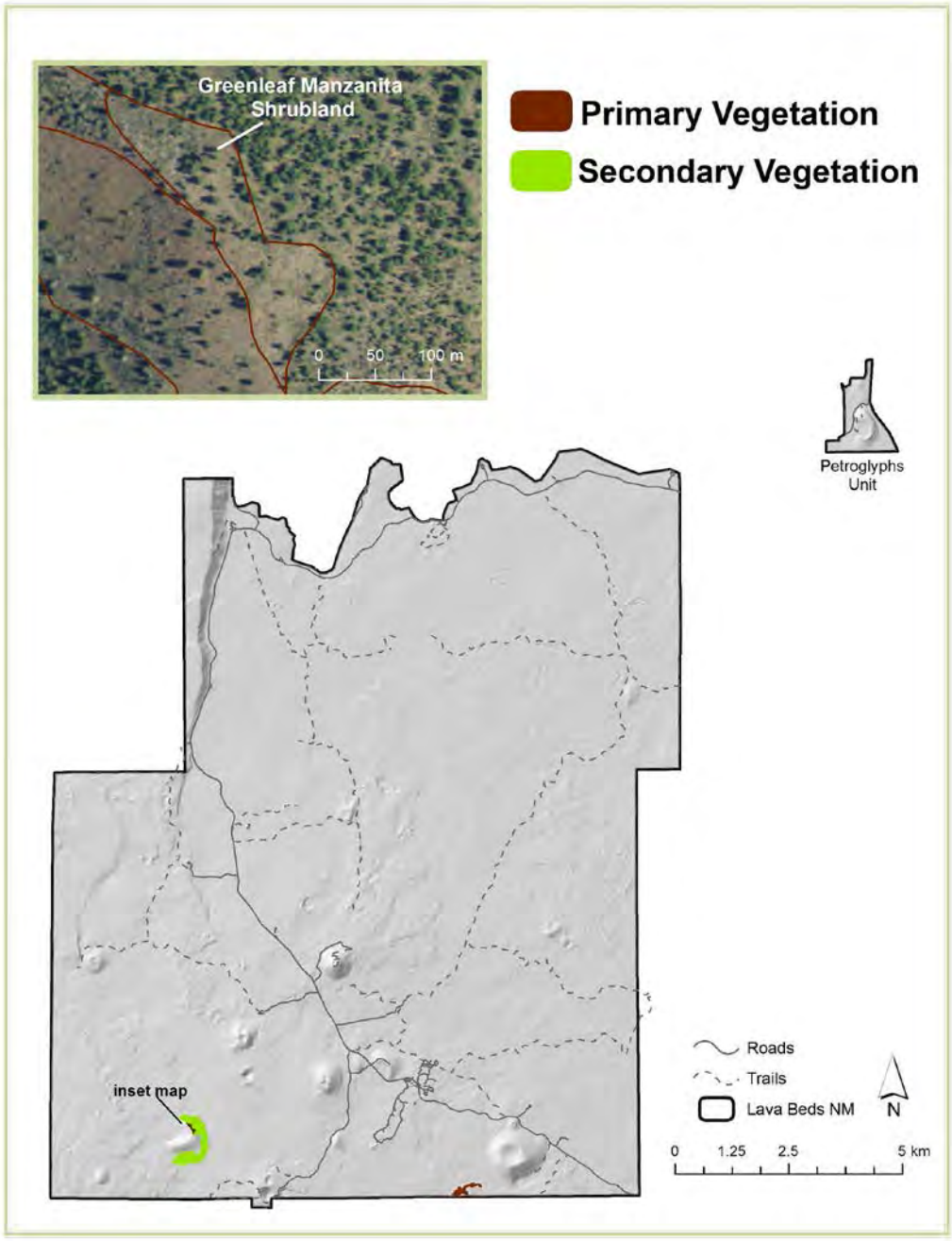
Cumulative area occupied (ha)*	
Primary vegetation	6.6
Secondary vegetation	10.6
Total	**17.2**
Percentage of Monument	**0.09**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1620-1660 m

Description: This vegetation consists of open to moderately dense stands dominated by the evergreen shrubs greenleaf manzanita (*Arctostaphylos patula*), averaging about 25% cover, and snowbrush ceanothus (*Ceanothus velutinus*), averaging 5-10% cover. Bluebunch wheatgrass (*Pseudoroegneria spicata*) is common in the understory, averaging almost 20% cover. Conifers (ponderosa pine (*Pinus ponderosa* var. *ponderosa*) and western juniper (*Juniperus occidentalis*) are scattered within the chaparral, and the chaparral is strongly intermixed with Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland vegetation.

Range and Distribution: Two stands large enough to be mapped (i.e., bigger than the 0.5 ha minimum mapping unit) were found at the south end of the park. Smaller stands are intermixed within Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland and White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland vegetation.



Above: Photo signature and range map for Greenleaf Manzanita Shrubland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Shrub vegetation is distinguishable on the imagery, but determining where Greenleaf Manzanita Shrubland occurred required on-the-ground knowledge. Hence the mapping of Greenleaf Manzanita Shrubland was based on the relevé sampling and the knowledge of the field crew leader. Chaparral is intermixed with conifer vegetation. In the polygons shown above were Greenleaf Manzanita Shrubland is the primary vegetation, a secondary vegetation of Ponderosa Pine Woodland is also coded into the database.

Representative Ground Photos:

Above: Greenleaf Manzanita Shrubland at the southern end of Lava Beds National Monument. The dominant shrub is greenleaf manzanita (*Arctostaphylos patula*).

5. Rubber Rabbitbrush Shrubland

Mapping Classification Common Name: Yellow Rabbitbrush - Rubber Rabbitbrush – Winterfat Shrubland Group

Mapping Classification Scientific Name: *Chrysothamnus viscidiflorus - Ericameria nauseosa - Krascheninnikovia lanata* Shrubland Group

Note: Winterfat (*Krascheninnikovia lanata*) is not found at Lava Beds

Map Code: G310

Common Species: rubber rabbitbrush **(***Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp*. viscidiflorus*), cheatgrass (*Bromus tectorum*), tall tumble mustard (*Sisymbrium altissimum*).

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.1 - M171 *Chrysothamnus viscidiflorus - Coleogyne ramosissima* / *Achnatherum hymenoides* Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup
Group: 3.B.1.Ne.1.d - G310 *Chrysothamnus viscidiflorus - Ericameria nauseosa - Krascheninnikovia lanata* Shrubland Group

Translated Name: Yellow Rabbitbrush - Rubber Rabbitbrush – Winterfat Shrubland Group

Associations that may dominate the map unit:
- Rubber Rabbitbrush Shrubland
- Yellow Rabbitbrush Shrub Herbaceous Vegetation

Associations that may be present but not dominant in the map unit:
- Squirreltail Herbaceous Vegetation [Provisional]
- Basin Wildrye Herbaceous Vegetation
- Cheatgrass Ruderal Herbaceous Vegetation
- Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Desert Gooseberry / Basin Wildrye Shrubland [Provisional]
- Western Juniper / Mountain Big Sagebrush Woodland
- Sparsely Vegetated Rock [Provisional]

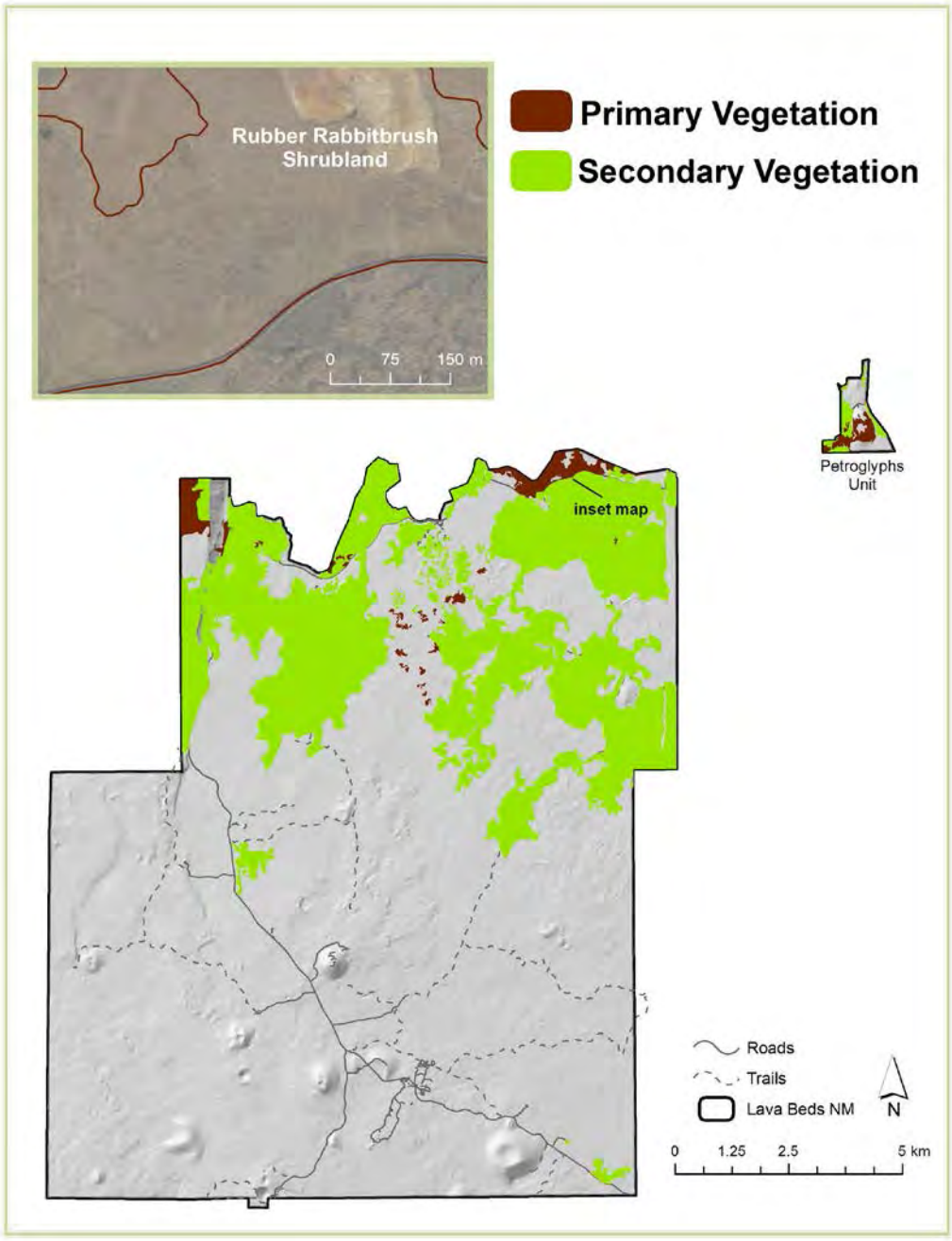
Cumulative area occupied (ha)*	
Primary vegetation	132.8
Secondary vegetation	967.0
Total	**1,099.9**
Percentage of Monument	**5.8**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1230-1390 m

Description: This vegetation is characterized by a relatively open (25% cover) shrub canopy co-dominated by rubber rabbitbrush (*Ericameria nauseosa*) and big sagebrush (*Artemisia tridentata* ssp. *vaseyana* and/or ssp. *tridentata*) shrubs that are 0.5-2 m tall, each averaging 10-15 % cover. There is an herbaceous layer dominated by cheatgrass (*Bromus tectorum*) (10-15% cover). Other shrubs and dwarf-shrubs may be present at low cover. Yellow rabbitbrush (*Chrysothamnus viscidiflorus*) may be present at high cover.

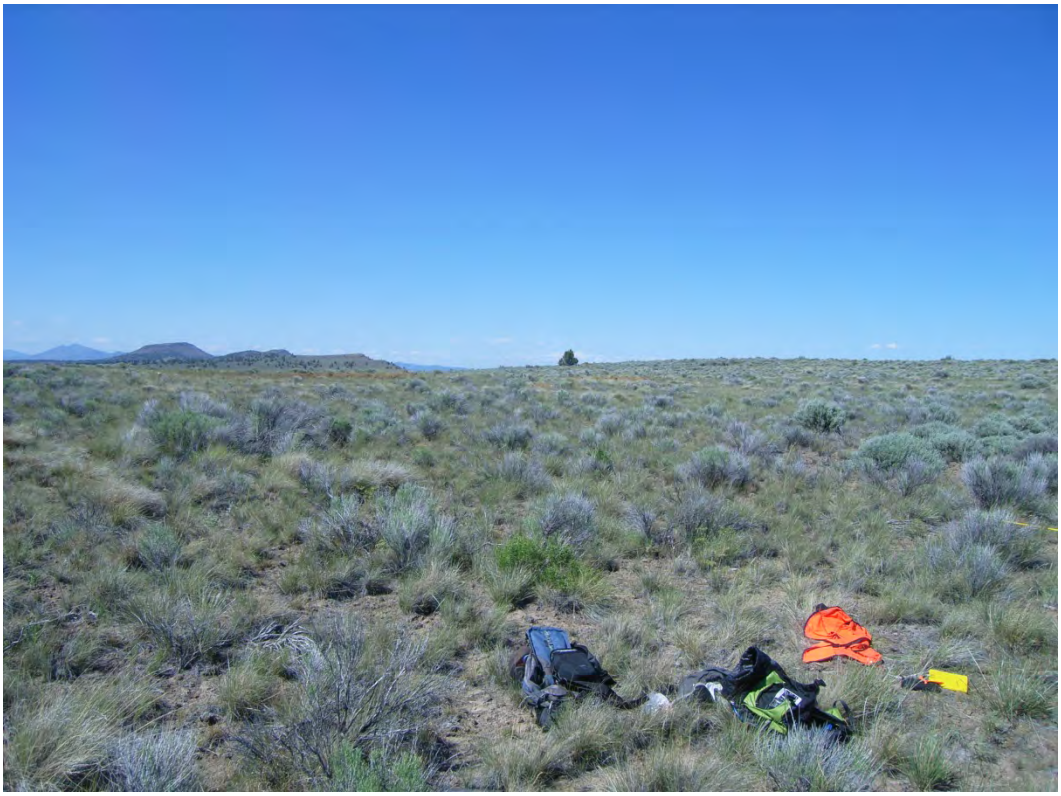
Range and Distribution: Widespread at the lower elevations towards the north end of the monument.



Above: Photo signature and range map for Rubber Rabbitbrush Shrubland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Rubber Rabbitbrush Shrubland has a coarse texture that distinguishes it from the smooth texture of the Cheatgrass Ruderal Herbaceous Vegetation with which it is often intermixed. Rubber Rabbitbrush Shrubland was separated from Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland and Mountain Big Sagebrush - Antelope Bitterbrush Shrubland using ancillary information (relevé data, and the pre-existing vegetation map (Erhard 1979).

Representative Ground Photo:



Above: Rubber Rabbitbrush Shrubland at the northern end of Lava Beds National Monument. The gray shrubs are rubber rabbitbrush (*Ericameria nauseosa*). The tussocks are bluebunch wheatgrass (*Pseudoroegneria spicata*).

