National Park Service
U.S. Department of the Interior

Natural Resources Stewardship and Science

Vegetation Inventory Project

Oregon Caves National Monument and Proposed Expansion Area

Natural Resource Technical Report NPS/ORCA/NRTR—2013/782

ON THIS PAGE
Upper Bigelow Lake in the glaciated Bigelow Basin. Yellow pond lily of the *Nuphar leptosepala* plant association occurs in the shallow waters of the lake (right), while wet meadow sedges belonging to the *Carex* spp. plant associations occur on saturated soils along the shoreline (left).

ON THE COVER
ORCA and KLMN staff in front of a Douglas-fir (*Pseudotsuga menziesii*) tree in Oregon Caves National Monument – this tree has the largest recorded diameter of any extant Douglas-fir tree.

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National Park Service
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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 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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Contents

Contents (continued)

Figures

Tables

Appendices

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List of Acronyms and Abbreviations

AA	Accuracy Assessment		m	Meter(s)
ac	Acre(s)		m^2	Square Meters
A.D.	Anno Domini		MMU	Minimum Mapping Unit
Basin	Bigelow Basin		N/A	Not Applicable
^oC	Degrees Celsius		NAD83	North American Datum of 1983
CA	California		NAIP	U.S. Department of Agriculture, National Agriculture Imagery Program
CEGL	Community Element Code--Global		NBII	National Biological Information Infrastructure Program
CES	Ecological System Code		NPS	National Park Service
cm	Centimeter(s)		NRC	Natural Resources Challenge
CNPS	California Native Plant Society		NVCS	National Vegetation Classification Standard
CO_2	Carbon dioxide		NVIP	National Vegetation Inventory Program
CRLA	Crater Lake National Park		ORCA	Oregon Caves National Monument
DVD	Digital Video Disk		Ph.D.	Doctor of Philosophy
°F	Degrees Fahrenheit		SOU	Southern Oregon University
FSA	United States Department of Agriculture, Farm Services Agency		sp./spp.	Species (singular/plural)
e.g.	for example (exempli gratia)		STD	Standard
ESRI	Environmental Systems Research		St.	Saint
et al.	and others (et alia)		TNC	The Nature Conservancy
FGDC	Federal Geographic Data Committee		TURB-OVEG	Dutch Software for Processing Phyto-sociological Data
FIPS	Federal Information Processing		TWIN-SPAN	Two-Way Indicator Species Analysis
ft	Foot/Feet		U.S.	United States of America
GIS	Geographic Information System		USDA	U.S. Department of Agriculture
GPS	Global Positioning System Receiver		USDI	U.S. Department of the Interior
ha	Hectare(s)		USFS	U.S. Forest Service
I&M	Inventory and Monitoring Program		USGS	U.S. Geological Survey
in	Inch(es)		USNVC	U.S. National Vegetation
KLMN	Klamath Inventory and Monitoring		UTM	Universal Transverse Mercator
km	Kilometer(s)		WASO	Washington Area Service Office
LABE	Lava Beds National Monument			

Executive Summary

The National Park Service Vegetation Inventory Program funded an effort, beginning in 2009, to classify and map the vegetation at Oregon Caves National Monument and its proposed expansion area (inclusive of the headwaters of Cave and Lake Creeks). Southern Oregon University staff performed the inventory work. The Klamath Network, Inventory and Monitoring Program coordinated the effort.

To classify the vegetation, we sampled 142 representative classification plots throughout the 1,820.8 hectare (4,499.3 acre) project area using traditional phytosociological methods (i.e., relevé sampling). The relevé plots were located and sampled primarily in 2009 and 2010. We identified 397 different vascular plant species in the classification plots, including many that were not previously recorded on the monument's species list. We classified the plot data into 34 plant associations using accepted statistical analyses. A key to the plant associations and description of each association are provided in Appendices B and C of this report. Mapping of the vegetation polygons was completed via manual digitizing using the most recent National Agriculture Imagery Program (NAIP) imagery. A number of plant associations could not be separated based on unique photo-signatures in the imagery or because they were spatially intermixed forming physiognomic vegetation classes (equivalent to complexes and mosaics). Based on this analysis we therefore defined 19 physiognomic vegetation mapping classes. The map also captures management activities in the year in which they occurred. These activities included major forest vegetation manipulations such as clear-cutting and plantation establishment. The percent cover attribute for the primary and secondary (if present) vegetation in each polygon was added and coded. The final map product is a geographic information system (GIS) database with far greater descriptive power than the predefined areal units of a standard chloropleth map, and it can also be generalized into a standard map. We conducted the accuracy assessment (AA) in 2011 by placing 444 stratified random accuracy assessment plots throughout the project area. The field data were compared to the vegetation map resulting in an overall thematic accuracy (area weighted) of 80.4%.

To complete this vegetation inventory project we produced the standard deliverables as described and presented herein and stored on the digital video disk (DVD) or flash drive distributed with this report. The primary deliverables include:

- This final report that includes plant association descriptions, the key to plant associations, description of the physiognomic map classes and their photo-signatures, accuracy assessment information, and project methods and results.
- A GIS database containing the attributed vegetation polygons, classification plots, and accuracy AA points.
- Digital photographs characterizing the classification plots and landscape features/objects of interest within the monument and proposed expansion area.
- Federal Geographic Data Committee (FGDC)-compliant metadata for all of the spatial data.

Introduction

Background

In 1994, the U.S. Geological Survey (USGS) and National Park Service (NPS) formed the USGS-NPS Vegetation Mapping Program, now named the National Vegetation Inventory Program (NVIP), to cooperatively inventory and map the vegetation in all of the U.S. National Parks that have significant natural resources. The goals of this program are to provide baseline ecological data for park resource managers, obtain data that can be examined in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997, Grossman et al. 1998).

In the same year, the NVIP also adopted the U.S. National Vegetation Classification (USNVC) (The Nature Conservancy (TNC) and Environmental Systems Research Institute (ESRI) 1994a, Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. The USNVC was intended to be a standardized and ultimately complete taxonomic treatment of vegetation communities in the United States at multiple hierarchical levels of thematic resolution, and maintained in TNC, later NatureServe, databases. The USNVC has eight levels with specific criteria set for each level. The upper three levels (Formation) are based on climate and physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels (Division/Group) focus largely on broad sets of diagnostic plant species and habitat factors along regional-to-continental topographic, edaphic, and disturbance gradients. The lower two levels (Alliance/Association) are distinguished by differences in local floristic composition (FGDC 1997).

The FGDC adopted a modified version of TNC's upper (physiognomic) hierarchy levels as a federal standard (FGDC-STD-005) (FGDC 1997), termed the National Vegetation Classification Standard (NVCS). The NVCS also adopted TNC's conceptual taxonomic levels for the floristic units of alliance and association, but did not formally recognize TNC's data because of the immense scope of establishing robust floristic units for the entire U.S. In 2008, the FGDC issued a revised standard of the NVCS (FGDC 2008) that replaced the 1997 standard. It defined an ongoing, peer-reviewed taxonomic process for acceptance of specific units of the prescribed classification (the USNVC) and redefined the structure of the upper levels of the classification hierarchy from that developed in 1997. The USNVC has since been revised by NatureServe and in 2008 the FGDC formally endorsed the revised version of the USNVC (FGDC 2008).This process and development and review of content remain active, with the most recent USNVC treatment available online at http://www.usnvc.org and/or at http://www.natureserve.org/explorer/.

The current FGDC standard requires that federally funded vegetation classification studies collect data in a manner that enables crosswalking the data to the USNVC and sharing between agencies, but does not require use of that standard by agencies for internal mission needs. In the interim for ongoing planning and development of a federally maintained data system for the USNVC, NatureServe (formerly a division within TNC) maintains the treatments of lower hierarchy units (alliances and associations), which although not complete or specific enough for all situations in local landscapes, are used as classification and mapping units by the NVIP whenever feasible. For purposes of this document, the federal standard (FGDC 2008) is denoted

as the NVCS; the USNVC will refer to the content, including NatureServe's treatment for vegetation floristic units (alliances and associations only). The upper level descriptions (Class through Group) are maintained by the FGDC consortium (www.usnvc.org) with a link to NatureServe Explorer for alliances and associations.

Use of the USNVC as the standard vegetation classification system is central to fulfilling the goals of the NVIP. This system:

- is vegetation based;
- uses a systematic approach to classify a continuum;
- emphasizes natural and existing 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 NVIP protocols and standard documents are available on the USGS-NPS-NVIP Website (http://biology.usgs.gov/npsveg/standards.html).

The use of the USNVC and the USGS-NPS vegetation mapping protocols facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS, as well as 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 communities and their relationship to environmental conditions and ecological processes across landscapes.

NPS National Vegetation Inventory Program

The Director of the NPS approved the Natural Resource Challenge (NRC) in 1999 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). The NRC provided funding for 12 baseline inventories to be completed in each of 270 parks with significant natural resources. Vegetation mapping and inventory is one of the 12 baseline inventories. Through the NRC, 270 park units in the NPS were organized into 32 networks for the purpose of accomplishing natural resource inventory and monitoring projects. The NVIP works closely with the networks to classify, describe, and map vegetation communities and document unique plant species and associations from park to park. The inventory of these resources helps park managers conserve plant 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 NVIP 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 NVIP follows well-established procedures that are compatible with other agencies and organizations. The inventory uses the NVCS, a system that is integrated with

the major scientific efforts in the taxonomic classification of vegetation, and is a FGDC standard. In addition, stringent quality control procedures ensure the reliability of the vegetation data and encourage the use of resulting maps, reports, and databases at multiple scales. A complete vegetation mapping project for a park includes, at a minimum, the following products:

- Detailed vegetation report
- Digital vegetation map
- Vegetation classification plot data
- Accuracy assessment data and analysis
- Dichotomous vegetation key
- Photo-interpretation key

Maps are produced in Universal Transverse Mercator (UTM) coordinates (NAD 83) with a 1:24,000 scale and a minimum mapping unit of 0.5 hectares (ha) (1.24 acres (ac)). The vegetation maps must meet the 2010 FGDC National Map Accuracy Standards for positional accuracy (which specify horizontal errors of less than 40.0 feet (ft) (12.2 meters (m)) on the ground for 1:24,000-scale maps), and the minimum class accuracy goal across all vegetation and land cover classes of 80%. Digital vegetation products are accompanied by FGDC-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 NVIP products are made available through the National Biological Information Infrastructure Program (NBII) (NBII 2013) and the NPS Data Store (URL: http://science.nature.nps.gov/nrdata/).

Klamath Network

The Klamath Network (KLMN) (Figure 1) encompasses six units managed by the NPS in northern California and southern Oregon and include: 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 park units comprise nearly 200,000 ha (494,211 ac) and range considerably in size from 196 to 73,775 ha (484 to 182,302 ac) and most of have dramatic vistas, mountains, volcanoes, lakes, caves, and considerable topographic relief.

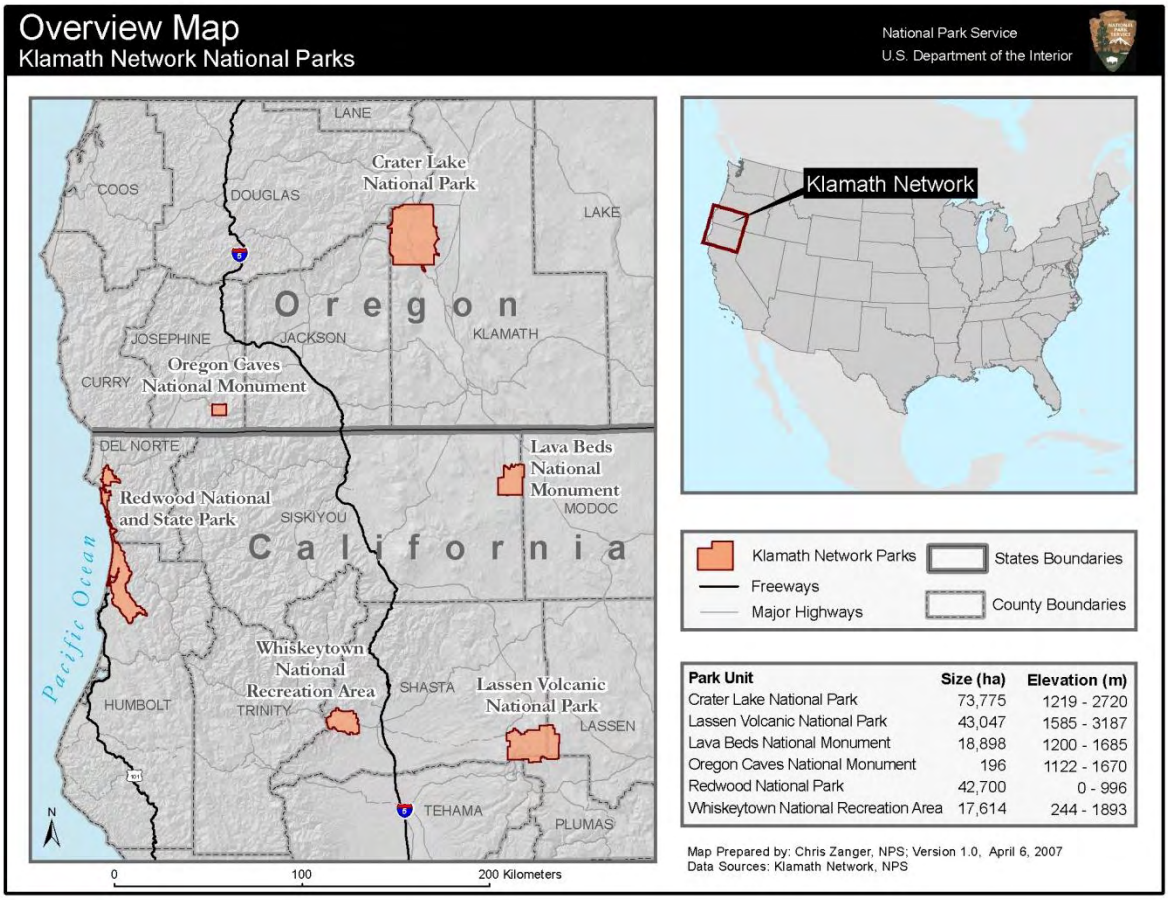

Figure 1. National Park units of the Klamath Network of southern Oregon and northern California

Oregon Caves National Monument and Proposed Expansion Area

The natural resources of the existing Oregon Caves National Monument (ORCA) (Figure 2) are relatively well-known from the long-history of NPS management. A proposal to expand the boundaries of the monument is under consideration therefore the natural resources of the proposed expansion area are poorly understood. Accordingly, the descriptions herein will focus mostly on the existing monument and will be supported with proposed expansion area data, as it becomes available.

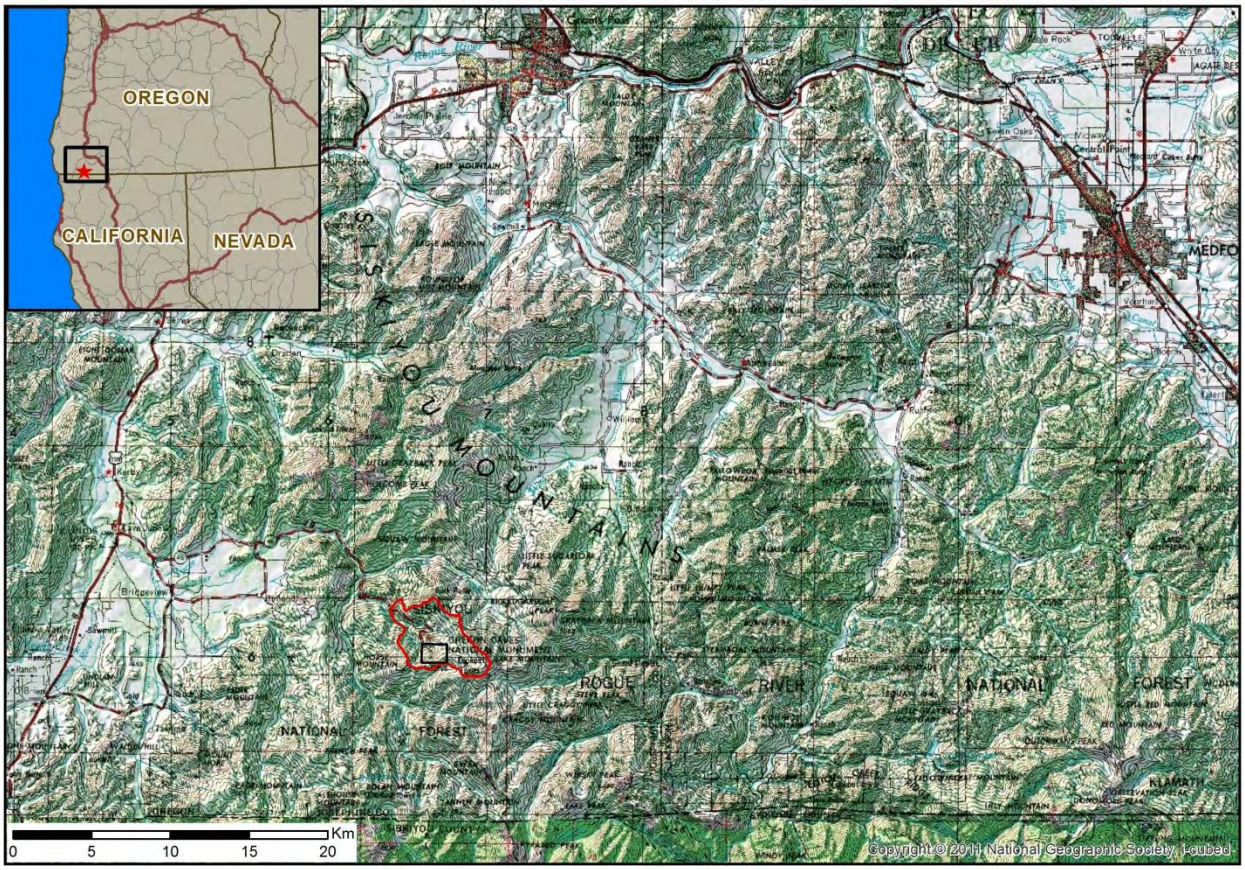

Figure 2. Oregon Caves National Monument location and surrounding region.

The existing196 ha (484 ac) ORCA was created by Presidential proclamation in 1909 by President William Howard Taft to protect a 4.8 kilometer (3 mile) cave "of unusual scientific interest and importance." The proclamation also states, in part, that "…the public interests will be promoted by reserving these caves with as much land as necessary for the proper protection thereof." The monument was transferred to the NPS for management in 1933. From 1933 to 1942, the Civilian Conservation Corps landscaped a 2.8 ha (7 ac) National Historic District and designed and constructed roads, trails, buildings, and the public water supply. The 1999 General Management Plan recommended protecting the monument's edges, scenic vistas, caves, and public water supply by adding 1,381 ha (3,410 ac) of adjacent late-successional U.S. Forest Service (USFS) lands. At the time of this report, the additional lands have not been incorporated in the monument and the current proposed expansion calls for adding a new total of 1,625 ha (4,015 ac) (Figure 3).

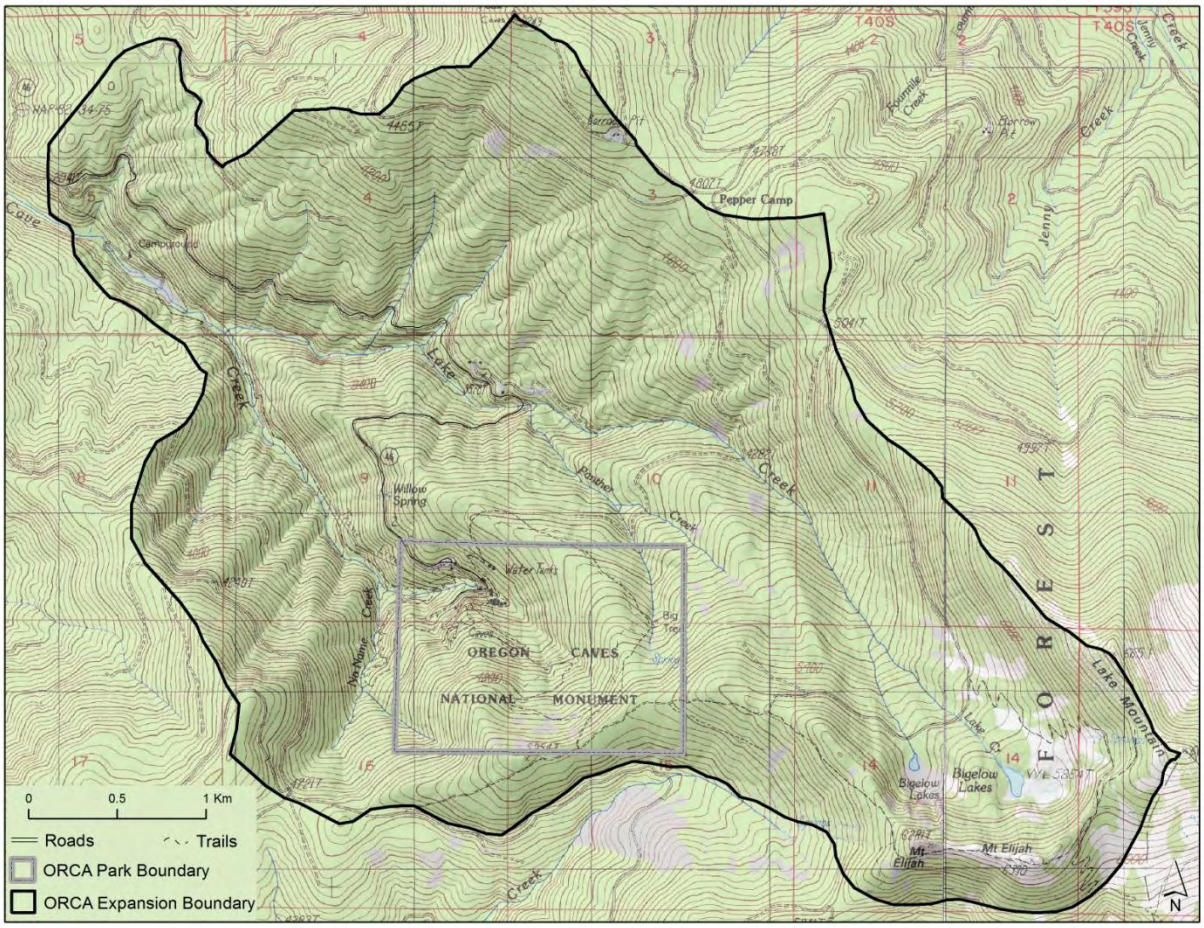

Figure 3. Oregon Caves National Monument and the proposed expansion area that comprise the project area.

ORCA is located near the top of a steep drainage in the Siskiyou Mountains of southwest Oregon in Josephine County, just north of the California border. The main part of the monument is accessible from a paved highway by driving 32 km (20 miles) east of Cave Junction via Oregon Highway 46. The 1.6 ha (4 ac) visitor center site is located in the town of Cave Junction.

Above ground, the monument includes the head and upper reach of a steep drainage and encompasses a remnant old-growth coniferous forest that supports a fantastic array of more than 500 plant species and protects a Douglas-fir tree (named “Big Tree”) with the widest known girth (approximately 4 m (13 ft) diameter at breast height). Below ground at ORCA is an active marble cave created by natural forces over hundreds of thousands of years in one of the world's most diverse geologic realms.

Natural Setting

ORCA is located in the forested, steep, mountainous terrain of the northwest corner of the Siskiyou Mountains in southwestern Oregon at elevations ranging from 1,122 to 1,670 m (3,680 to 5,480 ft) within the existing monument boundary. ORCA, although small in area, is ecologically diverse due to extreme relief, high soil and vegetation heterogeneity, and the presence of karst cave environments. Old-growth conifer forest, montane meadows, oak woodlands, and cave dwelling species endemic to the monument are important natural resources.

The climate of the region is strongly influenced by the Pacific Ocean, which contributes to relatively mild summers and winters. Temperatures typically range from -6.6° C (20° F) to 4.4° C (40° F) during the winter and from 10° C (50° F) to 32° C (90° F) during the summer. The cave temperature is 5.6 °C (42° F) year-round. Approximately 140 cm (55 in) of precipitation falls annually, mostly as wet snow. Moderate winds are common with prevailing winds from the west, storm winds from the south, and diurnal winds blowing up-canyon (from the northwest) during the day and down-canyon (from the southeast) in the evening.

The Klamath-Siskiyou Mountains of northern California and southern Oregon are renowned for their complex geologic history and diversity of geologic types (Whittaker 1960). This region exhibits one of the of the largest exposures of ultramafic rock in North America, one of the largest, most pristine, and most complete segments of old oceanic crust in Western America, and a variety of metavolcanics and other metasedimentary and sedimentary rocks (KellerLynn 2011). The geology underlying ORCA is predominantly composed of meta-basalt and the intrusive igneous diorite and gabbro of the Grayback Pluton (Figure 4). Smaller inclusions of argillite (meta-pelite), meta-diorite (meta-igneous), quartzite, and ultramafic rock (serpentinite and peridotite) also occur, as does the marble comprising the caves. The Grayback Pluton represents the dominant geology throughout much of the proposed expansion area. Evidence of prehistoric mountain glaciers occurs in the cirque valley (Bigelow Basin) south of Mt. Elijah in the proposed expansion area (KellerLynn 2011). The monument features one of the most biologically and physically diverse caves in the world. The ORCA caverns support one of the largest assemblages of endemic cave dwelling insects in the U.S., and have recently gained notoriety for Pleistocene-aged jaguar (*Panthera onca augusta*) and grizzly bear (*Ursus arctos*) fossils preserved in some of the deeper chambers.

The main cave at ORCA is one of only a few large marble caves in the Pacific Northwest. The cave formed mostly underwater as a braided passage network, due in part to a structural alignment between major faults and bedding strike, and a steep hydraulic gradient, that enabled ground-water dissolution of the bedrock. Continued fluctuations in groundwater levels and flow behavior also altered the cave where passages exhibit subsurface stream piracy, vertical shafts, bevels from flooding, and smooth ceilings from atmospheric corrosion. Formations in the main cave include speleothems that result from deposition, bedrock and fill features, and speleogens that result from solution (KellerLynn 2011). The wall rock is composed of late Triassic to mid-Permian metamorphosed sedimentary rock (mostly marble, with some argillite and metachert). Regionally, metamorphism is low grade (mid-level in greenschist facies) but higher grade metamorphosed sedimentary rocks (evidenced by the presence of garnet, biotite and actinolite) are exposed in the cave near quartz diorite plutons and dikes (KellerLynn 2011). Many of the geologic processes occurring within the cave are greatly influenced by aboveground factors, especially where there is an exchange of air, water, and food between the connected ecosystems.

ORCA preserves a pristine watershed in the headwater tributaries of the Illinois River, which is one of the last major undammed rivers in the Pacific Northwest still open to salmon and steelhead spawning. In addition, five small springs emerge within ORCA and flow most years. One of these springs forms the Upper Cave Creek that eventually seeps into the alluvium bed and re-emerges as Cave Creek near the main cave entrance. The underground water system in the cave has dissolved and eroded more than 4,572 m (15,000 ft) of known cave, a process which continues to occur. Surface streams that become intermittent following the spring snowmelt recharge the present cave stream. Water enters the cave from Upper Cave Creek surface and groundwater flows and seepage through overlying soil layers. Much of the cave hydrology is due to snowmelt resulting in water level changes throughout the year, with higher flows during the spring runoff and lower flows in late summer. The stream flows within the cave year-round even during periods of summer drought.

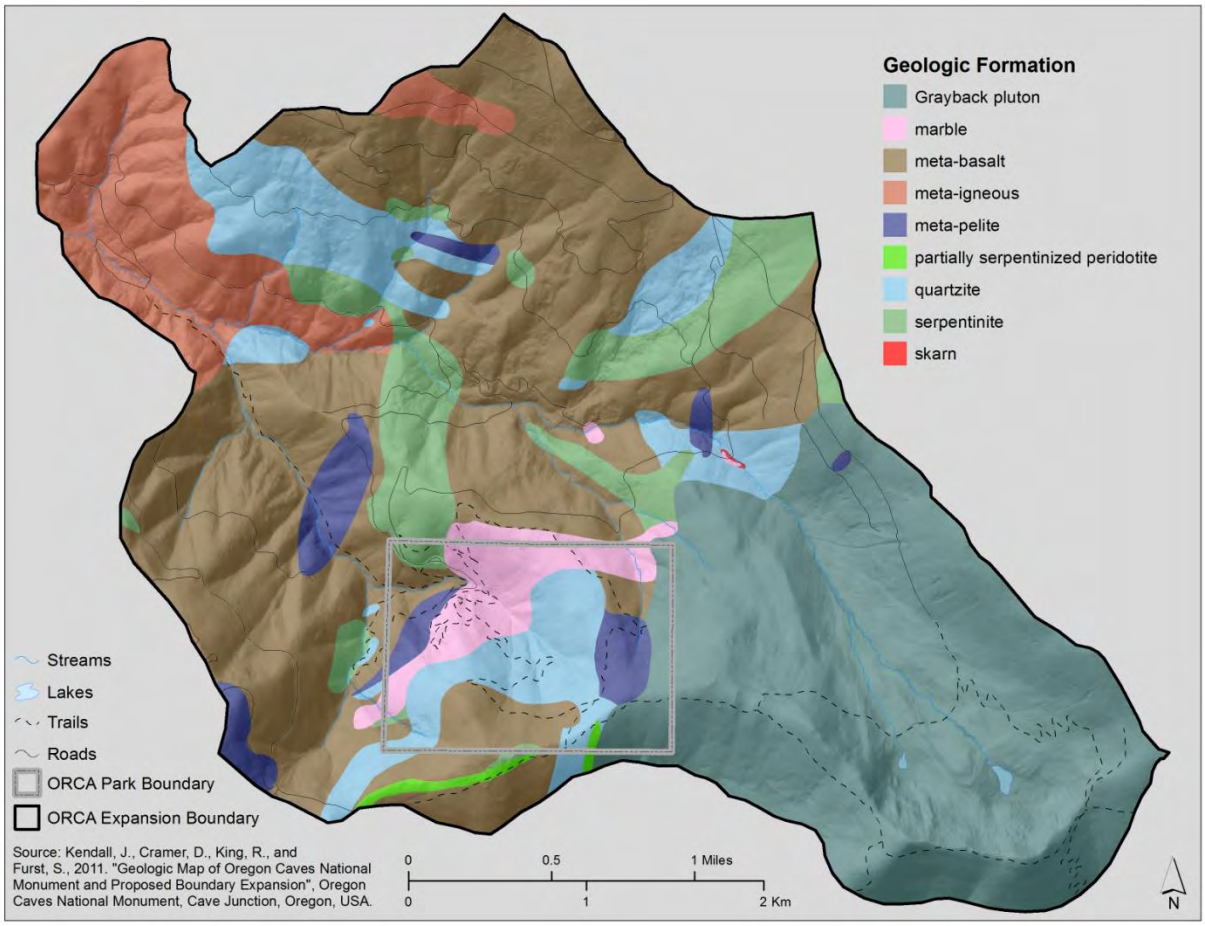

Figure 4. Geology of the Oregon Caves National Monument and proposed expansion area.

Vegetation and Flora

ORCA is located in the Klamath Mountains ecoregion (Omernik 1987), a large area of deeply dissected and folded mountains, foothills, terraces, and floodplains underlain by complex geology. The region is also reknowned for its high biodiversity. The principle natural influences on plants within ORCA are temperature and moisture, which are affected by precipitation, elevation, slope steepness/orientation, fire, humans, and soil types. The existing monument provides habitat for the following varity of plant species: at least 391 vascular plants (including thirteen regional endemics and 49 non-natives); 93 bryophytes; 120 lichens; and 250-to-400 taxa of macrofungi. The expansion area also contains many additional plant species, including species occuring in subalpine meadow and forest communities.

The vegetation occuring in the project area is described briefly here and in more detail in ensuing lengthy treatments in the Results, Accuracy Assessment, and Discussion sections and in the Appendices. At lower elevations between 900 m and 1200 m (2,953 ft and 3,937 ft), the vegetation is composed of mixed evergreen forest of tall, dense conifer and broad-leaved trees (Whittaker 1960). These evergreen forests are multistoried and the primary dominant tree species include Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), tanoak (*Lithocarpus densiflorus*), and madrone (*Arbutus menziesii*) that can occur in all forest layers (i.e., canopy, subcanopy, sapling, seedling). Large conifer individuals (mainly Douglas-fir, white fir, and sometimes sugar pine (*Pinus lambertiana*)) are emergent above the continuous canopy layer.

At middle elevations between 1200 m and 1700 m (3,937 ft and 5,577 ft), Douglas-fir and white fir occur in montane forest stands that lack broad-leaved tree cover . An additional conifer, Port Orford-cedar (*Chamaecyparis lawsoniana*) may dominate in this elevation zone as well, being restricted mostly to north-facing slopes and ravines. Above 1700 m (5,577 ft), the montane forest merges into and is replaced by subalpine forest stands characterized by Shasta red fir (*Abies magnifica* x *procera*), white fir (in the ecotone/transition zone), and mountain hemlock (*Tsuga mertensiana*). The subalpine zone habitats include a small glaciated cirque (Bigelow Basin) which supports two shallow lakes completely vegetated with the submerged and floating aquatic yellow pond lily (*Nuphar polysepala*). Bigelow Basin also provides many saturated habitats supporting wet meadow vegetation characterized by dense swards of graminoids; there are also large, dense patches of thinleaf alder (*Alnus incana* ssp. *tenuifolia*) and Eastwood's or mountain willow/willow species (*Salix eastwoodiae/Salix* spp.). Rimming the basin are rock outcrops and rocky slopes supporting sparse woodlands of Shasta red fir, chaparral shrubs, and prostrate herbs and subshrubs, particularly Oregon stonecrop (*Sedum oreganum*), spreading phlox (*Phlox diffusa*), and pinemat manzanita (*Arctostaphylos nevadensis*).

No special status plant species are known to occur within the monument. In the course of this project though, two special status plant species, bristly gentian (*Gentiana plurisetosa*) and California wild hollyhock (*Iliamna latibracteata*), were identified in meadows of the proposed expansion area.

Fauna

ORCA provides diverse habitat that supports approximately 50 mammal species (eight bat species), 86 bird species, 11 reptile and amphibian species, more than 200 arthropod species, eight snail/slug species, 75 butterfly species, more than 55 moth species, and eight species of aquatic (benthic) macro-invertebrates. Approximately 160 species also occur within the cave habitat seasonally and/or year-round.