6. Big Sagebrush - Purple Sage - Fernbush Shrubland

Mapping Classification Common Name: Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]

Mapping Classification Scientific Name: *Artemisia tridentata – Salvia dorrii – Chamaebatiaria millefolium* Shrubland [Provisional]

Map Code: NPSLABE004

Common Species: basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), purple sage (*Salvia dorrii*), antelope bitterbrush (*Purshia tridentate* var. *tridentata*), fernbush or desert sweet (*Chamaebatiaria millefolium*), wax currant (*Ribes cereum*), cheatgrass (*Bromus tectorum*), bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*), scabland penstemon *(Penstemon deustus* var. *pedicellatus*), granite prickly phlox (*Leptodactylon pungens*).

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.3 - M169 *Artemisia tridentata - Artemisia tripartita* ssp. *tripartita - Purshia tridentata* Great Basin & Intermountain Shrubland & Steppe Macrogroup

Association: Provisional vegetation association.

Associations that may dominate the map unit:
- Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]
- Fernbush - Wax Currant Shrubland [Provisional]

Associations that may be present but not dominant in the map unit:
- Cheatgrass Ruderal Herbaceous Vegetation
- Squirreltail Herbaceous Vegetation [Provisional]
- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation
- Desert Gooseberry / Basin Wildrye Shrubland [Provisional]
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Rubber Rabbitbrush Shrubland
- Chokecherry - Mixed Shrub Talus Shrubland
- Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation
- Sparsely Vegetated Rock [Provisional]
- Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]
- Fernbush - Wax Currant Shrubland [Provisional]
- Antelope Bitterbrush - Purple Sage Shrubland [Provisional]
- Western Juniper / Mountain Big Sagebrush Woodland
- Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

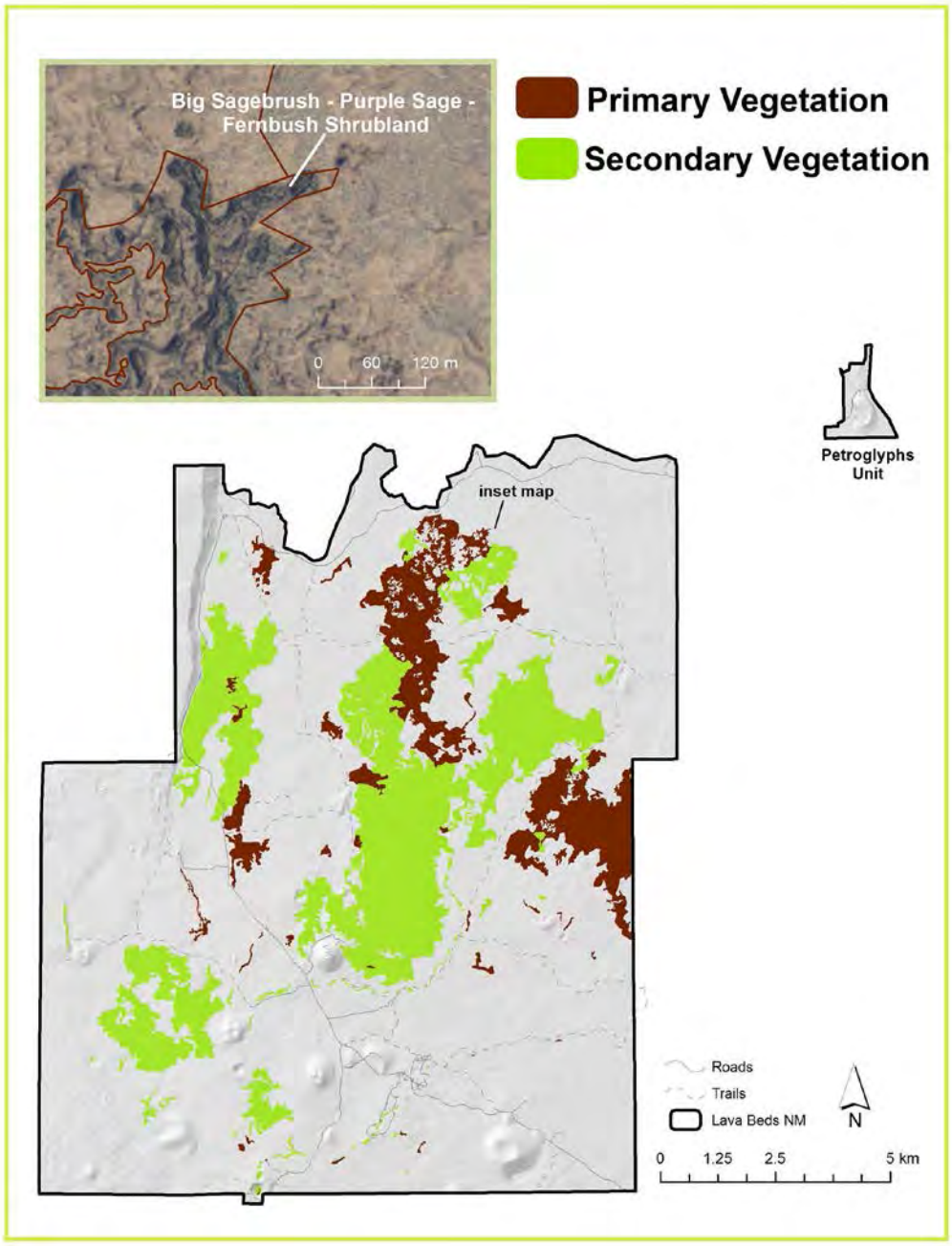
Cumulative area occupied (ha)*	
Primary vegetation	783.7
Secondary vegetation	1,306.9
Total	**2,090.6**
Percent of Monument	**11.0**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1245-1580 m

Description: This relatively sparse shrub vegetation is dominated by either basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) or mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), averaging 25% cover. Co-occurring shrubs include fernbush or desert sweet (*Chamaebatiaria millefolium*), purple sage (*Salvia dorrii*), and antelope bitterbrush (*Purshia tridentata* var. *tridentata*), all averaging < 5% cover. The perennial bunchgrass bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) can be present at covers ranging from near zero to 25%, while the annual cheatgrass (*Bromus tectorum*) may be present at covers ranging from near zero to 10%. The perennial herbs scabland penstemon (*Penstemon deustus* var. *pedicellatus*) and granite prickly phlox (*Leptodactylon pungens*) are sometimes present.

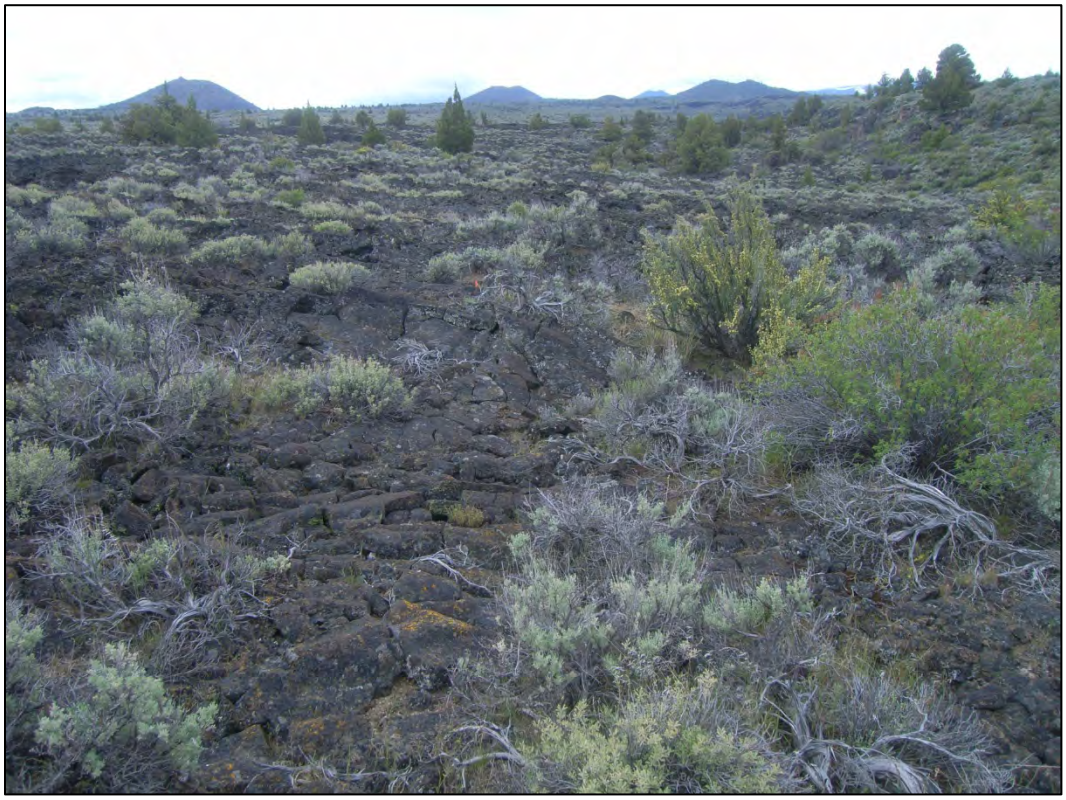
Range and Distribution: On sparsely vegetated lava flows, lava rock formations, and collapsed lava caves throughout the central portion of the monument. On similar substrata that are less common in the extreme north and south of the monument. Found on Schonchin Butte.



Above: Photo signature and range map for Big Sagebrush - Purple Sage - Fernbush Shrubland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: This vegetation could be discerned on the photo imagery due to the presence of rocky areas that were not devoid of vegetation nor densely vegetated. It was often intermixed with grassland, sagebrush, or Juniper - Mountain-mahogany Woodland (see inset photo above). Hence, it was often mapped as a secondary vegetation type co-occurring with more dominant vegetation.

Representative Ground Photo:



Above: Big Sagebrush - Purple Sage - Fernbush Shrubland at the northern end of Lava Beds National Monument.

7. Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland

Mapping Classification Common Name: Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation

Mapping Classification Scientific Name: *Artemisia tridentata* ssp. *tridentata* / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation

Map Code: CEGL001018

Common Species: basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), cheatgrass (*Bromus tectorum*), desert gooseberry (*Ribes velutinum*), yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*), antelope bitterbrush (*Purshia tridentata* var. *tridentata*), Thurber's needlegrass (*Achnatherum thurberianum*), Sandberg bluegrass (*Poa secunda*), squirreltail *(Elymus elymoides*), threadleaf phacelia (*Phacelia linearis*).

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.3 - M169 *Artemisia tridentata - Artemisia tripartita* ssp. *tripartita - Purshia tridentata* Great Basin & Intermountain Shrubland & Steppe Macrogroup
Group: 3.B.1.Ne.3.b - G302 *Artemisia tridentata - Artemisia tripartita - Purshia tridentata* Big Sagebrush Steppe Group
Alliance: A3183 *Artemisia tridentata* ssp. *tridentata - Artemisia tridentata* ssp. *xericensis* Mesic Shrubland & Steppe Alliance
Association: *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation

Translated Name: (Basin Big Sagebrush, Foothill Big Sagebrush) / Bluebunch Wheatgrass Shrub Herbaceous Vegetation

Associations that may dominate the map unit:
- Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation

Associations that may be present but not dominant in the map unit:
- Squirreltail Herbaceous Vegetation [Provisional]
- Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation [Provisional]
- Rubber Rabbitbrush Shrubland
- Desert Gooseberry / Basin Wildrye Shrubland [Provisional]
- Fernbush - Wax Currant Shrubland [Provisional]

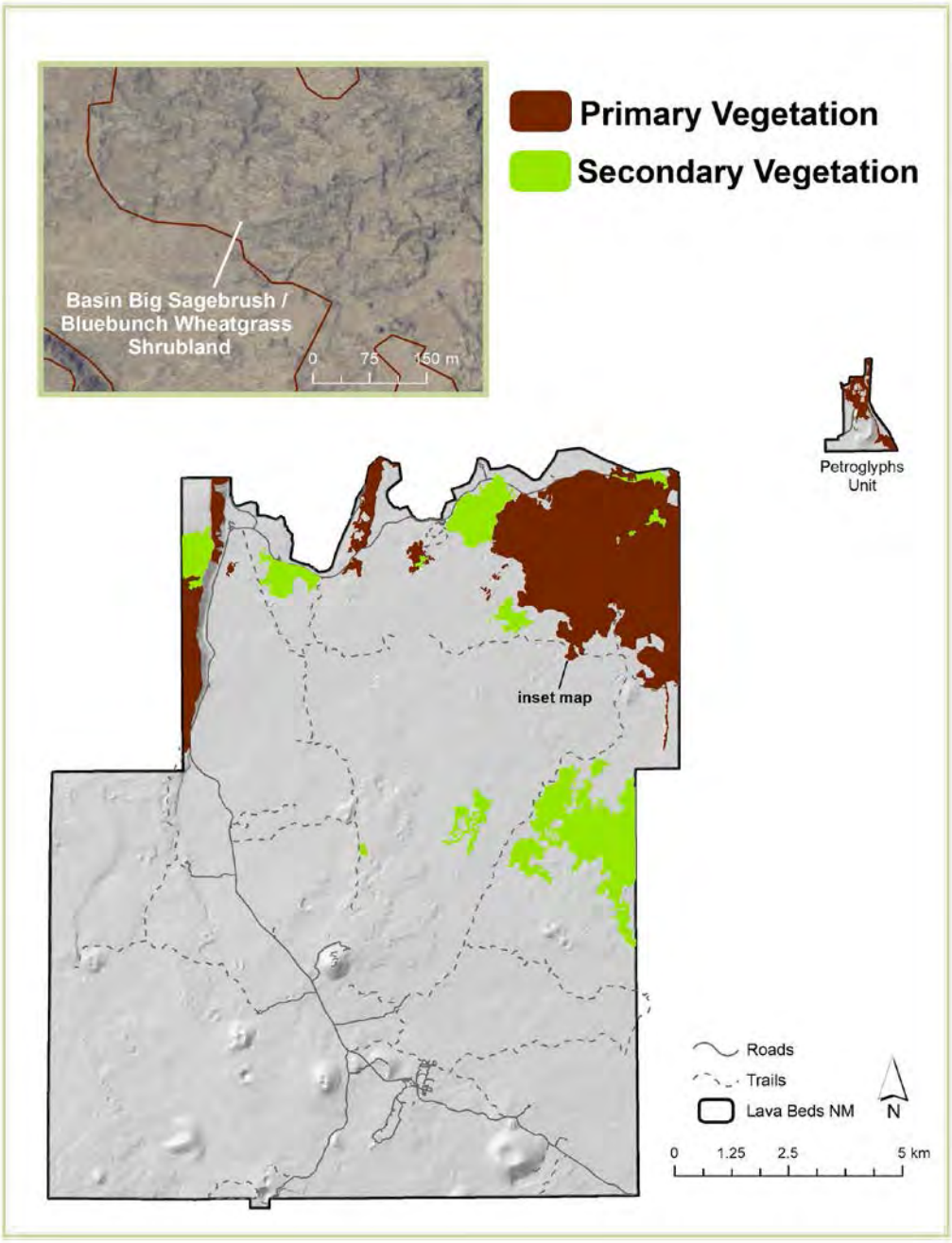
Cumulative area occupied (ha)*	
Primary vegetation	818.6
Secondary vegetation	214.0
Total	**1,032.6**
Percentage of Monument	**5.45**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1230-1320 m

Description: This shrubland association is dominated by basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), averaging about 19% cover. The shrubs antelope bitterbrush (*Purshia tridentata* var. *tridentata*) and yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*) are often present at lower cover. The non-native annual cheatgrass (*Bromus tectorum*) is ubiquitous, but not particularly abundant in any one area, averaging 12% cover. The perennial bunchgrass Thurber's needlegrass (*Achnatherum thurberianum*), Sandberg bluegrass (*Poa secunda*), and squirreltail (*Elymus elymoides*) are also present at low cover. Moving upslope from the basin floor to the foothills of the Medicine Lake Highlands, basin big sagebrush gives way to mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) with a broad zone of intergradation at the lower end of the middle elevations (~1330-1350 m) within the monument. The two *Artemisia tridentata* subspecies often co-occur and probably hybridize in this intergradation zone.

Range and Distribution: This vegetation occurs abundantly in less rocky areas in the northeastern portion of the monument and in the Petroglyphs Unit northeast of the main unit.



Above: Photo signature and range map for Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland was separated from grassland based on the coarser texture where Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland was dominant. A blueish color in the vegetation also allowed for delineation from the tawny brown of grassland. A lighter color on the imagery helped distinguish Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland from Big Sagebrush - Purple Sage - Fernbush Shrubland, which occurs on rock. Ancillary information was also helpful. This consisted of

the relevé data and the pre-existing vegetation map (Erhard 1979). From these information sources, it was determined that Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland gives way to Mountain Big Sagebrush - Antelope Bitterbrush Shrubland (*Artemisia tridentata* ssp. *vaseyana*) with a broad zone of intergradation at the lower end of the middle elevations (~1330-1350 m) within the monument.

Representative Ground Photo:

Above: Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland at the northeastern end of Lava Beds National Monument. The dominant shrub is basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*). On the far right, a carpet of cheatgrass (*Bromus tectorum*) can be seen near the tape and the person sampling the vegetation.

8. Mountain Big Sagebrush - Antelope Bitterbrush Shrubland

Mapping Classification Common Name: Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland

Mapping Classification Scientific Name: *Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland

Map Code: CEGL001032

Common Species: mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), antelope bitterbrush (*Purshia tridentata* var. *tridentata*), yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*), bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*), Idaho fescue (*Festuca idahoensis*), Thurber's needlegrass (*Achnatherum thurberianum*), Sandberg bluegrass (*Poa secunda*), tapertip hawksbeard (*Crepis acuminata*), threadleaf phacelia *(Phacelia linearis*), spreading phlox *(Phlox diffusa*)

USNVC Classification:
Class: 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class
Subclass: 3.B Cool Semi-Desert Scrub & Grassland Subclass
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland Formation
Division: 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
Macrogroup: 3.B.1.Ne.3 - M169 *Artemisia tridentata* - *Artemisia tripartita* ssp. *tripartita* - *Purshia tridentata* Great Basin & Intermountain Shrubland & Steppe Macrogroup
Group: 3.B.1.Ne.3.c - G304 *Artemisia tridentata* ssp. *spiciformis* - *Artemisia tridentata* ssp. *vaseyana* - *Artemisia cana* ssp. *viscidula* Tall Shrubland & Steppe Group
Alliance: A3208 *Artemisia tridentata* ssp. *vaseyana* - Mixed Shrubland Alliance
Association: *Artemisia tridentata* ssp. *vaseyana* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland

Translated Name: Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland

Associations that may dominate the map unit:
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland

Associations that may be present but not dominant in the map unit:
- Cheatgrass Ruderal Herbaceous Vegetation
- Yellow Rabbitbrush Shrub Herbaceous Vegetation
- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation
- Rubber Rabbitbrush Shrubland
- Chokecherry - Mixed Shrub Talus Shrubland
- Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]
- Antelope Bitterbrush - Purple Sage Shrubland [Provisional]
- Fernbush - Wax Currant Shrubland [Provisional]

- Western Juniper / Mountain Big Sagebrush Woodland
- Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland
- Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland
- Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

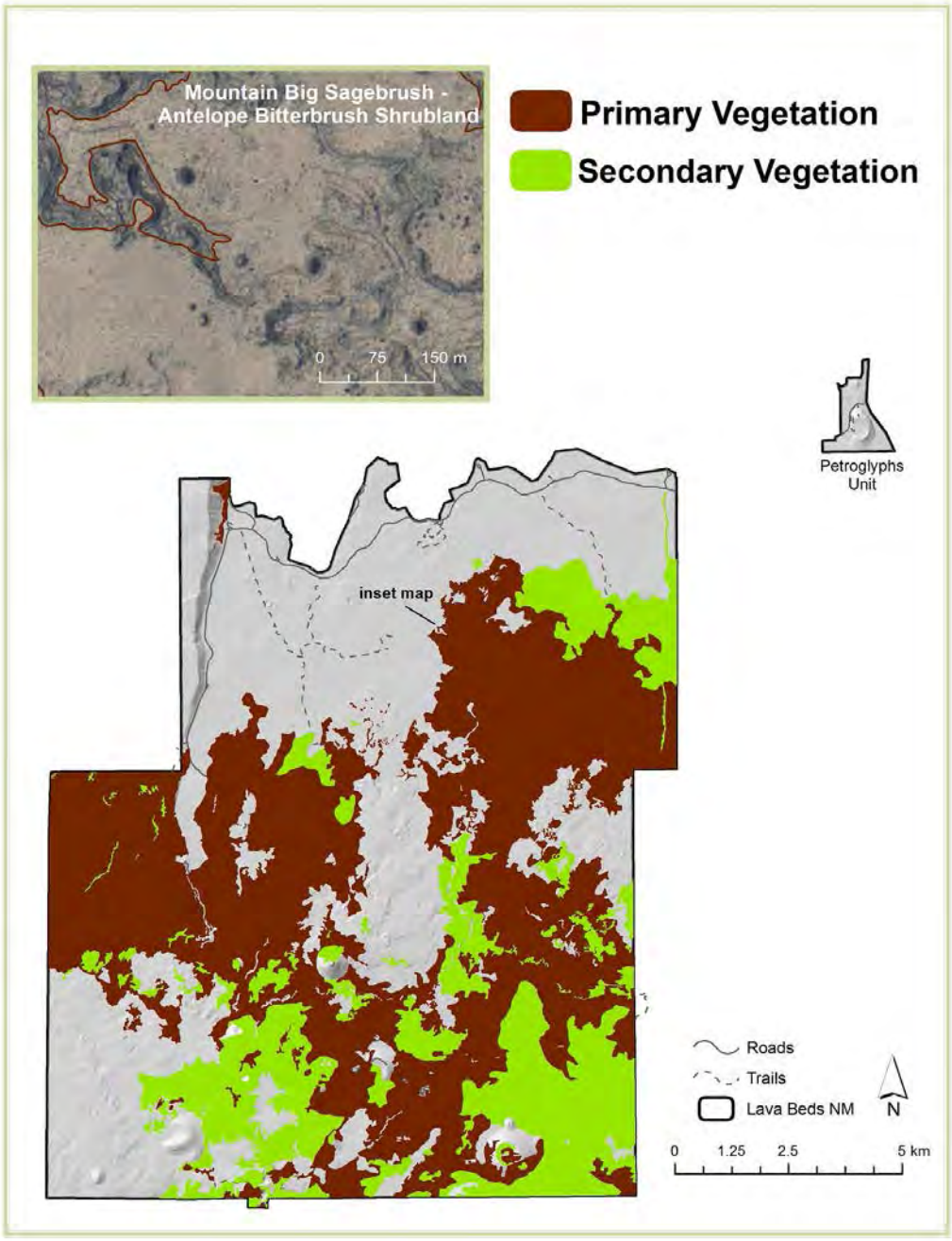
Cumulative area occupied (ha)*	
Primary vegetation	6,026.1
Secondary vegetation	1,153.1
Total	7,179.2
Percent of Monument	37.9

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1260-1570 m

Description: This vegetation is dominated by mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), averaging 15-20% cover, typically with well-developed herbaceous undergrowth dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*), averaging 5-10% cover. Other shrubs are usually present in the overstory, but no one species is a ubiquitous co-dominant. These shrubs associated with Mountain Big Sagebrush - Antelope Bitterbrush Shrubland include Saskatoon serviceberry (*Amelanchier alnifolia*), rabbitbrush species (*Chrysothamnus* and *Ericameria* spp.), spineless horsebrush (*Tetradymia canescens*), and antelope bitterbrush (*Purshia tridentata* var. *tridentata*). In addition there are often widely scattered western juniper (*Juniperus occidentalis*) trees. The herbaceous undergrowth is dominated by grasses. In disturbed stands, cheatgrass (*Bromus tectorum*) can be more abundant than bluebunch wheatgrass (*Pseudoroegneria spicata*).

Range and Distribution: Widespread throughout the monument except at the lowest elevations in the northern portion.

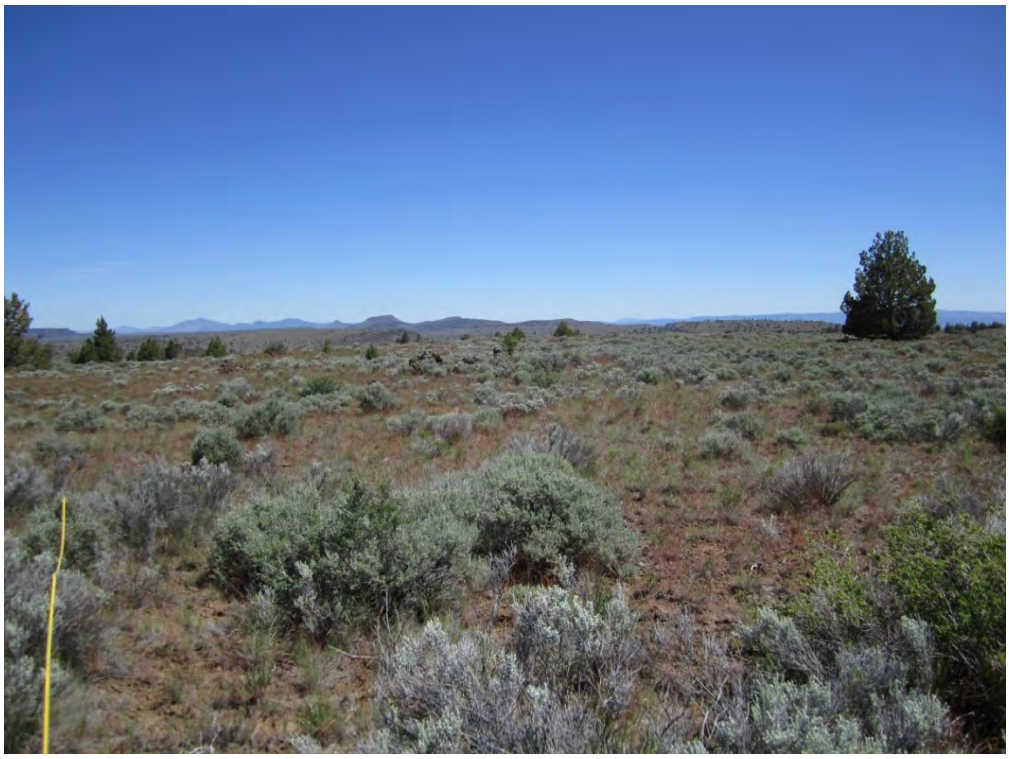


Above: Photo signature and range map for Mountain Big Sagebrush - Antelope Bitterbrush Shrubland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: The shrubland texture, which is coarser than grassland, and the absence of taller woodland species like western juniper distinguishes the shrubland types dominated by big sagebrush. The Mountain Big Sagebrush - Antelope Bitterbrush Shrubland formation was distinguished from Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland using ancillary information (plot data and Erhard 1979). From these information sources, it was determined that the transition zone between basin big sagebrush and mountain big sagebrush occurs at about 1330-1350 m within the monument.

Representative Ground Photos:

Above: Mountain Big Sagebrush - Antelope Bitterbrush Shrubland at Lava Beds National Monument. Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) is the dominant shrub. Antelope bitterbrush (*Purshia tridentata* var*. tridentata*) is also common. Bluebunch wheatgrass (*Pseudoroegneria spicata*) is the dominant herb.



Above: Mountain Big Sagebrush - Antelope Bitterbrush Shrubland at Lava Beds National Monument.

C. Woodland Vegetation

9. Ponderosa Pine Woodland

Mapping Classification Common Name: Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

Mapping Classification Scientific Name: *Pinus ponderosa* / *Arctostaphylos patula - Purshia tridentata* Woodland

Map Code: CEGL000063

Common Species: ponderosa pine (*Pinus ponderosa* var. *ponderosa*), greenleaf manzanita (*Arctostaphylos patula*), snowbrush ceanothus (*Ceanothus velutinus*), antelope bitterbrush (*Purshia tridentata* var. *tridentata*), wax currant (*Ribes cereum*), squirreltail (*Elymus elymoides*), Ross' sedge (*Carex rossii*), maiden blue eyed Mary (*Collinsia parviflora*).