Recent species lists indicate there are about 12 endemic macro-invertebrates using the main cave habitat including 11% of the approximately 110 arthropods known monument-wide. The main cave endemics include flies (Order - Diptera), beetles (Order - Coleoptera), millipedes (Order - Acari), grylloblatids/ice crawlers (Order - Grylloblattodea), springtails (Order - Collembola), and water mites (Order - Acariformes). Based on identifications by Dr. Steve Crawford (1994) (Burke Museum, Seattle, WA) there are at least nine invertebrate species only known from this cave system. Additionally, there are also at least 30 different microbe species that live in the caves, as well as tissue moths (Family - Geometridae), harvestmen (daddy longlegs (*Phalangium opilio*)), wood rats (*Neotoma fuscipes*), snails/slugs (Order - Stylommatophora), and spiders (Order - Araneae).

Many wildlife species use habitats outside of, and surrounding the cave. Commonly observed animals include black-tailed deer (*Odocoileus hemionus*), Stellar's Jay (*Cyanocitta stelleri*), Common Raven (*Corvus corax*), Douglas' squirrel (*Tamiasciurus douglasii*), and Townsend's chipmunk (*Eutamias townsendii*). Less frequently observed resident species include black bear (*Ursus americanus*), mountain lion (*Puma concolor*), flying squirrel (*Glaucomys sabrinus*), Pacific giant salamander (*Dicamptodon tenebrosus*), mountain beaver (*Aplodontia rufa*), rainbow trout (*Oncorhynchus mykiss*), and the Northern Spotted Owl (*Strix occidentalis* ssp. *caurina*).

North facing slopes, high elevation subsurface streams, and springs allow for permanent streamflow within the monument. These cool, physically complex streams contain significant amounts of coarse woody debris and gravel and support a variety of riparian reptile, amphibian, and fish species. Likewise, moist caves and/or riparian old-growth forest provides habitat for coastal crickets, rodents, and grylloblatids that typically occur in wetter areas found further north and west.

The monument is also home to a range of animals with special status, including the federally listed Northern Spotted Owl and several species of regional concern. These include: the mountain kingsnake (*Lampropeltis zonata*), tailed frog (*Ascaphus truei*), Del Norte salamander (*Plethodon elongatus*), Northern Goshawk (*Accipiter gentilis*), Olive-sided Flycatcher (*Contopus cooperi*), Little Willow Flycatcher (*Empidonax traillii* ssp. *brewsteri*), Siskiyou gazelle beetle (*Nebria gebleri* ssp. *siskiyouensis*), and Pacific fisher (*Martes pennanti*). Five species of concern occur in the cave: Townsend’s big-eared bat (*Corynorhinus townsendii*), long-eared myotis (*Myotis evotis*), fringed myotis (*M. thysanodes*), long-legged myotis (*M. volans*), and Yuma myotis (*M. yumanensis*).

Natural Resource Concerns

There are many concerns specific to the cave environment that are outside the scope of this project. The natural vegetation of the project area does indirectly effect the cave environment by intercepting and using water from rainfall and snowfall, influencing runoff, and providing nutrients. The watershed that is the source of the subterranean flows in the caves is within the project area and is the primary reason for the shape and size of the proposed expansion area.

A large portion (over one-third) of the land adjacent to the monument in the proposed expansion area has been logged (approximately 605 ha (1,495 ac)). As captured in the vegetation map, much of the logging was clear-cut (approximately 285 ha (704 ac)). Shelterwood cutting and comprises the second most common form of historic logging. Concerns about logged areas voiced by ORCA resource staff include changes in microclimate up to 150 m (492 ft) laterally into old growth forest, potential impacts on the hydrology of the caves, increased indices of non-native species, impaired viewsheds, and decreased population size of species of trillium, orchid, herpetofauna, vole, bat, and epiphytic plants. Extensive logging in the watershed (the caves water source) could increase the volume of water in the caves due to a loss of trees (many of them of extrodinary size) and the reduction of evapotranspiration. The effects of past timber harvest on the vegetation within ORCA and proposed expansion area are presented in more detail in the Discussion section in this report.

Fires have been suppressed in and around the monument through much of the last century. The area within the current ORCA boundary has not experienced a wildfire since 1921 (Agee 1991). Prescribed fires burned near the entrance in 1997 and 2007. Agee (1991) describes the historic fire frequency and natural fire rotation (the amount of time it takes for an area equal in size to the area of interest to burn once). at ORCA from 1400-1900 A.D as 80 years based on data presented on the proportion of the area burned each century during that time period (Agee 1991: Table 2). Using this estimate, some areas in ORCA likely burned more than once during a given 80-year period, and some less, with the average for the whole area being 80 years. Notably, Agee (1991) found a 100-year period lacking fire in the tree ring records, which may or may not be longer than the current fire free period. In contrast, the fire rotation immediately prior to fire suppression (1800-1900 A.D.) was 34 years. Fire frequency during this period may have been enhanced by miners and settlers (settlement burning was common in the Klamath Region) since it was so much more frequent than the previous two centuries. In summary, the analysis by Agee (1991) suggests that the fire frequency at ORCA was highly variable and the immediate pre-suppression fire regime may have had an important anthropogenic component.

In terms of fire behavior, the natural fire regime is one of highly variable mixed-severity (Agee 1991). Mixed-severity fires create complex early successional conditions and landscape level complexity in the form of age mosaics. Fire suppression can lead to landscape-level homogenization in the vegetation (Odion et al. 2010), a decline in beta diversity (differentiation among habitats), and reduced occurrence of species that thrive following fire and other disturbancese. Some of these species are generalists, such as manzanita shrubs, that will grow well following logging while other disturbance-adapted species will not establish in logged areas. Mixed serverity fires are particularly important in creating high-severity patches with dense concentrations of snags that provide valuable wildlife habitat (Hutto 2008). For example, beetles that are specialized to feed on freshly killed trees (which themselves are a unique, fire-adapted component of biodiversity) provide a major source of food for birds. In addition, many

of the bird species in the region are dependent on snags for nesting and/or foraging (Fontaine et al. 2009).

There are generally low incidences of non-native species within ORCA and a greater presence within the proposed expansion area. Potentially problematic invasive weeds include the yellow star-thistle (*Centaurea solstitialis*) found during this project. Yellow star-thistle can rapidly invade grasslands and forest openings, however infestations typically occur at lower elevations with warmer seasonal temperatures. Common mullein (*Verbascum thapsus*) also occurs in the monument and in the expansion area and can quickly invade recently disturbed sites, but decreases in abundance as perennial vegetation establishes. Several other non-native weeds of disturbed areas were identified during this study, including orchardgrass (*Dactylis glomerata* ssp. *glomerata*), prickly lettuce (*Lactuca serriola*), bristly dogstail grass (*Cynosurus echinatus*), common St. Johnswort (*Hypericum perforatum*), common sheep sorrel (*Rumex acetosella*), and spiny sowthistle (*Sonchus asper*). These species are not desirable, particularly in a natural area but they usually do not act as ecosystem transformers. Exceptions to this opinion could be orchardgrass, bristly dogstail grass, and common St. Johnswort if they occur in particular abundance. The expansion area also supports many planted trees (predominately Douglas-fir) which are likely artificially-selected nursery stock. The genetic make-up and diversity of the plantations may be considerably different than that in natural forests.

Other potential impacts from non-native species on the native vegetation could occur at ORCA. One example is the Port Orford-cedar root rot caused by the water mold *Phytophthora lateralis. Phytophthora lateralis* is a waterborne pathogen of the Phylum Oomycota (fungus-like eukaryotic microorganisms) that can locally exterminate Port-Orford cedar stands. The disease is often spread by mud on the wheels and undercarriage of vehicles. The disease is not currently affecting Port-Orford cedar within the existing monument boundary and the likelihood of introduction by vehicles entering the existing monument is low since the boundary lies entirely within the upper reaches of a tributary of Cave Creek and traffic is concentrated at its lowest elevation. However, this pathogen can also be transported from mud on hiker's boots and could spread along stream courses from higher elevations as there are numerous trails that traverse the high ridges in the existing monument and the proposed expansion area.

Post logging recovery, ongoing fire management, and potential impacts of non-native species represent important surrounding landscape-level natural resource concerns that directly affect the vegetation within the existing ORCA boundary. The current size and configuration of the existing monument boundary greatly preempts and limits any effective management influence on these landscape processes. The future development of the vegetation within the monument boundary will be subject to these landscape scale influences particularly at the watershed scale. Therefore, from a vegetation management and resource protection perspective, there is a significant case for an expanded monument boundary that extends to the watershed boundaries of the upper reaches of Cave Creek.

Oregon Caves Vegetation Inventory Project

The Klamath Network (KLMN) initiated a vegetation mapping plan for ORCA and proposed expansion area as part of a larger effort to complete vegetation inventory maps for each of the five parks in the network that were previously unmapped. An initial multi-year work plan was developed for the KLMN by Southern Oregon University (SOU) for three of the park units. These included Oregon Caves National Monument, Lava Beds National Monument (LABE), and Crater Lake National Park (CRLA). The SOU research team also collected field data for two seasons to support vegetation classification and accuracy assessment work at Lassen Volcanic National Park (LAVO). Planning between the KLMN, the Washington Area Service Office (WASO), and SOU project staffs was done to complete the plant community classification, digital database, and map products for a component of the LAVO Vegetation Inventory Project, as well as the inventory projects at ORCA, LABE, and CRLA. The work plan received approval from the WASO in 2007. Once approved and funded, the KLMN contracted with SOU to complete the projects. The SOU research team has been responsible for this project, including the following components:

- Aerial and ortho-photography;
- Classification of ORCA and proposed expansion area vegetation into associations;
- Dichotomous field key of vegetation associations;
- Formal description for each vegetation association;
- Ground photographs of each vegetation association and relevé;
- Field data in database format;
- Map and spatial database of ORCA and proposed expansion area;
- Formal description of vegetation map units in relation to associations;
- Digital and hardcopy maps of the vegetation of ORCA and proposed expansion area;
- Metadata for spatial databases;
- Complete accuracy assessment of spatial data;

The SOU research team organized the data collection and image acquisition for the ORCA vegetation inventory (classification and mapping) project beginning in 2009.

Scope of Work

Vegetation inventory for the project occurred on an approximately 1,821 ha (4,500 ac) area encompassing the existing ORCA and the proposed expansion area. Initially, we considered including an additional 500 m (1,640 ft) environs around the expansion area; some relevé classification plots were sampled in the environs, which was ultimately dropped from the mapping portion of the project to better focus on the existing monument and expansion area.

Methods

Protocols for this project as outlined in the following sections can be found in documents at the USGS-NPS Vegetation Inventory Program located at this website: http://science.nature.nps.gov/im/inventory/veg/guidance.cfm. In particular the following documents: TNC/ESRI (1994), Lea (2011), and Lea and Curtis (2010) provided valuable guidance.

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: I&M National Vegetation Inventory Program	(970) 225-3591
Andy Duff	Southern Oregon University	(541) 552-6253
Julie Evens	California Native Plant Society	(916) 327-0714
Todd Keeler-Wolf	CA Dept of Fish and Game	(916) 324-6857
David Larson	NPS: Lava Beds National Monument	(530) 667-8106
Michael Murray	NPS: Crater Lake	(541) 594-3072
Dennis Odion	Southern Oregon University	(541) 552-9624
Susan O'Neil	NPS: Klamath Network	(206) 220-4265
John Roth	NPS: Oregon Caves National Monument	(541) 592-2100 x230
Daniel Sarr	NPS: Klamath Network	(541) 552-8575
Ken Stumpf	Geographic Resource Solutions	(707) 822-8005
Chris Wayne	NPS:Crater Lake National Park GIS	(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 NVIP; (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 KLMN; and (5) discuss procedural issues and data.

It was decided at this meeting that the SOU research team would classifiy and map the vegetation within ORCA and the proposed expansion area. They were to develop a detailed proposal and budget for the project at ORCA including the proposed expansion area, as well as the projects at CRLA and LABE. The KLMN developed the detailed proposal with input from park staff and Dr. Karl Brown (NVIP Manager). The final proposal was presented to the NVIP in early January, 2007. The proposal was to conduct relevé sampling of vegetation types, develop a traditional vegetation classification, and to map vegetation polygons 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 NVIP and a task agreement was entered into with the Pacific Northwest Cooperative Ecosystems Studies Unit of the NPS with SOU as the cooperator.

Following the first field season a progress report and plan for completing vegetation classification and mapping was prepared and presented to the NVIP staff in April, 2010.

Field Surveys

Field methods used in this project followed NVCS and the USGS-NPS standards (e.g., TNC and ESRI 1994) and employ the California Native Plant Society relevé sampling protocol (CNPS 2007) as well as the relevé methods described in the NVIP 12-step process. Classification plot forms and individual data/field descriptions appear in Appendix A. The sampling area included ORCA and the proposed expansion area in their entirety (Figure 3).

Our first step was to delineate the project area into relatively homogeneous vegetation stands using vegetation signatures on the 2005 imagery and to classify these stands into general physiognomic classes that would serve as sampling strata. A total of 90 separate polygons representing putative stands were mapped into 16 general physiognomic vegetation classes prior to initiating field sampling. Riparian and wetland areas were identified with the help of existing stream and wetland coverages. In the summer of 2009, polygons in each physiognomic vegetation class were sampled following the general procedure for relevé sampling (CNPS 2007) and NVIP field methods online at: (http://biology.usgs.gov/npsveg/fieldmethodsrpt.pdf).

Field crews were led by Dennis Odion, Ph.D., an ecologist experienced in sampling high elevation forest, meadow, and riparian communities and using the relevé method. All physiognomic vegetation classes were visited to help ensure that the variation in vegetation in the landscape would be captured. Within each physiognomic vegetation class, 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 type. The sampling goal was to collect 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 representative plant communities, 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. Classification plots were generally located in stands exceeding the standard minimum mapping unit (MMU) of 0.5 ha (1.24 ac). A few classification plots were sampled in smaller patches of distinctive vegetation or communities of uncommon species. Plot size and shape requirements were consistent with NVIP guidelines (TNC and ESRI 1994a) 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 2009, 79 classification plots were sampled and many plant taxa (110) were encountered that were not on the ORCA plant species list. We used a Microsoft Access relational database modified from the USGS-NPS NVIP Plots v2 database (Plots v3 was not yet released). We captured the cover of all species within three tree, three shrub, and one herbaceous strata/stratum. The Jepson Manual for California (Hickman 1993) was the primary reference used to identify

plant taxa and the final taxa names conform to those in the USDA PLANTS database (2012). In 2010, 55 additional classification plots were sampled and a few more were added in 2011 and 2012 for associations that were undersampled. The Plots v3 database was used for data storage and management during the 2010-2012 sampling task. All plot locations are shown in Figure 5.

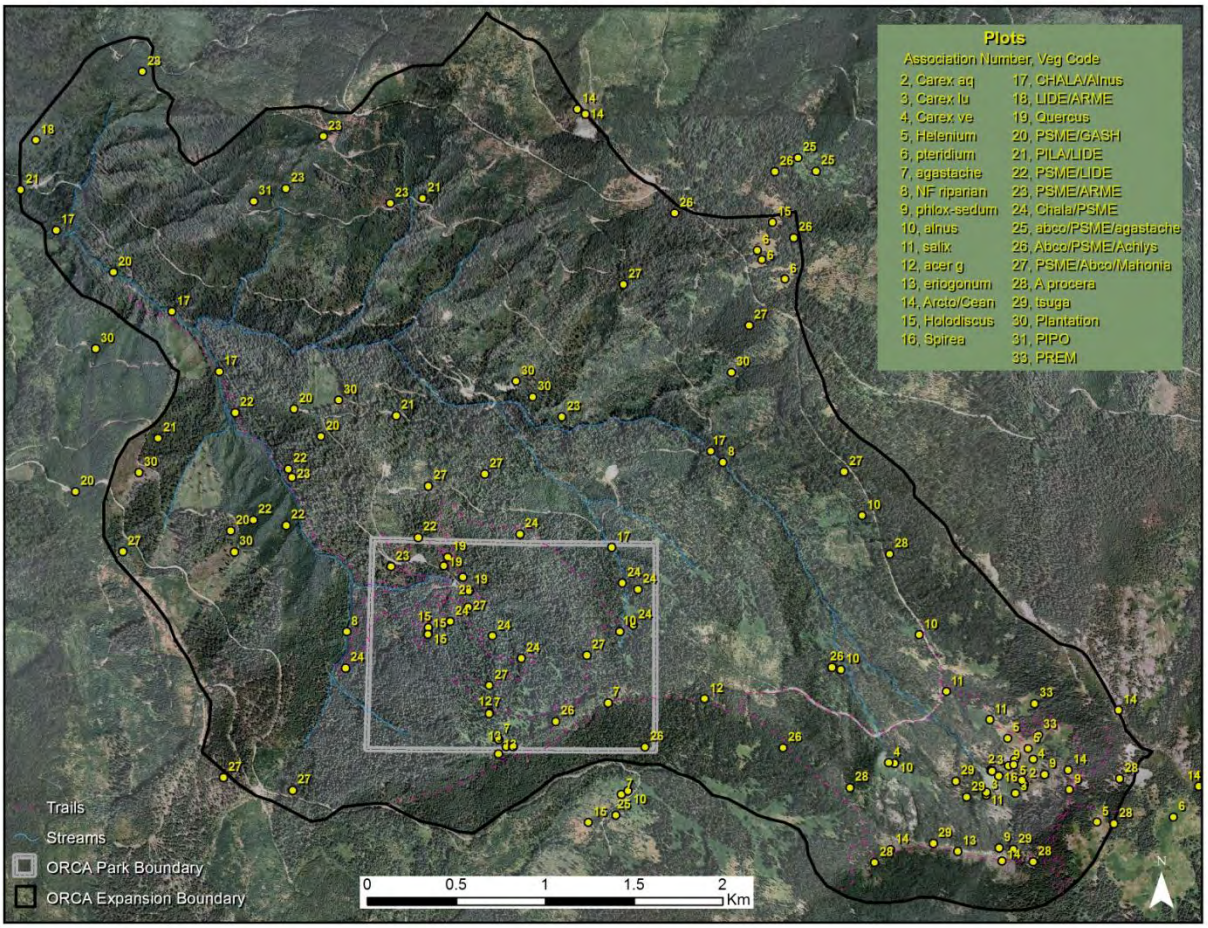

Figure 5. Vegetation classification plot (relevé) locations.

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). 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 an eight-category cover class scale (<1%, 1-2%, 2-5%, 5-15%, 15-25%, 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 SOU Herbarium. 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).

Vegetation Classification

The Plots v2 and v3 databases 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 and we retained all species/strata for the classification. 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). The TWINSPAN classification was modified by manual-sorting of some associations. Manual sorting mainly involved grouping plots based on aesthetically noteworthy and particularly conspicuous species in the field; two examples include Port Orford-cedar and sugar pine. The cover value for each is often lower than the species conspicuousness suggests and they were therefore not influential in the classification. We identified a sugar pine - tanoak forest association and a Port Orford-cedar - Douglas-fir forest association largely by manual sorting plots based on the presence of large individuals of these conspicuous tree species. The logic underlying this approach is that these phases of broader associations are recognizable in the field and needed for a lexicon of the natural vegetation even though both associations share so many dominant and characteristic species with other forest associations that they are not distinctive in the classification.

Naming conventions of associations follow the format of Sawyer et al. (2009). We named plant associations whenever possible by the most conspicuous and distinctive species within the ORCA project area, such as sugar pine and Port Orford-cedar, even if they were not necessarily dominant. However, in most cases the dominant or diagnostic species of the upper stratum was listed first, followed by the secondary dominant regardless of stratum. We present detailed descriptions, photographs, and range maps for each association in Appendix C.

Using the classification, we produced a dichotomous field key to the plant associations (Appendix B). 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.

Digital Imagery and Interpretation

The most current and high-quality spatial and spectral resolution imagery available was used to facilitate the vegetation classification and mapping of ORCA. The Oregon Geographic Information Council coordinated the acquisition of the project imagery for the state of Oregon in the summer of 2009 through an agreement with the United States Department of Agriculture, Farm Services Agency (FSA), National Agriculture Imagery Program (NAIP). The Oregon Geospatial Enterprise Office (2012) provided digital video disks (DVDs) of the imagery to the SOU research team. The imagery was projected to Oregon State Plane South Federal Information Processing Standards (FIPS) 3602 North American Datum (NAD) 1983 with a spatial resolution of 1.5 feet (international feet = 0.304800 m). The ORCA region imagery was then subset from the NAIP aerial orthophotography acquired for the entire state of Oregon. 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 at a spatial resolution of 1.5 feet. The KLMN staff did not make any additional modifications to the delivered NAIP imagery.

Mapping was performed by Dennis Odion, Ph.D., and facilitated by observations/knowledge of the vegetation acquired during field sampling and thorough reconnaissance of ORCA and the proposed expansion area. The classified plot data were overlaid with the imagery to serve as an interpretive guide and Dr. Odion delineated physiognomically distinct vegetation classes (Appendix E) from the imagery using onscreen digitizing techniques in GIS software. Because of the relatively small project area, the MMU was reduced to approximately 0.25 ha (0.62 ac) rather than the NVIP standard 0.5 ha (1.24 ac). Occasional field verification trips were undertaken to clarify vegetation patterns on the ground that were uncertain/confusing on the imagery.

Because it is often impossible to circumscribe an area of vegetation that consists entirely of a single type, more than one physiognomic vegetation class was captured in the attributes for each vegetation map polygon (Table 1). This database approach, utilized by Dr. Odion for the California Gap Analysis Project (Davis et al. 1998) provides a more detailed and accurate description of the vegetation than can be obtained by only considering one class or a mixture of classes for a polygon. Instead, when the proportion of the polygon occupied by the dominant, primary class type was less than 100%, the proportion was estimated and the proportion of a secondary class type was estimated. Further still, the percentages of up to two associations comprising the primary physiognomic vegetation class and up to two associations comprising the secondary physiognomic vegetation class (for a total of four possible associations) were also captured.

The following discussion presents two examples of the usefulness of the above-defined database approach. Willow thickets are one of the physiognomic vegetation classes mapped for ORCA, however these thickets often have fine-scale openings supporting subalpine wet meadow vegetation. These openings are much too small to map individually; the openings also vary in abundance among willow thickets and therefore are difficult to accurately describe using a single map class that represents a combination of classes with a fixed proportion. During the ORCA project mapping we could see the relative percentage of subalpine wet meadow intermixed in willow thickets and capture it in the map database. A second, very different example further illustrates the utility of a database mapping approach as applied herein. Mixed evergreen forest dominates the lower to middle elevations of the project area. This vegetation is complex, variable and may contain several plant associations. Because mixed evergreen forest associations are not distinctive on the NAIP imagery, the forest is mapped as one physiognomic class. However, when traversing large polygons in the project area occupied by this vegetation type a knowledgeable botanist/ecologist can estimate how much of the polygon appears to be dominated by the associations (e.g. *Pseudotsuga menziesii / Gaultheria shallon* Forest and *Pseudotsuga menziesii – Lithocarpus densiflorus* Forest). The relative abundance of each association is captured in the map database and it may be possible to capture a third and fourth association and relative abundance by having a secondary physiognomic vegetation class identified in the polygon.

This approach of attributing multiple vegetation classes 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 class or a pre-defined complex of vegetation classes (Appendix F). Importantly, the approach described in the previous paragraph does not preclude or alter the creation of such a vegetation map (mapping is still based on the identification of physiognomically distinctive

spatial units). The added value is that these units can be characterized and rendered in more detail than traditional, pre-GIS approaches to mapping vegetation.

Management is also captured in the vegetation spatial layer by using the USFS Managed Stands GIS layer that indicates polygons of all areas treated in the proposed expansion area and includes the treatment description and the date of completion. This layer was used to further inform the delineation of polygon boundaries in the vegetation map and assign the proper physiognomic vegetation class. The treatment description and the year of treatment were also retained in the attributes of each relevant polygon. If the same treatment type occurred in two contiguous polygons in the Managed Stands layer, but the year of treatment differed, the polygons were kept separate in the vegetation map, even though the current vegetation may be the same (e.g., a 25 vs. 26 year old plantation).

Table 1. The breakdown and description of attributes applied to vegetation map polygons.

Attribute of interest	Code	Description
Area	N/A	Polygon area in ha.
Primary vegetation	1veg	The dominant physiognomic vegetation in each polygon
Primary vegetation, percent cover	1veg_pct	The percent cover of the dominant physiognomic vegetation in each polygon (range 50-100%)
Secondary vegetation	2veg	The second most dominant physiognomic vegetation in each polygon intermixed at a scale below the minimum mapping unit.
Secondary vegetation, percent cover	2veg_pct	The percent cover of the secondary physiognomic vegetation in each polygon (range 10-50%)
Primary association	1ass1	The dominant vegetation association in the dominant physiognomic vegetation (1_veg) in each polygon
Primary association, percent cover	1ass1_pct	The percent cover of the dominant vegetation association in the dominant physiognomic vegetation (1_veg) in each polygon (range 50-100%)
Secondary association of primary vegetation (if present)	1_ass2	The secondary vegetation association in the dominant physiognomic vegetation (1_veg) in each polygon
Secondary association of primary vegetation, percent cover	1ass2_pct	The percent cover of the dominant vegetation association in the dominant physiognomic vegetation (primary vegetation) in each polygon (range 10-50%)
Primary association of secondary vegetation (if present)	2ass_1	The dominant vegetation association in the secondary physiognomic vegetation (2_veg) in each polygon

Table 1. The breakdown and description of attributes applied to vegetation map polygons (continued).

Attribute of interest	Code	Description
Primary association of secondary vegetation association, percent cover	2ass1_pct	The percent cover of the primary vegetation association in the secondary vegetation (2_veg) in each polygon (range 50-100%)
Secondary association of secondary vegetation association	2ass_2	The secondary vegetation association in the secondary physiognomic vegetation (2_veg) in each polygon
Secondary association of secondary vegetation association, percent cover	2ass2_pct	The percent cover of the secondary vegetation association in the secondary vegetation (2_veg) in each polygon (range 10-50%)
Management	Management	Type of logging undertaken throughout the polygon (from the USFS, Rogue River-Siskiyou National Forest Managed Stands Layer). Types of logging include clear cut (complete harvest of conifers), shelterwood (removal of most conifers), thinning (removal of subordinate conifers), final removal (secondary entry, usually leaving areas clear cut).
Year of harvest	Yr_harvest	In polygons with management, the year of harvest (from the USFS, Rogue River-Siskiyou National Forest Managed Stands Layer).

Accuracy Assessment

Following our delineation of the project area landscape into map polygons of distinctive physiognomic vegetation classes, we conducted an accuracy assessment (AA) of this vegetation map. The AA is a quantitative analysis of how well the vegetation map represents vegetation on the ground by comparing field observations with the map class assignment. Map errors occur when polygon attributes differ from field observations. Results of the AA 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 AA 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). Four map classes received more to many more sample observations than the 30 prescribed in Lea and Curtis (2010) due to aggregation following an attempt to define finer map classes.

We collected AA data during the 2011 field season, sampling 444 AA points throughout the ORCA project area. The field crew used GIS-stratified random point data uploaded into GPS units/receivers. 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 vegetation class 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. 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

actual coordinates of the point, the GPS receiver error (even if not moved), and then used the dichotomous field key produced from the vegetation classification (Appendix B) to determine the vegetation association where the point was located. If no homogeneous area of vegetation could be obtained by moving the point 100-200 m, and two physiognomic vegetation classes were present within the 0.5 ha (1.24 ac) area around the point, then both of these vegetation classes were recorded in order of relative abundance and the relative abundance was also noted. 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 444 AA locations were uploaded from the GPS units to create a GIS layer, which was merged with the data collected at each corresponding point (Figure 6). We reviewed all points that fell within 10 m (32.8 ft) of a polygon boundary then used the GPS receiver error to determine whether the point was certain to be within a mapped vegetation polygon or not. Where the distance from the point to a polygon boundary was less than the GPS receiver error (mostly 7 m or less (23 ft)), 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.

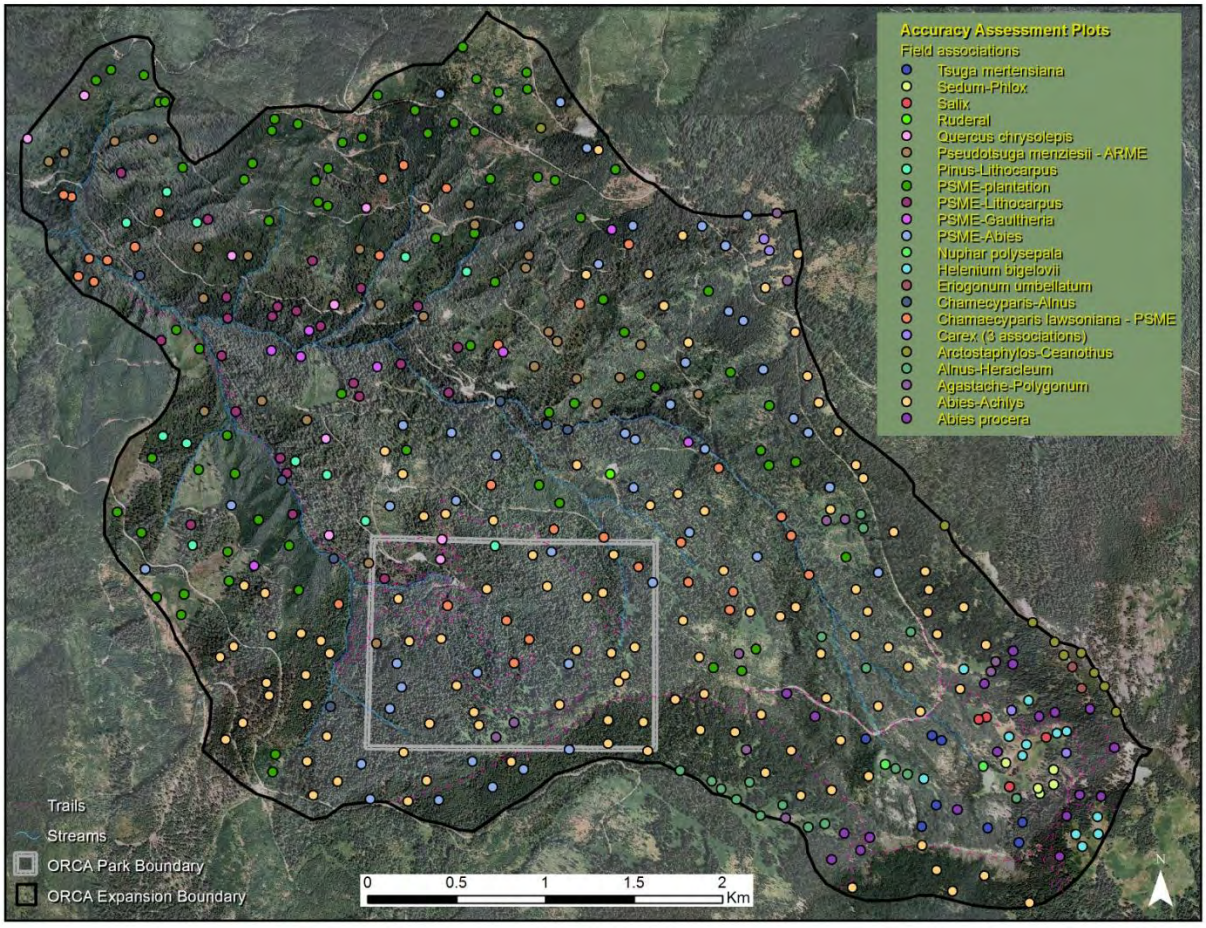

Figure 6. Location of Accuracy Assessment Plots with the vegetation associations attributed to the sites in the field.

In some AAs that have been done for vegetation maps at other National Parks, fuzzy logic may be used to assign levels of accuracy. We believe that this approach is not sufficiently straightforward for the user to conceptualize map biases and problems. We instead chose a binary AA- either right or wrong. However, this approach is complicated by our attribution of multiple vegetation classes to a polygon. In the great majority of cases in both the map and field data, the primary vegetation occupied over 80% of a polygon (see Results section). Our AA is based on comparison of the primary vegetation in the map with the vegetation confirmed at a location on the ground, with a few exceptions that include:

(1) Where the map indicated that the primary vegetation and secondary vegetation were equally abundant (a 50/50 mix), then we compared the point data with both the primary and secondary vegetation of the map polygon. We considered the polygon correctly labeled if the field vegetation corresponded to either the primary or secondary vegetation assignment in the map polygon;

(2) We considered all points within 15 m (approximately 50 ft) of a stream, as mapped in the USGS streams GIS layer, to be riparian, even if the vegetation could be considered an upland association. Many riparian areas at ORCA have the same dominant species as the adjacent upland vegetation (e.g., Douglas-fir), and sparse to low cover of riparian obligate species. Some AA plots that were streamside, therefore, did not key out to riparian vegetation. We concluded that it was more important to managers and users of the map to consider all streamside areas as riparian;

(3) We moved two AA points into the neighboring polygon because the field and photograph/imagery evidence suggested that this was the correct location of the point. For example, a point within Bigelow Lakes was moved a few meters into the adjacent willow thicket, which was the vegetation recorded at the site; and

(4) There were three physiognomic vegetation classes so rare that no AA points were sampled in these types. Two of these classes were never identified as primary vegetation in any polygon (bitter cherry (*Prunus emarginata*) thicket and young montane forests (logged)). The other, cushion buckwheat (*Eriogonum ovalifolium*) gravel field occurred in one known location where a vegetation classification plot was already sampled and no other locations were recorded in the AA plot database.

Results

Vegetation Classification

In 142 relevé plots, we documented 397 plant species as listed in Appendix D, which also describes the frequency with which each species was encountered. The plot by species matrix was classified into 34 plant associations that are listed in Table 2 below, and each is described in detail in Appendix C. Seventeen ORCA plant associations are analogous to associations listed in the USNVC of NatureServe (2009), however none are endemic to the project area. The forest associations are typical of the central Siskiyou Mountains, but some may reach their maximum development/greatest expression in the ORCA area (Whittaker 1960).

The diagram presented below and prepared by Whittaker (1960) provides an excellent summary of the forest-environment relations and the conditions that support different plant associations (Figure 7). At lower elevations in the project area, generally below 1200-1400 m (3,937-4,593 ft), dominant plant associations include four mixed evergreen forest associations. In each mixed evergreen association, the conifers Douglas-fir, white fir, and occasionally sugar pine are co-dominant with the broad-leaved, evergreen, sclerophyllous trees tanoak and/or madrone or the understory shrub, salal (*Gaultheria shallon*). There are two associations in this lower elevation zone that are largely lacking conifers and instead are dominated by tanoak or canyon live oak (*Quercus chrysolepis*). All of these forest associations intermix extensively and overlap substantially in species composition (Appendix E).