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nb Rocky Mountain Cool Temperate Forest Division
Macrogroup: 1.B.2.Nb.2- M501 *Pinus ponderosa* var. *ponderosa - Pseudotsuga menziesii - Pinus flexilis* Central Rocky Mountain Dry Forest Macrogroup
Group: 1.B.2.Nb.2.a - G213 *Pinus ponderosa* var. *ponderosa* Central Rocky Mountain Woodland & Savanna Group
Alliance: A3446 *Pinus ponderosa* / Shrub Understory Central Rocky Mountain Woodland Alliance
Association: *Pinus ponderosa* / *Arctostaphylos patula - Purshia tridentata* Woodland

Translated Name: Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

Associations that may dominate the map unit:
- Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

Associations that may be present but not dominant in the map unit:
- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Greenleaf Manzanita Sierran Chaparral Shrubland
- Western Juniper / Mountain Big Sagebrush Woodland
- Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland
- Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland
- White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland

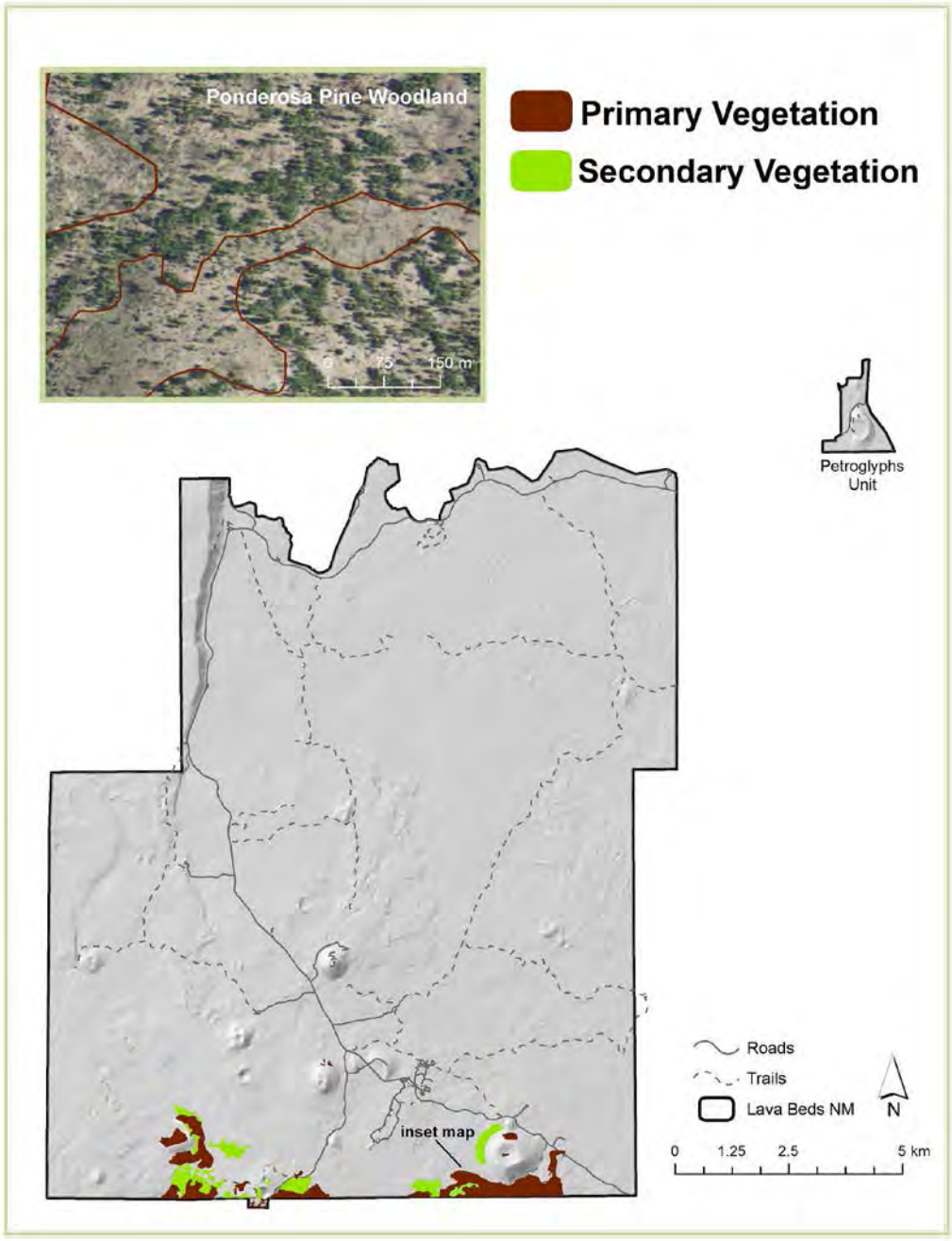
Cumulative area occupied (ha)*	
Primary vegetation	146.1
Secondary vegetation	27.6
Total	**173.7**
Percent of Monument	**0.9**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1520-1570 m

Description: This forest and woodland vegetation is dominated by mostly medium-sized (10-20 m tall) ponderosa pine (*Pinus ponderosa* var. *ponderosa*), averaging 33% cover. Stands range from open woodlands of scattered open grown trees to denser stands. Hence, the overstory cover of ponderosa pine may range from about 10% to 75%. Antelope bitterbrush (*Purshia tridentata* var. *tridentata*), snowbrush ceanothus (*Ceanothus velutinus*) and greenleaf manzanita (*Arctostaphylos patula*) are often present in the shrub layer at low to high cover.

Range and Distribution: Scattered stands at the south end of the monument.



Above: Photo signature and range map for Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Ponderosa pine (*Pinus ponderosa*) can be distinguished on the 2009 NAIP imagery by its brighter green color [compared to the grayer western juniper (*Juniperus occidentalis*)], and the bigger shadow it casts. In addition, the shadow is triangular in shape, owing to the pyramidal-shaped crown. Conversely, western juniper has a rounded crown and shadow. Areas where ponderosa pine exceeded 10% cover were mapped as Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland.

Representative Ground Photo:

Above: Ponderosa Pine Woodland at the southern end of Lava Beds National Monument. All the trees in this photo are ponderosa pine (*Pinus ponderosa* var. *ponderosa*).

10. Juniper - Mountain-mahogany Woodland

Mapping Classification Common Name: Western Juniper Woodland & Savanna Group and Curl-leaf Mountain-mahogany Scrub & Woodland Group

Mapping Classification Scientific Name: *Juniperus occidentalis* Woodland & Savanna Group and *Cercocarpus ledifolius* Scrub & Woodland Group

Map Code: G248

Common Species: western juniper (*Juniperus occidentalis* var. *occidentalis*), curl-leaf mountain-mahogany *(Cercocarpus ledifolius* var. *intercedens*), antelope bitterbrush (*Purshia tridentata* var. *tridentata*), desert gooseberry (*Ribes velutinum*), sulphur-flower buckwheat (*Eriogonum polyanthum*), branching phacelia (*Phacelia ramosissima* var. *ramosissima*), Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*), cheatgrass (*Bromus tectorum*)

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nc Western North American Cool Temperate Woodland & Scrub Division
Macrogroup: 1.B.2.Nc.1 - M026 *Pinus monophylla - Juniperus osteosperma - Juniperus occidentalis* Intermountain Woodland Macrogroup
Group: 1.B.2.Nc.1.b - G248 *Juniperus occidentalis* Woodland & Savanna Group
and
Group:1.B.2.Nc.1.d - G249 *Cercocarpus ledifolius* Scrub & Woodland Group

Translated Name: Western Juniper Woodland & Savanna Group and Curl-leaf Mountain-mahogany Scrub & Woodland Group

Associations that may dominate the map unit:
- Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland
- Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland
- Western Juniper / Mountain Big Sagebrush Woodland

Associations that may be present but not dominant in the map unit:
- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation
- Rubber Rabbitbrush Shrubland
- Fernbush - Wax Currant Shrubland [Provisional]
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Antelope Bitterbrush - Purple Sage Shrubland [Provisional]
- Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland
- Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]
- Sparsely Vegetated Rock [Provisional]
- Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland
- Western Juniper / Mountain Big Sagebrush Woodland

- Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

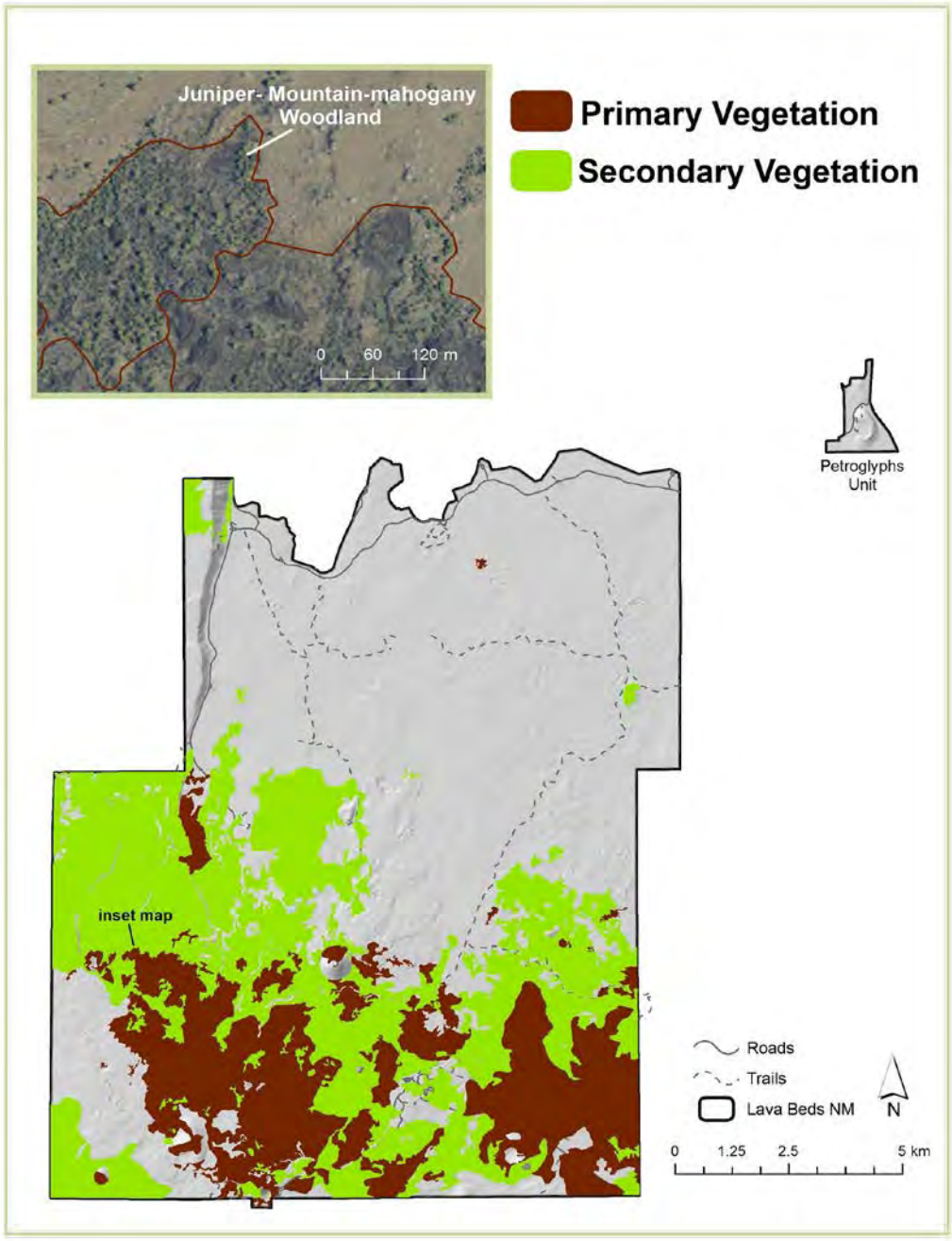
Cumulative area occupied (ha)*	
Primary vegetation	2176.9
Secondary vegetation	832.8.0
Total	3009.7
Percent of Monument	15.9

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1255-1635 m

Description: This is an open to closed woodland co-dominated by western juniper (*Juniperus occidentalis* var. *occidentalis*) and curl-leaf mountain-mahogany (*Cercocarpus ledifolius* var. *intercedens*), each averaging 15-20% cover, but with considerable variability (range in cover of 1-50% for each species). Antelope bitterbrush (*Purshia tridentata* var. *tridentata*) is often present at low to moderate cover (average 2-3%). The perennial bunchgrasses bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *spicata*) and Idaho fescue (*Festuca idahoensis*) are sometimes present at low to high cover. Stands may be dominated exclusively by either western juniper or curl-leaf mountain-mahogany where the two species do not co-occur.

Range and Distribution: Abundant throughout the middle and upper elevations of the monument.



Above: Photo signature and range map for Juniper - Mountain-mahogany Woodland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: The crowns of western juniper (*Juniperus occidentalis*) and large curl-leaf mountain-mahogany (*Cercocarpus ledifolius*) individuals can be seen readily in the NAIP imagery. Where the combined overstory cover of these species was 5% or greater, the area was mapped as Juniper - Mountain-mahogany Woodland. Where the cover was lower, the vegetation was considered Mountain Big Sagebrush - Antelope Bitterbrush Shrubland or Perennial Grassland. Areas with low cover of western juniper and high cover of curl-leaf mountain-

mahogany as well as areas with low cover of curl-leaf mountain-mahogany and high cover of western juniper were included in the mapped extent of this formation.

Representative Ground Photo:

Above: Juniper - Mountain-mahogany Woodland at the southern end of Lava Beds National Monument. The shrub on the left is curl-leaf mountain-mahogany (*Cercocarpus ledifolius*). In the upper right is western juniper (*Juniperus occidentalis*).

11.White Fir - Ponderosa Pine Woodland

Mapping Classification Common Name: White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland

Mapping Classification Scientific Name: *Abies concolor - Pinus ponderosa* / *Purshia tridentata* Woodland

Map Code: CEGL000259

Common Species: ponderosa pine (*Pinus ponderosa* var. *ponderosa*), white fir (*Abies concolor*), snowbrush ceanothus (*Ceanothus velutinus*), greenleaf manzanita (*Arctostaphylos patula*), antelope bitterbrush (*Purshia tridentata* var. *tridentata*), Sierra gooseberry (*Ribes roezlii* var. *roezlii*), squirreltail (*Elymus elymoides*), alpine alumroot (*Heuchera cylindrica* var. *alpina*)

USNVC Classification:
Class: 1 Mesomorphic Tree Vegetation Class
Subclass: 1.B Temperate & Boreal Forest & Woodland Subclass
Formation: 1.B.2 Cool Temperate Forest & Woodland Formation
Division: 1.B.2.Nd Vancouverian Cool Temperate Forest Division
Macrogroup: 1.B.2.Nd.2 - M023 *Calocedrus decurrens - Pinus jeffreyi - Abies concolor* var. *lowiana* Forest Macrogroup
Group: 1.B.2.Nd.2.a - G344 *Calocedrus decurrens - Pinus lambertiana - Abies concolor* Forest & Woodland Group
Alliance: A3677 *Abies concolor - Pinus ponderosa* Eastern Sierran Forest & Woodland Alliance
Association: *Abies concolor - Pinus ponderosa* / *Purshia tridentata* Woodland

Translated Name: White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland

Associations that may dominate the map unit:
- White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland
- Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

Associations that may be present but not dominant in the map unit:
- Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland

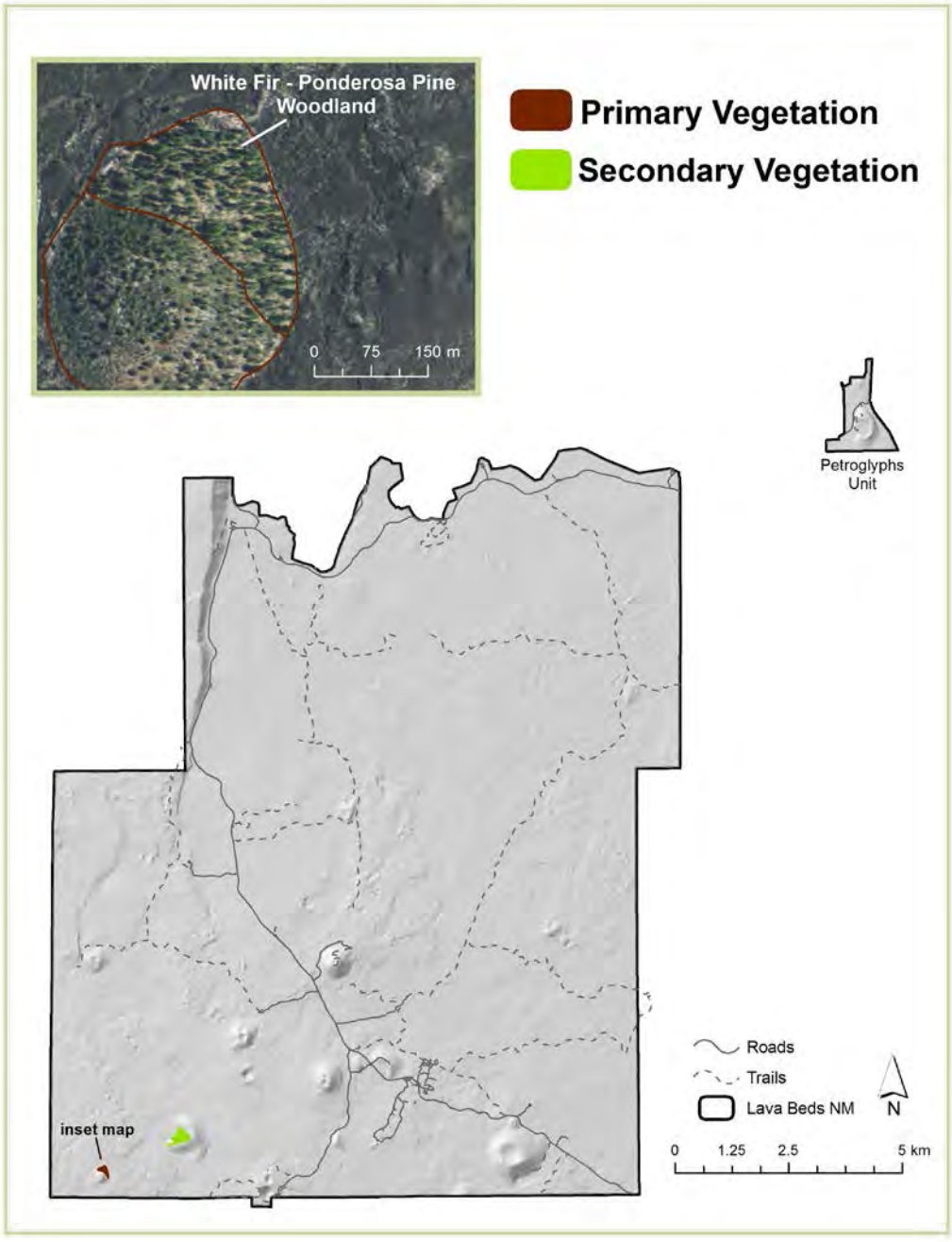
Cumulative area occupied (ha)*	
Primary vegetation	3.9
Secondary vegetation	3.0
Total	6.9
Percent of Monument	0.04

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1610-1660 m

Description: This forest vegetation is dominated by mostly medium-sized (10-20 m tall) ponderosa pine (*Pinus ponderosa* var. *ponderosa*) at moderate to high cover with white fir (*Abies concolor*) of varying size present and often co-dominant at low (> 2%) to high cover.

Range and Distribution: Two small areas of this forest vegetation occur on north-facing aspects at the south end of the monument.



Above: Photo signature and range map for White Fir - Ponderosa Pine Woodland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: A forest of conifers is apparent on the 2009 NAIP imagery (see inset map above). The presence of both ponderosa pine (*Pinus ponderosa* var. *ponderosa*) and white fir (*Abies concolor*) was ascertained from relevé data.

Representative Ground Photo:

Above: White Fir - Ponderosa Pine Woodland at the southern end of Lava Beds National Monument. The larger trees are ponderosa pine (*Pinus ponderosa* var. *ponderosa*) and the smaller trees in the center/left of the photo are white fir (*Abies concolor*).

12. Pacific Willow / Basin Wildrye Woodland

Mapping Classification Common Name: Pacific Willow / Basin Wildrye Woodland [Provisional]

Mapping Classification Scientific Name: *Salix lucida* ssp. *lasiandra* / *Leymus cinereus* Woodland [Provisional]

Map Code: NPSLABE008

Common Species: Pacific willow **(***Salix lucida* ssp. *lasiandra*), desert gooseberry (*Ribes velutinum*), Saskatoon serviceberry (*Amelanchier alnifolia* var. *semiintegrifolia*), yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*), basin wildrye (*Leymus cinereus*), *Sisymbrium altissimum* (tall tumblemustard), herb sophia (*Descurainia sophia*).

USNVC Classification:
Class: 2 Mesomorphic Shrub & Herb Vegetation Class
Subclass: 2.C Shrub & Herb Wetland Subclass
Formation: 2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation
Division: 2.C.4.Nb *Alnus viridis* ssp. *sinuata* - *Salix* spp. / *Carex* spp. - *Blennosperma nanum* - *Poa pratensis* Western North American Freshwater Shrubland, Wet Meadow & Marsh Division
Macrogroup: 2.C.4.Nb.2 - M075 Western North American Montane to Alpine Wet Shrubland & Wet Meadow Macrogroup
Group: 2.C.4.Nb.2.d - G527 *Salix* spp. - *Alnus* spp. - *Betula occidentalis* Riparian & Seep Shrubland Group
Alliance: A3769 *Salix boothii* - *Salix geyeriana* - *Salix lutea* Montane Shrubland Alliance
Association: Provisional vegetation association.

Associations that may dominate the map unit:

- Pacific Willow / Basin Wildrye Woodland [Provisional]

Associations that may be present but not dominant in the map unit:

- None

Cumulative area occupied (ha)*	
Primary vegetation	0.27
Secondary vegetation	
Total	**0.27**
Percent of Monument	**<0.01**

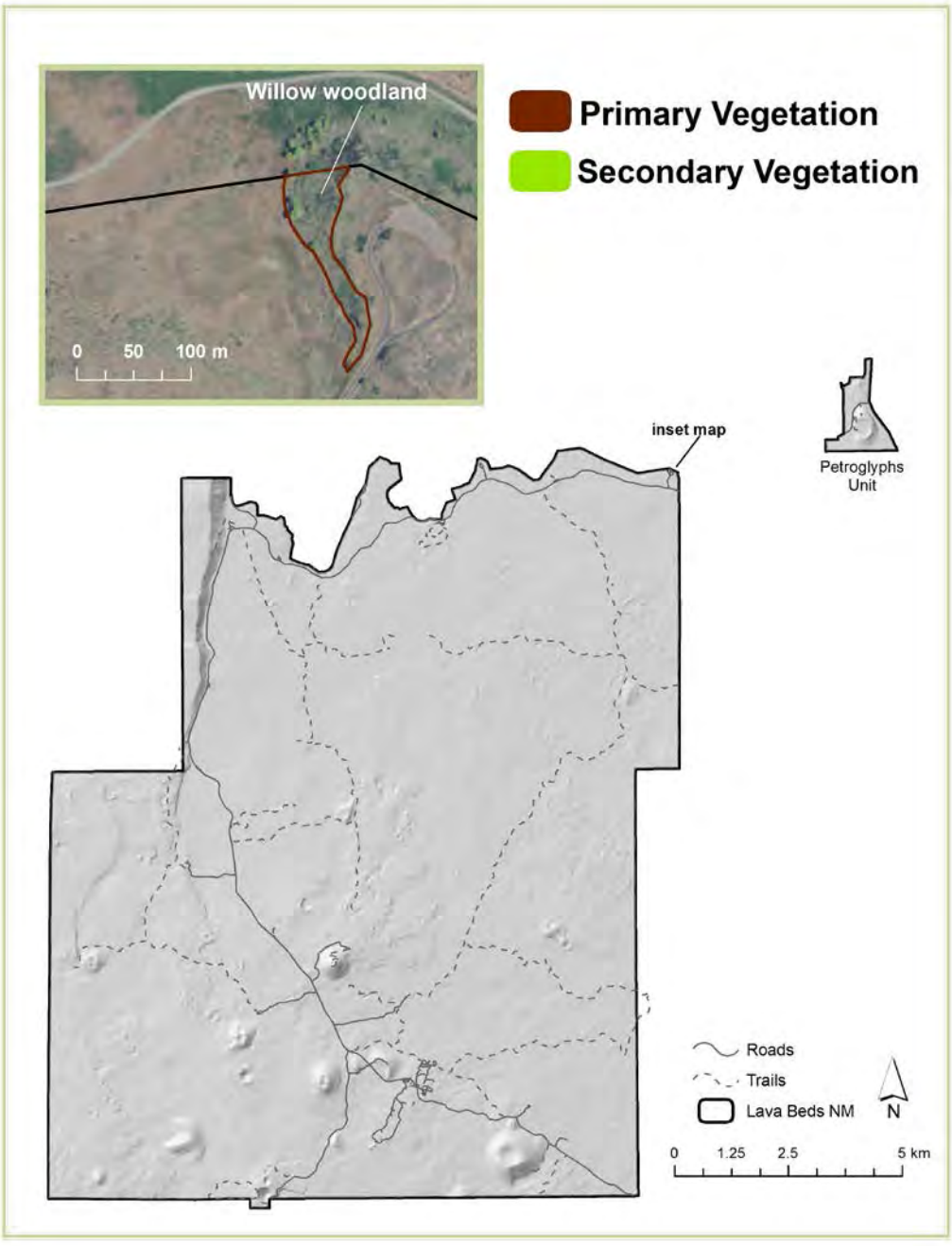
*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1230-1240 m

Description: This vegetation is dominated by Pacific willow (*Salix lucida* ssp. *lasiandra*), and the perennial bunchgrass basin wildrye (*Leymus cinereus*), both averaging 37.5%. The shrubs desert gooseberry (*Ribes velutinum*), yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*),

and Saskatoon serviceberry (*Amelanchier alnifolia* var. *semiintegrifolia*) are present at moderate to high cover.

Range and Distribution: One small stand at the northeast end of the monument along the historic shoreline of Tule Lake.



Above: Photo signature and range map for Pacific Willow / Basin Wildrye Woodland in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Pacific Willow / Basin Wildrye Woodland occurs in one area of the monument as shown in the map above. The occurrence of this vegetation was documented during field work.

Representative Ground Photo:

Above: Pacific Willow / Basin Wildrye Woodland at the northern end of Lava Beds National Monument.

13. Sparsely Vegetated Rock

Mapping Classification Common Name: Sparsely Vegetated Rock [Provisional]

Mapping Classification Scientific Name: N/A

Map Code: NPSLABE009

Common Species: curl-leaf mountain-mahogany (*Cercocarpus ledifolius* var. *intercedens*), purple sage (*Salvia dorrii*), rubber rabbitbrush (*Ericameria nauseosa*), fernbush or desert sweet (*Chamaebatiaria millefolium*), cheatgrass (*Bromus tectorum*), Sandberg bluegrass (*Poa secunda*).

USNVC Classification:
Class: 6 Cryptogam - Open Mesomorphic Vegetation Class
Subclass: 6.B Temperate & Boreal Open Rock Vegetation Subclass
Formation: 6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation
Division: 6.B.1.Nb Western North American Temperate Cliff, Scree & Rock Vegetation Division
Macrogroup: 6.B.1.Nb.1 – M6887 Western North American Temperate Cliff, Scree & Rock Vegetation Macrogroup

Association: Provisional vegetation association.

Associations that may dominate the map unit:
- Sparsely Vegetated Rock [Provisional]

Associations that may be present but not dominant in the map unit:
- Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation
- Basin Wildrye Herbaceous Vegetation
- Chokecherry - Mixed Shrub Talus Shrubland
- Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland
- Big Sagebrush - Purple Sage - Fernbush Shrubland [Provisional]
- Fernbush - Wax Currant Shrubland [Provisional]
- Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland
- Antelope Bitterbrush - Purple Sage Shrubland [Provisional]
- Western Juniper / Mountain Big Sagebrush Woodland
- Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland
- Sparsely Vegetated Rock [Provisional]

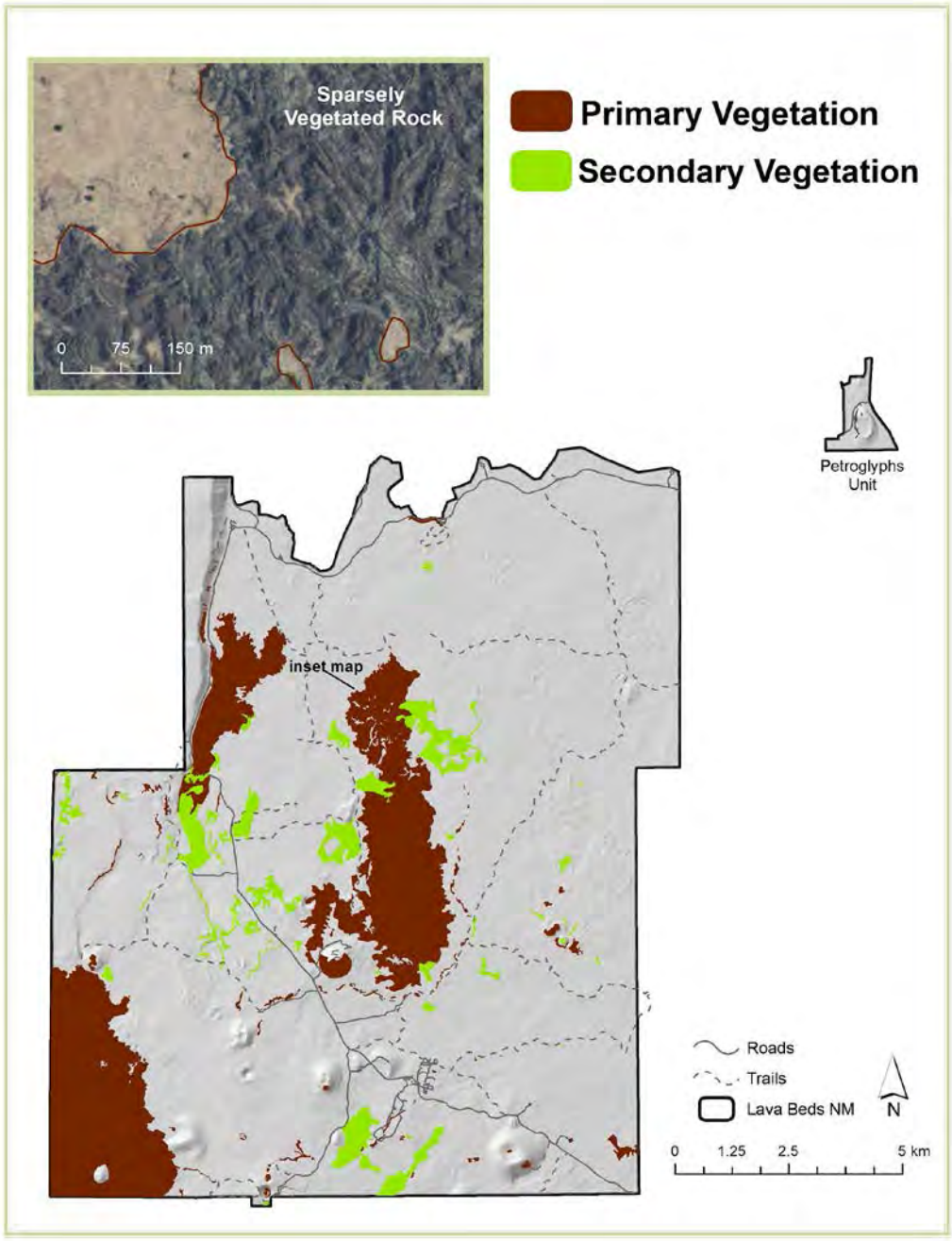
Cumulative area occupied (ha)*	
Primary vegetation	1,692.6
Secondary vegetation	196.8
Total	1,889
Percentage of Monument	10.0

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1240-1730 m

Description: This mapped vegetation type is defined by bare rock and sparse vegetation cover. Scattered individuals or small patches of the shrubs curl-leaf mountain-mahogany (*Cercocarpus ledifolius* var. *intercedens*), purple sage (*Salvia dorrii*), rubber rabbitbrush (*Ericameria nauseosa*), and/or fernbush or desert sweet (*Chamaebatiaria millefolium*) account for most of the vegetation, which averages less than 5% cover collectively.