At mid-elevations, generally from 1400-1700 m (4,593-5,577 ft), the broad-leaved trees give way, presumably due to heavy snow and freezing winter temperatures. Forests remain dominated by Douglas-fir and white fir, the two most abundant species sampled in the overall project area. There are three montane forest associations in this mid-elevation zone dominated by these two conifers (but with different understory species) and one association co-dominated by the conifer Port-Orford cedar. In contrast to the noteworthy, very large stature of the native conifer forests, Douglas-fir plantations (20-40 years old) with small trees 5-20 m (16-66 ft) tall are commonly scattered outside the existing monument. Riparian forests dominated by a Port Orford-cedar / white alder (*Alnus rhombifolia*) association line several small streams in the project area.

At the highest elevations, generally above 1700 m (5,577 ft), Douglas-fir and white fir forests merge into and are replaced by forests dominated by Shasta red fir and mountain hemlock.

Throughout the three elevation zones there are patches of shrub vegetation in two associations, one dominated by greenleaf manzanita (*Arctostaphylos patula*) and the other by ocean spray (*Holodiscus discolor*). Several other shrub and herbaceous vegetation associations occur as forest openings on the upper slopes within the montane and subalpine zones. Openings on shallow soils typically support the sulphur-flower buckwheat (*Eriogonum umbellatum*) – bigseed biscuitroot (*Lomatium macrocarpum*) dwarf-shrub association. Openings on wetter sites often support the thinleaf alder (*Alnus incana* ssp. *tenuifolia*) / common cowparsnip (*Heracleum maximum*) and Rocky Mountain maple (*Acer glabrum*) tall shrub associations and the two herbaceous associations nettleleaf giant hyssop (*Agastache urticifolia*) – poke knotweed (*Polygonum phytolaccifolium*) and bracken fern (*Pteridium aquilinum*) - mixed graminoids.

Table 2. List of plant associations for the Oregon Caves National Monument project area.

Plant Association	Abbreviated name	USNVC type
Herbaceous (meadow) associations		
Nuphar polysepala	*Nuphar*	*Nuphar polysepala* Herbaceous Vegetation
Carex aquatilis	*Carex aquatilis*	*Carex aquatilis* var. *dives* Herbaceous Vegetation
Carex luzulina	*Carex luzulina*	N/A
Carex exsiccata - Caltha leptosepala	*Carex-Caltha*	*Carex vesicaria* Herbaceous Vegetation
Helenium bigelovii - Potentilla glandulosa	*Helenium-Potentilla*	N/A
Pteridium aquilinum - graminoid	*Pteridium*	N/A
Agastache urticifolia - Polygonum phytolaccifolium	*Agastache-Polygonum*	N/A
Sedum oregonense - Phlox diffusa	*Sedum-Phlox*	N/A
non-forested riparian	non-forested riparian	N/A
Shrub associations		
Alnus incana / Heracleum maximum	*Alnus-Heracleum*	*Alnus incana* / Mesic Forbs Shrubland
Salix eastwoodiae / Senecio triangularis	*Salix-Senecio*	*Salix eastwoodiae / Deschampsia cespitosa* Shrubland
Acer glabrum	*Acer glabrum*	N/A
Prunus emarginata	*Prunus emarginata*	N/A
Arctostaphylos patula - Ceanothus velutinus	*Arctostaphylos-Ceanothus*	*Arctostaphylos patula* Sierran Chaparral Shrubland
Eriogonum ovalifolium	*Eriogonum ovalifolium*	N/A
Eriogonum umbellatum - Lomatium macrocarpum	*Eriogonum-Lomatium*	N/A
Spiraea douglasii	*Spirea douglasii*	N/A
Holodiscus discolor	*Holodiscus discolor*	N/A
Landing area/Ruderal/ unregenerated clear cut	Ruderal	N/A
Forest Associations		
Chamaecyparis lawsoniana / Alnus rhombifolia	*Chamaecyparis-Alnus*	*Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla* Forest

Table 2. List of plant associations for the Oregon Caves National Monument project area (continued).

Plant Association	Abbreviated name	USNVC type
Lithocarpus densiflorus - Arbutus menziesii	*Lithocarpus-Arbutus*	N/A
Quercus chrysolepis	*Quercus chrysolepis*	*Pseudotsuga menziesii - Quercus chrysolepis* Forest
Pseudotsuga menziesii / Gaultheria shallon	*Pseudotsuga-Gaultheria*	*Pseudotsuga menziesii / Lithocarpus densiflorus / Gaultheria shallon* Forest
Pinus lambertiana - Lithocarpus densiflorus	*Pinus-Lithocarpus*	N/A
Pseudotsuga menziesii - Lithocarpus densiflorus	*Pseudotsuga-Lithocarpus*	*Pseudotsuga menziesii / Lithocarpus densiflorus / Gaultheria shallon* Forest
Pseudotsuga menziesii - Arbutus menziesii	*Pseudotsuga-Arbutus*	*Pseudotsuga menziesii - Arbutus menziesii / Gaultheria shallon* Forest
Chamaecyparis lawsoniana - Pseudotsuga menziesii	*Chamaecyparis-Pseudotsuga*	*Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla* Forest
Abies concolor / Agastache urticifolia	*Abies-Agastache*	*Pseudotsuga menziesii - Abies concolor - Calocedrus decurrens* Forest
Abies concolor /Achlys triphylla	*Abies-Achlys*	*Abies concolor / Maianthemum stellatum* Forest
Pseudotsuga menziesii - Abies concolor / Mahonia nervosa	*Pseudotsuga-Abies*	*Abies concolor - Pseudotsuga menziesii / Mahonia nervosa* Forest
Abies magnifica x procera	*Abies magnifica x procera*	*Abies magnifica* / Sparse Understory Forest
Tsuga mertensiana - Abies procera	*Tsuga-Abies*	*Tsuga mertensiana* / Sparse Understory Forest
Pseudotsuga menziesii plantation	*Pseudotsuga plantation*	N/A
Pinus ponderosa plantation	*Pinus ponderosa* plantation	N/A

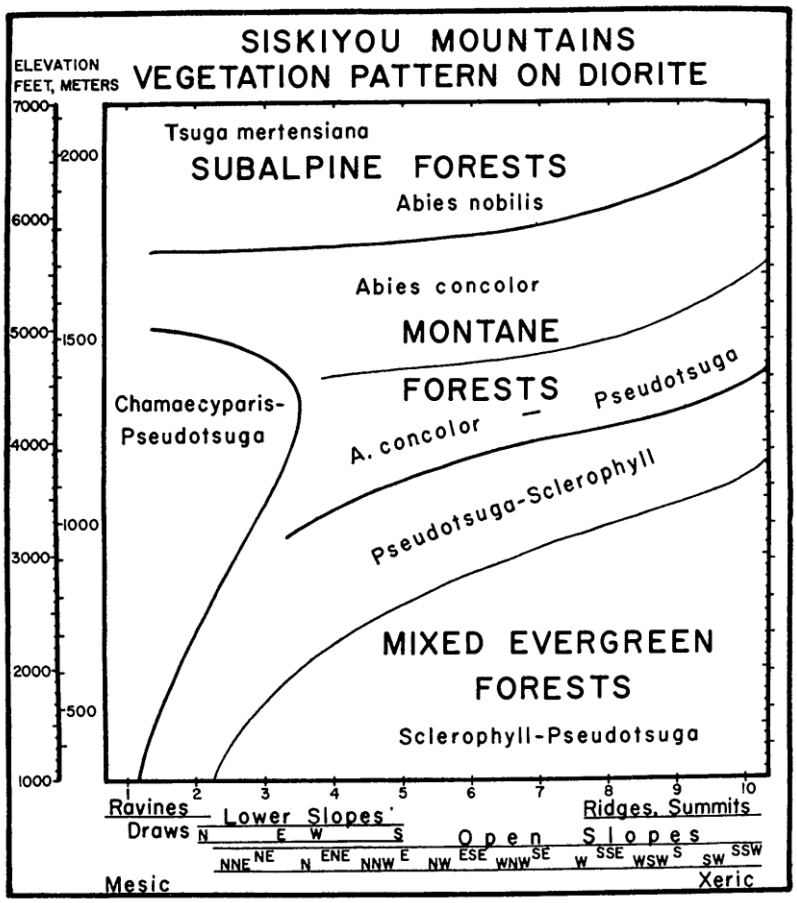

Figure 7. Mosaic chart of vegetation environment relations on diorite in the central Siskiyou Mountains from the studies of R. H. Whittaker (1960). Whittaker's non-serpentine sites were mainly within and around the project area.

The Bigelow Basin, at the highest elevations at the east end of the project area, represents a small glaciated landform (cirque) with a mosaic of unique vegetation. A diagram illustrating the general vegetation relationships and distribution of associations in this subalpine basin is shown below (Figure 8). The bottom of the basin contains two tarns (small lakes) vegetated with the yellow pond lily association. There are three sedge (*Carex* spp.) wet meadow associations that have become established on the shores and slopes surrounding both small lakes and they are separated along a moisture gradient. Alder (*Alnus* spp.) and willow tall shrub associations occur within the wet meadows as small patches. On the drier margins of the wet meadows a seasonally dry meadow association characterized by Bigelow's sneezeweed – sticky cinquefoil (*Helenium bigelovii – Potentilla glandulosa*) occurs, with scattered patches of bitter cherry forming another shrubland association in this habitat. Along drier moraines as well as rocky slopes and outcrops higher in the basin an herbaceous/dwarf-shrub association dominated by cream stonecrop (*Sedum oregonense*) and other, mostly prostrate species occurs. The previous shrub associations described above, along with subalpine forest associations, occur in patches along the cirque rim on the upper edge of the basin.

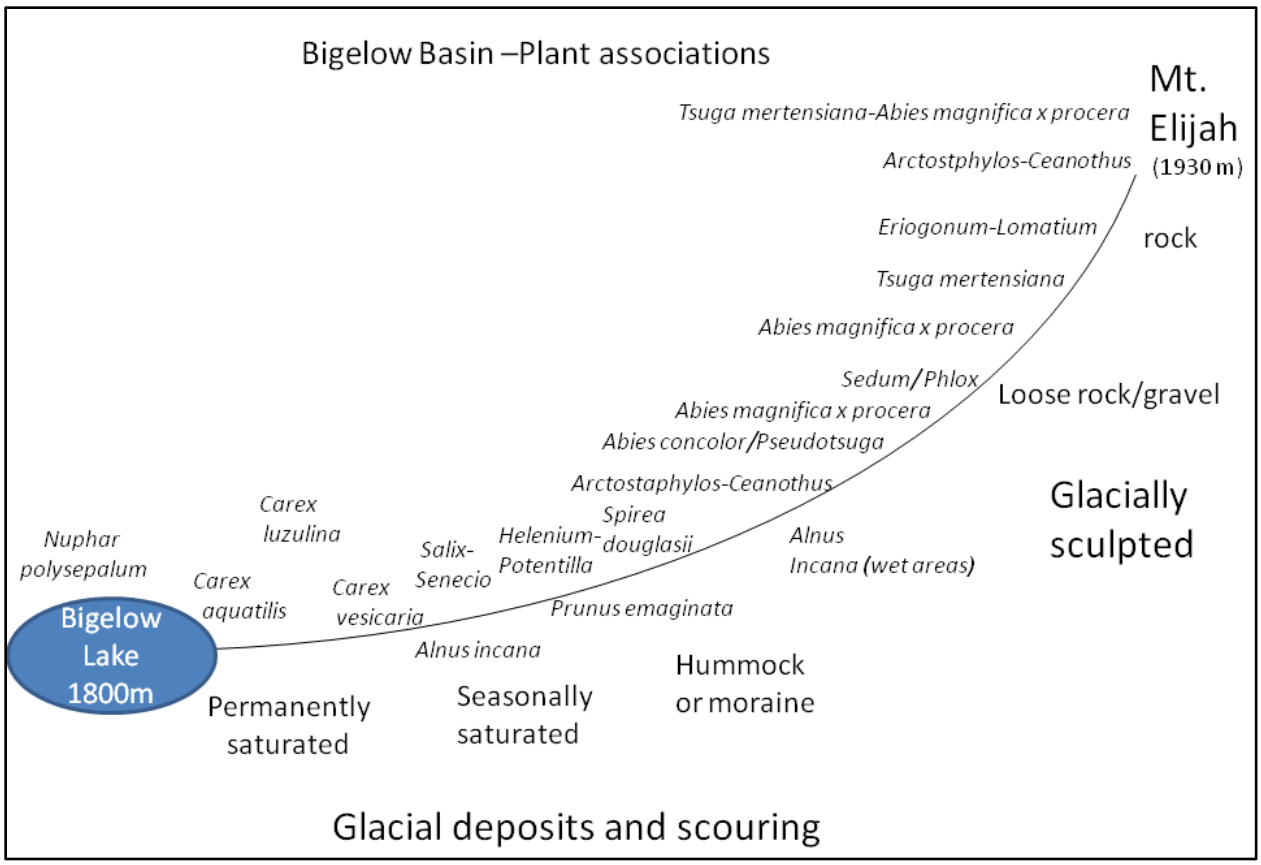

Figure 8. Diagram illustrating the distribution of associations in the Bigelow Basin along elevation and moisture gradients and in relation to glaciated landforms.

Digital Imagery and Interpretation

Vegetation Map

The 19 mapped physiognomic vegetation classes and their relation to the classified vegetation associations are shown in Table 3. The final ORCA vegetation map is presented in Appendix F. The vegetation map consists of 269 polygons comprising an area of 1820.8 ha (4,499.3 ac) (Table 4). Average polygon size is 6.7 ha (16.6 ac). One-hundred-twenty polygons were 100% dominated by one physiognomic vegetation class. The remaining polygons contain two physiognomic vegetation classes, of these:

(1) 61 were 90% dominated by the primary physiognomic class;
(2) 34 were 80% dominated by the primary class type;
(3) 16 were 70% dominated by the primary class type;
(4) 16 polygons were 60% dominated by the primary class type; and
(5) 24 polygons had a 50/50 split between the two physiognomic vegetation class types present.

The most common physiognomic vegetation in the ORCA project area was montane forest and the second most common was mixed evergreen forest. Maps showing the distribution of each physiognomic class are presented in Appendix C.

Table 3. The physiognomic vegetation classes mapped and the classified plant associations that may be found in each physiognomic class.

Physiognomic vegetation class	**Associations within physiognomic vegetation class**
Herbaceous vegetation	
1. Lake	***Nuphar polysepalum***
2. Subalpine wet meadow	***Carex* associations (all)** ***Helenium bigelovii - Potentilla glandulosa***
3. Subalpine seasonally dry meadow	***Helenium bigelovii - Potentilla glandulosa*** ***Agastache urticifolia - Polygonum phytolaccifolium*** ***Pteridium aquilinum*** ***Carex* species associations** ***Prunus emarginata*** ***Eriogonum umbellatum - Lomatium***
4. Montane seasonally dry meadow	***Agastache urticifolia - Polygonum phytolaccifolium*** ***Pteridium aquilinum*** ***Holodiscus discolor*** ***Eriogonum umbellatum - Lomatium***
Shrub vegetation	
5. Alder thicket	***Alnus incana / Heracleum maximum*** ***Carex* associations**
6. Willow thicket	***Salix eastwoodiae / Senecio triangularis*** ***Alnus incana / Heracleum maximum***
7. Bitter cherry thicket	***Prunus emarginata***
8. Montane chaparral	***Arctostaphylos patula - Ceanothus velutinus*** ***Holodiscus discolor*** ***Eriogonum umbellatum - Lomatium macrocarpum***
9. Montane open shrubland	***Eriogonum umbellatum - Lomatium macrocarpum*** ***Holodiscus discolor*** ***Arctostaphylos patula - Ceanothus velutinus***
Herbaceous and low shrub vegetation	
10. Subalpine rock field/outcrop	***Sedum oregonense - Phlox diffusa*** ***Arctostaphylos patula - Ceanothus velutinus*** ***Eriogonum umbellatum - Lomatium macrocarpum*** ***Tsuga mertensiana - Abies procera***
11. Cushion buckwheat gravel field	***Eriogonum ovalifolium***

Table 3. The physiognomic vegetation classes mapped and the classified plant associations that may be found in each physiognomic class (continued).

Physiognomic vegetation class	**Associations within physiognomic vegetation class**
Forest vegetation	
12. Riparian forest	***Chamaecyparis lawsoniana / Alnus rhombifolia***
13. Sclerophyll forest	***Quercus chrysolepis*** ***Lithocarpus densiflorus - Arbutus menziesii***
14. Mixed evergreen forest	***Pseudotsuga menziesii - Lithocarpus densiflorus*** ***Pseudotsuga menziesii - Arbutus menziesii*** ***Pseudotsuga menziesii / Gaultheria shallon*** ***Chamaecyparis lawsoniana - Pseudotsuga menziesii***
15. Montane forest	***Pseudotsuga menziesii - Abies concolor / Mahonia nervosa*** ***Abies concolor / Achlys triphylla*** ***Chamaecyparis lawsoniana - Pseudotsuga menziesii*** ***Abies concolor / Agastache urticifolia***
16. Subalpine forest	***Tsuga mertensiana - Abies procera*** ***Abies procera***
17. Plantation	***Pseudotsuga menziesii*** **plantation**
18. Young montane forest (logged)	***Pseudotsuga menziesii - Abies concolor / Mahonia nervosa*** ***Abies concolor / Achlys triphylla*** ***Abies concolor / Agastache urticifolia*** ***Pseudotsuga menziesii*** **plantation** ***Acer glabrum***
19. Ruderal (weedy clearcut area or landing)	**Landing area** ***Holodiscus discolor*** ***Abies concolor / Agastache urticifolia*** ***Pteridium aquilinum***

Table 4. Area of each physiognomic vegetation class mapped as the primary and secondary vegetation.

		Status in polygon		Total Area (ha)	% of total project area
	Vegetation	**Primary (ha)**	**Secondary (ha)**		
1	Lake	1.4	0.0	1.4	0.1
2	Subalpine wet meadow	4.6	2.4	6.9	0.4
3	Subalpine seasonally dry meadow	11.0	0.2	11.2	0.6
4	Montane seasonally dry meadow	13.0	2.6	15.6	0.9
5	Alder Thicket	23.7	8.7	32.4	1.8
6	Willow thicket	2.8	1.1	3.9	0.2
7	Bitter Cherry	0.1	0.1	0.2	0.0
8	Montane Chaparral	24.1	6.6	30.7	1.7
9	Montane Open Shrubland	11.6	6.4	18.0	1.0
10	Subalpine rock field	7.4	4.2	11.6	0.6
11	Cushion Buckwheat	1.4	0.0	1.4	0.1
12	Riparian forest	57.8	0.0	57.8	3.2
13	Sclerophyll forest	25.3	17.6	42.9	2.4
14	Mixed Evergreen forest	373.5	47.4	420.9	23.1
15	Montane Forest	574.2	48.3	622.5	34.2
16	Subalpine forest	191.3	5.2	196.4	10.8
17	Plantation	274.2	13.3	287.5	15.8
18	Young montane forest (logged)	29.2	20.1	48.3	2.7
19	Ruderal	3.2	7.1	10.2	0.6
20	Developed	0.9	0	0	0.0
21	Quarry	1.1	0.0	0.0	0.0
	Total	**1630.6**	**191.2**	**1820.8**	**100.0**

Accuracy Assessment

Table 5 contains the contingency table showing concordance between the vegetation map and field data and errors of omission and commission in the map. In most cases (371 of 444), an AA point represented a polygon that was 80% or more dominated by one physiognomic vegetation class. Conversely, there were 18 points that represented polygons where the mapped vegetation was only 50% dominated by the primary vegetation. There were 34 points that represented polygons where the primary vegetation comprised 60-70% of the vegetation cover in the polygon. Conversely, there were 31 of the 82 AA points that were considered a mismatch with the map where the field identified vegetation did occur in 10-40% of a polygon. Thus, the 80.4% accuracy is a fairly conservative figure in that many of the 18.2% of inaccurately classified points were partially but not completely incorrect.

Most of the incorrectly attributed/classified points were those mapped as montane forest (Table 5). A large number of AA points were sampled in this vegetation zone because it was the most common and we had attempted to map it in more detail if possible (which did not effectively occur). Not surprisingly, a number of AA points that were classified on the ground as montane forest represented polygons mapped as either subalpine forest (15 of 138) or mixed evergreen forest (20 of 138).

As described in the sections on photo-signature and mapping considerations for each physiognomic vegetation class type mapped (Appendix E), montane forests are not distinguishable from subalpine and mixed-evergreen forests in the imagery. We therefore relied on elevation criteria from our classification plot sampling and from Whittaker (1960). Because montane forests share both an upper and lower boundary with other respective forest classes from which they are not distinguishable in the imagery, montane forest was found to have greater map error than other forest physiognomic class types. For example, both mixed evergreen forest and subalpine forest had very low errors of omission and commission (none for subalpine forest). The findings suggest that the individual boundary between the montane and the subalpine physiognomic vegetation classes are fairly accurate because only 15 points were incorrect out of a combined total of 165. Similarly, only 20 out of a combined total of 201 montane forest and mixed evergreen forest points were incorrect.

The greatest percentage error in the map occurred among wetland meadow classes, which occupied a relatively small area and therefore were represented by limited numbers of AA points. For example, out of 12 AA points identified as subalpine seasonally dry meadow in the field, five were in polygons mapped as subalpine wet meadow. Of the nine AA points in polygons mapped as subalpine wet meadow, only two were correct. A major factor in this inaccuracy was the difficulty during the mapping effort of discriminating in the aerial photographs the fine scale differences between herbaceous vegetation classes that occur among one another (vegetation mosaic). In addition, a review of the field data suggests that meadow type inaccuracy was also related to one common species that can occur in wet and dry meadows, corn lily (*Veratrum californicum*). This tall, conspicuous species often occurs in large monospecific patches spanning these meadow classes. It also is a bright green color in the photo-signature, just like many wet meadow species, so it was generally mapped as wet meadows. However, the classification and field key places it with dry meadows. We did not revise the classification because corn lily is so commonly associated with the subalpine seasonally dry meadow physiognomic vegetation class.

Table 5. Accuracy Assessment contingency table for Oregon Caves National Monument and proposed expansion area. Accuracy was calculated according to Lea and Curtis (2010).

	Accuracy assessment field observation points																				
Vegetation classes	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	ROW TOTAL (n_{i+})	USERS' ACCURACY ($P_{J=X\|i=X}$)
1. Lake	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100.0%
2. Subalpine wet meadow	0	2	5	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10	20.0%
3. Subalpine seasonally dry meadow	0	1	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	60.0%
4. Montane seasonally dry meadow	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	100.0%
5. Alder thicket	0	1	1	1	14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	18	77.8%
6. Willow thicket	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	75.0%
7. Bitter cherry thicket	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
8. Montane chaparral	0	0	0	0	0	0	0	8	1	0	0	0	0	0	1	0	3	0	0	13	61.5%
9. Montane open shrubland	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	100.0%
10. Subalpine rock field	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5	100.0%
11. Buckwheat gravel field	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
12. Riparian forest	0	0	0	0	0	0	0	0	0	0	0	8	0	0	3	0	0	0	0	11	72.7%
13. Sclerophyll forest	0	0	0	0	0	0	0	0	0	0	0	0	4	1	1	0	0	0	0	6	66.7%
14. Mixed evergreen forest	0	0	0	0	0	0	0	0	0	0	0	2	4	63	20	0	1	0	0	90	70.0%
15. Montane forest	0	0	0	0	2	0	0	0	0	0	0	0	0	3	138	0	1	0	0	144	95.8%
16. Subalpine forest	0	0	0	0	0	0	0	1	0	0	0	0	0	0	15	27	0	0	0	43	62.8%
17. Plantation	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	75	0	0	81	92.6%
18. Young montane forests	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
19. Ruderal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	100.0%
COLUMN TOTAL (n_{+j})	1	4	12	13	17	4	0	9	2	5	0	10	9	68	183	27	80	0	1	444	
AREA WEIGHTED PRODUCERS' ACCURACY ($P_{i=Y\|J=Y}$)	1.00	0.32	0.56	0.70	0.72	0.81	0.00	0.81	0.88	1.00	0.00	0.82	0.56	0.93	0.75	1.00	0.94	0.00	1.00		**80.4%**

Discussion

The ORCA 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 ORCA and the proposed expansion area. As with previous studies in the region, the vegetation inventory within ORCA demonstrates the exceptional floristic diversity of the central Siskiyou Mountains. 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.

Vegetation Classification

The vegetation of ORCA was sampled and classified into 34 associations that were mapped in 19 physiognomic vegetation classes; the accuracy assessment rate is 80.4% and the field work documented the occurrence of 397 vascular plant species. The addition of the proposed expansion area created a far more complicated project than would have been undertaken had just the existing monument been inventoried and mapped. Of the 34 classified associations, only 19 occurred within the existing monument boundary. Fifteen additional associations were captured by using the expansion area as the project area boundary, most of which were within the Bigelow Basin. Also, the plantations were much more variable than we anticipated. This variation was related not only to environment, but also the wide range in the amount of time since clear-cutting and plantation establishment, which occurred from the early 1960s until the late 1980s.

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 dry margins of subalpine meadows and diverse combinations of post-logging communities represent variation that we did not capture adequately and would likely benefit from additional fine-scale sampling. The mapping could also be improved in the Bigelow Basin with a more fine-scale effort that can better separate the complex mosaic of wet and dry meadows. The Basin was the only portion of our map with considerable inaccuracies. One reason for the inaccuracy beyond the high degree of heterogeneity may be that livestock grazing had recently been terminated in the Basin at the beginning of our project. It is possible the wet meadow areas changed between the initial sampling and the collection of AA data, by which time the meadows had been recovering for three to four years. The efforts described above would improve the overall classification and map, particularly in the case of the meadows since such details fall below the MMU used in this project.

Accuracy Assessment

It may be possible to slightly improve map accuracy by moving the boundary between montane forest and subalpine forest physiognomic vegetation classes down in elevation. However, this change would result in montane forest AA points being included in the subalpine forest map polygons, therefore this tradeoff would likely minimize any possible increase in overall map accuracy. Similarly, moving the mixed evergreen forest boundary up in elevation slightly could improve accuracy, but may also be offset by montane forest AA points being included in mixed evergreen forest map polygons. Overall, given the complex area where montane forests overlap

at their upper and lower elevations with other forest vegetation classes, the mapping appeared to be reasonably accurate.

The map accuracy could also be improved by combining the following three physiognomic vegetation classes: (1) subalpine wet meadow; (2) subalpine seasonally dry meadow; and (3) montane seasonally dry meadow. However, these types collectively account for relatively little area (18.1 ha) (44.7 ac), so the overall map accuracy would again be little changed by these modifications. In addition, the number of AA points in these classes was limited, and may not adequately reflect true accuracy for these classes in the map.

The Proposed Expansion Area

The proposed expansion area boundary encompasses the entirety of the upper Cave Creek watershed, including Lake Creek, and was selected to protect the water resources supporting the ORCA karstic environment. As a consequence it also captures a highly scenic and floristically diverse mountain landscape. The proposed expansion, if successful, would greatly expand the overall vegetation diversity established within the boundaries of ORCA. The proposed expansion would also include a greater area of vegetation associations that are limited within the existing monument but are more prevalent at lower and higher elevations. Through this inclusion of a larger area and a greater number of habitats, particularly at the higher elevations, the number of vascular plant species would be considerably higher than are known within the current monument boundary.

Natural Resource Concerns

Historic Timber Harvest

A large portion (over one-third) of the land adjacent to the monument in the proposed expansion area had been logged (605 ha (1,606 ac)) over several decades. As captured in the vegetation map, much of the logging was clear-cutting (285 ha (704 ac)). Shelterwood cutting, while not as intensive, comprised the second most common form of historic logging. Intensive logging was mostly followed by dense plantings of Douglas-fir, a valuable commercial species. Presumably, the genetic diversity of the plantings differs considerably from that of naturally-occurring Douglas-fir trees. Heavily harvested areas are early successional and lack in size class diversity, large woody debris, and snags, all key features of similar forest types subject to natural disturbances. In addition, the deep litter and humus layer that characterize the forest floor of unlogged, and even recently burned stands, is often greatly reduced. Instead, bare mineral soil, often highly eroded, is prevalent and may provide sites for establishment of invasive plant species.

In many cases, plantation establishment was only partially successful. At these locations and in many areas where plantings were successful, native vegetation is present in significant cover and can be quite vigorous, particularly where there is resprouting by broad-leaved evergreens. It appears that natural succession is proceeding in these forests and may converge with natural forests in composition over time, but structural convergence may require a longer period, if it indeed occurs.

The conditions resulting from forest management activities and subsequent recovery are highly variable due to the length of time since the activity and different successional trajectories that

appear to have established on sites as a function of the intensity of the disturbance, effectiveness of reforestation efforts, site conditions, recent climate, and other factors. This variation in formerly-logged areas was much more than had been anticipated and could not be fully captured in the vegetation classification and map. However, this inventory does provide information about composition, structure, and distribution of logged and recovering forests in the proposed expansion area. Such baseline information may prove useful in setting goals and appropriate standards for passive or active restoration of these forests. More detailed analyses of logged areas may be warranted should (assuming the expansion occurs) ORCA resource staff design projects to restore areas that have been degraded by past logging. From the perspective of interpretive value to park visitors it may be worthwhile to allow some previously logged areas to naturally recover as a demonstration of logging history and the dynamics of forest succession over time. The juxtaposition of intensive logging units and unlogged forests in the proposed expansion area is ideal for showcasing historic land use effects and federal land management agencies' past approaches to commercial forest management.

Non-Native Species

The vegetation database contains information on the presence and absence of all non-native invasive species encountered in the classification and AA 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 KLMN's invasive species protocol (Odion et al. 2011).

Wildlife Habitat

Although this study did not emphasize sampling of detailed wildlife habitat or structural parameters, the delineation of 19 physiognomic classes 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).

Natural Resource Interpretation

This inventory project illustrates the rich vegetation mosaic that has become established on much of the western Siskiyou Mountains. It thereby provides a valuable resource for ORCA interpretive staff to educate visitors about this important vegetation mosaic and the diverse ecological processes affecting its development and change.

Within the monument and proposed expansion area the vegetation pattern is structured by many physical and biological factors interacting in time and space. The climatic effects of elevation on temperature are present in the broad zonation of the entire project area, from the mixed evergreen forests at the lowest elevations to the subalpine forests at the highest elevations. The interaction of topography and incoming storms create the deep snowpack that covers the upper elevations in winter, and channel the moisture into tarns, wetlands, streams, and ultimately the caves themselves. This distribution of water, interacting with the different rock types is perhaps the first layer of control on/support for the vegetation structure, function, and composition in the project area.

Even within this modest-sized landscape, vegetation dynamics are caused by variation in climate and a variety of disturbance types. Avalanches, rockslides, floods, and debris flows are likely common disturbance processes in the landscape in the cool seasons with fire, perhaps the most important disturbance during the warm dry summers. Mixed-severity fires create early successional conditions and landscape complexity in the form of age mosaics. Age mosaics helped shape the rich habitat/species diversity of the ORCA landscape and are likely to be important for many species that use snags and early successional habitats. Natural pest and pathogens undoubtedly augment the vegetation mosaics resulting from environmental complexity and fire.

The Bigelow Basin is a nearly textbook example of a glaciated subalpine basin with a U-shaped cross-section, glacial features, relictual tarn lakes, and a diverse mosaic of wetlands. The Bigelow Lakes are reaching the final stages of hydrarch succession (transition from aquatic communities to forest communities in stages over time), and will fill and form a meadow. Likewise, trees will likely continue to invade the meadow margins, drying soils and converting wetlands to upland types. This compact landscape is a great place to contemplate past and continued environmental changes. This vegetation inventory project provides an important benchmark for evaluating these and similar processes of environmental change in the Basin and elsewhere in the monument and proposed expansion area.

The forested areas of the monument and expansion area provide a characteristic regional setting for studying natural and human-caused disturbance dynamics and their implications for native plant and animal diversity. The post-logging succession in particular may be an important interpretive resource for ORCA. Interpretive walks through native and secondary forests might provide an ideal showcase to illustrate and communicate intensive 20th century forestry approaches and their outcomes.

The proposed expansion area, in general, provides the potential to greatly expand the narrative and field sites for interpreting the unique glacial, climatic, disturbance, and human history of the western Siskiyou Mountains. This vegetation inventory project will provide a valuable snapshot of the vegetation types and attributes based on interpretation of 2009 aerial imagery and ground sampling between 2009-2011.

As stated above, this study provides an in-depth resource for interpretive staff to develop communication programs that describe the complex vegetation mosaic within the monument, proposed expansion area, and the surrounding western Siskiyou Mountains. In particular, the vegetation association descriptions (Appendix C) and the key to the associations (Appendix B) provide valuable tools to effectively communicate both vegetation classification and distribution patterns. 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.

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 mapping (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.

In addition, the dynamics of the secondary forests in the proposed expansion area could be explored. Research evaluating the habitat these forests provide for native plant and vertebrate diversity could investigate their current microclimate, understory plant diversity, and wildlife habitat values (e.g. land bird and small mammal diversity). Secondary forests could also be targeted for long-term research in forest succession to document the rate and magnitude of change over time. A subset of these forests might also be the focus for restoration efforts to explore the prospects for increasing heterogeneity or to alter current trends of succession through the introduction of prescribed fire or mechanical treatments.

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Appendix A. Field Data Forms and Instructions

Instructions for ORCA 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.

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-plant 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%

ORCA 2010 Vegetation Mapping Data Sheet

_____

Survey Date _____

Plot Code_____Park Code ORCA _____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: ORCA_____

Photographer_____Photograph #_____

This photographs shows the habitat types at site: ORCA_____

Photographer_____Photograph #_____

Photographer_____Photograph #_____

Topographic position (circle one)

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

ORCA AA 2011 - Name_____Date_____
Waypoint number_ORCA_____
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) _____

ORCA AA 2011 - Name_____Date_____
Waypoint number_ORCA_____
Coordinates: X_____Y_____
Elevation_____M
Plot offset?_____GPS Error_____Plot Size__.5 ha_____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 Main Vegetation Categories

1. Vegetation is not planted, nor has logging of most of the stand occurred. If logging has occurred, it has only been a partial harvest. **Natural Vegetation.**
2. Even-aged plantings of conifers and stumps from clear-cut logging present, or site is a landing area for log decks (barren weed field). Thinned plantations may be becoming more like natural vegetation……**Anthropogenic Vegetation.**

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

1. 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%..... **Herbaceous Vegetation.**

2. 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……**Shrublands.**

3. 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……
……**Forests and Woodlands.**

Herbaceous Vegetation

1. Aquatic vegetation submerged in water except for floating leaves. Bigelow Lakes.....
……**1. *Nuphar polysepalum* association**.

1.' Vegetation is not mostly submerged in water. It does not have floating leaves and occur in Bigelow Lakes, but may occur along the margins of the Lakes.

2. Wetland and wet meadow vegetation (including lake margins) occurring in dense swards with 75% or greater total plant cover. *Helenium bigelovii* and/or *Carex* spp. cover > 5%.