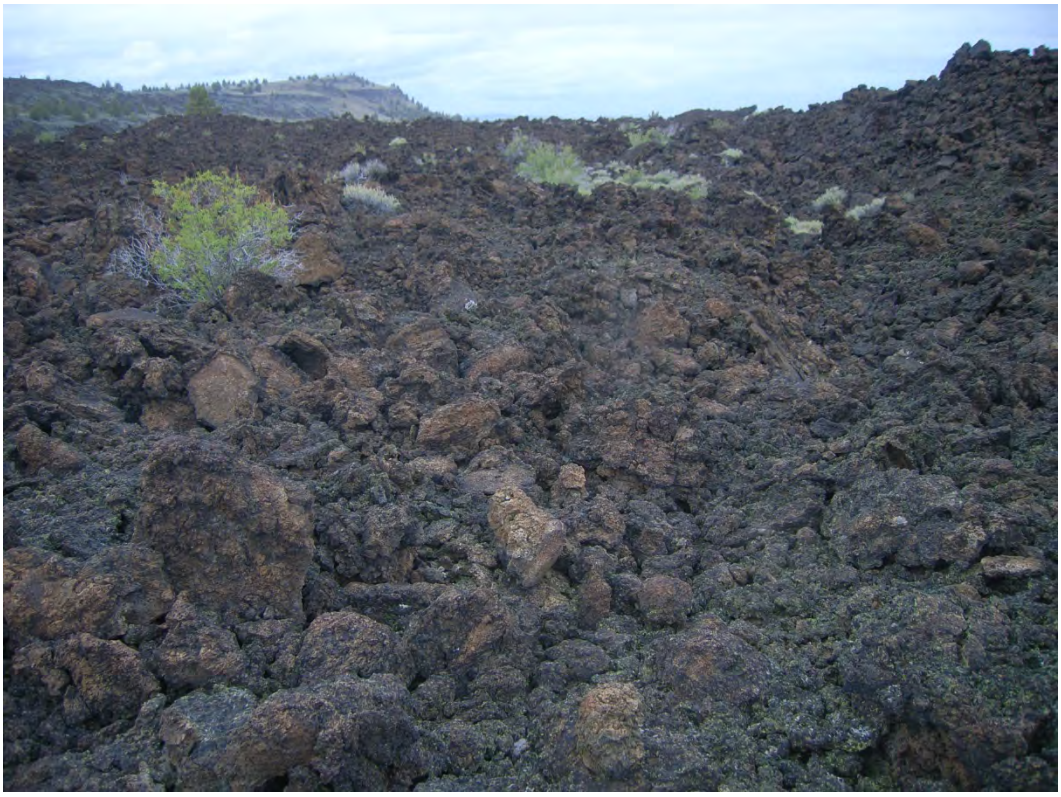
Range and Distribution: Large expanses of Sparsely Vegetated Rock occur throughout the monument.



Above: Photo signature and range map for Sparsely Vegetated Rock in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Sparsely Vegetated Rock was recognizable by the dominant brown color tone (see inset map above), and the presence of some very sparse shrub vegetation (generally gray). The geology map (Figure 4, Donnelly-Nolan 2010) was used to help delineate Sparsely Vegetated Rock. Recent lava flows were mapped as Sparsely Vegetated Rock.

Representative Ground Photo:



Above: Sparsely Vegetated Rock at the southern end of Lava Beds National Monument.

D. Unnatural Land Cover

14. Pavement-Developed

Mapping Classification Common Name: Mixed Urban or Built-up Land

Mapping Classification Scientific Name: N/A

Map Code: LULC16

Land Use and Land Cover Classification:
Level I: 1 Urban or Built-up Land
Level II: 16 Mixed Urban or Built-up Land

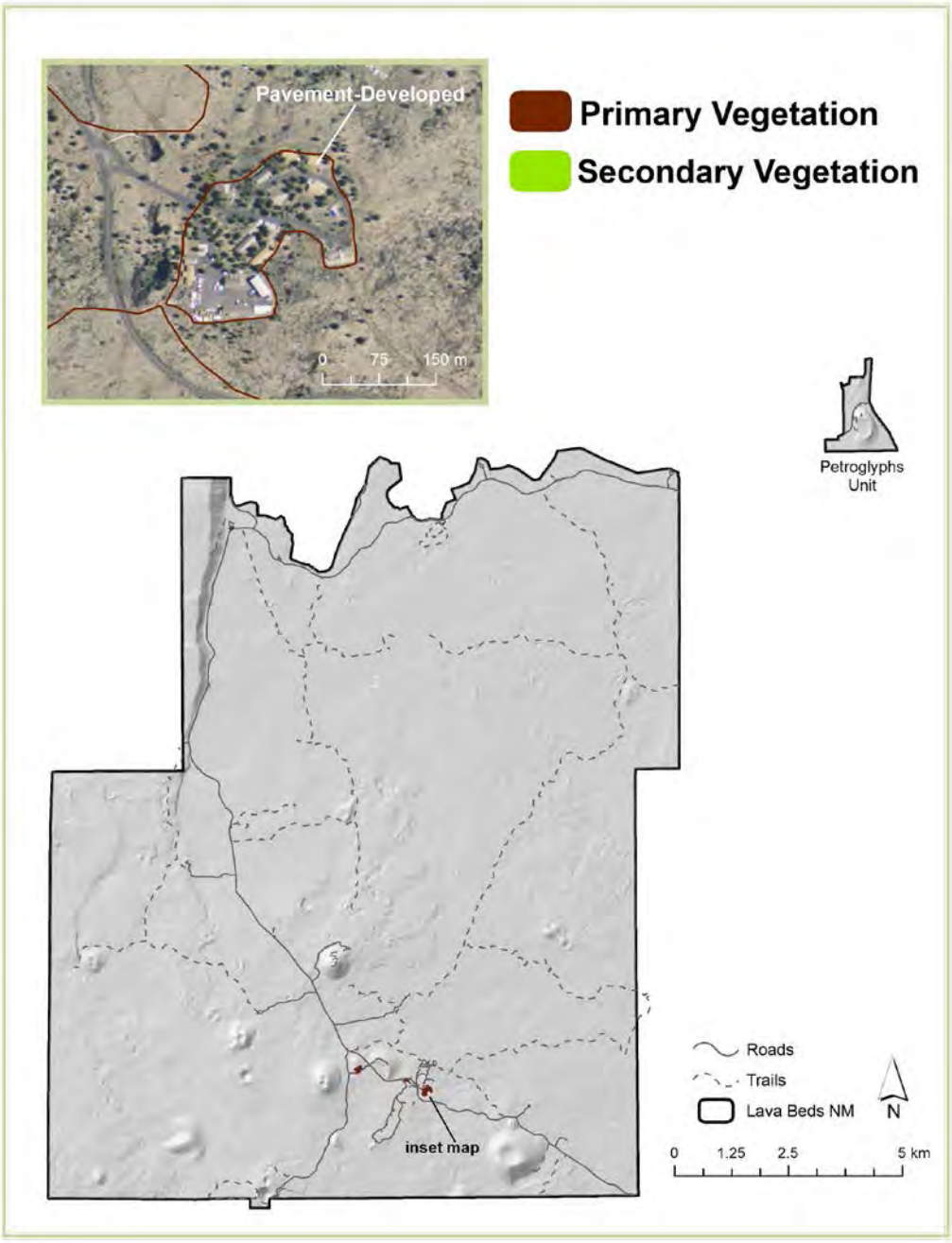
Common Species: None.

Cumulative area occupied (ha)*	
Primary vegetation (land cover)	9.6
Secondary vegetation	0
Total	**9.6**
Percent of Monument	**0.05**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Description: Selected parking areas and buildings in the monument.

Range and Distribution: At the north end of the monument near the entrance, and in the south central part of the monument, associated with the visitors center and park offices.



Above: Photo signature and range map for Pavement-Developed in Lava Beds National Monument.

Photo Signature and Mapping Considerations: Parking areas and buildings were relatively easy to identify and delineate on the imagery, especially with knowledge of the Visitors Center and Administrative Headquarters locations. Roads were not delineated.

Representative Ground Photo: None taken.

15. Irrigated Agriculture

Mapping Classification Common Name: Cropland and Pasture

Mapping Classification Scientific Name: N/A

Map Code: LULC21

Land Use and Land Cover Classification:
Level I: 2 Agriculture Land
Level II: 21 Cropland and Pasture

Common Species: Species cultivated for hay. No relevés were done in this type.

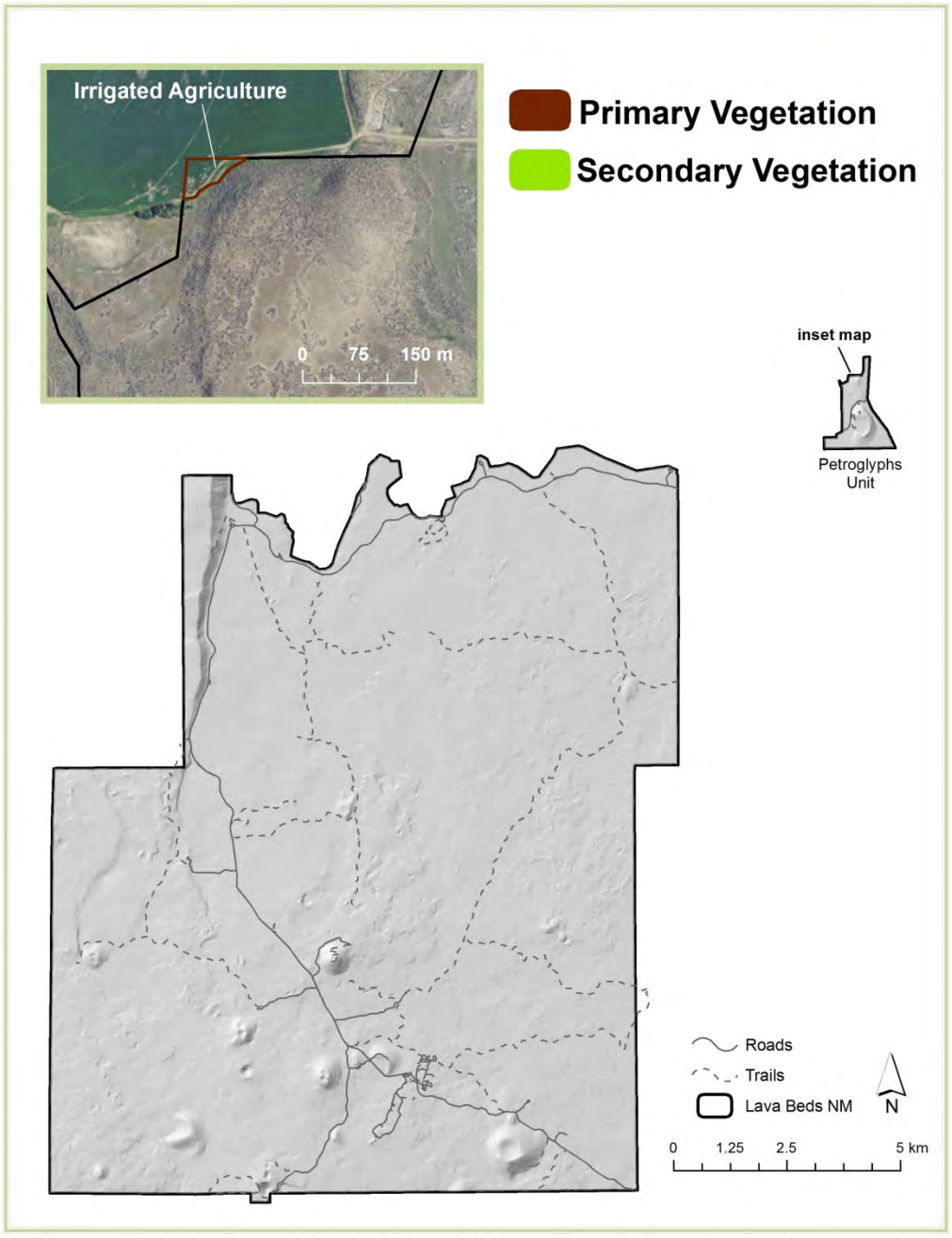
Cumulative area occupied (ha)*	
Primary vegetation	0.7
Secondary vegetation	0
Total	**0.6**
Percent of Monument	**<0.01**

*Calculated as the sum of the total area of all polygons in which this vegetation was present. The area from each polygon is the product of the total polygon area and the proportion that the vegetation occupied in each polygon.

Elevation: 1230 m.

Description: The edge of a couple of irrigated fields extends just inside the monument boundary used for this mapping project.

Range and Distribution: At the Petroglyphs unit of the monument.



Above: Photo signature and range map for Irrigated Agriculture in Lava Beds National Monument.

Photo Signature and Mapping Considerations: The bright green of the irrigated agricultural field was readily discernable on the imagery.
Representative Ground Photo: None taken.

Appendix G. Species List

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs (out of 169)
Abies concolor	white fir	Pinaceae	Native	3
Achillea millefolium	common yarrow	Asteraceae	Native	58
Achnatherum hymenoides	Indian ricegrass	Poaceae	Native	1
Achnatherum occidentale ssp. *californicum*	California needlegrass	Poaceae	Native	32
Achnatherum thurberianum	Thurber's needlegrass	Poaceae	Native	69
Agastache parvifolia	smallleaf giant hyssop	Lamiaceae	Native	6
Ageratina occidentalis	western snakeroot	Asteraceae	Native	1
Agoseris glauca var. *glauca*	pale agoseris	Asteraceae	Native	3
Agoseris glauca var. *laciniata*	false agoseris	Asteraceae	Native	12
Agoseris grandiflora	bigflower agoseris	Asteraceae	Native	18
Agoseris heterophylla	annual agoseris	Asteraceae	Native	17
Agoseris retrorsa	spearleaf agoseris	Asteraceae	Native	4
Amaranthus albus	prostrate pigweed	Amaranthaceae	Introduced	1
Amelanchier alnifolia var. *semiintegrifolia*	Saskatoon serviceberry	Rosaceae	Native	9
Amelanchier utahensis	Utah serviceberry	Rosaceae	Native	1
Amsinckia menziesii var. *intermedia*	common fiddleneck	Boraginaceae	Native	4
Amsinckia tessellata var. *tessellata*	bristly fiddleneck	Boraginaceae	Native	7
Antennaria dimorpha	low pussytoes	Asteraceae	Native	13
Antennaria geyeri	pinewoods pussytoes	Asteraceae	Native	24
Antennaria rosea	rosy pussytoes	Asteraceae	Native	15
Arabis holboellii var. *pinetorum*	Holboell's rockcress	Brassicaceae	Native	23
Arabis holboellii var. *retrofracta*	second rockcress	Brassicaceae	Native	10
Arabis sparsiflora var. sparsiflora	*sicklepod rockcress*	*Brassicaceae*	*Native*	*52*
Arabis sparsiflora var. *subvillosa*	hairystem rockcress	Brassicaceae	Native	1
Arctostaphylos patula	greenleaf manzanita	Ericaceae	Native	14
Arenaria kingii ssp. *compacta*	King's compact sandwort	Caryophyllaceae	Native	4
Artemisia arbuscula ssp. *arbuscula*	little sagebrush	Asteraceae	Native	2
Artemisia tridentata ssp. *tridentata*	basin big sagebrush	Asteraceae	Native	43
Artemisia tridentata ssp. *vaseyana*	mountain big sagebrush	Asteraceae	Native	58
Artemisia tridentata ssp. *wyomingensis*	Wyoming big sagebrush	Asteraceae	Native	1
Asclepias cordifolia	heartleaf milkweed	Asclepiadaceae	Native	1
Asclepias fascicularis	Mexican whorled milkweed	Asclepiadaceae	Native	3
Astragalus curvicarpus var. *curvicarpus*	curvepod milkvetch	Fabaceae	Native	5
Astragalus filipes	basalt milkvetch	Fabaceae	Native	13
Astragalus lentiginosus var. *salinus*	salty loco milkvetch	Fabaceae	Native	1

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs (out of 169)
Astragalus purshii	woollypod milkvetch	Fabaceae	Native	15
Balsamorhiza sagittata	arrowleaf balsamroot	Asteraceae	Native	4
Blepharipappus scaber	rough eyelashweed	Asteraceae	Native	3
Bromus carinatus	California brome	Poaceae	Native	2
Bromus tectorum	cheatgrass	Poaceae	Introduced	152
Calocedrus decurrens	incense cedar	Cupressaceae	Native	1
Calochortus macrocarpus	sagebrush mariposa lily	Liliaceae	Native	42
Carex praegracilis	clustered field sedge	Cyperaceae	Native	2
Carex rossii	Ross' sedge	Cyperaceae	Native	32
Castilleja applegatei ssp. *pinetorum*	wavyleaf Indian paintbrush	Scrophulariaceae	Native	17
Castilleja linariifolia	Wyoming Indian paintbrush	Scrophulariaceae	Native	4
Castilleja pilosa	parrothead Indian paintbrush	Scrophulariaceae	Native	4
Ceanothus prostratus	prostrate ceanothus	Rhamnaceae	Native	1
Ceanothus velutinus	snowbrush ceanothus	Rhamnaceae	Native	10
Cercocarpus ledifolius var. *intercedens*	curl-leaf mountain-mahogany	Rosaceae	Native	69
Chaenactis douglasii var. *douglasii*	Douglas' dustymaiden	Asteraceae	Native	40
Chamaebatiaria millefolium	Fernbush (aka desert sweet)	Rosaceae	Native	19
Chamerion angustifolium	fireweed	Onagraceae	Native	1
Chenopodium album	lambsquarters	Chenopodiaceae	Introduced	1
Chrysothamnus viscidiflorus ssp. *viscidiflorus*	yellow rabbitbrush	Asteraceae	Native	71
Cirsium cymosum	peregrine thistle	Asteraceae	Native	1
Clarkia lassenensis	Mt. Lassen clarkia	Onagraceae	Native	52
Clarkia rhomboidea	diamond clarkia	Onagraceae	Native	31
Claytonia perfoliata ssp. *mexicana*	miner's lettuce	Portulacaceae	Native	4
Claytonia rubra ssp. *rubra*	redstem springbeauty	Portulacaceae	Native	57
Collinsia parviflora	maiden blue eyed Mary	Scrophulariaceae	Native	83
Collinsia torreyi	Torrey's blue eyed Mary	Scrophulariaceae	Native	8
Collomia grandiflora	grand collomia	Polemoniaceae	Native	27
Collomia tinctoria	staining collomia	Polemoniaceae	Native	27
Crepis acuminata	tapertip hawksbeard	Asteraceae	Native	65
Crepis bakeri	Baker's hawksbeard	Asteraceae	Native	3
Crepis intermedia	limestone hawksbeard	Asteraceae	Native	1
Crepis occidentalis	largeflower hawksbeard	Asteraceae	Native	8
Crocidium multicaule	common spring-gold	Asteraceae	Native	1
Cryptantha ambigua	basin cryptantha	Boraginaceae	Native	40
Cryptantha intermedia	Clearwater cryptantha	Boraginaceae	Native	1

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs (out of 169)
Cryptantha simulans	pinewoods cryptantha	Boraginaceae	Native	15
Cryptantha sobolifera	Waterton Lakes cryptantha	Boraginaceae	Native	1
Cryptantha torreyana	Torrey's cryptantha	Boraginaceae	Native	13
Cryptantha watsonii	Watson's cryptantha	Boraginaceae	Native	6
Cycladenia humilis var. *humilis*	Sacramento waxydogbane	Apocynaceae	Native	4
Cystopteris fragilis	brittle bladderfern	Dryopteridaceae	Native	9
Delphinium andersonii	Anderson's larkspur	Ranunculaceae	Native	9
Delphinium nudicaule	red larkspur	Ranunculaceae	Native	4
Descurainia pinnata ssp. *halictorum*	western tansymustard	Brassicaceae	Native	52
Descurainia sophia	herb sophia	Brassicaceae	Introduced	35
Dimeresia howellii	doublet	Asteraceae	Native	4
Draba verna	spring draba	Brassicaceae	Introduced	53
Elymus elymoides	squirreltail	Poaceae	Native	109
Epilobium brachycarpum	tall annual willowherb	Onagraceae	Native	91
Epilobium minutum	chaparral willowherb	Onagraceae	Native	29
Ericameria bloomeri	rabbitbush	Asteraceae	Native	11
Ericameria nauseosa	rubber rabbitbrush	Asteraceae	Native	84
Erigeron aphanactis var. *aphanactis*	rayless shaggy fleabane	Asteraceae	Native	1
Erigeron bloomeri var. *bloomeri*	scabland fleabane	Asteraceae	Native	4
Erigeron elegantulus	blue dwarf fleabane	Asteraceae	Native	4
Erigeron filifolius	threadleaf fleabane	Asteraceae	Native	40
Erigeron linearis	desert yellow fleabane	Asteraceae	Native	3
Eriogonum microthecum var. *ambiguum*	slender buckwheat	Polygonaceae	Native	4
Eriogonum nudum var. *pubiflorum*	naked buckwheat	Polygonaceae	Native	35
Eriogonum ovalifolium var. *nivale*	cushion buckwheat	Polygonaceae	Native	1
Eriogonum polyanthum	sulphur-flower buckwheat	Polygonaceae	Native	10
Eriogonum strictum	Blue Mountain buckwheat	Polygonaceae	Native	4
Eriogonum umbellatum var. *nevadense*	sulphur-flower buckwheat	Polygonaceae	Native	46
Eriogonum vimineum	wickerstem buckwheat	Polygonaceae	Native	23
Eriophyllum lanatum var. *achillaeoides*	common woolly sunflower	Asteraceae	Native	3
Eriophyllum lanatum var. *integrifolium*	common woolly sunflower	Asteraceae	Native	1
Erodium cicutarium	redstem stork's bill	Geraniaceae	Introduced	13
Erysimum capitatum var. *capitatum*	sanddune wallflower	Brassicaceae	Native	5
Eschscholzia californica	California poppy	Papaveraceae	Native	1
Festuca idahoensis	Idaho fescue	Poaceae	Native	45
Frangula rubra ssp. *rubra*	red buckthorn	Rhamnaceae	Native	1
Frasera albicaulis var. *modocensis*	Modoc frasera	Gentianaceae	Native	9

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs (out of 169)
Frasera albicaulis var. *nitida*	whitestem frasera	Gentianaceae	Native	7
Fritillaria atropurpurea	spotted fritillary	Liliaceae	Native	5
Galium aparine	stickywilly	Rubiaceae	Native	14
Gayophytum racemosum	blackfoot groundsmoke	Onagraceae	Native	1
Gayophytum ramosissimum	pinyon groundsmoke	Onagraceae	Native	8
Geum triflorum	old man's whiskers	Rosaceae	Native	1
Grayia spinosa	spiny hopsage	Chenopodiaceae	Native	4
Hackelia cusickii	Cusick's stickseed	Boraginaceae	Native	2
Hemizonella minima	opposite-leaved tarweed	Asteraceae	Native	18
Hesperostipa comata ssp. *comata*	needle and thread	Poaceae	Native	6
Heuchera cylindrica var. *alpina*	alpine alumroot	Saxifragaceae	Native	8
Hieracium albiflorum	white hawkweed	Asteraceae	Native	1
Hieracium scouleri	Scouler's woollyweed	Asteraceae	Native	5
Holodiscus discolor	oceanspray	Rosaceae	Native	6
Holosteum umbellatum	jagged chickweed	Caryophyllaceae	Introduced	26
Ipomopsis congesta ssp. *palmifrons*	ballhead ipomopsis	Polemoniaceae	Native	4
Iva axillaris	povertyweed	Asteraceae	Native	1
Juncus arcticus ssp. *littoralis*	mountain rush	Juncaceae	Native	3
Juniperus occidentalis	western juniper	Cupressaceae	Native	72
Kelloggia galioides	milk kelloggia	Rubiaceae	Native	3
Koeleria macrantha	prairie Junegrass	Poaceae	Native	27
Lactuca serriola	prickly lettuce	Asteraceae	Introduced	48
Lagophylla ramosissima	branched lagophylla	Asteraceae	Native	7
Lappula occidentalis var. *cupulata*	flatspine stickseed	Boraginaceae	Native	1
Layia glandulosa	whitedaisy tidytips	Asteraceae	Native	2
Leptosiphon septentrionalis	northern linanthus	Polemoniaceae	Native	1
Leptosiphon ciliatus ssp. *ciliatus*	whiskerbrush	Polemoniaceae	Native	1
Leucocrinum montanum	common starlily	Liliaceae	Native	2
Leucophysalis nana	dwarf chamaesaracha	Solanaceae	Native	1
Lewisia rediviva	bitter root	Portulacaceae	Native	1
Leymus cinereus	basin wildrye	Poaceae	Native	13
Linanthus pungens	granite prickly phlox	Polemoniaceae	Native	45
Linum lewisii var. *lewisii*	prairie flax	Linaceae	Native	7
Lithophragma glabrum	bulbous woodland-star	Saxifragaceae	Native	1
Lithophragma tenellum	slender woodland-star	Saxifragaceae	Native	11
Lomatium macrocarpum	bigseed biscuitroot	Apiaceae	Native	14
Lomatium nevadense var. *nevadense*	Nevada biscuitroot	Apiaceae	Native	28

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs (out of 169)
Lupinus subvexus var. *subvexus*	valley lupine	Fabaceae	Native	5
Machaeranthera canescens ssp. *canescens* var. *canescens*	hoary tansyaster	Asteraceae	Native	16
Madia gracilis	grassy tarweed	Asteraceae	Native	10
Mentzelia albicaulis	whitestem blazingstar	Loasaceae	Native	71
Mentzelia laevicaulis	smoothstem blazingstar	Loasaceae	Native	7
Mentzelia montana	variegated-bract blazingstar	Loasaceae	Native	46
Microseris nutans	nodding microseris	Asteraceae	Native	6
Microsteris gracilis	slender phlox	Polemoniaceae	Native	57
Mimulus nanus	dwarf purple monkeyflower	Scrophulariaceae	Native	27
Mimulus suksdorfii	Suksdorf's monkeyflower	Scrophulariaceae	Native	13
Monardella odoratissima	mountain monardella	Lamiaceae	Native	5
Monardella odoratissima ssp. *odoratissima*	mountain monardella	Lamiaceae	Native	14
Monardella odoratissima ssp. *pallida*	mountain monardella	Lamiaceae	Native	1
Myosotis stricta	strict forget-me-not	Boraginaceae	Introduced	1
Nama densum	leafy nama	Hydrophyllaceae	Native	21
Nothocalais troximoides	sagebrush false dandelion	Asteraceae	Native	9
Orobanche corymbosa	flat-top broomrape	Orobanchaceae	Native	1
Orobanche fasciculata	clustered broomrape	Orobanchaceae	Native	2
Packera cana	woolly groundsel	Asteraceae	Native	37
Penstemon deustus var. *pedicellatus*	scabland penstemon	Scrophulariaceae	Native	19
Penstemon deustus var. *suffrutescens*	scabland penstemon	Scrophulariaceae	Native	5
Penstemon humilis	low beardtongue	Scrophulariaceae	Native	52
Penstemon laetus ssp. *sagittatus*	mountain blue penstemon	Scrophulariaceae	Native	30
Penstemon speciosus	royal penstemon	Scrophulariaceae	Native	5
Phacelia bicolor	twocolor phacelia	Hydrophyllaceae	Native	1
Phacelia hastata var. *compacta*	compact phacelia	Hydrophyllaceae	Native	4
Phacelia hastata var. *hastata*	silverleaf phacelia	Hydrophyllaceae	Native	13
Phacelia heterophylla ssp. virgata	varileaf phacelia	Hydrophyllaceae	Native	55
Phacelia linearis	threadleaf phacelia	Hydrophyllaceae	Native	78
Phacelia mutabilis	changeable phacelia	Hydrophyllaceae	Native	4
Phacelia ramosissima var. *ramosissima*	branching phacelia	Hydrophyllaceae	Native	41
Phlox diffusa	spreading phlox	Polemoniaceae	Native	45
Phlox hoodii ssp. *canescens*	carpet phlox	Polemoniaceae	Native	1
Phoenicaulis cheiranthoides	wallflower phoenicaulis	Brassicaceae	Native	1
Phoradendron bolleanum	Bollean mistletoe	Viscaceae	Native	2
Pinus ponderosa var. *ponderosa*	ponderosa pine	Pinaceae	Native	22