3. Cover of *Carex* spp. > 50% or if lower, remaining cover mostly saturated soil or standing water.

4. Cover of *Carex aquatilis* > 50%, cover of other *Carex* spp. < 50%……
……**2. *Carex aquatilis* association.**

4.' Cover of *Carex aquatilis* < 50%, cover of other *Carex* spp. > 50%.

5. Cover of *Carex luzulina* > 40%, cover of other *Carex* spp. < 40%.....……**3. *Carex luzulina* association.**

5.' Cover of *Carex luzulina* < 40%, *Carex vesicaria* is the dominant sedge, cover of *Caltha leptosepala* > 5%.
……**4. *Carex exsiccata - Caltha leptosepala* association.**

3.' Cover of *Carex* spp. < 50%.

6. Meadow vegetation dominated by *Helenium bigelovii*, *Potentilla glandulosa,* and *Senecio triangularis*, or in localized patches by *Veratrum californicum*. Cover of these species together is > 50%.....……
……**5. *Helenium bigelovii - Potentilla glandulosa* association**.

6.' Meadow vegetation dominated by ferns or robust herbs. Combined cover of *Helenium bigelovii*, *Potentilla glandulosa*, *Senecio triangularis*, and *Veratrum californicum* is less than 25%.

7. *Pteridium aquilinum* often dominant (> 10% cover) with various grasses and sedges….**6. *Pteridium aquilinum - graminoid* association**.

7.' *Pteridium aquilinum* absent or rare (< 5% cover). Cover of *Agastache urticifolia* > 10%.....……
……**7. *Agastache urticifolia - Polygonum phytolaccifolium* association**.

2.' Upland vegetation or rocky streambanks. Upland vegetation can be sparse or dense. If vegetation is sparse it contains at least some xerophytic species (e.g., *Sedum oregonense, Phlox diffusa*). If vegetation is dense, it is dominated by *Danthonia californica* or *Agastache urticifolia*. *Helenium bigelovii* and *Carex* spp. absent or rare (< 5% cover).

8. Vegetation dominated by *Sedum oregonense* and *Phlox diffusa,* together accounting for > 10% relative cover……
……**8. *Sedum oregonense - Phlox diffusa* association.**

8.' *Sedum oregonense* and *Phlox diffusa* absent or < 5% cover.

9. Cover of *Agastache urticifolia* > 10%……
.....**7. *Agastache urticifolia - Polygonum phytolaccifolium* association.**

9.' *Agastache urticifolia* cover < 5%, early successional or rocky streamside or debris flow deposit……**9. Non-forested riparian association.**

Shrublands

1. Tall shrubs (2.5-5 m) or small trees with deciduous, mesophyllous leaves forming thickets around meadows and/or on seeps. Sclerophyllous shrubs generally absent. Cover of shrubs > 40%. Cover of forest trees (e.g., conifers) < 5%.

    2. Shrub layer dominated by *Alnus incana.* No other species having > 5% cover……. ……**10. *Alnus incana / Heracleum maximum* association**.

    2.' Shrub layer composed of *Salix eastwoodiae* or *Acer glabrum* or *Prunus emarginata,* no other shrub with greater cover than one of these species.

        3. Shrub layer composed mostly or entirely of *Salix eastwoodiae,* no other shrub species having greater cover. ……..**11. *Salix eastwoodiae / Senecio triangularis* association.**

        3.' Shrub layer dominated by *Acer glabrum* or *Prunus emarginata*, no other shrub species having greater cover.

            4. Shrub layer composed mostly or entirely of *Acer glabrum,* no other shrub species having greater cover....**12. *Acer glabrum* association.**

            4.' Shrub layer composed mostly or entirely of *Prunus emarginata,* no other shrub species having greater cover…….. ……**13. *Prunus emarginata* association.**

1' Low to medium (< 2.5 m) shrubs with sclerophyllous leaves or a mix of sclerophyllous and deciduous leaved shrubs. Habitat is dry and either rocky and of low site productivity thereby limiting conifer growth, or relatively recently logged or burned and will succeed to conifers eventually.

5. Mostly low to medium (< 2.5 m) sclerophyllous shrubs. Cover of *Arctostaphylos patula* > 20% . If deciduous shrubs present, then at < 20% cover…….. ……..**14. *Arctostaphylos patula – Ceanothus velutinus* association**.

5.' Low to medium shrubs (0-2.5 m) on dry or rocky habitats. Sclerophyllous shrubs present or absent; if present, then under 20% cover.

    6. *Eriogonum ovalifolium* present > 5% with no other shrub species more abundant……**15. *Eriogonum ovalifolium* association.**

    6.' *Eriogonum ovalifolium* absent or < 5%.

        7. *Eriogonum umbellatum* present with at least > 2% cover with *Lomatium macrocarpum*. Total cover of all other shrub species present, excluding *Quercus garryana* var*. breweri* and *Amelanchier alnifolia* is < 20%. *Quercus garryana* var. *breweri* and *Amelanchier alnifolia* may be present in abundance……

……**16. *Eriogonum umbellatum - Lomatium macrocarpum* association**.

7.' *Eriogonum umbellatum* present or absent. *Lomatium macrocarpum* absent. *Spiraea douglasii* and *Holodiscus discolor* present with > 5% cover.

8. Cover of *Spiraea douglasii* > 40%.....**17. *Spiraea douglasii* association.**

8.' Cover of *Holodiscus discolor* > 5%. No other species present with significantly greater cover……..
.....**18. *Holodiscus discolor* association**.

Forests and Woodlands

1. Forest vegetation within one average tree length or 10 m of running water or seasonally flooded area (e.g. wet meadow). Broad-leaved deciduous overstory species are > 10% cover. Riparian or meadow-associated vegetation abundant.

2. Low trees (< 10 m) or tall shrub vegetation in thickets around meadow seeps or along streams. Tree layer dominated by *Alnus incana,* and sometimes *Salix* spp. …….
……**10. *Alnus incana - Heracleum maximum association*** *(see shrub associations).*

2.' Forest dominated by tall trees in streamside setting ……..
……**19. *Chamaecyparis lawsoniana / Alnus rhombifolia* association**.

1'. Upland forest vegetation not located adjacent to a stream or wet meadow and is dominated by conifer and/or broad-leaved evergreen trees. Broad-leaved deciduous trees generally lacking (< 5% cover).

3. Mixed evergreen forest with broad-leaved evergreen trees common and occasionally dominant. *Whipplea modesta* almost always present in herb layer.

4. *Chamaecyparis lawsoniana* > 5% cover, generally co-dominant in the tallest overstory layer……**26. *Chamaecyparis lawsoniana - Pseudotsuga menziesii* association.**

4.' *Chamaecyparis lawsoniana* < 5% overstory cover.

5. Conifers comprising < 10% of the forest overstory.

6. Broad-leaved evergreens with overstory dominated by *Lithocarpus densiflorus* and *Arbutus menziesii*……..
……**20. *Lithocarpus densiflorus - Arbutus menziesii* association**.

6.' Broad-leaved evergreens dominated by *Quercus chrysolepis* (50% or more of total broad-leaved evergreen cover)……..
……**21. *Quercus chrysolepis* association**.

5.’ Conifers comprising >10% of the forest overstory, overtopping broad-leaved trees.

7. Dense, Ericaceous shrub layer (> 40% cover of shrub species) dominated by *Gaultheria shallon*, *Rhododendron macrophyllum,* and *Vaccinium* spp.……
…….**22. *Pseudotsuga menziesii / Gaultheria shallon* association.**

7.’ Shrub layer with < 40% cover of Ericaceous shrub species, subcanopy dominated by broad-leaved evergreen tree species (which may be shrubby).

8. *Pinus lambertiana* present (> 5% cover) in overstory forest layer……
23. *Pinus lambertiana / Lithocarpus densiflorus* association.

8.’ *Pinus lambertiana* < 5% in forest overstory.

9. Subcanopy trees dominated by *Lithocarpus densiflorus* and/or *Quercus chrysolepis*. *Arbutus menziesii* absent or rare (< 5% cover).……..
24. *Pseudotsuga menziesii / Lithocarpus densiflorus* association.

9.*’ Arbutus menziesii* common (> 5% cover) in subcanopy.
25. *Pseudotsuga menziesii / Arbutus menziesii* association.

3.’ Forests lacking evergreen hardwood trees, or evergreen hardwood trees only incidental, comprising < 5% cover. *Whipplea modesta* absent or rare in the herb layer.

10. *Abies concolor*, *Pseudotsuga menziesii*, or *Chamaecyparis lawsoniana* are the dominant overstory trees (one of these three has the highest overstory cover of any tree species).

12. *Chamaecyparis lawsoniana* present in the forest overstory, generally common (> 10% cover)……..
…….**26. *Chamaecyparis lawsoniana - Pseudotsuga menziesii* association.**

12’ *Chamaecyparis lawsoniana* absent or rare in the forest overstory.

13. *Agastache urticifolia* > 10% cover in the understory.……
……**27. *Abies concolor / Agastache urticifolia* association.**

13’. *Agastache urticifolia* < 10% cover in the understory.

14. *Abies concolor* is more dominant than *Pseudotsuga menziesii* and *Bromus laevipes* is generally common in the understory. *Mahonia nervosa* cover is usually < 5% in the

understory……**28. *Abies concolor / Achlys triphylla* association**.

14'. *Pseudotsuga menziesii* is more dominant than *Abies concolor*, which is often present as a subcanopy tree. *Bromus laevipes* is absent or rare in understory. *Mahonia nervosa* usually > 5% cover in understory……..

29. *Pseudotsuga menziesii - Abies concolor / Mahonia nervosa* association.

10.' *Tsuga mertensiana* and/or *Abies magnifica x procera* are dominant overstory trees (> 40% cover).

15. *Abies magnifica x procera* occurs in relatively pure stands, or is mixed with *Abies concolor* and/or lesser amounts of *Tsuga mertensiana* ……. .....**30. *Abies magnifica x procera* association**.

15.' *Tsuga mertensiana* is the dominant overstory tree, it exceeds the combined cover of *Abies* spp. ……..
……**31. *Tsuga mertensiana - Abies magnifica x procera* association.**

Anthropogenic vegetation

1. Mostly herbaceous vegetation of ruderal species and grasses. Some small trees and shrubs present but not dominant.……**34. Landing area.**

1.' Vegetation dominated by dense stands of planted conifers. Stumps present**.**

2. Area predominantly planted with *Pseudotsuga menziesii*…….
…… **32. *Pseudotsuga menziesii* plantation association.**

2.' Area predominantly planted with *Pinus ponderosa*.……..
…… **33. *Pinus ponderosa* plantation association.**

Appendix C. Vegetation Association Descriptions

U.S. NATIONAL VEGETATION CLASSIFICATION

Oregon Caves National Monument and Proposed Expansion Area
December 2012

By Dominic A. DiPaolo, Southern Oregon University, Dennis C. Odion, and Ayzik Solomeshch, University of California, Davis.

COMMON NAME: *NUPHAR POLYSEPALA* **ASSOCIATION**

SYNONYMS
USNVC English Name: Rocky Mountain Pond-lily Herbaceous Vegetation

USNVC Scientific Name: *Nuphar polysepala* Herbaceous Vegetation

USNVC Identifier: CEGL002001

USNVC CLASSIFICATION:
Formation Class: Aquatic Wetland Vegetation
Formation Subclass: Freshwater Aquatic Vegetation
Formation: Freshwater Aquatic Vegetation
Division: North American Freshwater Aquatic Vegetation
Macrogroup: Western North American Freshwater Aquatic Vegetation
Group: *Nuphar* spp. - *Potamogeton* spp. - *Lemna* spp. Freshwater Aquatic Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This herbaceous aquatic community occurs in the Bigelow Lakes in open water to near the lake shore. Elevation of sample plot is 1797 m.

Vegetation Description: The *Nuphar polysepala* association is characterized by the submerged aquatic plant Rocky Mountain Pond-lily (*Nuphar lutea* ssp. *polysepala*) with its leaves floating at the lake surface. No other aquatic species are noted in the Bigelow Lakes. The cover of yellow pond-lily, including submerged parts, is about 50-60%. Western quillwort (*Isoetes occidentalis*) and a mannagrass (*Glyceria* spp.) species occur at very low cover in shallow water.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Herb	Aquatic herb (floating & submergent)	*Nuphar lutea* ssp. *polysepala* (Rocky Mountain pond-lily)	50-75	62.5

Diagnostic Species: *Nuphar lutea* ssp. *polysepala* (=*Nuphar polysepala*).
Constant Species: *Nuphar lutea* ssp. *polysepala.*
Other Noteworthy Species: None.
Species Richness of Sample Plot: 3
Local Range: Bigelow Lakes.
Classification Comments: In lieu of sampling plots, the entire surface of the lakes was surveyed from the shore and the cover of *Nuphar lutea* ssp. *polysepala* and other species encountered are estimates for this area.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Sawyer, J. O. et al. 2009.
Plots: Relevé 140, 1 plot covering the entire *Nuphar polysepala* association.

Oregon Caves National Monument Inventory Notes: This association is not encountered elsewhere in the Oregon Caves National Monument or the proposed expansion area.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association is composed of floating aquatic vegetation. It occurs on permanently flooded ponds, lakes, deeper beaver ponds, and glacial kettle lakes, from sea level to 3140 m (10,300 feet) elevation. Soils are usually organic Histosols, on anoxic muck or peat. Water is 40 to 200 cm (1.25-6.5 feet) deep, although stands have been observed where water levels fluctuate seasonally, leaving *Nuphar* high and dry on exposed mudflats, especially in drought years. Stands can completely fill smaller ponds, or stands may be only as large as the water depth allows and are part of a larger mosaic of other freshwater emergent marsh communities.

Vegetation Description: This aquatic association is characterized by the dominance of *Nuphar polysepala (= Nuphar lutea* ssp. *polysepala; = Nuphar polysepalum),* which is often the only species present. Cover is continuous, intermittent, or open. Other aquatic and emergent herbs present may include *Menyanthes* spp., *Potamogeton* spp., *Glyceria* spp., *Eleocharis* spp., *Carex* spp. *Equisetum* spp., *Typha* spp., and *Lemna* spp. Many of these associates are in shallower, adjacent water.

Characteristic Species: *Nuphar lutea* ssp. *polysepala* (Rocky Mountain Pond-lily).
USFWS Wetland System: Type 5 - Inland open freshwater; System: Palustrine; Class: Aquatic Bed. The USFWS Wetland Inventory (1996 national list) recognizes *Nuphar lutea* as an OBL (obligate wetland species) plant (Sawyer et al. 2009).

DISTRIBUTION

Range: Canada, United States.
States/Provinces: CA, CO, ID, MT, OR, WA, WY?, BC.
Federal Lands: Widespread and common, this association is likely to occur elsewhere on federal lands in suitable habitat within its known range.

CONSERVATION STATUS

Rank: G5 (1-Feb-1996).
Reason: Secure.

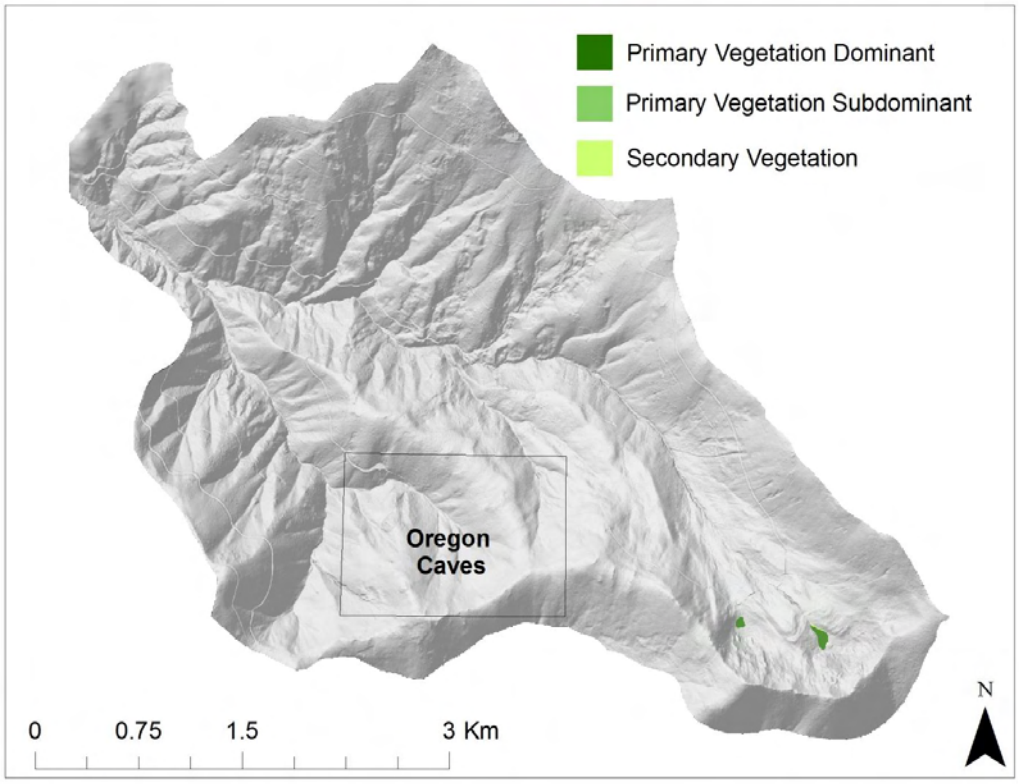
SOURCES

Global Description Authors: Western Ecology Working Group, mod. K. A. Schultz.
Global Description References: Boggs, K. 2000, Bourgeron, P. S., and L. D. Engelking, editors. 1994, CONHP [Colorado Natural Heritage Program], Christy, J. A. 2004, Christy, J. A. et al. 1998, Crowe, E. A. et al. 2004, Dorn, R. D. 1984, Driscoll, R. S. et al. 1984, Egler, F. E. 1934, Hansen, H. P. 1942, Hop, K. et al. 2007, IDCDC [Idaho Conservation Data Center]. 2005, Jankovsky-Jones, M. et al. 2001, Jankovsky-Jones, M. et al. 1999, Kagan, J. S. et al. 2000-2004, Kovalchik, B. L. 1993, Kovalchik, B. L. 2001, Kunze, L. M. 1994, Marr, J. W. et al. 1980, McCain, C., and J. A. Christy. 2005, Murray, M. P. 2000, Peck, M. E. 1919, Ramaley, F., and

W. W. Robbins. 1909, Reid, M. S. et al. 2004, Rodwell, J. S., ed. 1995, Salas, D. et al. 2005, Sawyer, J. O., and T. Keeler-Wolf. 1995, Seyer, S. C. 1979, Seyer, S. C. 1981, Shephard, M. E. 1995, Titus, J. H., and J. A. Christy. 1996, Titus, J. H., and J. A. Christy. 1999, Viereck, L. A. et al. 1992, WNDD [Wyoming Natural Diversity Database]. No date, WNHP [Washington Natural Heritage Program]. No date, Western Ecology Working Group of NatureServe. No date, Youngblood, A. P. et al. 1985.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 15, 2012).

Association Range and Distribution



***Nuphar polysepala* association.** Edge of lower Bigelow Lake, late summer, elevation 1700 m. The ***Nuphar polysepala* association** is on the right side of the photo. No other species are present in the association. The left side of the photo is dominated by *Carex exsiccata* and *Carex spectabilis*, common species in the ***Carex* spp. associations** described in this classification.

COMMON NAME: *CAREX AQUATILIS* ASSOCIATION

SYNONYMS
USNVC English Name: Sitka Sedge Herbaceous Vegetation

USNVC Scientific Name: *Carex aquatilis* var. *dives* Herbaceous Vegetation

USNVC Identifier: CEGL001826

USNVC CLASSIFICATION:
Formation Class: 2 - Shrubland & Grassland
Formation Subclass: 2.B - Temperate & Boreal Grassland, Savanna & Shrubland
Formation: 2.B.5 - Temperate & Boreal Bog & Fen
Division: 2.B.5.Na - North American Bog & Fen
Macrogroup: North Pacific Bog & Fen
Group: North Pacific Alkaline Fen Group
Alliance: Alliances are under review

LOCAL INFORMATION

Environmental Description: This type comprises a narrow band of emergent wetland vegetation occupying the shallow wet zone along the edge of Bigelow Lakes. The topographic position this association occupies is the basin floor or a step in slope. Soil texture is muck.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1794	4	315	1
Range	1789-1798	0-7	0-270	0-2

Vegetation Description: This emergent wetland vegetation is dominated by pure to nearly pure stands of Sitka sedge (*Carex aquatilis* var. *dives*). Congdon's bulrush (*Scirpus congdonii*) is also common though not nearly as abundant as Sitka sedge.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Vaccinium uliginosum* (bog blueberry)	0-1	0.25
Herb	Graminoid	*Carex aquatilis* var. *dives* (Sitka sedge)	50-100	75
		Scirpus congdonii (Congdon's bulrush)	2-15	6.75
		Carex lenticularis (lakeshore sedge)	0-5	1.75
		Deschampsia cespitosa (tufted hairgrass)	0.5-1	0.5
		Eleocharis acicularis (needle spikerush)	0-2	0.75
		Carex luzulina (woodrush sedge)	0-1	0.25
	Perennial herb	*Caltha leptosepala* (white marsh marigold)	0-1	0.25
		Epilobium ciliatum ssp. *glandulosum* (fringed willowherb)	0-1	0.25
		Platanthera leucostachys (Sierra bog orchid)	0-1	0.25

Species Richness:

Plot Species Richness Average	8.5
Plot Species Richness Range	5 - 12
Total Species Richness (all plots)	14

Diagnostic species: *Carex aquatilis* var. *dives.*
Constant species: *Carex aquatilis* var. *dives, Scirpus congdonii, Deschampsia cespitosa.*
Other Noteworthy Species: None.
Local Range: Bigelow Lakes.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Sawyer, J. O. et al. 2009.
Plots: Relevés 129, 130.
Oregon Caves National Monument Inventory Notes: This association has a very limited distribution in the Oregon Caves National Monument and the proposed expansion area.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: From Christy (2004): Habitat is usually montane fens. The association is widespread and important in the Cascade Range and, like *Carex aquatilis* Herbaceous Vegetation (CEGL001802), includes a heterogeneous mix of species that do not segregate in any meaningful way.

Vegetation Description: *Carex aquatilis* var. *dives* is the primary species, averaging 54% cover, and many stands occur as monotypic reed swamp with cover ranging from 5% to 99%. Some of these stands intergrade with *Carex utriculata* Herbaceous Vegetation (CEGL001562) in seasonally flooded depressions. The herb layer is astonishingly diverse with more than 120 species recorded, but most of these have relatively low constancy and reflect the patchy distribution of many different taxa. *Dodecatheon jeffreyi, Carex utriculata*, and *Hypericum anagalloides* are the only other species with constancy higher than 20%. Species with significant patches include *Caltha leptosepala* ssp. *howellii, Eleocharis quinqueflora, Equisetum fluviatile, Viola macloskeyi, Cicuta douglasii*, and *Agrostis humilis* (= *Agrostis thurberiana*). Trees and shrubs are scarce, although many different species are present. Stands may occur on old beaver terraces on seepage slopes and also in sag ponds on slopes prone to slumping. *Carex aquatilis* var. *dives* can intermix with forest ecotone or meadow taxa as long as enough soil moisture is present. Plants become progressively dwarfed as conditions become drier.

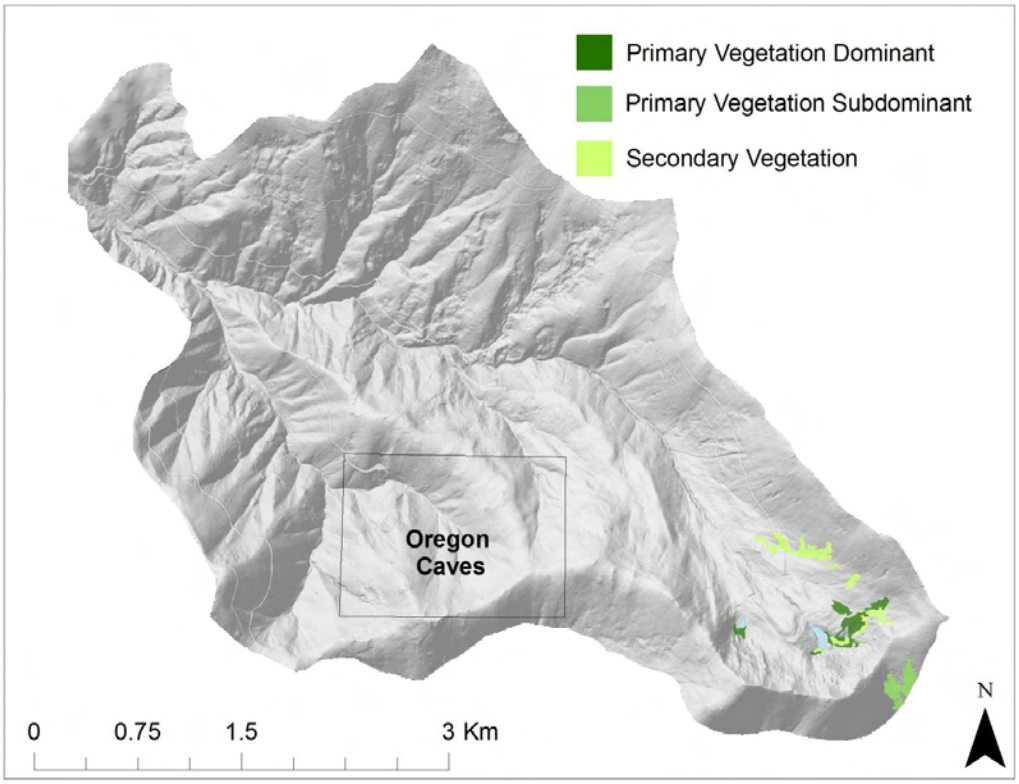
Characteristic Species: *Carex aquatilis* var. *dives* (Sitka sedge).
USFWS Wetland System: Type 3-Inland shallow fresh marshes; System: Palustrine; Class: Emergent Wetland. The USFWS Wetland Inventory (1996 national list) recognizes *Carex aquatilis* as an OBL (obligate wetland species) plant (Sawyer et al. 2009).

DISTRIBUTION
Range: Canada, United States.
States/Provinces: AK, BC, CA?, OR, WA.
Federal Lands: This association is likely to occur elsewhere within the Rogue River-Siskiyou National Forest at higher elevation in similar habitats.
CONSERVATION STATUS
Rank: G4 (01Feb1996).
Reason: Apparently Secure.

SOURCES
Global Description Authors: Christy 2004.
Global Description References: Boggs, K. 2000, Bourgeron, P. S., and L. D. Engelking, ed. 1994, Campbell, A. G. 1973, Christy, J. A. 2004, Crowe, E. A. et al. 2004, Driscoll, R. S. et al. 1984, Frenkel, R. E. et al. 1986, Hemstrom, M. A. et al. 1987, Kagan, J. S. et al. 2000-2004, Kovalchik, B. L. 1987, Kovalchik, B. L. 2001, Kunze, L. M. 1994, McCain, C., and J. A. Christy. 2005, Murray, M. P. 2000, Roach, A. W. 1952, Seyer, S. C. 1979, Seyer, S. C. 1983, Shephard, M. E. 1995, Titus, J. H. 1996, Titus, J. H., and J. A. Christy. 1996, Titus, J. H., and J. A. Christy. 1999, WNHP [Washington Natural Heritage Program]. No date, Western Ecology Working Group of NatureServe. No date, Wilson, C. E. 1986.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 15, 2012).

Association Range and Distribution



Carex aquatilis association is on right side of tape, *Carex luzulina* association on left side of tape.

COMMON NAME: *CAREX LUZULINA* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: The *Carex luzulina* association comprises a narrow zone of emergent wetland vegetation along the edge of the Bigelow Lakes. This vegetation association occurs on the basin floor just upslope from the wetter *Carex aquatilis* association and downslope from the drier *Carex vesicaria - Caltha leptosepala* association, occupying a soil moisture regime transitional between these two associations. Soil texture is muck.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1792	5	96	0
Range	1782-1799	3-7	5-212	0

Vegetation Description: The *Carex luzulina* association is characterized by emergent wetland vegetation dominated by nearly pure stands of woodrush sedge (*Carex luzulina*). Congdon's bulrush (*Scirpus congdonii*) and Sitka sedge (*Carex aquatilis* var. *dives*) are also abundant. The forbs Bigelow's sneezeweed (*Helenium bigelovii*) and tinker's penny (*Hypericum anagalloides*) are constant across all sample plots though they are present at low cover.

Most Abundant Species:

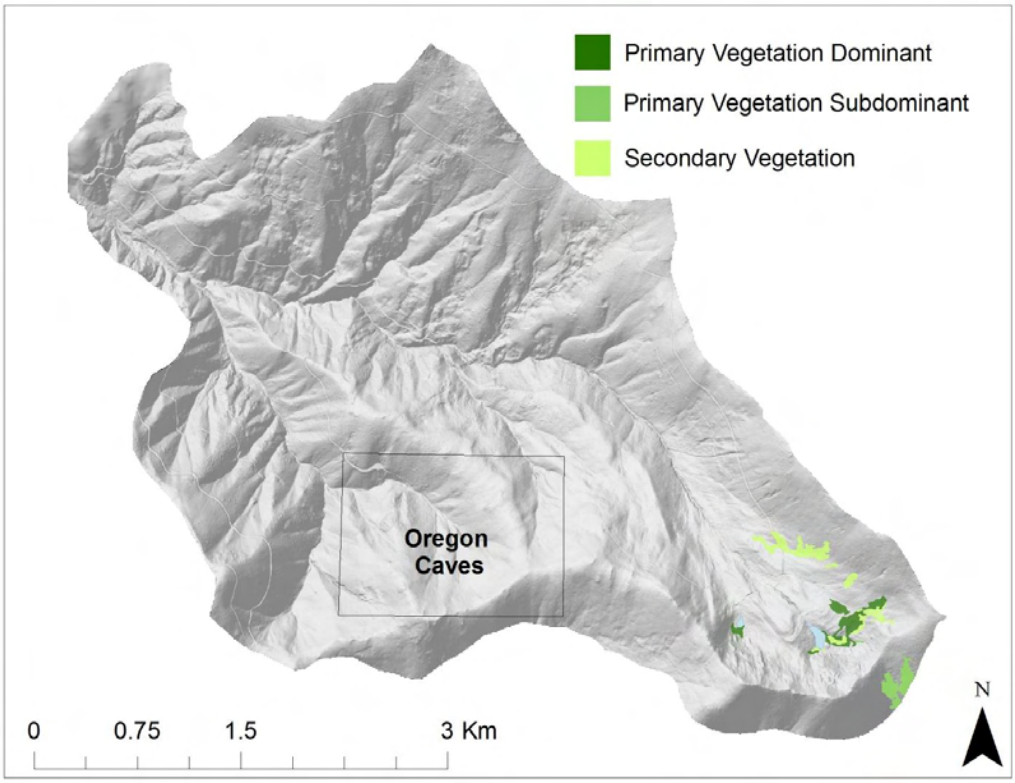
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Herb	Graminoid	*Carex luzulina* (woodrush sedge)	25-50	37.5
		Scirpus congdonii (Congdon's bulrush)	1-50	16.33
		Carex aquatilis var. *dives* (Sitka sedge)	2-15	5.67
		Carex echinata ssp. *echinata* (star sedge)	0.5-1	0.5
	Perennial herb	*Caltha leptosepala* (white marsh marigold)	0-5	1.33
		Tofieldia glutinosa (sticky tofieldia)	0-5	1.33
		Polygonum bistortoides (American bistort)	0-2	0.67
		Trifolium longipes (longstalk clover)	0-2	0.67
		Helenium bigelovii (Bigelow's sneezeweed)	0.5-1	0.5
		Hypericum anagalloides (tinker's penny)	0.5-1	0.5

Species Richness:

Plot Species Richness Average	16.7
Plot Species Richness Range	13 - 19
Total Species Richness (all plots)	28

Diagnostic species: *Carex luzulina*.
Constant species: *Carex luzulina, Carex aquatilis* var. *dives, Carex echinata* ssp. *echinata, Helenium bigelovii, Hypericum anagalloides, Scirpus congdonii.*
Other Noteworthy Species: None.
Local Range: The Bigelow Lakes.
Classification Comments: This association is treated in A Manual of California Vegetation as *Carex luzulina* Provisional Herbaceous Alliance (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Sawyer, J. O. et al. 2009.
Plots: Relevés 130, 133, 134.
Oregon Caves National Monument Inventory Notes: This association has a very limited distribution in the Oregon Caves National Monument and the proposed expansion area. Not treated in the USNVC database. This is potentially a distinct association present elsewhere in the region. Further investigation is recommended to determine if this is a distinct association.

Association Range and Distribution



***Carex aquatilis* association** on the right side of tape, ***Carex luzulina* association** on the left side of tape.

COMMON NAME: *CAREX EXSICCATA - CALTHA LEPTOSEPALA* ASSOCIATION

SYNONYMS
USNVC English Name: Inflated Sedge Herbaceous Vegetation

USNVC Scientific Name: *Carex vesicaria* Herbaceous Vegetation

USNVC Identifier: CEGL002661

USNVC CLASSIFICATION:
Formation Class: 2 - Shrubland & Grassland
Formation Subclass: 2.B - Temperate & Boreal Grassland, Savanna & Shrubland
Formation: 2.B.6 - Temperate & Boreal Freshwater Shrubland, Wet Meadow & Marsh
Division: 2.B.6.Nb - Western North American Freshwater Shrubland, Wet Meadow & Marsh
Macrogroup: Western North American Montane Wet Shrubland & Wet Meadow
Group: *Carex* spp. - *Calamagrostis* spp. Montane Wet Meadow Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association comprises a narrow band of emergent wetland vegetation around the edge of Bigelow Lakes at a zone upslope and slightly drier than that of the *Carex luzulina* association. This zone likely dries out seasonally as water recedes from the lake margins. This association is also widespread in saturated soils elsewhere in the Bigelow Basin. Soil texture is loam or muck.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1750	9	290	88.5
Range	1699-1800	3 - 15	240-340	88 - 89

Vegetation Description: The *Carex exsiccata - Caltha leptosepala* association is dominated by a mix of graminoids and broad-leaved perennial herbs. The most abundant and co-dominant graminoids are western inflated sedge (*Carex exsiccata*), tufted hairgrass (*Deschampsia cespitosa*), and Congdon's bulrush (*Scirpus congdonii*) while co-dominant perennial herbs include white marsh marigold (*Caltha leptosepala*) and Bigelow's sneezeweed (*Helenium bigelovii*).

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Herb	Graminoid	*Carex exsiccata* (western inflated sedge)	5-15	10
		Deschampsia cespitosa (tufted hairgrass)	5-15	10
		Scirpus congdonii (Congdon's bulrush)	5-15	10
		Carex spectabilis (showy sedge)	0-15	5
		Scirpus microcarpus (panicled bulrush)	0-15	5
	Sub-shrub	*Potentilla glandulosa* (sticky cinquefoil)	2-5	3.5
	Perennial herb	*Caltha leptosepala* (white marsh marigold)	5-15	10
		Helenium bigelovii (Bigelow's sneezeweed)	5-15	10

Polygonum bistorta (meadow bistort)	2-15	6.75
Boykinia major (large boykinia)	0.5-15	5.25
Hypericum anagalloides (tinker's penny)	0.5-15	5.25
Veratrum californicum (California false hellebore)	0.5-15	5.25
Tofieldia glutinosa (sticky tofieldia)	2-5	3.5
Aster foliaceus (alpine leafybract aster)	0.5-5	2
Achillea millefolium (common yarrow)	0.5-5	2

Species Richness:

Plot Species Richness Average	28
Plot Species Richness Range	27 - 29
Total Species Richness (all plots)	42

Diagnostic species: *Carex exsiccata* (= *Carex vesicaria* var. *major*), *Carex spectabilis, Scirpus congdonii,* and *Scirpus microcarpus.*
Constant species: *Caltha leptosepala, Carex exsiccata, Helenium bigelovii, Potentilla glandulosa, Polygonum bistorta, Boykinia major, Hypericum anagalloides, Deschampsia cespitosa, Veratrum californicum, Aster foliaceus, Achillea millefolium, Gentiana plurisetosa, Scirpus congdonii, Tofieldia glutinosa.*
Other Noteworthy Species: None.
Local Range: The Bigelow Basin and nearby wet meadows.
Classification Comments: Specimens west of the Cascade Mountains identified as *Carex vesicaria* have been called *Carex vesicaria* var. *major* or treated as a separate species *Carex exsiccata.*
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Sawyer, J. O. et al. 2009.
Plots: Relevés 51, 69.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Stands of this vegetation association are commonly found in wet meadows, around the edges of montane lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains throughout the western United States. Elevations range from 1075-2900 m (3525-9500 feet). They can occur in standing water or on sites that become relatively dry during the later part of the growing season. Many sites are located where beaver ponds have filled with sediment. A wide range of soils are associated with this association. Histosols are most common and often have organic accumulations greater than 1 meter thick. Mollisols and Entisols are also associated with this association. Soil texture varies widely from loamy clay to sandy loam.

Vegetation Description: This association is characterized by the dominance of *Carex vesicaria*, with 20-98% cover. Other graminoids can be present and can be codominant. *Juncus balticus, Deschampsia cespitosa, Carex nebrascensis, Carex utriculata, Calamagrostis stricta, Eleocharis*

palustris, and *Glyceria* spp. are some of the more common associated species. Forbs can include *Epilobium* spp., *Galium trifidum, Camassia quamash, Symphyotrichum foliaceum (= Aster foliaceus), Equisetum arvense,* and *Mentha arvensis*.

Characteristic Species: *Carex vesicaria* (inflated sedge).
USFWS Wetland System: Type 3-Inland shallow fresh marshes; System: Palustrine; Class: Emergent Wetland. The USFWS Wetland Inventory (1996 national list) recognizes *Carex vesicaria* as an OBL (obligate wetland species) plant in California (Sawyer et al. 2009).

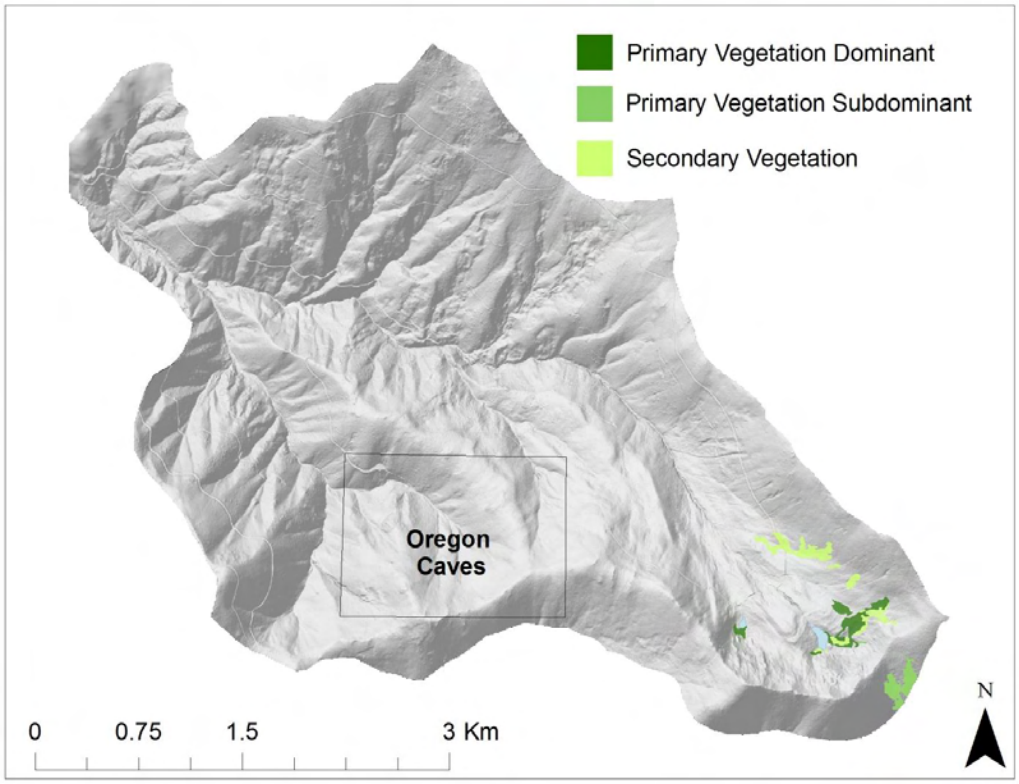
DISTRIBUTION
Range: United States.
States/Provinces: AZ, CA, CO, ID, MT, NV?, OR, WA, WY.
Federal Lands: This association is known from stands throughout the montane western United States.

CONSERVATION STATUS
Rank: G4Q (02Dec1998).
Reason: Apparently Secure.

SOURCES
Global Description Author: T. Keeler-Wolf, mod. G. Kittel.
Global Description References: Bourgeron, P. S., and L. D. Engelking, ed. 1994, CONHP [Colorado Natural Heritage Program]. 2003, CONHP [Colorado Natural Heritage Program]. 2006-2010, Carsey, K., et al. 2003, Christy, J. A., and L. C. Cornelius. 1980, Cogan, D. et al. 2005, Cooper, D. J., and C. Severn. 1992, Crowe, E. A., and R. R. Clausnitzer. 1997, Hansen, P. L. et al. 1995, Henderson, J. S., and M. L. McAllister. 1983, Hop, K. et al. 2007, IDCDC [Idaho Conservation Data Center]. 2005, Kagan, J. S. et al. 2000-2004, Keeler-Wolf, T. et al. 2003a, Kittel, G. et al. 1999b, Kovalchik, B. L. 1987, Manning, M. E., and W. G. Padgett. 1991, Potter, D. A. 2005, Reid, M. S. et al. 2004, Reid, M. S., and M. E. Hall. 2010, Sanderson, J., and S. Kettler. 1996, WNDD [Wyoming Natural Diversity Database]. No date, WNHP [Washington Natural Heritage Program]. No date, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 15, 2012).

Association Range and Distribution



***Carex exsiccata - Caltha leptosepala* association.** Right side of tape. Relevé 69, elevation 1699 m. White flowers in foreground are *Veratrum californicum*. Yellow flowers are *Helenium bigelovii*. Right side of photo dominated by *Carex exsiccata* and *Carex spectabilis*.

COMMON NAME: *HELENIUM BIGELOVII - POTENTILLA GLANDULOSA* **ASSOCIATION**

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This herbaceous vegetation association occurs on high slopes or ledges on slopes in seasonally wet meadow environments. Soil texture is muck, loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1817	10	228	20
Range	1784 - 1885	4 - 15	160 - 280	0.5 - 70

Vegetation Description: This vegetation association is characterized by high herbaceous cover, generally over 75%. Bigelow's sneezeweed (*Helenium bigelovii*), sticky cinquefoil (*Potentilla glandulosa*), and arrowleaf ragwort (*Senecio triangularis*) are often dominant. One of two species of hairgrass (*Deschampsia* spp.), either slender hairgrass (*Deschampsia elongata*) or tufted hairgrass (*Deschampsia cespitosa*) are present, but not both in the same location. California oatgrass (*Danthonia californica*) is also present. Dense patches (clones) of California false hellebore (*Veratrum californicum*) are often intermixed within this association.

Most Abundant Species:

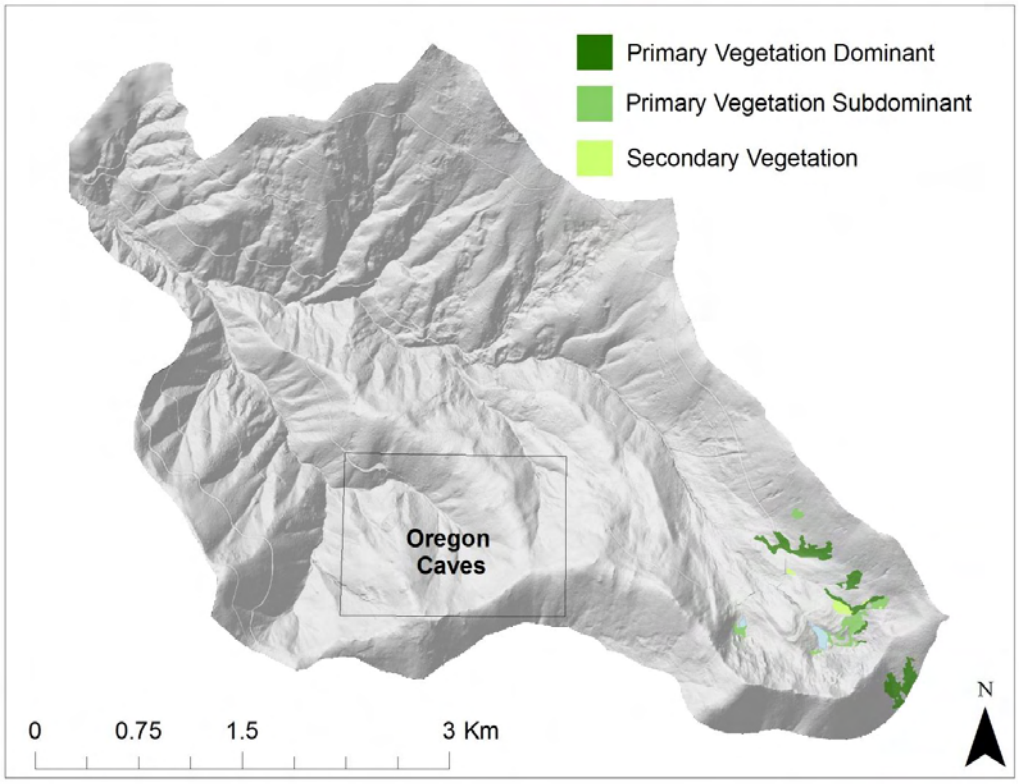
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Herb	Sub-shrub	*Potentilla glandulosa* (sticky cinquefoil)	0-15	5.13
		Potentilla gracilis (slender cinquefoil)	0-15	2.63
		Senecio triangularis (arrowleaf ragwort)	0-15	3.38
	Perennial herb	*Helenium bigelovii* (Bigelow's sneezeweed)	0.5-15	6
		Veratrum californicum (California false hellebore)	0.5-15	5.25
		Achillea millefolium (common yarrow)	0-15	3.75
		Trifolium longipes (longstalk clover)	0.5-5	1.5
		Potentilla drummondii (Drummond's cinquefoil)	0-5	1.38
		Castilleja miniata ssp. *miniata* (giant red Indian paintbrush)	0-5	1.38
	Graminoid	*Danthonia californica* (California oatgrass)	0-15	5.38
		Deschampsia cespitosa (tufted hairgrass)	0-15	3.38

Species Richness:

Plot Species Richness Average	19.75
Plot Species Richness Range	10 - 25
Total Species Richness (all plots)	47

Characteristic Species: *Helenium bigelovii, Potentilla glandulosa, Senecio triangularis.*
Diagnostic species: None.
Constant species: *Helenium bigelovii, Trifolium longipes.*
Other Noteworthy Species: None.
Local Range: The Bigelow Basin and nearby wet meadows. This association likely occurs in similar wet meadow habitats at high elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: This association may be similar to the *Senecio triangularis* Herbaceous Vegetation Alliance (CEGL001987) in the USNVC database (NatureServe 2011).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe 2011.
Plots: Relevés 58, 116, 117, 128.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association present elsewhere in the region. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Helenium bigelovii - Potentilla glandulosa* association.** Near relevé 117, elevation 1793 m. Yellow flowers are *Helenium bigelovii*. Reddish flowers are *Castilleja miniata* ssp. *miniata*. Common graminoids are *Danthonia californica* and *Deschampsia cespitosa*.

***Helenium bigelovii - Potentilla glandulosa* association.** Locally dominated patch of *Veratrum californicum*. Relevé 116, elevation1784 m. Associated with *V. californicum* (foreground) are *Castilleja miniata* ssp*. miniata, Helenium bigelovii* (yellow flowers), and *Rudbeckia occidentalis* (brown flower heads).

COMMON NAME: *PTERIDIUM AQUILINUM* – GRAMINOID ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association is characterized by dense, seasonally wet meadow vegetation on gradually sloping terrain high on slopes or on summits at higher elevations. Soil texture is loam or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1606	15	189	51
Range	1513 - 1868	3 - 21	66 - 260	4 - 91

Vegetation Description: This vegetation association is predominantly composed of western brackenfern (*Pteridium aquilinum* var. *pubescens*) along with a variety of graminoids, including species of sedge (*Carex* spp.). California oatgrass (*Danthonia californica*) is often the dominant grass followed by Kentucky bluegrass (*Poa pratensis*). Common yarrow (*Achillea millefolium*) is more common in this association than elsewhere in sampled herbaceous vegetation.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Herb	Fern or fern ally	*Pteridium aquilinum* var. *pubescens* (western brackenfern)	5-15	10
	Sub-shrub	*Senecio triangularis* (arrowleaf ragwort)	0-15	2.1
	Perennial herb	*Achillea millefolium* (common yarrow)	0.5-15	4.2
		Heracleum maximum (common cowparsnip)	0-15	4
		Hypericum perforatum (common St. Johnswort)	0-15	2.8
		Artemisia douglasiana (Douglas' sagewort)	0-15	2.7
		Rumex acetosella (common sheep sorrel)	0-15	2.5
		Rudbeckia occidentalis (western coneflower)	0-15	2.1
	Graminoid	*Danthonia californica* (California oatgrass)	0-25	4.7
		Poa pratensis (Kentucky bluegrass)	0-15	3

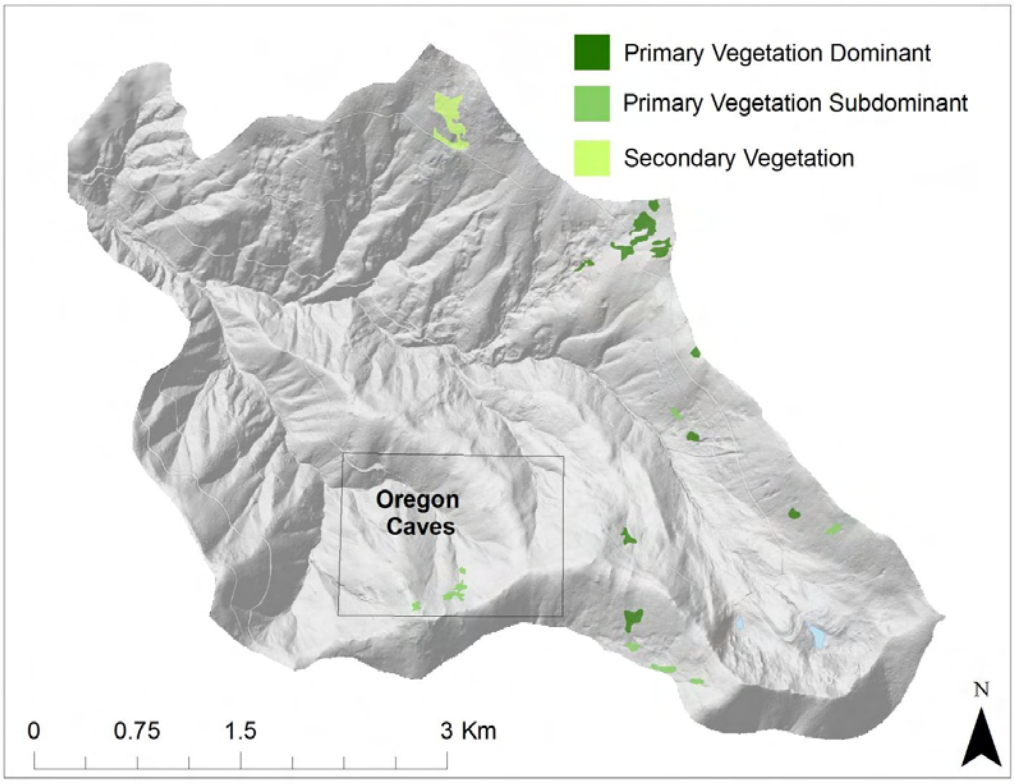
Species Richness:

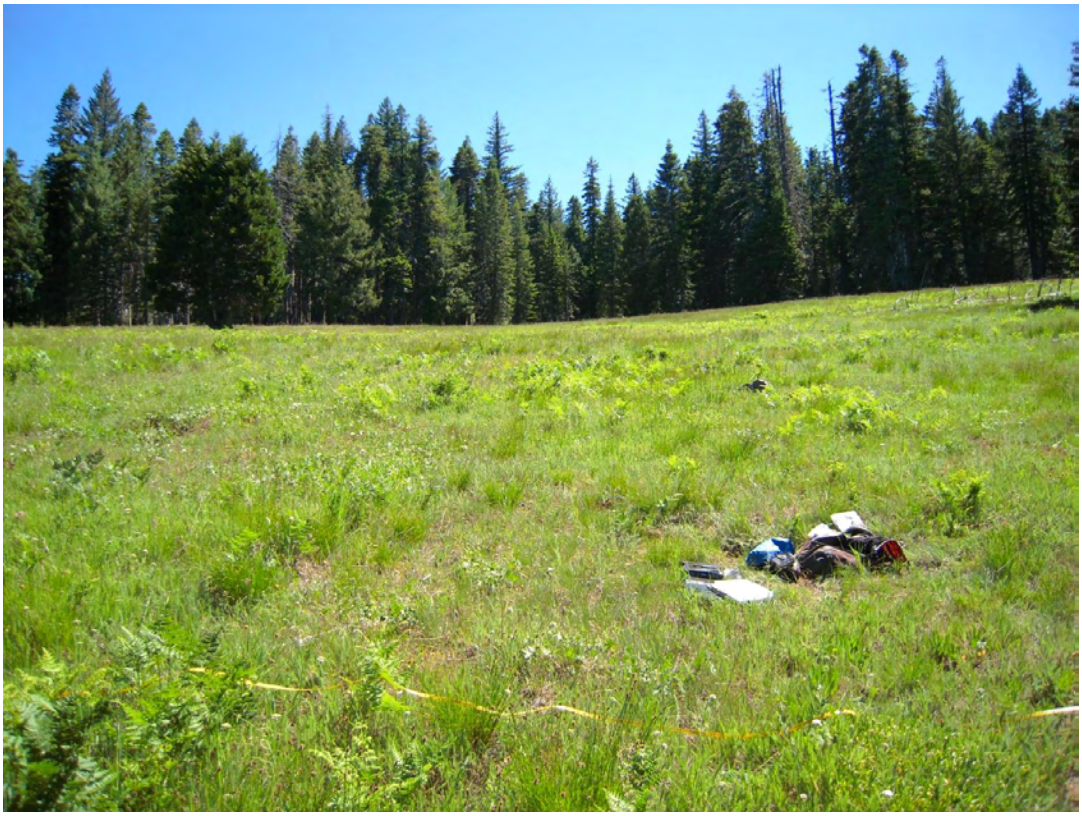
Plot Species Richness Average	29.6
Plot Species Richness Range	19 - 40
Total Species Richness (all plots)	101

Diagnostic species: *Poa pratensis.*
Constant species: *Pteridium aquilinum* var. *pubescens, Achillea millefolium.*

Other Noteworthy Species: None.
Local Range: This association occurs in meadow openings scattered within the Oregon Caves National Monument and across the proposed expansion area above 1300 m. This association likely occurs in similar meadow habitats at high elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevés 42, 55, 60, 105, 108.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution





***Pteridium aquilinum - graminoid* association.** Relevé 105, elevation 1513 m. Commonly associated with *Pteridium aquilinum* var*. pubescens* (immediate foreground, far left) are the grass *Danthonia californica* and the clover *Trifolium longipes* (immediate foreground, far right).

COMMON NAME: ***AGASTACHE URTICIFOLIA - POLYGONUM PHYTOLACCIFOLIUM*** **ASSOCIATION**

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association is comprised of tall herbaceous meadow vegetation occupying forest or shrubland openings and edges in seasonally wet areas adjacent to *Salix eastwoodiae / Senecio triangularis*, *Alnus incana / Heracleum maximum*, or *Acer glabrum* associations (see descriptions of these co-occurring associations). Topographic positions include high slopes, mid-slopes, and summits. Soil texture is loam, clay loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1565	31	2	57
Range	1516 - 1631	23 - 47	285 - 58	25 - 85

Vegetation Description: This vegetation association is characterized by dense stands of nettleleaf giant hyssop (*Agastache urticifolia*) and poke knotweed (*Polygonum phytolaccifolium*) clones to 1.25 m tall. These stands are interspersed with relatively few other species, such as Alice Eastwood's fleabane (*Erigeron aliceae*) and occasional patches of common cowparsnip (*Heracleum maximum*). Small patches of white fir (*Abies concolor*) and Douglas-fir (*Pseudotsuga menziesii*) too small (< 400 m^2) to be considered separate associations often occur in these meadows (see the *Abies concolor / Agastache urticifolia* association).

Most Abundant Species:

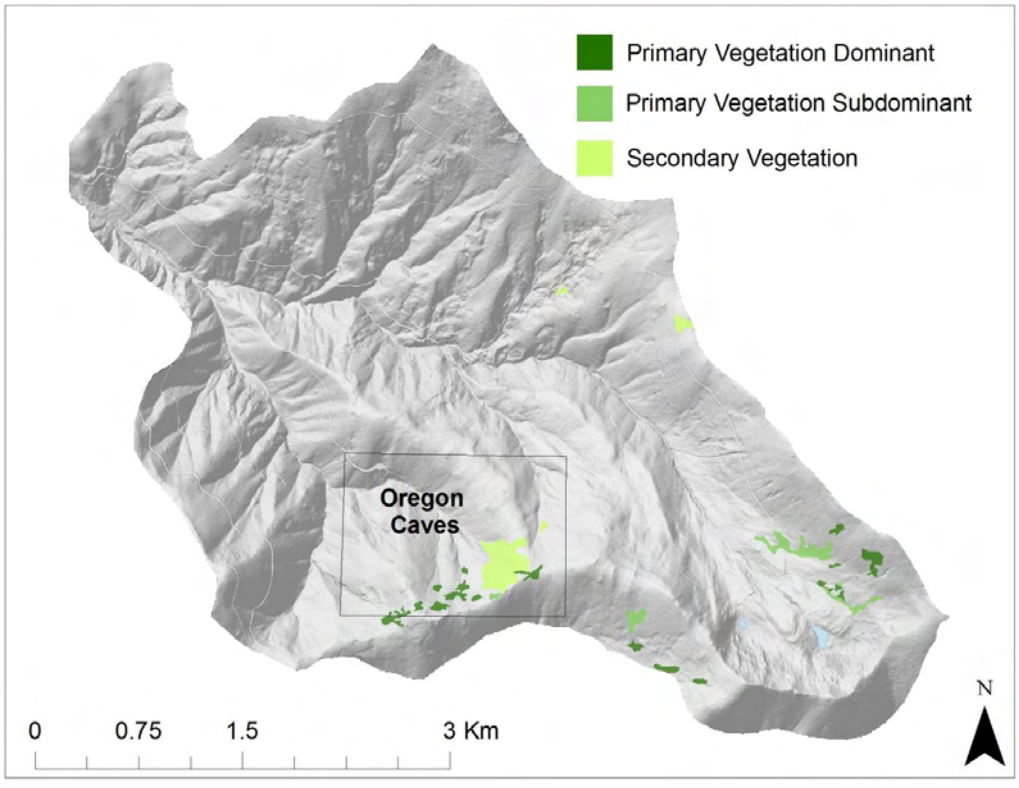
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Prunus emarginata* (bitter cherry)	0-15	3.38
Herb	Sub-shrub	*Agastache urticifolia* (nettleleaf giant hyssop)	5-25	15
		Erigeron aliceae (Alice Eastwood's fleabane)	0.5-15	5.5
		Senecio triangularis (arrowleaf ragwort)	0-15	3.38
	Perennial herb	*Polygonum phytolaccifolium* (poke knotweed)	5-25	15
		Heracleum maximum (common cowparsnip)	0-50	9.75
		Castilleja miniata ssp. *miniata* (giant red Indian paintbrush)	0.5-15	3.88
		Osmorhiza occidentalis (western sweetroot)	0.5-5	1.5
	Perennial vine	*Lathyrus nevadensis* (Sierra pea)	0-15	2.88
	Annual herb	*Polygonum douglasii* (Douglas' knotweed)	0-5	1.75

Species Richness:

Plot Species Richness Average	25.75
Plot Species Richness Range	20 - 33
Total Species Richness (all plots)	70

Diagnostic species: *Polygonum phytolaccifolium.*
Constant species: *Agastache urticifolia, Castilleja miniata* ssp. *miniata, Erigeron aliceae, Osmorhiza occidentalis, Polygonum phytolaccifolium.*
Other Noteworthy Species: None.
Local Range: This association occurs in meadow openings scattered within the Oregon Caves National Monument and across the proposed expansion area above 1300 m. This association likely occurs in similar meadow habitats at high elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevés 12, 20, 36, 113.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Agastache urticifolia - Polygonum phytolaccifolium* association.** Relevé 12, elevation 1521m. *Agastache urticifolia* at far right (light purple flowers). *Heracleum maximum* (white flowers) is common in this plot.

COMMON NAME: *SEDUM OREGONENSE - PHLOX DIFFUSA* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at higher elevations on summits, ridges, and steep upper slopes. At locations supporting this association the ground layer is on average about one-third covered by rock and 10-20% is bare soil. Soils are coarse and well-drained sandy loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1852	28	283	30
Range	1797 - 1903	10 - 45	215 - 30	10 - 60

Vegetation Description: The vegetation structure of this association is open with woody species occurring in low cover. Many of the species present occur at higher elevations in the region. Spreading phlox (*Phlox diffusa*) and cream stonecrop (*Sedum oregonense*) commonly have a combined cover around 20%. Pinemat manzanita (*Arctostaphylos nevadensis*) is often co-dominant but patchy in its distribution between stands. Other shrub species such as greenleaf manzanita (*Arctostaphylos patula*) are present in low cover. Several woody perennial herbs occur in this association including ballhead sandwort (*Arenaria congesta*) and common woolly sunflower (*Eriophyllum lanatum*).

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Abies magnifica x procera* (Shasta red fir)	0-15	6.13
	Broad-leaved evergreen shrub	*Arctostaphylos nevadensis* (pinemat manzanita)	0-15	4.25
		Arctostaphylos patula (greenleaf manzanita)	0-5	1.88
		Quercus sadleriana (deer oak)	0-5	1.38
	Broad-leaved deciduous shrub	*Prunus emarginata* (bitter cherry)	0-5	2
Herb	Sub-shrub	*Arenaria congesta* (ballhead sandwort)	0-15	2.63
		Eriophyllum lanatum (common woolly sunflower)	0-5	2.63
		Eriogonum umbellatum (sulphur-flower buckwheat)	0-5	1.75
	Perennial herb	*Phlox diffusa* (spreading phlox)	0.5-15	7.63
		Sedum oregonense (cream stonecrop)	0.5-15	7.63

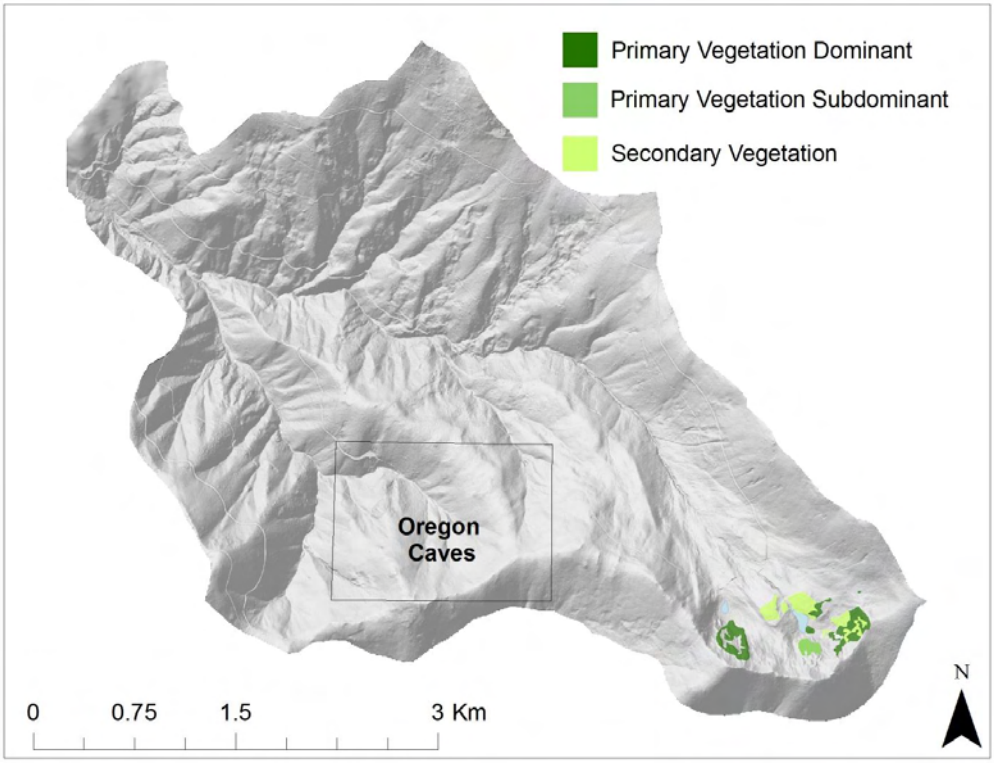
	Achillea millefolium (common yarrow)	0-15	3.75
Graminoid	*Elymus elymoides* (squirreltail)	0-5	1.25

Species Richness:

Plot Species Richness Average	27.75
Plot Species Richness Range	16 - 45
Total Species Richness (all plots)	74

Diagnostic species: *Sedum oregonense, Phlox diffusa.*
Constant species: *Sedum oregonense, Phlox diffusa.*
Other Noteworthy Species: *Achillea millefolium, Eriophyllum lanatum.*
Local Range: This association occurs in dry, rocky openings on slopes and summits in the Bigelow Basin. It is likely to also occur in similar habitats at high elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevés 50, 52, 118, 120.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



Sedum oregonense - Phlox diffusa association. Relevé 50, elevation 1797 m. Common herb associates with S. oregonense and P. diffusa are Potentilla drummondii, Trifolium longipes, and Eriophyllum lanatum. The low shrub in the background is Arctostaphylos nevadensis.

COMMON NAME: NON-FORESTED RIPARIAN ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association occupies stream bank areas that are not forested due to fluvial disturbances such as scouring or debris flows. Topographic positions this association occupies are mid-slope and channel bed. Exposed bedrock and fluvial deposits are characteristic of this association. Soil texture is clay loam or sand. This is a rare association in the Oregon Caves National Monument and proposed expansion area, only two plots sampled.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1251	16	31	25
Range	1173 - 1328	11 - 20	358 - 62	10 - 40

Vegetation Description: An exceptionally wide range of species occur in this vegetation association, none of which are truly dominant. Conifer seedlings are abundant and some conifer trees occur in the sampling plots. A variety of broad-leaved deciduous shrubs common to mesic, montane sites in the region are important in this vegetation association. Sparse to moderate herb cover is comprised of a variety of moist site species. The diagnostic species Lyall's angelica (*Angelica arguta*) is constant with low cover. Moss cover is often abundant on exposed bedrock.