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs (out of 169)
Plagiobothrys hispidus	Cascade popcornflower	Boraginaceae	Native	5
Plagiobothrys tenellus	Pacific popcornflower	Boraginaceae	Native	1
Plectritis macrocera	longhorn plectritis	Valerianaceae	Native	37
Poa secunda	Sandberg bluegrass	Poaceae	Native	120
Poa wheeleri	Wheeler's bluegrass	Poaceae	Native	1
Polemonium micranthum	annual polemonium	Polemoniaceae	Native	2
Polygonum amphibium var. *emersum*	longroot smartweed	Polygonaceae	Native	1
Potentilla glandulosa ssp. *globosa*	sticky cinquefoil	Rosaceae	Native	10
Potentilla glandulosa ssp. *pseudorupestris*	sticky cinquefoil	Rosaceae	Native	3
Prunus emarginata	bitter cherry	Rosaceae	Native	4
Prunus virginiana var. *demissa*	western chokecherry	Rosaceae	Native	15
Pseudoroegneria spicata ssp. *spicata*	bluebunch wheatgrass	Poaceae	Native	87
Purshia tridentata var. *tridentata*	antelope bitterbrush	Rosaceae	Native	104
Pyrola picta	whiteveined wintergreen	Pyrolaceae	Native	2
Ribes cereum	wax currant	Grossulariaceae	Native	36
Ribes roezlii var. *roezlii*	Sierra gooseberry	Grossulariaceae	Native	8
Ribes velutinum	desert gooseberry	Grossulariaceae	Native	72
Salix lucida ssp. *lasiandra*	Pacific willow	Salicaceae	Native	1
Salvia dorrii ssp. *dorrii* var. *incana*	purple sage	Lamiaceae	Native	24
Sambucus nigra ssp. *canadensis*	American black elderberry	Caprifoliaceae	Native	3
Scrophularia lanceolata	lanceleaf figwort	Scrophulariaceae	Native	15
Scutellaria nana	dwarf skullcap	Lamiaceae	Native	1
Secale cereale	cereal rye	Poaceae	Introduced	1
Senecio integerrimus var. *exaltatus*	Columbia ragwort	Asteraceae	Native	3
Silene douglasii var. *douglasii*	Douglas's catchfly	Caryophyllaceae	Native	9
Sisymbrium altissimum	tall tumblemustard	Brassicaceae	Introduced	60
Stephanomeria minor var. *minor*	narrowleaf wirelettuce	Asteraceae	Native	27
Stephanomeria virgata ssp. *pleurocarpa*	wand wirelettuce	Asteraceae	Native	10
Symphoricarpos rotundifolius var. *rotundifolius*	roundleaf snowberry	Caprifoliaceae	Native	9
Tetradymia canescens	spineless horsebrush	Asteraceae	Native	33
Tragopogon dubius	yellow salsify	Asteraceae	Introduced	36
Urtica dioica ssp. *holosericea*	stinging nettle	Urticaceae	Native	3
Verbascum thapsus	common mullein	Scrophulariaceae	Introduced	3
Viola purpurea ssp. *venosa*	goosefoot violet	Violaceae	Native	14
Vulpia bromoides	brome fescue	Poaceae	Introduced	1
Vulpia microstachys var. *pauciflora*	Pacific fescue	Poaceae	Native	15
Vulpia myuros	annual fescue	Poaceae	Introduced	1

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs (out of 169)
Vulpia octoflora	sixweeks fescue	Poaceae	Native	1
Woodsia scopulina	Rocky Mountain woodsia	Dryopteridaceae	Native	1
Wyethia mollis	woolly mule-ears	Asteraceae	Native	1
Zigadenus paniculatus	foothill deathcamas	Liliaceae	Native	20

Appendix H. Accuracy Assessment Tables

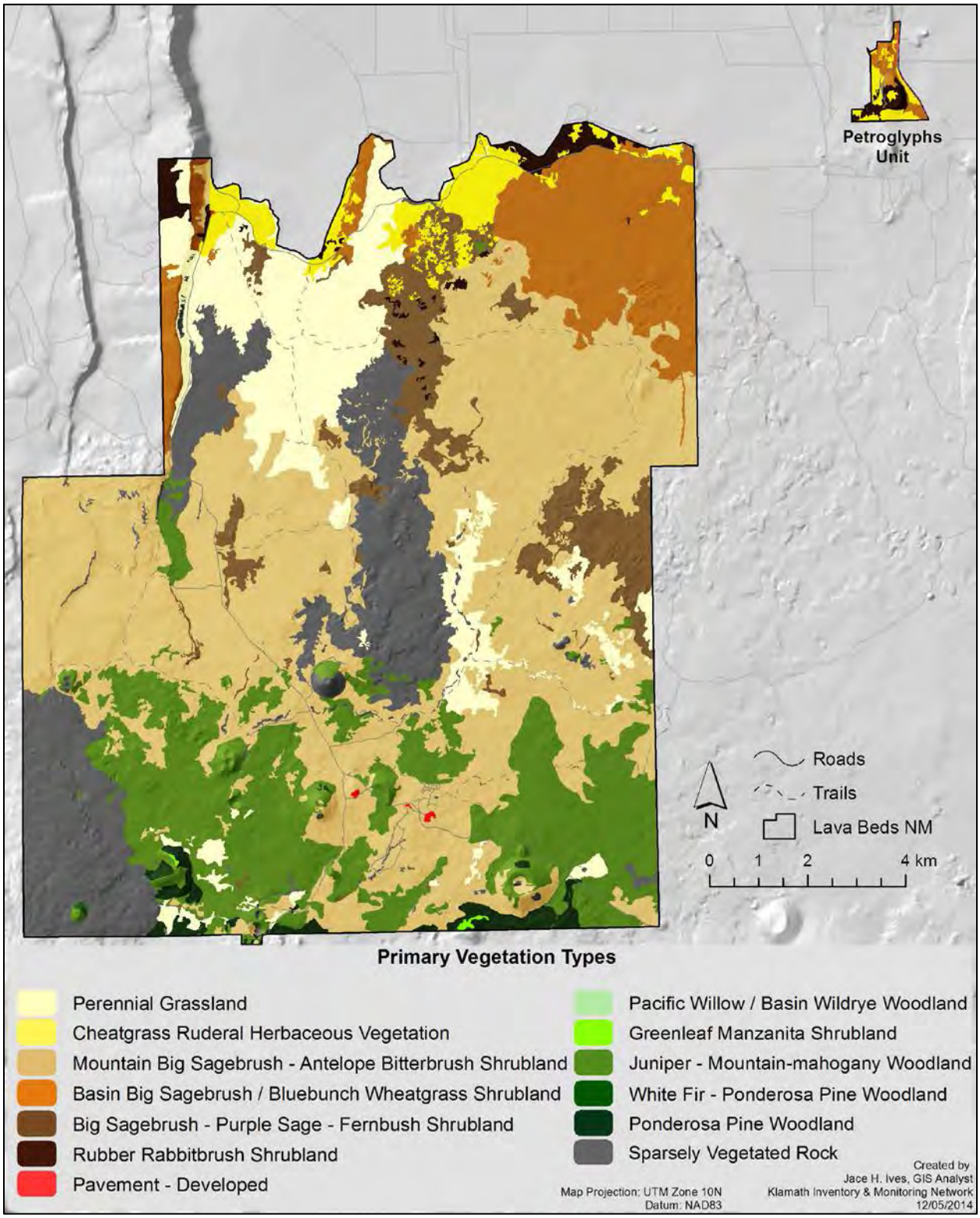
Table H1. Accuracy assessment contingency table for Lava Beds National Monument vegetation map units. Accuracy was calculated according to Lea and Curtis (2010). The rows in the table represent the map, and the columns represent the field AA points.

	1. Perennial Grassland	2. Cheatgrass Ruderal Herbaceous Vegetation	3. Chokecherry Shrubland	4. Greenleaf Manzanita Shrubland	5. Rubber Rabbitbrush Shrubland	6. Big Sagebrush - Purple Sage - Fernbush Shrubland	7. Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland	8. Mountain Big Sagebrush - Antelope Bitterbrush Shrubland	9. Ponderosa Pine Woodland	10. Juniper - Mountain-mahogany Woodland	11. White Fir - Ponderosa Pine Woodland	12. Pacific Willow / Basin Wildrye Woodland	13. Sparsely Vegetated Rock	ROW TOTAL (n_{+i})	USERS' % ACCURACY ($P_{J=X\|I=X}$)
1. Perennial Grassland	57	5	0	0	0	5	1	6	0	0	0	0	0	74	77.0%
2. Cheatgrass Ruderal Herbaceous Vegetation	2	26	0	0	1	0	1	2	0	0	0	0	0	32	81.3%
3. Chokecherry Shrubland	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.0%
4. Greenleaf Manzanita Shrubland	0	0	0	2	0	0	0	1	1	0	0	0	0	3	66.7%
5. Rubber Rabbitbrush Shrubland	4	2	0	0	32	0	0	5	0	1	0	0	0	44	72.7%
6. Big Sagebrush - Purple Sage - Fernbush Shrubland	0	0	0	0	0	31	2	1	0	0	0	0	4	38	81.6%
7. Basin Big Sagebrush / Bluebunch Wheatgrass Shrubland	0	1	0	0	0	0	40	0	0	0	0	0	0	41	97.6%
8. Mountain Big Sagebrush - Antelope Bitterbrush Shrubland	2	0	0	0	0	5	3	90	0	0	0	0	0	100	90%
9. Ponderosa Pine Woodland	0	0	0	1	0	0	0	0	37	4	1	0	0	43	86.0%
10. Juniper - Mountain-mahogany Woodland	0	0	0	0	0	0	0	13	1	77	0	0	6	98	79.6%
11. White Fir - Ponderosa Pine Woodland	0	0	0	0	0	0	0	0	2	0	2	0	0	4	50.0%
12. Pacific Willow / Basin Wildrye Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
13. Sparsely Vegetated Rock	0	0	0	0	0	1	0	0	0	0	0	0	15	16	93.8%
COLUMN TOTAL (n_{+j})	65	34	0	3	33	42	47	118	40	83	3	0	26	494	
AREA WEIGHTED PRODUCERS' % ACCURACY ($P_{I=Y\|J=Y}$)	82.6	75.4	0.0	71.6	97.3	75.2	74.1	87.5	98.6	78.7	46.3	0	80.3		**85.3**

Table H2. Accuracy Assessment contingency table for associations in Lava Beds National Monument vegetation associations. Accuracy was calculated according to Lea and Curtis (2010). The rows in the table represent the map, and the columns represent the field AA points.

	Accuracy Assessment Field Observation Points																									
	1. Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation	2. Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation	3.Basin Wildrye Herbaceous Vegetation	4. Needle and Thread Grass Great Basin Herbaceous Vegetation	5.Cheatgrass Ruderal Herbaceous Vegetation	6.Squirreltail Herbaceous Vegetation	7. Chokecherry - Mixed Shrub Talus Shrubland.	8.Greenleaf Manzanita Sierran Chaparral Shrubland	9.Oceanspray - Desert Gooseberry Shrubland.	10. Rubber Rabbitbrush Shrubland	11. Yellow Rabbitbrush Shrub Herbaceous Vegetation	12. Big Sagebrush - Purple Sage - Fernbush Shrubland	13.Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	14. Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland	15.Antelope Bitterbrush - Purple Sage Shrubland	16.Fernbush - Wax Currant Shrubland	17. Desert Gooseberry / Basin Wildrye Shrubland	18.Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland	19.Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland	20.Western Juniper / Mountain Big Sagebrush Woodland	21.Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland	22.White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland	23.Pacific Willow / Basin Wildrye Woodland	24. Sparsely Vegetated Rock	ROW TOTAL (n_{i+})	AREA WEIGHTED USERS' % ACCURACY ($P_{i=x|i=x}$)
1. Bigseed Biscuitroot - Sandberg Bluegrass Herbaceous Vegetation	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	75
2. Bluebunch Wheatgrass - Sandberg Bluegrass Herbaceous Vegetation	0	41	0	0	1	0	0	0	0	0	0	4	2	3	0	0	1	0	0	0	0	0	0	52	79
3. Basin Wildrye Herbaceous Vegetation	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
4. Needle and Thread Grass Great Basin Herbaceous Vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Cheatgrass Ruderal Herbaceous Vegetation	0	0	0	0	24	0	0	0	0	1	0	0	1	3	0	0	0	0	0	0	0	0	0	29	83
6. Squirreltail Herbaceous Vegetation	0	3	0	0	3	12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	19	63
7. Chokecherry - Mixed Shrub Talus Shrubland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
8. Greenleaf Manzanita Sierran Chaparral Shrubland	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	100
9. Oceanspray - Desert Gooseberry Shrubland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10. Rubber Rabbitbrush Shrubland.	0	2	0	0	1	1	0	0	0	25	0	0	0	4	0	0	0	0	1	0	0	0	1	35	71
11. Yellow Rabbitbrush Shrub Herbaceous Vegetation	0	1	0	0	2	0	0	0	0	2	3	0	0	2	0	0	0	0	0	0	0	0	0	10	30
12. Big Sagebrush - Purple Sage - Fernbush Shrubland	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	30	
13. Basin Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	0	0	0	0	2	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	39	95
14. Mountain Big Sagebrush - Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland	0	2	0	0	0	0	0	0	0	0	0	6	2	90	0	0	0	0	0	0	0	0	0	100	90
15. Antelope Bitterbrush - Purple Sage Shrubland	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	3	33
16. Fernbush - Wax Currant Shrubland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
17. Desert Gooseberry / Basin Wildrye Shrubland	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	3	33
18. Ponderosa Pine / Greenleaf Manzanita - Antelope Bitterbrush Woodland	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	38	4	0	0	1	0	46	56
19. Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	43	13		1	0	63	68
20. Western Juniper / Mountain Big Sagebrush Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	100
21. Curl-leaf Mountain-mahogany / Mountain Big Sagebrush Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	8	19	0	0	1	34	56
22. White Fir - Ponderosa Pine / Antelope Bitterbrush Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	4	50
23. Pacific Willow / Basin Wildrye Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24. Sparsely Vegetated Rock	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	12	14	85
COLUMN TOTAL (n+j)	3	50	0	0	35	15	0	3	0	28	3	41	46	112	1	0	3	40	48	24	19	4	0	17	494	
AREA WEIGHTED PRODUCERS' ACCURACY (Pi=Y|J=Y) %	100	92	NA	NA	82	69	NA	100	NA	94	100	70	100	73	100	NA	18	100	97	29	100	50	NA	69		81.4

Appendix I. Vegetation Map of Lava Beds National Monument



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