Most Abundant Species:

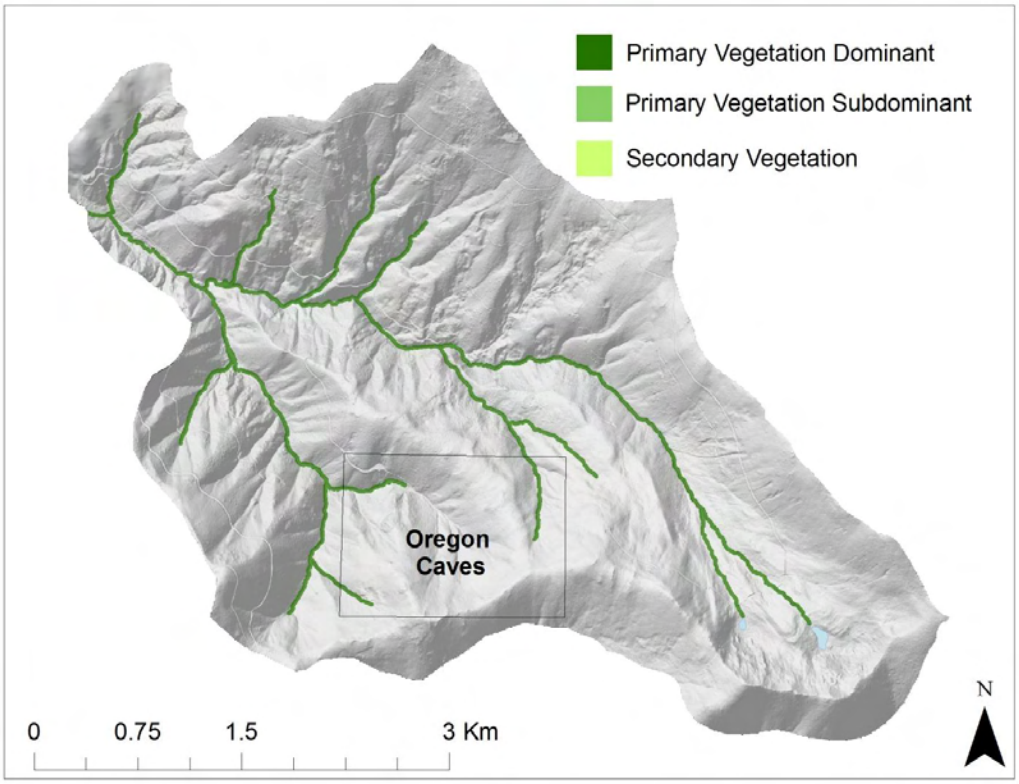
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Chamaecyparis lawsoniana* (Port Orford cedar)	0.5-15	5.25
		Abies grandis (grand fir)	0.5-5	2
	Broad-leaved deciduous shrub	*Ribes sanguineum* (redflower currant)	0.5-5	2
		Salix lucida (shining willow)	0-5	2.5
		Salix scouleriana (Scouler's willow)	0-5	1.75
		Rubus parviflorus (thimbleberry)	0.5-2	1
		Vaccinium parvifolium (red huckleberry)	0-5	1.75
Herb	Perennial herb	*Boykinia occidentalis* (coastal brookfoam)	0-15	5
		Fragaria vesca (woodland strawberry)	0.5-5	2
		Adenocaulon bicolor (American trailplant)	0-5	1.75
		Petasites frigidus var. *palmatus* (arctic sweet coltsfoot)	0-5	1.75
		Epilobium angustifolium (fireweed)	0.5-2	1
	Fern or fern ally	*Adiantum aleuticum* (Aleutian maidenhair)	0-5	1.75
		Equisetum arvense (field horsetail)	0-5	1.75

Species Richness:

Plot Species Richness Average	50.5
Plot Species Richness Range	40 - 61
Total Species Richness (all plots)	85

Diagnostic species: *Angelica arguta, Abies grandis* (seedlings).
Constant species: *Abies grandis* (seedlings), *Anaphalis margaritacea, Anemone deltoidea, Angelica arguta, Chamaecyparis lawsoniana* (seedlings) *Epilobium angustifolium, Fragaria vesca, Galium triflorum, Hieracium albiflorum, Lathyrus nevadensis, Pseudotsuga menziesii* (seedlings), *Ribes sanguineum, Rubus parviflorus, Vancouveria hexandra.*
Other Noteworthy Species: None.
Local Range: This association occurs infrequently along larger order streams in the Oregon Caves National Monument and proposed expansion area. Similar vegetation is likely to occur in sparsely forested riparian areas at middle elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: This association is possibly similar to the Mediterranean California Foothill and Lower Montane Riparian Woodland (CES206.944) in the USNVC database (NatureServe 2011).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe 2011.
Plots: Relevés 9, 55.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



Non-forested riparian association. Relevé 5, elevation 1173 m. Linear plot at this location only extended 2-3 m on either side of stream. Conifer seedlings are common, including both *Abies grandis* and *Chamaecyparis lawsoniana*.

Non-forested riparian association. Relevé 99, elevation 1328 m. In the immediate foreground on the right is a debris flow deposit. Centerline of the relevé is to the right of the tape. Numerous herbs are present in low abundance, such as *Achlys triphylla* and *Fragaria vesca*. Numerous, small conifer seedlings are also present (*Abies grandis* and *Chamaecyparis lawsoniana*).

COMMON NAME: *ALNUS INCANA / HERACLEUM MAXIMUM* **ASSOCIATION**

SYNONYMS
USNVC English Name: Gray Alder / Mesic Forbs Shrubland

USNVC Scientific Name: *Alnus incana* / Mesic Forbs Shrubland

USNVC Identifier: CEGL001147

USNVC CLASSIFICATION:
Formation Class: 2 - Shrubland & Grassland
Formation Subclass: 2.B - Temperate & Boreal Grassland, Savanna & Shrubland
Formation: 2.B.6 - Temperate & Boreal Freshwater Shrubland, Wet Meadow & Marsh
Division: 2.B.6.Nb - Western North American Freshwater Shrubland, Wet Meadow & Marsh
Macrogroup: Western North American Montane Wet Shrubland & Wet Meadow
Group: *Alnus incana - Betula occidentalis* Riparian/Seep Shrubland Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs in wet meadows in patches or along meadow edges. This association also occurs on seeps and along streams in adjacent forested areas. Topographic positions are varied and include high slope, mid-slope, and low level. Soil texture is loam, sandy loam, or clay loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1596	20	342	81
Range	1477 - 1699	8 - 38	265 - 80	60 - 94

Vegetation Description: This vegetation association is comprised of copses of gray alder (*Alnus incana*) forming a tall (2–5 m) shrub layer that occupies at least 25% cover. Associated wet meadow species, such as common cowparsnip (*Heracleum maximum*) and small enchanter's nightshade (*Circaea alpina*) form a thick herbaceous layer.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Alnus incana* (gray alder)	25-50	41
		Sambucus racemosa var. *microbotrys* (red elderberry)	0-15	6.17
Herb	Sub-shrub	*Senecio triangularis* (arrowleaf ragwort)	0-15	3.42
	Perennial herb	*Circaea alpina* (small enchanter's nightshade)	0.5-15	7.33
		Dicentra formosa ssp. *formosa* (Pacific bleeding heart)	0-50	7
		Stachys ajugoides var. *ajugoides* (bugle hedgenettle)	0-15	5.58
		Heracleum maximum (common cowparsnip)	0.5-15	4.67
		Claytonia sibirica (Siberian springbeauty)	0-15	4

	Maianthemum stellatum (starry false lily of the valley)	0-15	4
	Viola glabella (pioneer violet)	0-15	4
	Asarum caudatum var. *caudatum* (British Columbia wildginger)	0.5-15	2.08
Fern and fern ally	*Athyrium filix-femina* (common ladyfern)	0-15	5.58
Annual vine	*Galium aparine* (stickywilly)	0-15	5

Species Richness:

Plot Species Richness Average	28.5
Plot Species Richness Range	21 – 31
Total Species Richness (all plots)	81

Diagnostic species: *Alnus incana.*
Constant species: *Alnus incana, Asarum caudatum* var. *caudatum, Circaea alpina, Heracleum maximum.*
Other Noteworthy Species: *Sambucus racemosa* var. *microbotrys* is moderately abundant in 4 out of 6 plots.
Local Range: This association occurs in wet meadows and in wet forest openings scattered within the Oregon Caves National Monument and across the proposed expansion area above 1400 m. This association likely occurs in similar habitats at high elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: This association is similar to the *Alnus incana* Shrubland Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Sawyer, J. O. et al. 2009.
Plots: Relevés 15, 35, 44, 46, 68, 70.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association occurs at elevations of 1710 to 2805 m (5600-9200 feet). Stands occur on streambanks in narrow valleys and on moist terraces and floodplains adjacent to streams with a bedload of boulders, cobble, or gravel. Channel type is variable, ranging from high-gradient reaches that support the association as stringers, to more extensive stands on sites with a developed floodplain. Soils are sandy-skeletal to loamy-skeletal, often with greater than 50% coarse fragments. Soils typically have a seasonally high water table with mottling in the top 25 cm of the surface.

Vegetation Description: These riparian shrublands are characterized by stands of medium-tall and tall deciduous shrubs and a thick herbaceous undergrowth of forbs and wetland-indicator grasses. *Alnus incana* clearly dominates the tall-shrub overstory with over 25% cover. Conifers, including *Abies lasiocarpa, Picea engelmannii,* and *Pinus contorta*, are sometimes present. A somewhat sparse low-shrub layer is often present and may include *Lonicera involucrata, Cornus sericea*, and species of *Ribes, Rosa*, and *Salix*. Undisturbed stands have abundant forbs and

native grasses. The undergrowth is characterized by a mixed forb cover of *Angelica arguta, Heracleum maximum (= Heracleum lanatum), Osmorhiza berteroi, Senecio triangularis, Galium triflorum, Polemonium* sp., *Rudbeckia occidentalis, Equisetum arvense, Mertensia* spp., *Aconitum columbianum,* and/or *Maianthemum stellatum* with over 100% cover in combination. Graminoids are often present and include *Cinna latifolia, Elymus glaucus, Glyceria striata, Bromus inermis, Calamagrostis canadensis*, and *Poa pratensis*. Stands disturbed by season-long livestock grazing have reduced forb cover and increased non-native grasses, including *Poa pratensis* and *Agrostis stolonifera*. Large stands (>100 m2), with the native herbaceous undergrowth intact are uncommon.

Characteristic Species: *Alnus incana, Galium triflorum, Osmorhiza berteroi, Rudbeckia occidentalis, Senecio triangularis, Bromus inermis, Calamagrostis canadensis, Elymus glaucus, Glyceria striata, Poa pratensis, Equisetum arvense.*

USFWS Wetland System: Type 6-Shrub swamps; System: Palustrine; Class: Scrub-Shrub Wetland. The USFWS Wetland Inventory (1996 national list) recognizes *Alnus incana* ssp. *tenuifolia* as an OBL+ (obligate wetland species) plant. (Sawyer et al. 2009).

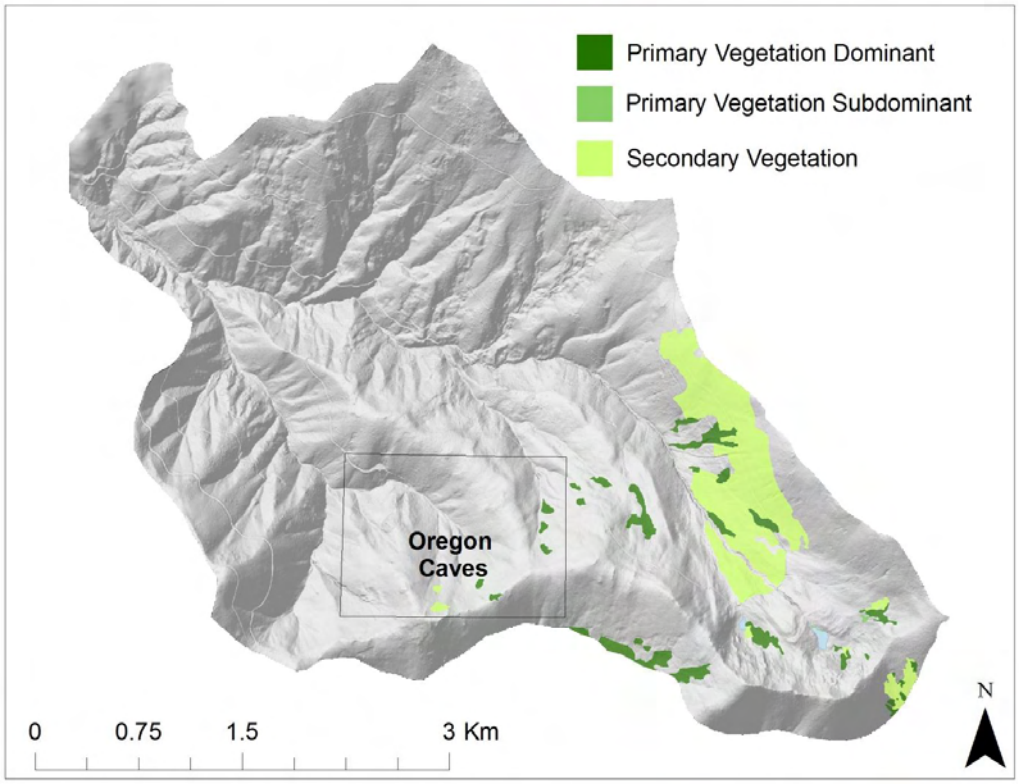
DISTRIBUTION
Range: United States.
States/Provinces: CA, CO, ID, MT, NV, OR?, UT, WA, WY.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

CONSERVATION STATUS
Rank: G3 (16Oct2000).
Reason: G3 – Vulnerable. This association has a wide range, but stands of this riparian shrubland association are restricted to small patches less than 10 acres in size. High-quality examples of this association without non-native species are uncommon as most stands are within watersheds with numerous threats including livestock grazing, logging, recreational activities, hydrologic modifications, and road building. Recent classification work in Washington and Oregon indicates that this association does not occur in those states. The rank is changed from G3G4 to G3 as the range of the association is not as widespread as it was originally considered.

Global Description Author: M. Jankovsky-Jones
Global Description References: Bell, J. et al. 2009, Bourgeron, P. S., and L. D. Engelking, ed. 1994, CONHP [Colorado Natural Heritage Program]. 2003, CONHP [Colorado Natural Heritage Program]. 2006-2010, Carsey, K. et al. 2003, Cogan, D. et al. 2005, Cooper, D. J., and T. R. Cottrell. 1990, Driscoll, R. S. et al. 1984, Hansen, P. L. et al. 1995, IDCDC [Idaho Conservation Data Center]. 2005, Johnston, B. C. 1987, Jones, G. 1992b, Kagan, J. S. et al. 2000-2004, Kettler, S., and A. McMullen. 1996, Kittel, G. M., and N. D. Lederer. 1993, Kittel, G. et al. 1999a, Kittel, G. et al. 1994, Kittel, G. et al. 1996, Kittel, G. et al. 1995, Kovalchik, B. L. 1993, MTNHP [Montana Natural Heritage Program]. 2002, Manning, M. E., and W. G. Padgett. 1995, Padgett, W. G. et al. 1988, Padgett, W. G. et al. 1989, WNDD [Wyoming Natural Diversity Database]. No date, Western Ecology Working Group of NatureServe. No date, Young, J. F. 1982, Youngblood, A. P. et al. 1985.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 27, 2012).

Association Range and Distribution



***Alnus incana* / *Heracleum maximum* association**. Relevé 68, elevation 1612 m. *Alnus incana* copse. Fern at lower left and elsewhere towards the bottom of the photo is *Athyrium filix-femina.*

COMMON NAME: *SALIX EASTWOODIAE / SENECIO TRIANGULARIS* ASSOCIATION

SYNONYMS
USNVC English Name: Sierran Willow / Tufted Hairgrass Shrubland

USNVC Scientific Name: *Salix eastwoodiae / Deschampsia cespitosa* Shrubland

USNVC Identifier: CEGL003128

USNVC CLASSIFICATION
Formation Class: 2 - Shrubland & Grassland
Formation Subclass: 2.B - Temperate & Boreal Grassland, Savanna & Shrubland
Formation: 2.B.6 - Temperate & Boreal Freshwater Shrubland, Wet Meadow & Marsh
Division: 2.B.6.Nb - Western North American Freshwater Shrubland, Wet Meadow & Marsh
Macrogroup: Western North American Montane Wet Shrubland & Wet Meadow
Group: *Salix* spp. Riparian & Seep Shrubland Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs in wet areas, particularly wet meadows. This type also occurs in some riparian areas where disturbances have reduced the forest overstory cover. Topographic positions are varied and include the basin floor, high slopes, and mid-slopes. Soil texture is loam, clay loam, silt loam, sandy, or muck.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1769	6	289	20
Range	1701 - 1801	2 - 12	230 - 40	3 - 65

Vegetation Description: This vegetation association is composed of dense thickets of mountain willow (*Salix eastwoodiae*) and occasionally elderberry species (*Sambucus* spp.) forming a medium to tall (1–5 m) overstory shrub layer that occupies at least 25% cover and often over 50% cover. Herbaceous layer cover is typically moderate and composed of herbs and graminoids common in wet open areas elsewhere in the Oregon Caves National Monument and proposed expansion area.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Salix eastwoodiae* (mountain willow)	25-87.5	50.3
Herb	Sub-shrub	*Senecio triangularis* (arrowleaf ragwort)	0.5-15	5.1
	Perennial herb	*Helenium bigelovii* (Bigelow's sneezeweed)	0.5-15	3.8
		Viola glabella (pioneer violet)	0.5-15	3
		Caltha leptosepala (white marsh marigold)	0-15	2.7
		Stachys rigida (rough hedgenettle)	0-15	2.6

	Circaea alpina (small enchanter's nightshade)	0-15	2.3
	Castilleja miniata ssp. *miniata* (giant red Indian paintbrush)	0.5-2	0.7
Graminoid	*Carex luzulina* (woodrush sedge)	0-15	2.1
	Carex spectabilis (showy sedge)	0-15	2.63

Species Richness:

Plot Species Richness Average	23.2
Plot Species Richness Range	14 - 37
Total Species Richness (all plots)	67

Diagnostic species: *Salix eastwoodiae.*
Constant species: *Salix eastwoodiae, Castilleja miniata* ssp. *miniata, Helenium bigelovii, Senecio triangularis, Viola glabella.*
Other Noteworthy Species: None.
Local Range: The Bigelow Basin and nearby seeps and wet meadows. This association likely occurs in similar seep and wet meadow habitats at high elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: The *Salix eastwoodiae / Deschampsia cespitosa* Shrubland described in the USNVC database is selected as analogous to this local association based on it having the same dominant *Salix* species and a similar geographic range and environmental setting. However, many sample plots from this local association do not contain the diagnostic species *Deschampsia cespitosa* and therefore it may not be analogous to the USNVC association *Salix eastwoodiae / Deschampsia cespitosa* Shrubland (NatureServe 2011). This local association may be similar to the *Salix eastwoodiae* Shrubland Alliance in A Manual of California Vegetation (Sawyer et al. 2009). Major and Taylor (1977) present a *Salix eastwoodiae / Senecio triangularis* Association in Terrestrial Vegetation of California.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Major, J., and D. W. Taylor. 1977, NatureServe. 2011, Sawyer, J. O. et al. 2009.
Plots: Relevés 47, 53, 115, 131, 136.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Stands of this shrubland are found adjacent to or near streambanks in mesic to wet meadows at mid to high elevations (2110-3350 m [6920-11,000 feet]). Slopes are gentle to moderate (5-20%). They often appear in basins or as stringer meadows with streams present. These sites are at the bottom of broad to very broad valleys with moderate upland slopes and variable valley bottom gradients. This association is often found near first-order streams within the upper portions of mountain drainages. Slopes are usually convex in shape. Stands are formed on volcanic flows and glaciated granitic batholiths. The stands are seasonally to permanently saturated. Water typically is received by subsurface and overland flows from upstream slopes or upslope on a seasonal basis. Along streams, these stands can be seasonally

flooded; however, the association does not appear to be significantly influenced by streamside disturbance (Potter 2000).

Vegetation Description: Stands form a two-story structure with a moderately open to intermittent low to moderately tall shrub layer dominated by *Salix eastwoodiae*. The understory herbaceous layer can be well-developed where openings in the shrub layer occur. A variety of species are found in the herbaceous layer including: *Oreostemma alpigenum (= Aster alpigenus), Mimulus primuloides, Polygonum bistortoides, Allium validum, Perideridia parishii, Deschampsia cespitosa, Carex scopulorum, Trisetum spicatum, Carex subnigricans, Phleum alpinum, Calamagrostis breweri*, and *Calamagrostis canadensis*. Moss is commonly found in this association (Potter 2000).

Characteristic Species: *Salix eastwoodiae, Oreostemma alpigenum, Deschampsia cespitosa.*

USFWS Wetland System: Type 6-Shrub swamps; System: Palustrine; Class: Scrub-Shrub Wetland. The USFWS Wetland Inventory (1996 national list) recognizes *Salix eastwoodiae* as an OBL (obligate wetland species) plant. (Sawyer et al. 2009).

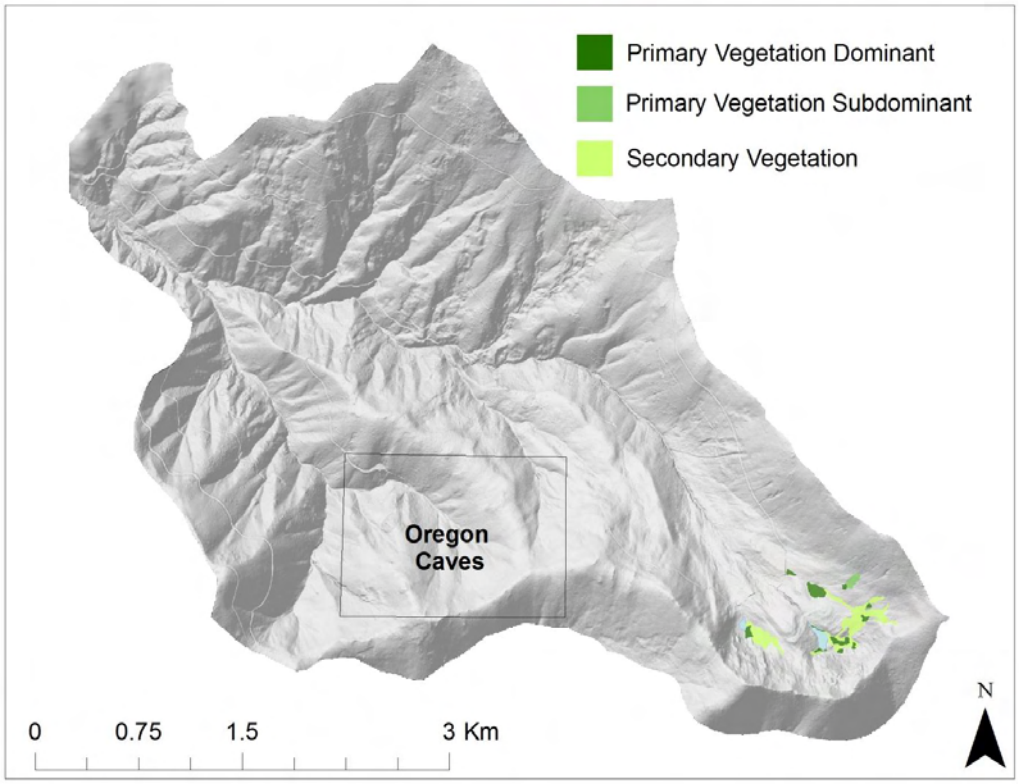
DISTRIBUTION
Range: United States.
States/Provinces: CA.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

CONSERVATION STATUS
Rank: G3G4 (19Feb2003).
Reason: G3 – Vulnerable. Numerous small stands probably occur through the High Sierra Nevada.

Global Description Author: T. Keeler-Wolf.
Global Description References: Keeler-Wolf, T. 2002, Keeler-Wolf, T. et al. 2003a, Potter, D. A. 2000, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 27, 2012).

Association Range and Distribution



***Salix eastwoodiae / Senecio triangularis* association** (center right) from a slight distance. Near relevé 47, elevation 1788 m. In the foreground is the *Carex exsiccata - Caltha leptosepala* association.

Interior of the ***Salix eastwoodiae / Senecio triangularis*** **association.** Relevé 53, elevation 1771 m. *Senicio triangularis* is in the right foreground with yellow flowers.

COMMON NAME: *ACER GLABRUM* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This shrubland vegetation association is mostly found in patches in meadows high on slopes. It is also found along streams in forested areas. Soil texture is silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1539	34	350	72
Range	1520 - 1574	22 - 45	320 - 25	62 - 88

Vegetation Description: This vegetation association is composed of copses of Rocky Mountain maple (*Acer glabrum*) forming a tall (2–5 m) overstory shrub layer that occupies at least 25% cover. Species associated with wet meadows, such as common cowparsnip (*Heracleum maximum*), taperfruit shortscale sedge (*Carex leptopoda*), nettleleaf giant hyssop (*Agastache urticifolia*), and poke knotweed (*Polygonum phytolaccifolium*) form the herbaceous layer.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Abies concolor* (white fir)	1-2	1.16
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Acer glabrum* (Rocky Mountain maple)	25-82.5	50.16
Herb	Perennial herb	*Polygonum phytolaccifolium* (poke knotweed)	0.5-5	1.83
		Heracleum maximum (common cowparsnip)	0.5-2	1.16
		Agastache urticifolia (nettleleaf giant hyssop)	0.5-5	1.83
		Vancouveria hexandra (white insideout flower)	0.5-5	1.83
	Perennial vine	*Vicia americana* ssp. *americana* (American vetch)	0.5-15	3.67
	Graminoid	*Elymus glaucus* (blue wildrye)	0.5-5	1.5

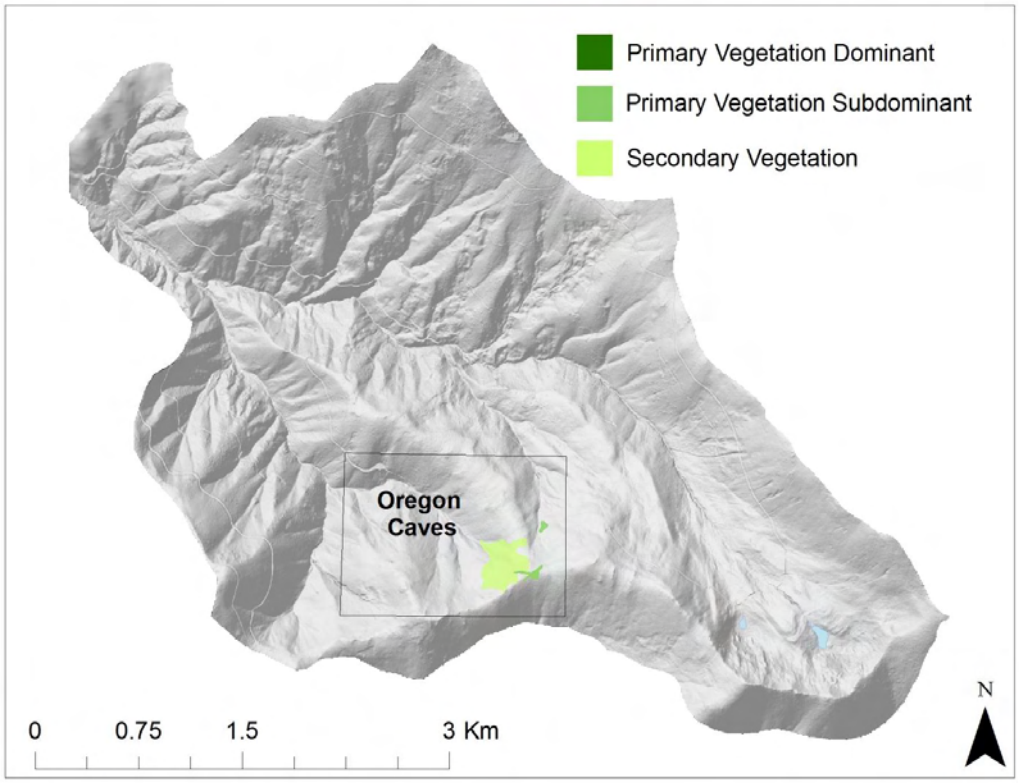
Species Richness:

Plot Species Richness Average	45
Plot Species Richness Range	33 - 60
Total Species Richness (all plots)	85

Diagnostic species: *Acer glabrum.*
Constant species: *Abies concolor, Acer glabrum, Achlys triphylla, Actaea rubra, Agastache urticifolia, Elymus glaucus, Heracleum maximum, Maianthemum stellatum, Polygonum*

phytolaccifolium, Ranunculus uncinatus, Rubus parviflorus, Vancouveria hexandra, Vicia americana.
Other Noteworthy Species: None.
Local Range: This association occurs in wet meadows and forest openings within the Oregon Caves National Monument.
Classification Comments: This local vegetation association is similar to the *Acer glabrum* Provisional Shrubland Alliance concept in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Sawyer, J. O. et al. 2009.
Plots: Relevés 54, 126, 127.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Acer glabrum* association**. Interior of an *Acer glabrum* thicket. Relevé 127, elevation 1574 m.

***Acer glabrum* association**. The edge of a patch of *Acer glabrum*. The white flowered herb in left foreground is *Polygonum phytolaccifolium*. On far right is the white flower of *Heracleum maximum*. Relevé 127, elevation 1574 m.

COMMON NAME: *PRUNUS EMARGINATA* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs in montane meadows and other open upland habitats, usually at the edge of conifer forests. Topographic position is midslope. Soil texture is sandy loam. This association is characterized from only two sample plots.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1850	17	247	95
Range	1836 - 1864	16 - 17	244 - 250	94 - 95

Vegetation Description: This vegetation association is composed of dense stands of bitter cherry (*Prunus emarginata*) with shrubs as tall as 5 meters often occurring at the transition between meadow and conifer forest. Herbaceous cover is sparse under dense shrub cover. Where openings in the shrub canopy occur, species common in adjacent meadow are abundant.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Prunus emarginata* (bitter cherry)	25-50	37.5
Herb	Graminoid	*Elymus glaucus* (blue wildlye)	2-5	3.5
		Carex subfusca (Brown sedge)	1-2	1.5
	Perennial herb	*Lathyrus nevadensis* (Sierra pea)	1-5	3
		Erigeron aliceae (Alice Eastwood's fleabane)	1-2	1.5

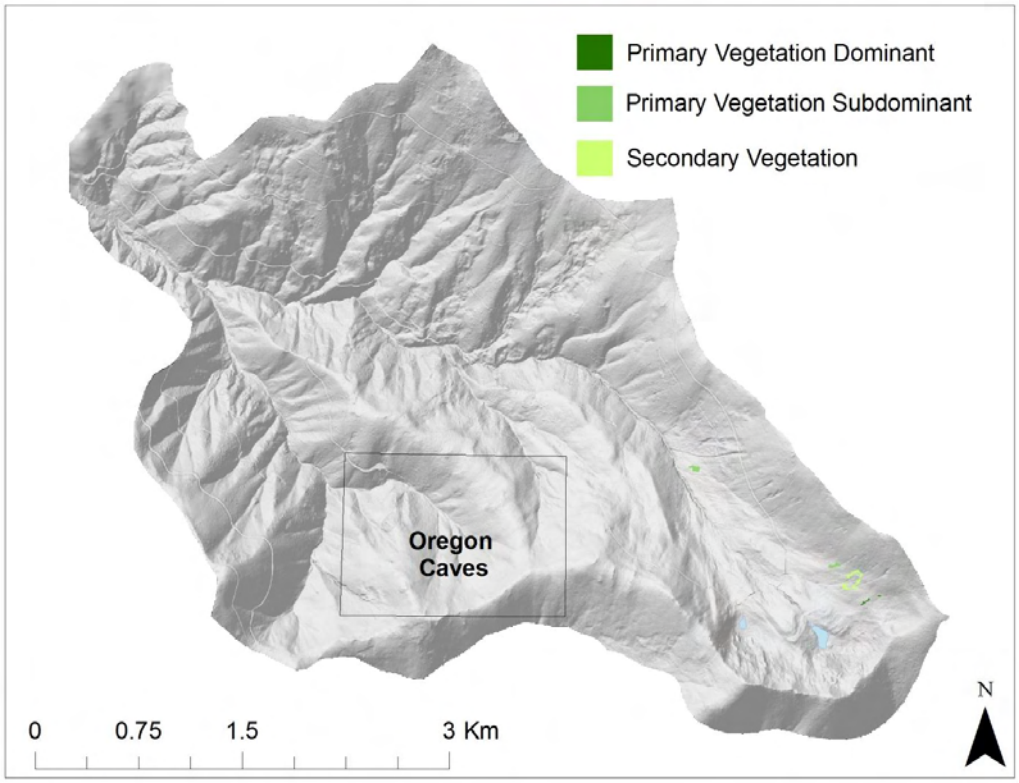
Species Richness:

Plot Species Richness Average	27
Plot Species Richness Range	24 - 30
Total Species Richness (all plots)	37

Diagnostic species: *Prunus emarginata*.
Constant species: *Prunus emarginata, Elymus glaucus, Lathyrus nevadensis, Carex subfusca, Erigeron aliceae, Abies procera, Abies concolor, Achillea millefolium, Agastache urticifolia, Bromus carinatus, Eriophyllum lanatum, Lupinus albicaulis* var. *albicaulis, Potentilla gracilis, Veratrum californicum.*
Other Noteworthy Species: None.

Local Range: This association occurs infrequently on the edge of meadows in the Bigelow Basin and elsewhere in the proposed expansion area above 1400 m.
Classification Comments: This association is similar to the *Prunus emarginata* Sierran Chaparral Shrubland (CEGL005822) in the USNVC database (NatureServe. 2011). The authors state that "This association [*Prunus emarginata* Sierran Chaparral Shrubland] may also occur in the Klamath Mountains and the adjacent high north coast ranges." This local association is not common in the in the Oregon Caves National Monument and proposed expansion area. Only two stands were sampled. More sample plots are needed to adequately describe this association.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011.
Plots: Relevés 138, 139.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Prunus emarginata* shrubland association.** Relevé 139, elevation 1864 m. A dense stand of *Prunus emarginata* at the transition between meadow and conifer forest. Herbaceous cover under the shrub layer is sparse although *Elymus glaucus* is moderately abundant.

COMMON NAME: *ARCTOSTAPHYLOS PATULA - CEANOTHUS VELUTINUS* ASSOCIATION

SYNONYMS
USNVC English Name: Greenleaf Manzanita Sierran Chaparral Shrubland

USNVC Scientific Name: *Arctostaphylos patula* Sierran Chaparral Shrubland

USNVC Identifier: CEGL005820

USNVC CLASSIFICATION:
Formation Class: 2 - Shrubland & Grassland
Formation Subclass: 2.B - Temperate & Boreal Grassland, Savanna & Shrubland
Formation: 2.B.2 - Temperate Grassland, Meadow, Shrubland & Savanna
Division: 2.B.2.Nd - Western North American Interior Sclerophyllous Chaparral Shrubland
Macrogroup: Cool Interior Chaparral
Group: *Arctostaphylos patula - Arctostaphylos nevadensis - Ceanothus velutinus* Montane Sclerophyll Scrub Group [Provisional]
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs high on slopes, on summits, and on basin floors at high elevations and typically on southerly aspects in the Oregon Caves National Monument and proposed expansion area. Soil texture is sandy loam, silt loam, or clay loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1817	19	173	37
Range	1529 - 1988	6 - 35	122 - 270	5 - 83

Vegetation Description: This vegetation association is composed of moderately dense, medium-sized shrubs with greenleaf manzanita (*Arctostaphylos patula*) being the most frequent and abundant. Evergreen shrubs predominate (i.e. montane chaparral) but deciduous shrub components such as Saskatoon serviceberry (*Amelanchier alnifolia*) and bitter cherry (*Prunus emarginata*) are almost always present. Small conifers including Shasta red fir (*Abies magnifica x procera*), white fir (*Abies concolor*), and Douglas-fir (*Pseudotsuga menziesii*) are typically scattered throughout the stands in low cover. The sub-shrub scabland penstemon (*Penstemon deustus*) is frequent, although the overall herbaceous layer is very sparse. Stands of this vegetation association may also be co-dominated by snowbush ceanothus (*Ceanothus velutinus* var. *velutinus*). Snowbush ceanothus can form small, relatively pure stands within this vegetation association, sometimes replacing greenleaf manzanita to the extent it may be considered its own association.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Arctostaphylos patula* (greenleaf manzanita)	0-50	17.29
		Ceanothus velutinus var. *velutinus* (snowbush ceanothus)	0-20	9.57
	Broad-leaved deciduous shrub	*Prunus emarginata* (bitter cherry)	0-15	6.29
		Amelanchier alnifolia (Saskatoon serviceberry)	0-15	5.93
		Holodiscus discolor (oceanspray)	0-5	0.79
	Needle-leaved evergreen shrub	*Abies concolor* (white fir)	0-15	2.14
Herb	Sub-shrub	*Penstemon deustus* (scabland penstemon)	0-5	0.93
		Eriophyllum lanatum (common woolly sunflower)	0-2	0.43
	Perennial herb	*Phlox diffusa* (spreading phlox)	0-5	0.71
	Fern or fern ally	*Cheilanthes gracillima* (lace lipfern)	0-5	0.86

Species Richness:

Plot Species Richness Average	24.57
Plot Species Richness Range	22 - 29
Total Species Richness (all plots)	86

Diagnostic species: *Arctostaphylos patula* (at high cover).
Constant species: None.
Other Noteworthy Species: *Ceanothus velutinus* var. *velutinus.*
Local Range: This association occurs at middle and high elevations in the Oregon Caves National Monument, the proposed expansion area, and across the mountainous regions of southwest Oregon and Northwest California
Classification Comments: Several sample plots contain *Ceanothus velutinus* var. *velutinus* at high cover but two do not contain it at all. One sample plot contains *C. velutinus* var. *velutinus* at high cover but does not contain *Arctostaphylos patula*. *A. patula* is clearly the diagnostic species for this association but *C. velutinus* var. *velutinus* is included in the common name of this local association because of its frequency, abundance, and co-occurrence in similar environmental settings. This association may be similar to the *Arctostaphylos patula* Shrubland Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Sawyer, J. O. et al. 2009.
Plots: Relevés 57, 62, 63, 66, 111, 123, 137.
Oregon Caves 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.

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 associations, and others are edaphically controlled, probably persisting from 50 to more than 100 years at least without being invaded by conifers. Although fires in this association 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.

Characteristic Species: *Arctostaphylos patula*.
USFWS Wetland System: Not applicable.

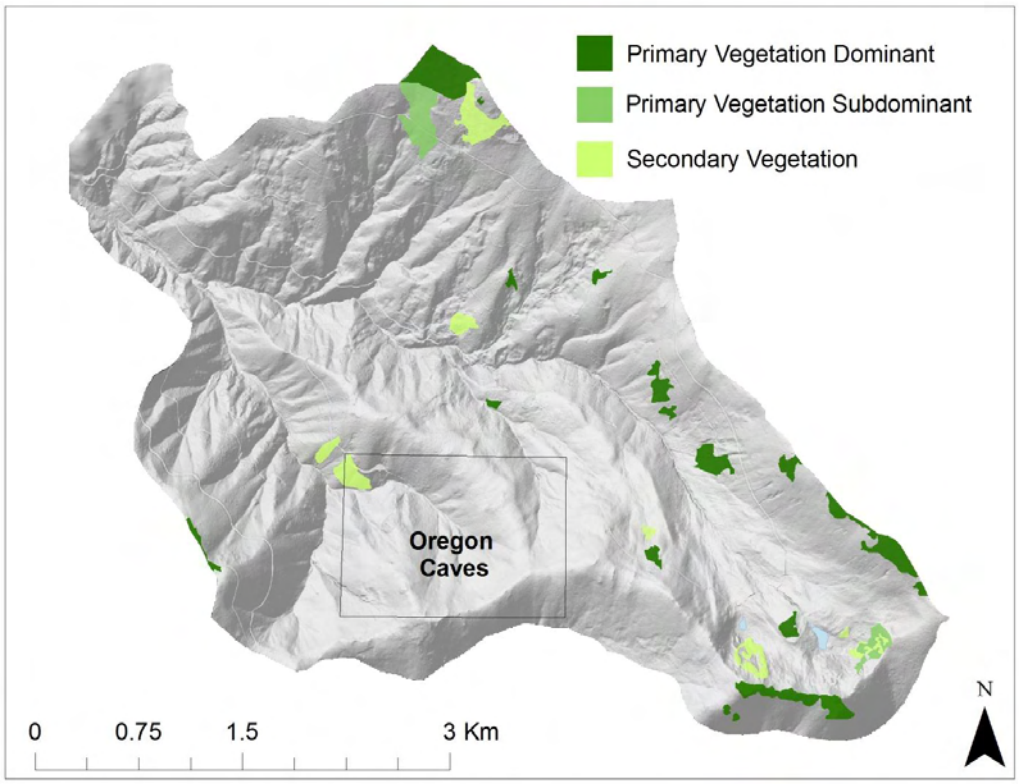
DISTRIBUTION
Range: United States.
States/Provinces: CA.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

CONSERVATION STATUS
Rank: G5? (11Feb2003).
Reason: G5 – Secure. Probably a widespread seral association of the mountains of California.

Global Description Author: T. Keeler-Wolf.
Global Description References: Keeler-Wolf, T. et al. 2003a. Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 29, 2012).

Association Range and Distribution



***Arctostaphylos patula - Ceanothus velutinus* association**. Relevé 123, elevation 1888 m. Low-growing *A. patula* is strongly dominant in this plot. Red flowers near the center of the photo are *Castilleja arachnoidea*. To the left of the dead shrub is *Penstemon deustus*.

***Arctostaphylos patula - Ceanothus velutinus* association.** Relevé 111, elevation 1529. The shrub with white flowers is *C. velutinus*, which may be locally dominant. Other shrubs include *A. patula* (center foreground). Small conifers (*Pseudotsuga menziesii* and *Abies concolor*) are present. In the absence of fire, these trees will eventually dominate the site.

COMMON NAME: *ERIOGONUM OVALIFOLIUM* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association has a very limited extent within Oregon Caves National Monument and proposed expansion area and is described from one sample plot. Its topographic position is high slope near a hilltop where shallow soils have resulted in sparse vegetation growth and tree cover. Soil texture is sandy loam.

Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
1969	22	190	15

Vegetation Description: This association is a sparsely vegetated high elevation opening among subalpine conifer forest with high cover of *Eriogonum ovalifolium.* The surrounding forest is often dominated by *Abies procera*, which also occurs as scattered trees within the opening.

Most Abundant Species:

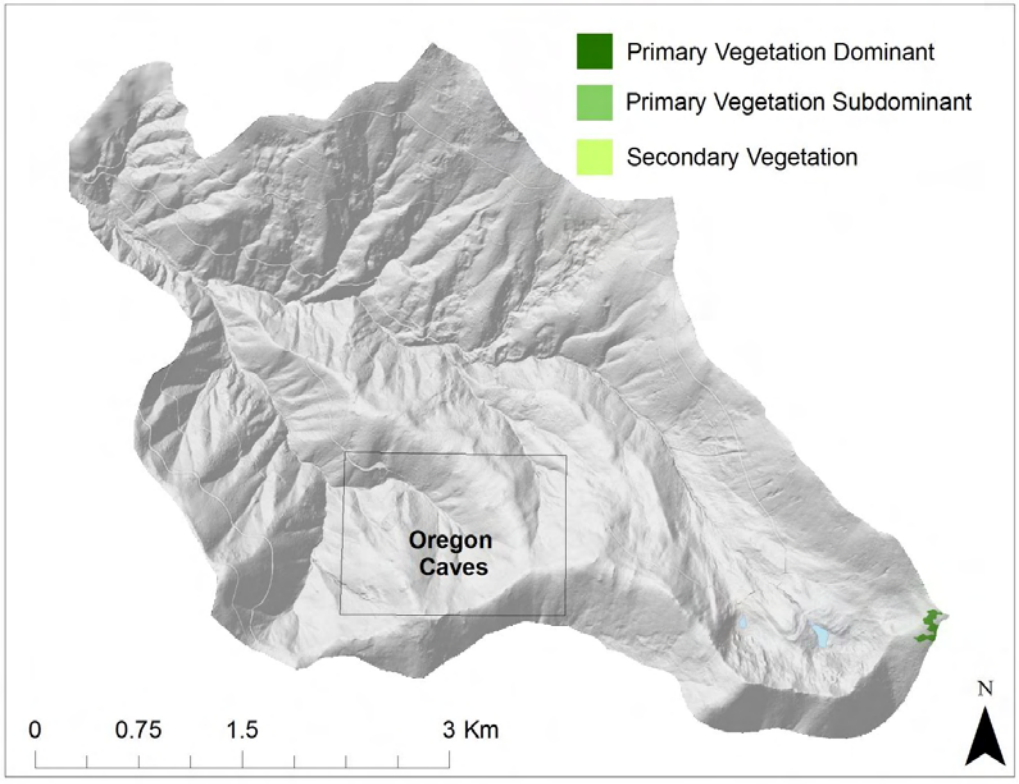
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Abies magnifica* x *procera* (Shasta red fir)	2-5	3.5
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Abies magnifica* x *procera* (Shasta red fir)	25-50	37.5
Herb	Perennial herb	*Castilleja arachnoidea* (cobwebby Indian paintbrush)	2-5	3.5
		Cistanthe umbellata (Mt. Hood pussypaws)	2-5	3.5
		Eriogonum ovalifolium (cushion buckwheat)	5-15	10

Diagnostic species: *Eriogonum ovalifolium*.
Constant species: N/A.
Other Noteworthy Species: *Abies magnifica* x *procera.*
Species Richness of Sample Plot: 7.

Local Range: This association occurs near the top of a high ridge above the Bigelow Basin.

Classification Comments: This association is rare in the Oregon Caves National Monument and proposed expansion area. Only one stand was sampled. More sample plots are needed to adequately describe this association.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevé 65.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association present elsewhere in the region. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Eriogonum ovalifolium* association.** Relevé 65, elevation 1969 m. A sparsely vegetated opening with high cover of *Eriogonum ovalifolium* surrounded by a subalpine conifer forest dominated by *Abies magnifica x procera*

COMMON NAME: *ERIOGONUM UMBELLATUM - LOMATIUM MACROCARPUM* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association is a low-statured upland shrub association occurring on generally steep, rocky slopes and summits with limited soil development. Soil texture is loam or sandy loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1696	30	173	29
Range	1614 - 1922	5 - 40	85 - 272	2 - 75

Vegetation Description: Comprised of a mixture of low to moderately tall shrubs, this vegetation association is characteristically open with the sub-shrub sulphur-flower buckwheat (*Eriogonum umbellatum*) forming the dominant groundcover. Saskatoon serviceberry (*Amelanchier alnifolia*) is a commonly associated shrub. A shrubby variety of Oregon white oak (*Quecus garryana* var. *breweri*) may also be common, but is not constant. Tree saplings are occasional. In the sparse herbaceous layer, common woolly sunflower (*Eriophyllum lanatum*) is sometimes present, but not as frequent as the constant species Red Mountain catchfly (*Silene campanulata* ssp. *glandulosa*) or bigseed biscuitroot (*Lomatium macrocarpum*).

Most Abundant Species:

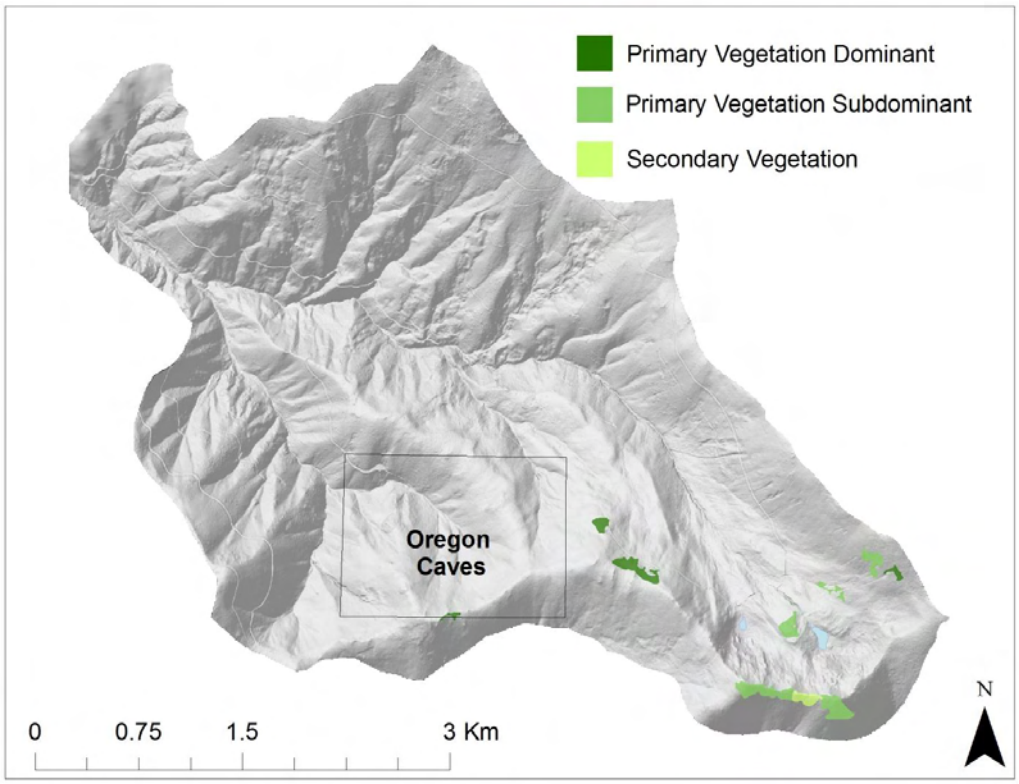
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Calocedrus decurrens* (incense cedar)	0-5	2.88
	Broad-leaved evergreen shrub	*Arctostaphylos patula* (greenleaf manzanita)	0-5	1.25
	Broad-leaved deciduous shrub	*Amelanchier alnifolia* (Saskatoon serviceberry)	0.5-15	6.5
		Quercus garryana var. *breweri* (Oregon white oak)	0-25	6.25
		Holodiscus discolor (oceanspray)	0-15	4.38
Herb	Sub-shrub	*Eriogonum umbellatum* (sulphur-flower buckwheat)	2-50	13.63
		Eriophyllum lanatum (common woolly sunflower)	0-15	3
	Perennial herb	*Silene campanulata* ssp. *glandulosa* (Red Mountain catchfly)	0.5-5	2.25
		Lomatium macrocarpum (bigseed biscuitroot)	0.5-5	1.25
		Achillea millefolium (common yarrow)	0.5-1	0.5
	Graminoid	*Elymus glaucus* (blue wildrye)	0-15	3

Species Richness:

Plot Species Richness Average	23.25
Plot Species Richness Range	18 - 27
Total Species Richness (all plots)	57

Diagnostic species: *Lomatium macrocarpum.*
Constant species: *Eriogonum umbellatum, Lomatium macrocarpum, Amelanchier alnifolia, Silene campanulata* ssp. *glandulosa, Achillea millefolium.*
Other Noteworthy Species: *Quecus garryana* var. *brewerii.*
Local Range: This association occurs in dry and/or rocky openings on slopes and summits above 1500 m in the Oregon Caves National Monument and proposed expansion area. This association likely occurs in similar habitats at high elevations elsewhere in the central Siskiyou Mountains.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevés 18, 19, 112, 121.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Eriogonum umbellatum - Lomatium macrocarpum* association.** Relevé 121, elevation 1922 m. *Eriogonum umbellatum* is the low shrub in the center of the photo. Red flowers are *Castilleja arachnoidea.* The shrub in the upper right is *Arctostaphylos patula.*

COMMON NAME: *SPIRAEA DOUGLASII* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This is a rare upland shrub vegetation association found only in one mound-like area on the basin floor of Bigelow Basin. The ground is rocky and not as saturated as the rest of the basin. Soil texture is silt loam.

Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
1788	2	250	5

Vegetation Description: This vegetation association is comprised of a dense cover of low rose spirea (*Spiraea douglasii*) shrubs. Greenleaf manzanita (*Arctostaphylos patula*) is also common but not nearly as abundant as rose spirea. The herbaceous layer is sparse, mostly due to the near solid shrub cover.

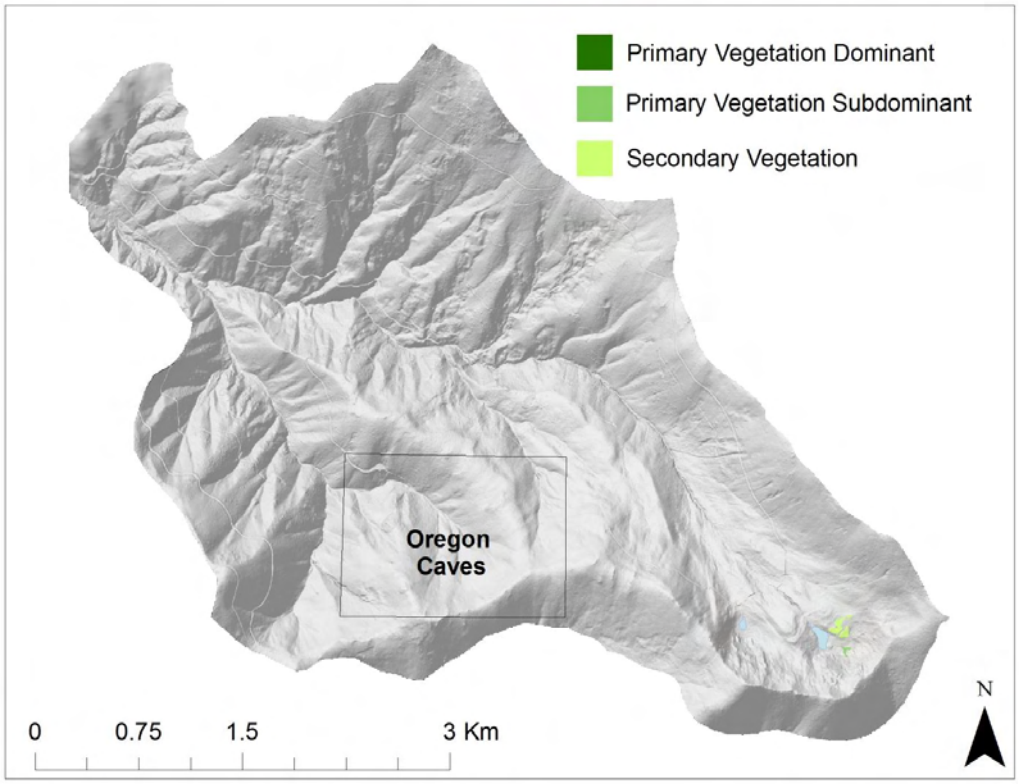
Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Broad-leaved deciduous shrub	*Spiraea douglasii* (rose spirea)	50-75	62.5
	Broad-leaved evergreen shrub	*Arctostaphylos patula* (greenleaf manzanita)	5-15	10
Herb	Sub-shrub	*Potentilla glandulosa* (sticky cinquefoil)	2-5	3.5
		Eriophyllum lanatum (common woolly sunflower)	0.5-1	0.5
	Perennial herb	*Achillea millefolium* (common yarrow)	1-2	1.5
		Agastache urticifolia (nettleleaf giant hyssop)	0.5-1	0.5
	Graminoid	*Elymus glaucus* (blue wildrye)	1-2	1.5
		Elymus elymoides ssp. *brevifolius* (squirreltail)	0.5-1	0.5

Diagnostic species: *Spiraea douglasii*.
Constant species: *Spiraea douglasii*.
Other Noteworthy Species: None.
Species Richness of Sample Plot: 14
Local Range: Known from only one site, a low rise in the Bigelow Basin.
Classification Comments: With only one sample plot for this association, it is difficult to determine if this is a distinct vegetation association.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.

Plots: Relevé 135.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Spiraea douglasii* association,** center, showing dominance of *S. douglasii.* Grass in the foreground is *Danthonia californica*. Relevé 135, elevation 1788 m.

COMMON NAME*: HOLODISCUS DISCOLOR* **ASSOCIATION**

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association can occur in a variety of environmental situations from middle to upper slopes at middle to high elevations. Sites include rocky slopes with limited soil development where oceanspray (*Holodiscus discolor*) often grows from small rock crevices, marble outcrops above cave entrances, and sometimes as a successional association following logging at middle elevations. Soil texture is loam, silt loam or sandy clay.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1421	26	284	31
Range	1331 - 1563	6 - 47	220 - 322	5 - 60

Vegetation Description: This vegetation association is composed of somewhat open deciduous shrub vegetation that is highly variable and often contains a moderate abundance of small trees. Small trees scattered amid oceanspray include white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), and canyon live oak (*Quercus chrysolepis*). The low shrub/vine common whipplea (*Whipplea modesta*) is the most abundant ground cover. A diversity of herbaceous species occur but with no one species in every plot. Chaparral willowherb (*Epilobium minutum*) and woodland strawberry (*Fragaria vesca*) are in most plots.

Most Abundant Species:

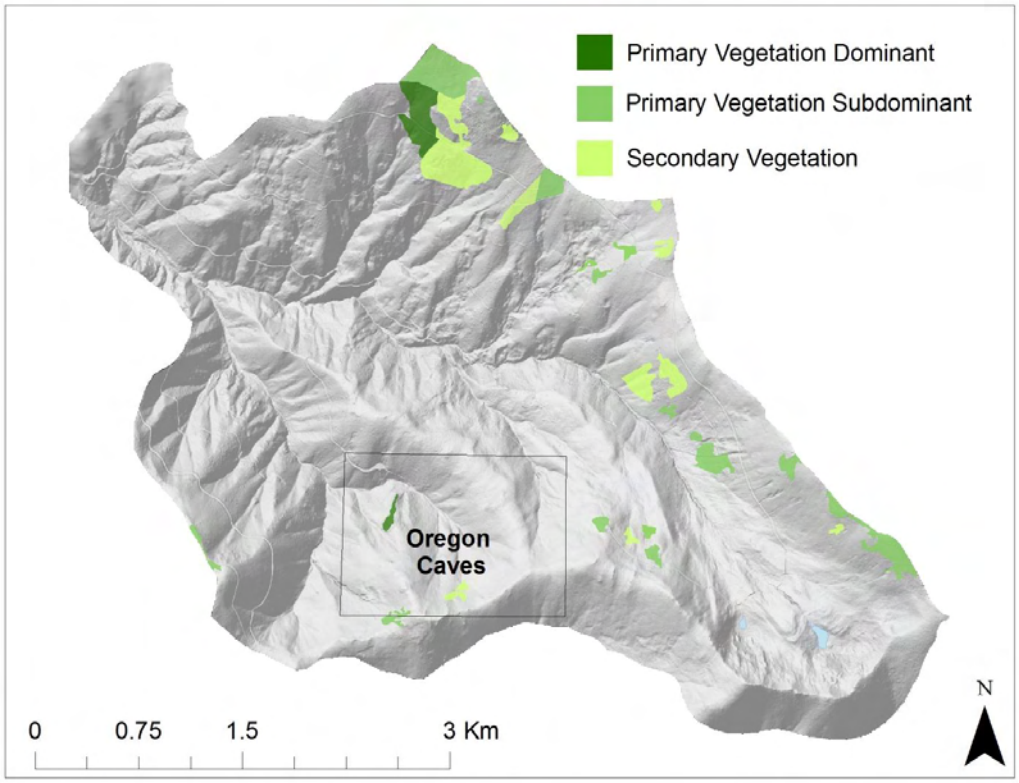
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Pseudotsuga menziesii* (Douglas-fir)	0-15	3.2
		Abies concolor (white fir)	0-15	3.2
	Broad-leaved deciduous shrub	*Holodiscus discolor* (oceanspray)	5-21.5	15.33
	Broad-leaved evergreen shrub	*Whipplea modesta* (common whipplea)	0-15	3.4
		Quercus chrysolepis var. *chrysolepis* (canyon live oak)	0-8.5	3.2
Herb	Perennial herb	*Achillea millefolium* (common yarrow)	0-15	2.3
		Agastache urticifolia (nettleleaf giant hyssop)	0-5	1.4
	Annual herb	*Epilobium minutum* (chaparral willowherb)	0.5-5	1.1
	Graminoid	*Elymus glaucus* (blue wildlye)	0-15	2.5

Species Richness:

Plot Species Richness Average	35
Plot Species Richness Range	24 - 41
Total Species Richness (all plots)	98

Diagnostic species: None.
Constant species: *Holodiscus discolor.*
Other Noteworthy Species: None.
Local Range: This association occurs in forest openings and cut over areas in the Oregon Caves National Monument and proposed expansion area. This association likely occurs elsewhere in the central Siskiyou Mountains.
Classification Comments: The USNVC vegetation association *Holodiscus discolor - Sambucus racemosa* Shrubland (CEGL003130) is similar to this local association in its characteristic species *Holodiscus discolor* and environmental setting, although it lacks *Sambucus racemosa* and many other common species in the USNVC association type. It is also unclear whether this local association fits into the *Chrysolepis sempervirens - Quercus vacciniifolia* California Montane Chaparral Group under which the *Holodiscus discolor - Sambucus racemosa* Shrubland is classified in the USNVC database (NatureServe 2011). It is possible that in the cases where this association is successional to a forest with which it is similar in the USNVC type *Abies concolor - Pseudotsuga menziesii / Holodiscus discolor* Forest (CEGL000021) (NatureServe 2011). This association is also similar to the *Holodiscus discolor* Shrubland Alliance in Sawyer et al. 2009.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011, Sawyer, J. O. et al. 2009.
Plots: Relevés 6, 37, 87, 100, 106.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Holodiscus discolor* association.** Relevé 100, elevation 1331 m. Marble outcrop above the entrance to Oregon Caves dominated by *Holodiscus discolor* (shrub with white flowers in top center and upper left). The ground cover behind field assistant Katie Heard is *Whipplea modesta*.

COMMON NAME: *CHAMAECYPARIS LAWSONIANA / ALNUS RHOMBIFOLIA* ASSOCIATION

SYNONYMS
USNVC English Name: White Fir - Port Orford-cedar - Douglas-fir / (Dwarf Oregon-grape) / Sweet After Death Forest

USNVC Scientific Name: *Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla* Forest

USNVC Identifier: CEGL000041

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Vancouverian Lowland & Montane Rainforest
Group: *Sequoia sempervirens - Chamaecyparis lawsoniana - Pseudotsuga menziesii* Forest Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs from the lowest elevations in the Oregon Caves National Monument and proposed expansion area up to middle elevations. A forested wetland association, it occurs along streams in mesic drainages. Topographic positions which this association occupies include middle slopes and channel walls. Soil texture is loam, sandy loam, or sandy clay.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1050	12.4	296	44
Range	818 - 1370	5 - 19	168 - 8	40 - 50

Vegetation Description: This vegetation association is a closed, multistory, dense streamside conifer forest. Overstory conifer trees can be quite large (average DBH = 100cm). Broad-leaved evergreens such as tanoak (*Lithocarpus densiflorus*) are generally absent from the overstory but are present on the drier slopes above the stream corridor. White alder (*Alnus rhombifolia*) and other smaller deciduous trees often occupy the midstory. A shrub layer is generally lacking, except for shrub-sized canyon live oak (*Quercus chrysolepis*). The herbaceous layer is rich in species with western swordfern (*Polystichum munitum*), sweet after death (*Achlys triphylla*), oneleaf foamflower (*Tiarella trifoliata* var. *unifoliata*), and many other perennial herbs frequent and in moderate abundance.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pseudotsuga menziesii* (Douglas-fir)	5-50	15.5
		Chamaecyparis lawsoniana (Port Orford-cedar)	0-15	4.7
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Chamaecyparis lawsoniana* (Port Orford-cedar)	0-24	7.8
		Taxus brevifolia (Pacific yew)	0-7.5	3.1
	Broad-leaved deciduous shrub	*Alnus rhombifolia* (white alder)	0-15	4.7
		Corylus cornuta var. *californica* (California hazelnut)	0-15	4.5
		Acer macrophyllum (bigleaf maple)	0.5-5	2.8
		Salix lasiolepis (arroyo willow)	0-15	3
	Broad-leaved evergreen shrub	*Mahonia nervosa* (Cascade barberry)	0-5	1
Herb	Perennial herb	*Achlys triphylla* (sweet after death)	0-15	2.9
		Tiarella trifoliata var. *unifoliata* (oneleaf foamflower)	0.5-15	2.8
	Fern or fern ally	*Polystichum munitum* (western swordfern)	0.5-15	3.4

Species Richness:

Plot Species Richness Average	46.6
Plot Species Richness Range	41 - 57
Total Species Richness (all plots)	98

Diagnostic species: *Chamaecyparis lawsoniana* (in streamside environment), *Alnus rhombifolia*.
Constant species: *Acer macrophyllum, Chamaecyparis lawsoniana, Pseudotsuga menziesii, Galium triflorum, Polystichum munitum, Pteridium aquilinum* var. *pubescens, Rubus ursinus, Tiarella trifoliata* var. *unifoliata, Vancouveria hexandra.*
Other Noteworthy Species: None.
Local Range: This association occurs along larger order streams in the Oregon Caves National Monument and proposed expansion area. This association is likely to occur along streams at middle elevations elsewhere in the central Siskiyou Mountains where *Chamaecyparis lawsoniana* is present.
Classification Comments: The USNVC association *Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla* Forest selected as analogous to this local association is similar except that it lacks the principal species *Alnus rhombifolia* of the local association. This local association is also similar to the *Chamaecyparis lawsoniana - Pseudotsuga menziesii / Lithocarpus densiflorus / Gaultheria shallon* (CEGL000043) Forest in the USNVC database but it lacks the diagnostic high shrub cover (NatureServe 2011). This association is similar to the *Chamaecyparis lawsoniana* Forest Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011, Sawyer, J. O. et al. 2009.

Plots: Relevés 26, 71, 93, 98, 102.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association occurs in a mountainous region (Klamath Mountains Province) of rugged, deeply dissected terrain. Geologically, the province is very complex and of very old deposits. Rock types include volcanic tuffs and sedimentary rocks which have been metamorphosed into schists, gneisses, marbles, and other metavolcanic and metasedimentary rocks. Sandstones, siltstones, and shales have been deposited near the coast. The most notable rock types are granitics and elongated, stringer-like outcrops of serpentine. Elevations of this region vary from sea level to over 1520 m. The climate of the region is maritime with wet, mild winters, cool, relatively dry summers at higher elevations, and warm to hot summers at lower elevations, prolonged cloudy periods, and high annual precipitation. Precipitation varies from over 150 cm annually near the coast, to less than 75 cm annually on the eastern slope, where a rainshadow effect is pronounced and summers are very dry.
This association occurs in scattered localities throughout most of the range of *Chamaecyparis lawsoniana*, particularly in the eastern and southern areas. It is found from 900-1540 m elevation, predominantly on slopes of northerly and westerly aspects. Sites include concave midslopes or valley bottoms, and slope percents vary greatly, from flat to steep (range from 0-60%). Soils are derived from a variety of parent materials, but a large proportion of stands occur on ultramafic colluvium and alluvium. Other parent materials are colluvium of granitics, schists, and metavolcanics. Soil textures are variable, from sandy loams to clay loams, but all horizons have high proportions of gravels and cobbles. Typical depth to the surface of the C horizon ranges from 45-60 cm, and most soils are moist to wet in all horizons, even through much of the summer. Litter covers at least 90% of the ground surface.

Vegetation Description: This association is both structurally and compositionally variable. The tree canopy, usually over 50 m in height, is dominated by a mix of the evergreen needle-leaved *Chamaecyparis lawsoniana, Pseudotsuga menziesii*, and *Abies concolor*. Any one of these three species can be the most abundant in a particular stand, but total canopy cover is typically 70% or higher. Several other conifers can be present, including *Abies magnifica, Picea breweriana*, and *Chamaecyparis nootkatensis*. A lower canopy layer is present, dominated by a mix of conifer regeneration and broad-leaved evergreen species. Conifers important in this layer include *Chamaecyparis lawsoniana, Abies concolor, Taxus brevifolia*, and in some stands *Calocedrus decurrens*. Broad-leaved species can include *Lithocarpus densiflorus* and *Chrysolepis chrysophylla (= Castanopsis chrysophylla)*. The shrub layers are very diverse and variable, with cover ranging from 13% to over 35%. Species include both evergreen and deciduous, tall and short, broad-leaved shrubs, with a pattern of occasional local dominance. The low, evergreen *Mahonia nervosa* has the highest constancy, occurring in nearly all stands and in some quite abundant. Some of the tall-shrub species include *Rhododendron occidentale, Quercus sadleriana*, and *Quercus vacciniifolia*, while short species include *Whipplea modesta, Rubus ursinus, Chimaphila umbellata, Rosa gymnocarpa, Paxistima myrsinites*, and *Vaccinium membranaceum*. The herbaceous layer is very diverse and abundant; most species are perennial forbs. *Achlys triphylla* is always present and often has cover over 10%. Some of the more constant species include *Adenocaulon bicolor, Clintonia uniflora, Prosartes hookeri (=*

Disporum hookeri), Goodyera oblongifolia, Linnaea borealis, Tiarella trifoliata, Trientalis borealis ssp. *latifolia*, and *Trillium ovatum*. Cover of mosses is low, usually less than 5%.

Characteristic Species: *Chamaecyparis lawsoniana, Mahonia nervosa, Achlys triphylla.*
USFWS Wetland System: The USFWS Wetland Inventory (1996 national list) recognizes *Chamaecyparis lawsoniana* as a FACU (Facultative Upland) plant. (Sawyer et al. 2009).

DISTRIBUTION
Range: United States.
States/Provinces: CA, OR.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

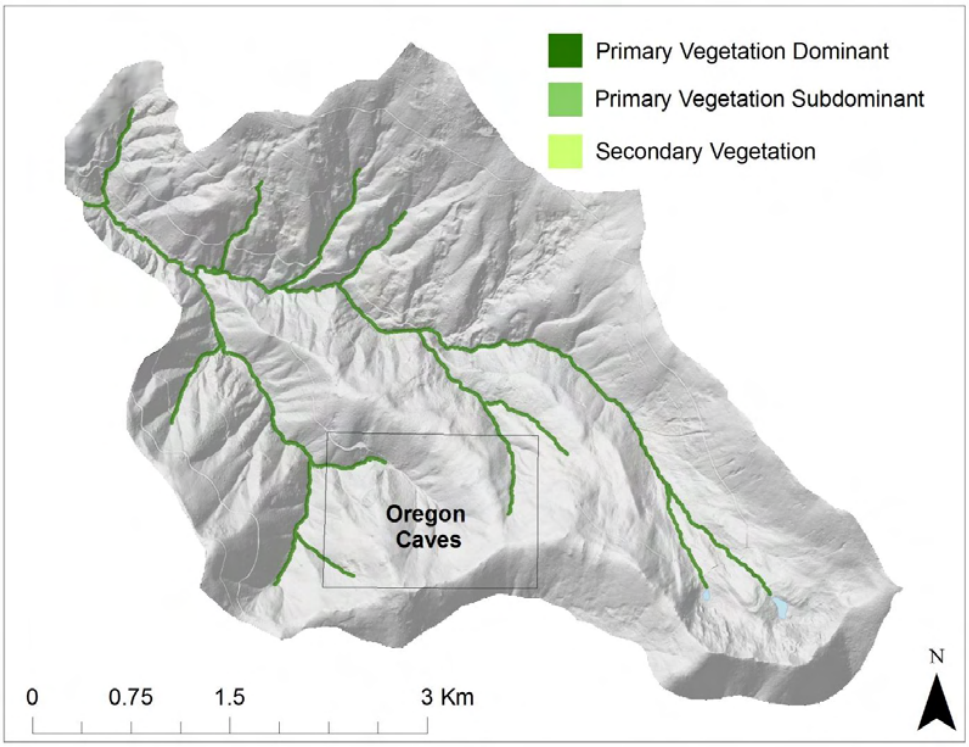
CONSERVATION STATUS
Rank: G2 (14Oct1997).
Reason: G2 – Imperiled.
Reasons: A naturally very restricted range of distribution of *Chamaecyparis lawsoniana* has been compounded by impacts from logging and introduced disease. This is an old-growth forest association, in which stands are generally over 300 years old, and are highly productive. There are few known examples (fewer than 20 stands at less than 10 sites). *Chamaecyparis lawsoniana* is seriously threatened by a root-killing fungus, *Phytophthora lateralis*, which was recently introduced into the natural range of this tree. Spores of the fungus are carried in water, and have been spread in the tires of logging trucks. Many stands have been decimated by this pathogen, and Port Orford-cedar may be considered in the near future for Federal listing as a threatened species under the Endangered Species Act.

Global Description Author: M.S. Reid, mod. M. Schindel, J. S. Kagan.

Global Description References: Atzet, T. A. et al. 1996, Atzet, T., and D. L. Wheeler. 1984, Bourgeron, P. S., and L. D. Engelking, ed. 1994, Driscoll, R. S. et al. 1984, Hawk, G. M. 1977, Jimerson, T. J. 1994, Kagan, J. S. et al. 2000-2004, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 1, 2012).

Association Range and Distribution



***Chamaecyparis lawsoniana / Alnus rhombifolia* association.** Relevé 93, elevations 895 m. Riparian forest. The left side of the creek is dominated by *A. rhombifolia*. The right side of the creek is dominated by relatively small, but dense *Chamaecyparis lawsoniana, Pseudotsuga menziesii, and Taxus brevifolia*.

The broad-leaved tree *Acer macrophyllum* is also present. Understory herbs are exceptionally diverse and include *Polystichum munitum* and *Tiarella trifoliata* var. *unifoliata.*

COMMON NAME: *LITHOCARPUS DENSIFLORUS - ARBUTUS MENZIESII* ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association is a rare occurrence in the Oregon Caves National Monument and proposed expansion area. It may also occur on similar warm, dry upland sites where conifers have been harvested and tanoak (*Lithocarpus densiflorus*) becomes dominant. The topographic position is middle slope. Soil texture is clay loam. It is characterized by only one plot at a relatively low elevation.

Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
949	22	308	85

Vegetation Description: This medium-sized forest association is composed of broad-leaved evergreen trees and shrubs, in particular tanoak and Pacific madrone (*Arbutus menziesii*), with little or no conifer cover in the overstory or midstory. The shrub layer is often well developed and herbs may or may not be common.

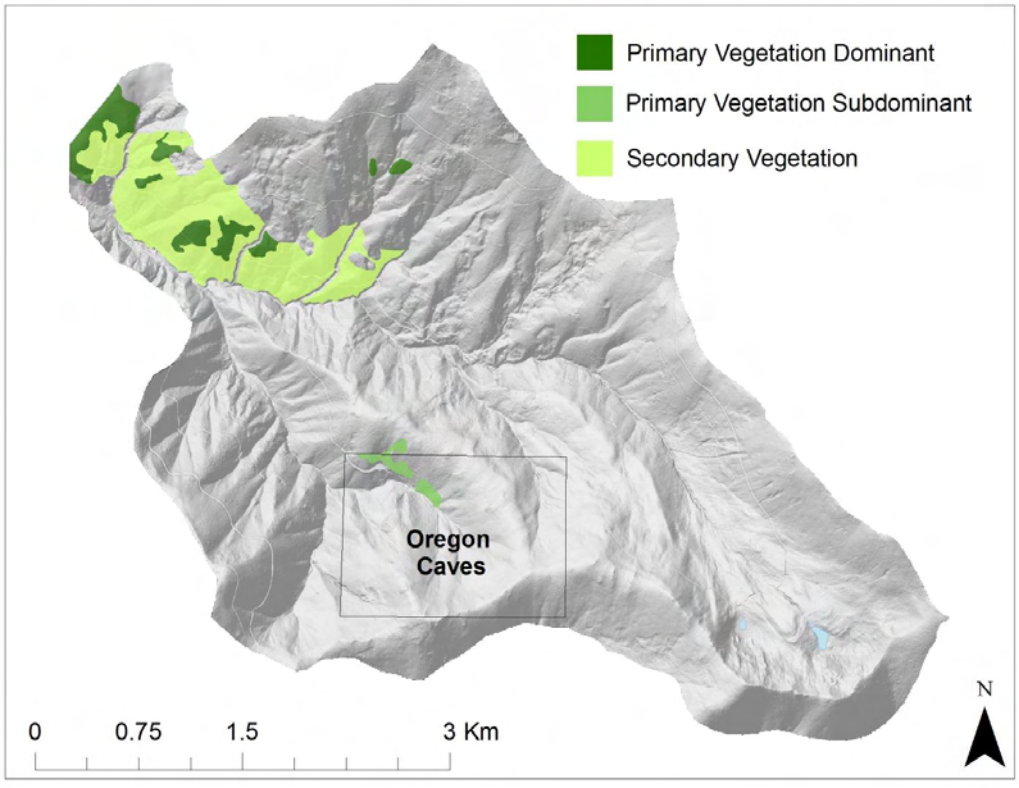
Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Broad-leaved evergreen tree	*Lithocarpus densiflorus* (tanoak)	5-15	10
		Arbutus menziesii (Pacific madrone)	5-15	10
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Lithocarpus densiflorus* (tanoak)	15-25	20
		Mahonia nervosa (Cascade barberry)	0.5-1	0.5
	Needle-leaved evergreen shrub	*Pseudotsuga menziesii* (Douglas-fir)	0.5-1	0.5
		Abies concolor (white fir)	0.5-1	0.5
Herb	Perennial herb	*Achlys triphylla* (sweet after death)	0.5-1	0.5
		Boschniakia strobilacea (California groundcone)	0.5-1	0.5
		Disporum hookeri (drops-of-gold)	0.5-1	0.5
	Fern or fern ally	*Pteridium aquilinum* var. *pubescens* (hairy brackenfern)	0.5-1	0.5

Diagnostic species: None. Dominance of *Lithocarpus densiflorus* and lack (or very low cover) of conifer trees in the overstory and midstory is diagnostic.

Constant species: *Lithocarpus densiflorus.*
Other Noteworthy Species*:* *Arbutus menziesii.*
Species Richness of Sample Plot: 10
Local Range: This association occurs on south facing aspects below 1400 m within the Oregon Caves National Monument and proposed expansion area. This association likely occurs elsewhere in the central Siskiyou Mountains on south facing aspects at middle to low elevations.
Classification Comments: A *Lithocarpus densiflorus - Arbutus menziesii* association is presented in Evens and Kentner (2006) and in Keeler-Wolf et al. (2003b). This local association may be similar to the *Lithocarpus densiflorus* Forest Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: Evens, J. M., and E. Kentner. 2006, Keeler-Wolf, T. et al. 2003b, Sawyer, J. O. et al. 2009.
Plots: Relevé 73.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Lithocarpus densiflorus - Arbutus menziesii* association.** Relevé 73, elevation 949 m. A dense understory dominated by *L. densiflorus* and scattered *Pseudotsuga menziesii* saplings. The herbaceous layer is very sparse (e.g. scattered *Boschniakia strobilacea*).

COMMON NAME: *QUERCUS CHRYSOLEPIS* ASSOCIATION

SYNONYMS
USNVC English Name: Douglas-fir - Canyon Live Oak Forest

USNVC Scientific Name: *Pseudotsuga menziesii - Quercus chrysolepis* Forest

USNVC Identifier: CEGL005814

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Southern Vancouverian Montane & Foothill Forest
Group: *Calocedrus decurrens - Pinus lambertiana - Pinus jeffreyi* Forest & Woodland Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs from near the lowest elevations in the Oregon Caves National Monument and proposed expansion area up to middle elevations on south facing slopes. The topographic position it occupies is midslope. Edaphic conditions often control the distribution of this association, however on some sites it may occur as a result of logging overstory conifers. Soil texture is clay loam, silt loam, or sandy loam. This is a relatively rare association in the Oregon Caves National Monument and proposed expansion area characterized by three plots.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1253	36	207	52
Range	1222 - 1269	34 - 40	190 - 212	10 - 75

Vegetation Description: This short to moderately tall forest association is composed of broad-leaved evergreen trees with little or no conifer cover in the overstory or midstory. Canyon live oak (*Quercus chrysolepis* var. *chrysolepis*) dominates in the overstory and understory. The shrub layer is often well developed with the shrubby forms of broad-leaved evergreen trees present, such as canyon live oak and Pacific madrone (*Arbutus menziesii*), as well as the shrubs common snowberry (*Symphoricarpos albus*), oceanspray (*Holodiscus discolor*), wood rose (*Rosa gymnocarpa*), and Saskatoon serviceberry (*Amelanchier alnifolia*). Herbs may be common.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Broad-leaved evergreen tree	*Quercus chrysolepis* var. *chrysolepis* (canyon live oak)	0-15	6.67
	Needle-leaved evergreen tree	*Pseudotsuga menziesii* (Douglas-fir)	1-5	2.83

Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Quercus chrysolepis* var. *chrysolepis* (canyon live oak)	0.5-15	12.08
		Arbutus menziesii (Pacific madrone)	0-2	1.25
		Mahonia nervosa (Cascade barberry)	0.5-2	1
		Whipplea modesta (common whipplea)	1-15	5
	Needle-leaved evergreen shrub	*Abies concolor* (white fir)	0.5-1	1
	Broad-leaved deciduous shrub	*Symphoricarpos albus* (common snowberry)	0.5-15	4.75
		Holodiscus discolor (oceanspray)	0.5-5	1.92
		Rosa gymnocarpa (wood rose)	0.5-5	1.67
		Amelanchier alnifolia (Saskatoon serviceberry)	0.5-1	0.75
Herb	Perennial herb	*Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley)	0.5-1	0.75
		Penstemon anguineus (Siskiyou beardtongue)	0.5-1	0.75
	Annual herb	*Epilobium minutum* (chaparral willowherb)	0.5-1	0.75

Species Richness:

Plot Species Richness Average	27.67
Plot Species Richness Range	24 - 30
Total Species Richness (all plots)	46

Diagnostic species: Overstory dominance of *Quercus chrysolepis* var. *chrysolepis* and < 10% total overstory cover of conifers is diagnostic.
Constant species: *Quercus chrysolepis* var. *chrysolepis, Pseudotsuga menziesii, Abies concolor, Whipplea modesta, Epilobium minutum, Mahonia nervosa, Maianthemum racemosum* ssp. *racemosum, Penstemon anguineus, Rosa gymnocarpa, Symphoricarpos albus, Amelanchier alnifolia, Holodiscus discolor.*
Other Noteworthy Species: None.
Local Range: This association occurs on mostly south facing aspects below 1400 m within the Oregon Caves National Monument and proposed expansion area. This association likely occurs elsewhere in the central Siskiyou Mountains on south facing aspects at middle to low elevations.
Classification Comments: The USNVC association *Pseudotsuga menziesii - Quercus chrysolepis* Forest selected as analogous to this local association is similar except that *P. menziesii* occurs at much lower cover in the local association type. This local type possibly aligns more closely to the *Pseudotsuga menziesii / Quercus chrysolepis* Woodland (CEGL000926) in the USNVC database but vegetation descriptions and plot data needed to make that determination are lacking (NatureServe 2011). This association is also similar to the *Quercus chrysolepis* Forest Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011, Sawyer, J. O. et al. 2009.
Plots: Relevés 11, 77, 86.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: According to Taylor and Teare (1979) this association is the most widespread in their study area, occurring at low elevations (below 4500 feet) on north-facing slopes, but shifting to southerly exposures at higher elevations (between 4500 and 5500 feet). The substrate is all pre-Cretaceous metamorphic rock, and the soils are largely Sheetiron-Josephine complex with annual precipitation averaging about 1018 mm (40 inches). This association is also known from the Shasta-Trinity National Forest in the Klamath Province of northwestern California and Yosemite National Park in the Sierra Nevada. This association is widespread in the Klamath Province, occurring at low elevations (below 1370 m [4500 feet]) on north-facing slopes, but shifting to southerly exposures at higher elevations (between 1370 and 1675 m [4500-5500 feet]). The substrate is all pre-Cretaceous metamorphic rock, and the soils are largely Sheetiron-Josephine complex with annual precipitation averaging about 1018 mm (40 inches). Stands at Yosemite National Park are found at mesic sites with some cold-air drainages, on low to mid elevations (1220-1615 m [4000-5300 feet]). Aspects are generally northerly but can be trending south (northeast to west) at its highest elevations in semi-protected locations. Often associated with riparian drainages, these sites are on moderate to somewhat steep (6-26 degrees), convex slopes. Soil development is minimal with shallow to medium depths, and textures are mostly stony but range from stony to clay and of granitic parent material. Penetrability is easy to difficult.

Vegetation Description: Stands in the southern Klamath Province are dominated by *Pseudotsuga menziesii* and *Quercus chrysolepis*. Other species such as *Arbutus menziesii* and *Acer macrophyllum* are common, while they are rare or absent in the local stands of this association. Stands of this forest at Yosemite National Park are dominated by *Pseudotsuga menziesii* and *Quercus chrysolepis*. *Calocedrus decurrens, Umbellularia californica, Pinus ponderosa,* and *Quercus kelloggii* are often present in the tree canopy. Other species that may be present include *Abies concolor, Alnus rhombifolia, Alnus incana, Acer macrophyllum, Cornus nuttallii, Rhododendron occidentale, Toxicodendron diversilobum, Ceanothus integerrimus, Corylus cornuta, Arctostaphylos viscida, Arctostaphylos patula*, and *Pteridium aquilinum*. Stands in the Klamath Ecoregion differ somewhat from the local Yosemite National Park stands. Thus, this association may actually be found to be different although the two main species are the same.

Characteristic Species: *Pseudotsuga menziesii* and *Quercus chrysolepis.*
USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: United States.
States/Provinces: CA.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest), BLM (Medford District).

CONSERVATION STATUS

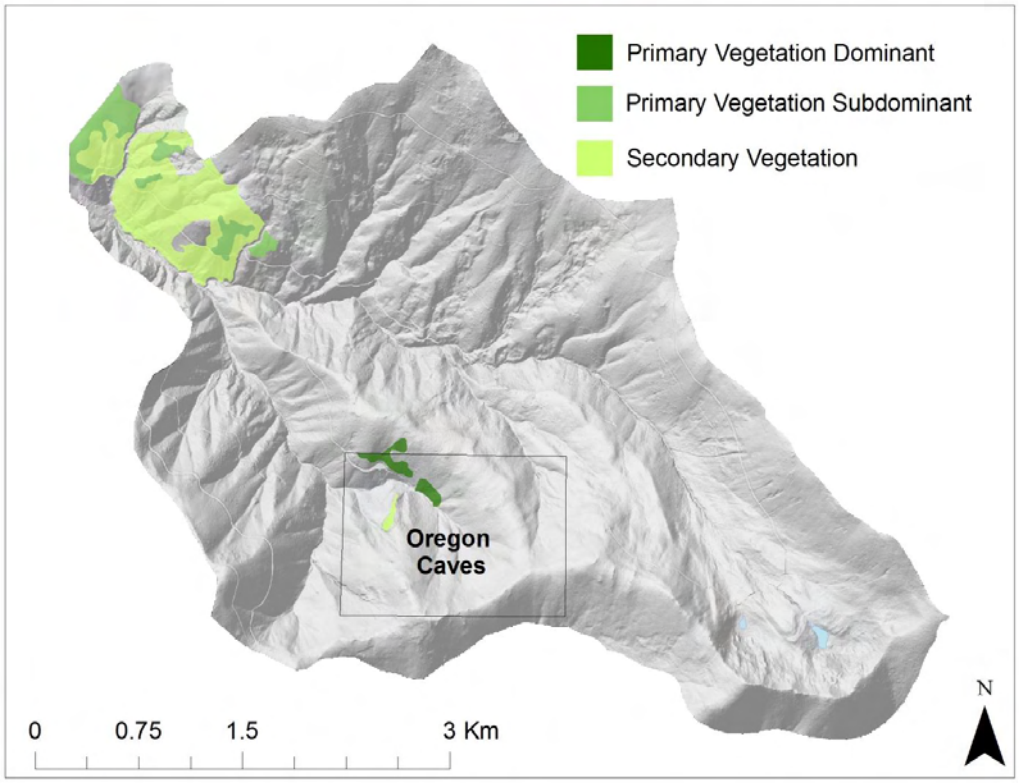
Rank: G3? (11Feb2003).

Reason: G3 – Vulnerable. High-quality old-growth stands are relatively uncommon as a result of logging and improper fire regimes.
Global Description Author: T. Keeler-Wolf, mod. M. J. Russo.

Global Description References: Keeler-Wolf, T. et al. 2003a, Taylor, D. W., and K. A. Teare. 1979, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 2, 2012).

Association Range and Distribution



***Quercus chrysolepis* association**. Relevé 11, elevation 1269 m. An almost pure stand of *Quercus chrysolepis* var. *chrysolepis*. Some conifers had existed in the area shown, but had died or were felled. The very low understory growth is *Whipplea modesta*. Sprouts or young *Q. chrysolepis* and *Arbutus menziesii* are also present in the understory.

COMMON NAME: *PSEUDOTSUGA MENZIESII / GAULTHERIA SHALLON* ASSOCIATION

SYNONYMS
USNVC English Name: Douglas-fir / Salal / Pineland Sword Fern Forest

USNVC Scientific Name: *Pseudotsuga menziesii / Gaultheria shallon* / *Polystichum munitum* Forest

USNVC Identifier: CEGL000070

USNVC CLASSIFICATION:
Formation Class: 1 - Forest to Open Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 – Cool Temperate Forest
Division: 1.B.2.Nd – Vancouverian Cool Temperate Forest
Macrogroup: Vancouverian Lowland & Montane Rainforest
Group: *Pseudotsuga menziesii – Tsuga heterophylla – Polystichum munitum* Forest Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs on lower elevation slopes within the Oregon Caves National Monument and proposed expansion area. Topographic positions include high slope, midslope, low slope, and low level. Soil texture is sandy loam or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1024	37	32	85
Range	877 - 1163	25 - 58	285 - 120	80 - 90

Vegetation Description: This tall (60+ m), multistory forest association is composed of large conifer trees (average DBH = 110 cm) and a very well developed Ericaceous shrub layer. Emergent conifers, mostly Douglas-fir (*Pseudotsuga menziesii*) but occasionally sugar pine (*Pinus lambertiana*), protrude well above the overstory. The overstory and midstory consists of broad-leaved evergreens, such as tanoak (*Lithocarpus densiflorus*), and shorter conifers such as Douglas-fir and occasionally Port Orford-cedar (*Chamaecyparis lawsoniana*) on lower slopes. The shrub layer often consist of tall (up to 5 m) Pacific rhododendron (*Rhododendron macrophyllum*) and/or shrubby forms of broad-leaved evergreen trees present growing above a dense, low ground cover of salal (*Gaultheria shallon*). Herbs are uncommon.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pseudotsuga menziesii* (Douglas-fir)	5-50	19.6
		Chamaecyparis lawsoniana (Port Orford-cedar)	0-15	4

	Broad-leaved evergreen tree	*Arbutus menziesii* (Pacific madrone)	0-15	2.8
		Lithocarpus densiflorus (tanoak)	0-15	2.7
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Gaultheria shallon* (salal)	0.5-50	26.4
		Rhododendron macrophyllum (Pacific rhododendron)	0-50	23.2
		Lithocarpus densiflorus (tanoak)	0.5-40	21.7
		Chrysolepis chrysophylla (giant chinquapin)	0-30	7.7
		Mahonia nervosa (Cascade barberry)	0.5-5	2.3
	Needle-leaved evergreen shrub	*Chamaecyparis lawsoniana* (Port Orford-cedar)	0-23.5	6.1
		Pseudotsuga menziesii (Douglas-fir)	0-5	1.7

Species Richness:

Plot Species Richness Average	19.2
Plot Species Richness Range	16 - 23
Total Species Richness (all plots)	38

Diagnostic species: *Gaultheria shallon.*
Constant species: *Pseudotsuga menziesii, Gaultheria shallon, Chrysolepis chrysophylla, Lithocarpus densiflorus, Mahonia nervosa.*
Other Noteworthy Species: None.
Local Range: This association occurs within the proposed expansion area mostly below 1200 m with a small inclusion at the lowest elevations within the Oregon Caves National Monument. This association likely occurs elsewhere in the central and western Siskiyou Mountains at middle to low elevations.
Classification Comments: The USNVC types *Pseudotsuga menziesii / Lithocarpus densiflorus / Rhododendron occidentale* Forest (CEGL000077) and *Pseudotsuga menziesii / Lithocarpus densiflorus / Gaultheria shallon* Forest (CEGL000075) may be similar to this local association type (NatureServe 2011). The lack of detailed vegetation information for either of these USNVC types made this selection difficult. A *Pseudotsuga menziesii / Gaultheria shallon* association is treated by Simpson (1980).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011, Sawyer, J. O. et al. 2009, Simpson, L. G. 1980.
Plots: Relevés 1, 2, 25, 27, 32.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Not available.
Vegetation Description: Not available.
Characteristic Species: Not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: United States.
States/Provinces: OR.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

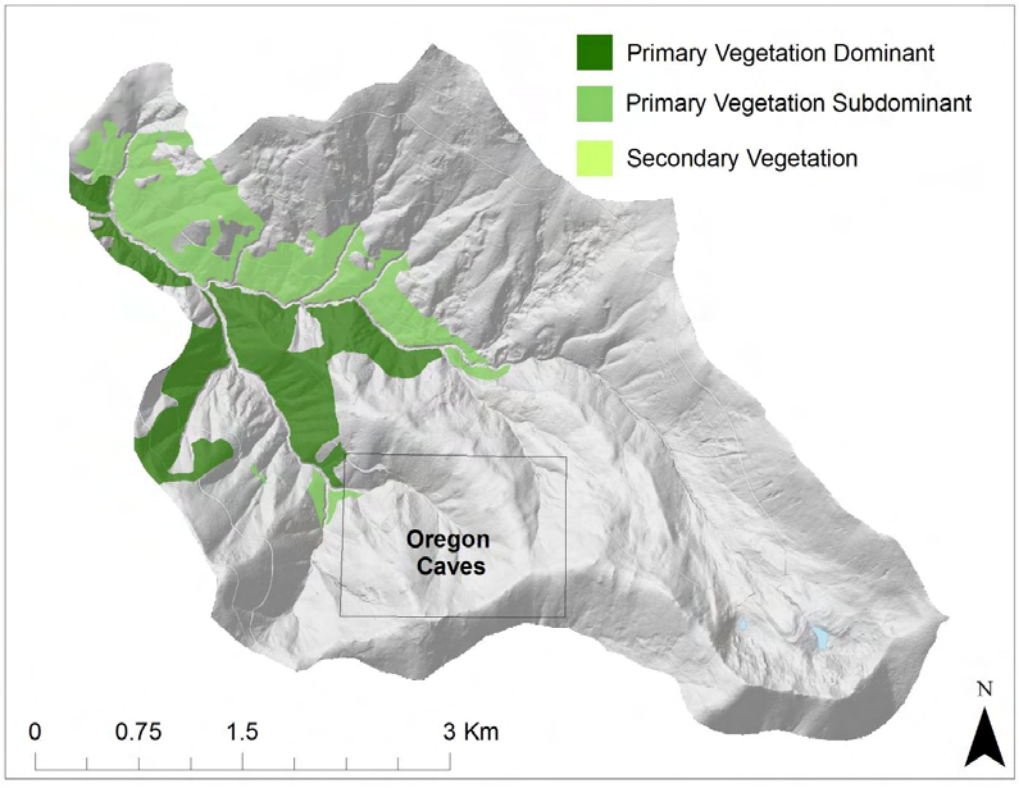
CONSERVATION STATUS
Rank: G4 (01Feb1996).
Reason: G4 - Apparently Secure.

Global Description Author: Western Ecology Group.

Global Description References: Atzet, T., and L. A. McCrimmon. 1990, Bourgeron, P. S., and L. D. Engelking, ed. 1994, Driscoll, R. S. et al. 1984, Kagan, J. S. et al. 2000-2004, Klinka, K. et al. 1996, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 2, 2012).

Association Range and Distribution



Pseudotsuga menziesii / Gaultheria shallon association. Relevé 1, elevation 1099 m. Most of the understory cover is *Rhododendron macrophyllum*, while most of the midstory cover is *Lithocarpus densiflorus*. Both of these species can be particularly common in this association. Large (1-2 m DBH) *P. menziesii* are typically scattered.

Pseudotsuga menziesii / Gaultheria shallon association. Relevé 2, elevation 1090m. *G. shallon* is to the immediate left in the foreground. The *P. menziesii* bole behind and left of botanist Kristi Merganthaler is about 2 m DBH.

COMMON NAME: ***PINUS LAMBERTIANA / LITHOCARPUS DENSIFLORUS*** **ASSOCIATION**

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs mostly at lower elevations in the Oregon Caves National Monument and proposed expansion area. Topographic positions include high slope and midslope. Soil texture is loam, clay loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1084	29	115	76
Range	859 - 1244	18 - 40	0 - 226	65 - 85

Vegetation Description: This is a closed, multilayer forest association of very tall trees (height >50 m, DBH average = 110 cm). Emergent conifer trees rising above the overstory consist of Douglas-fir (*Pseudotsuga menziesii*) and sugar pine (*Pinus lambertiana*), the latter being an aspect dominant rather than a true dominant. The overstory and midstory are dominated by Douglas-fir and the broad-leaved evergreens tanoak (*Lithocarpus densiflorus*) and Pacific madrone (*Arbutus menziesii*). These broad-leaved evergreen trees are abundant in the shrub layer as well, along with canyon live oak (*Quercus chrysolepis* var. *chrysolepis*). The herbaceous layer is sparse and generally lacks sweet after death (*Achlys triphylla*) that is otherwise ubiquitous under conifer forests at low to middle elevations in Oregon Caves National Monument.

Most Abundant Species:

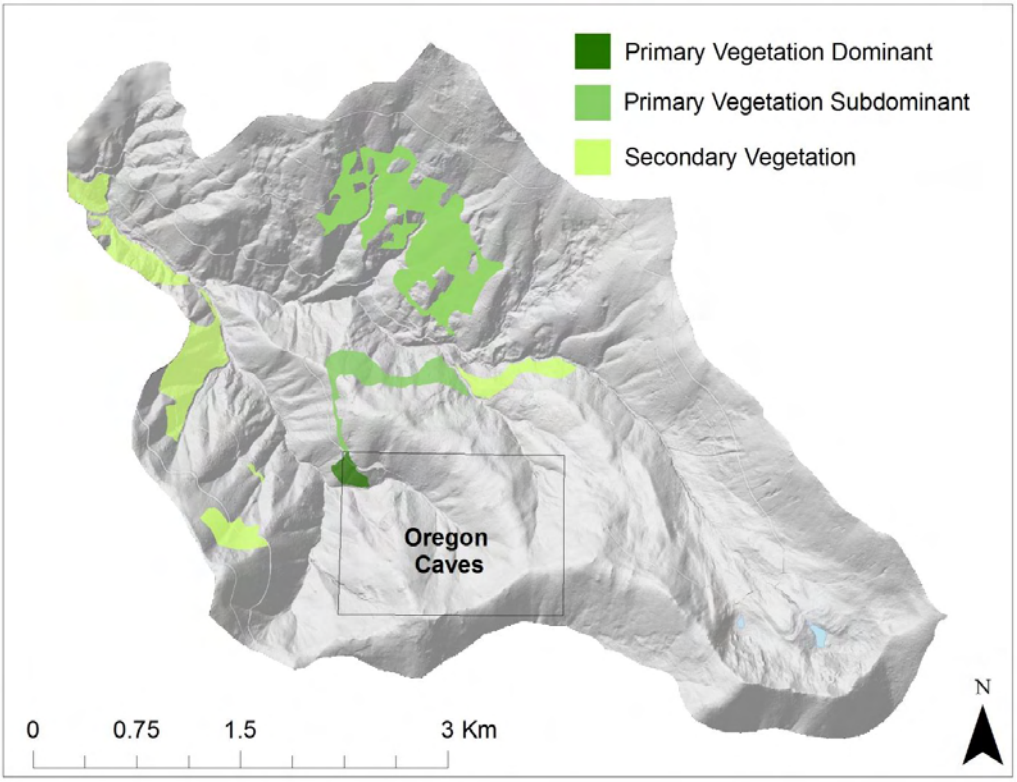
Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pinus lambertiana* (sugar pine)	2-15	6.75
		Pseudotsuga menziesii (Douglas-fir)	5-20	12.5
		Calocedrus decurrens (incense cedar)	0-15	2.88
	Broad-leaved evergreen tree	*Lithocarpus densiflorus* (tanoak)	0-5	1.75
		Arbutus menziesii (Pacific madrone)	0-15	3.38
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Pseudotsuga menziesii* (Douglas-fir)	0.5-15	4.38
	Broad-leaved evergreen shrub	*Lithocarpus densiflorus* (tanoak)	15-37	24.38
		Quercus chrysolepis var. *chrysolepis* (canyon live oak)	0.5-50	11.13
		Arbutus menziesii (Pacific madrone)	0-15	5.88
		Chrysolepis chrysophylla (giant chinquapin)	0-15	2.75
Herb	Perennial herb	*Goodyera oblongifolia* (western rattlesnake plantain)	0.5-1	0.5

Species Richness:

Plot Species Richness Average	20.25
Plot Species Richness Range	13 - 29
Total Species Richness (all plots)	42

Diagnostic species: *Pinus lambertiana* (emergent overstory layer).
Constant species: *Pinus lambertiana, Lithocarpus densiflorus, Pseudotsuga menziesii, Quercus chrysolepis* var. *chrysolepis, Goodyera oblongifolia.*
Other Noteworthy Species: None.
Local Range: This association occurs within the proposed expansion area below 1400 m with a small inclusion at the lowest elevations within the Oregon Caves National Monument. This association likely occurs elsewhere in the central Siskiyou Mountains at middle to low elevations.
Classification Comments: The *Pinus lambertiana - Pinus ponderosa - Pseudotsuga menziesii / Festuca californica* Forest (CEGL000065) in the USNVC database is somewhat similar to this local association type but the USNVC association type lacks *Lithocarpus densiflorus* and may refer rather to *Pinus lambertiana* forest types of drier inland environments (NatureServe 2011). This association is similar to the *Pinus lambertiana* Forest Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011, Sawyer, J. O. et al. 2009.
Plots: Relevés 29, 72, 78, 101.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation type.

Association Range and Distribution



***Pinus lambertiana - Lithocarpus densiflorus* association.** Relevé 29, elevation 1088 m. *P. lambertiana* (148 cm DBH) towers above the *L. densiflorus* and *Quercus chrysolepis* var. *chrysolepis* dominated midstory and understory. Herbs are sparse.

COMMON NAME: *PSEUDOTSUGA MENZIESII / LITHOCARPUS DENSIFLORUS* **ASSOCIATION**

SYNONYMS:
USNVC English Name: Douglas-fir / Tanoak / Salal Forest

USNVC Scientific Name: *Pseudotsuga menziesii / Lithocarpus densiflorus / Gaultheria shallon* Forest

USNVC Identifier: CEGL000075

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.1 - Warm Temperate Forest
Division: 1.B.1.Nc - Southwestern North American Warm Temperate Forest
Macrogroup: Californian-Vancouverian Foothill & Valley Forest & Woodland
Group: *Pseudotsuga menziesii - Lithocarpus densiflorus - Arbutus menziesii* Forest Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This upland forest association occurs on middle slopes that are generally south facing at low to middle elevations within Oregon Caves National Monument and proposed expansion area. Soil texture is loam, clay loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1071	25	171	82
Range	936 – 1261	18 – 33	97 – 255	70 – 90

Vegetation Description: This is a tall mixed evergreen forest association with multiple canopy layers. Emergent Douglas-fir (*Pseudotsuga menziesii*) (average DBH ~100 cm) occur above a dense overstory dominated by tanoak (*Lithocarpus densiflorus*), the most abundant broad-leaf evergreen species in this association. Salal (*Gaultheria shallon*) and Cascade barberry (*Mahonia nervosa*) are common in a low shrub layer but often with less than 20% cover. Small white fir (*Abies concolor*) saplings are often present. The herbaceous layer is fairly sparse with sweet after death (*Achlys triphylla*) and western swordfern (*Polystichum munitum*) constant through all sample plots at low cover.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pseudotsuga menziesii* (Douglas-fir)	5-25	16.7

Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Pseudotsuga menziesii* (Douglas-fir)	0.5-15	5.6
		Abies concolor (white fir)	0.5-50	11.3
	Broad-leaved evergreen shrub	*Lithocarpus densiflorus* (tanoak)	16.5-58	30.6
		Quercus chrysolepis var. *chrysolepis* (canyon live oak)	0-33.5	12.4
		Gaultheria shallon (salal)	0-15	6.25
		Mahonia nervosa (Cascade barberry)	0-15	5.13
		Whipplea modesta (common whipplea)	0.5-5	2.25
	Broad-leaved deciduous shrub	*Rubus ursinus* (California blackberry)	0.5-1	0.5
Herb	Sub-shrub	*Pyrola picta* (whiteveined wintergreen)	0.5-1	0.5
	Perennial herb	*Achlys triphylla* (sweet after death)	0.5-5	2.75
		Trientalis borealis ssp. *latifolia* (broadleaf starflower)	0-5	1.13
	Fern or fern ally	*Polystichum munitum* (western swordfern)	0.5-5	1.5

Species Richness:

Plot Species Richness Average	28
Plot Species Richness Range	23 - 37
Total Species Richness (all plots)	57

Characteristic Species: *Pseudotsuga menziesii, Lithocarpus densiflorus.*
Diagnostic species: None.
Constant species: *Pseudotsuga menziesii, Lithocarpus densiflorus, Abies concolor, Achlys triphylla, Polystichum munitum, Pyrola picta, Rubus ursinus, Whipplea modesta.*
Other Noteworthy Species: None.
Local Range: This type occurs within the Oregon Caves National Monument and the proposed expansion area below 1400 m. This association likely occurs elsewhere in the central and western Siskiyou Mountains at middle to low elevations.
Classification Comments: This association is similar to the *Pseudotsuga menziesii / Lithocarpus densiflorus / Quercus chrysolepis* Forest (CEGL000076) in the USNVC database. The otherwise abundant *Q. chrysolepis* is absent from one plot, precluding its classification to the above USNVC association type (NatureServe 2011).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011.
Plots: Relevés 9, 21, 31, 94, 95.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Not available.
Vegetation Description: Not available.
Characteristic Species: Not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION

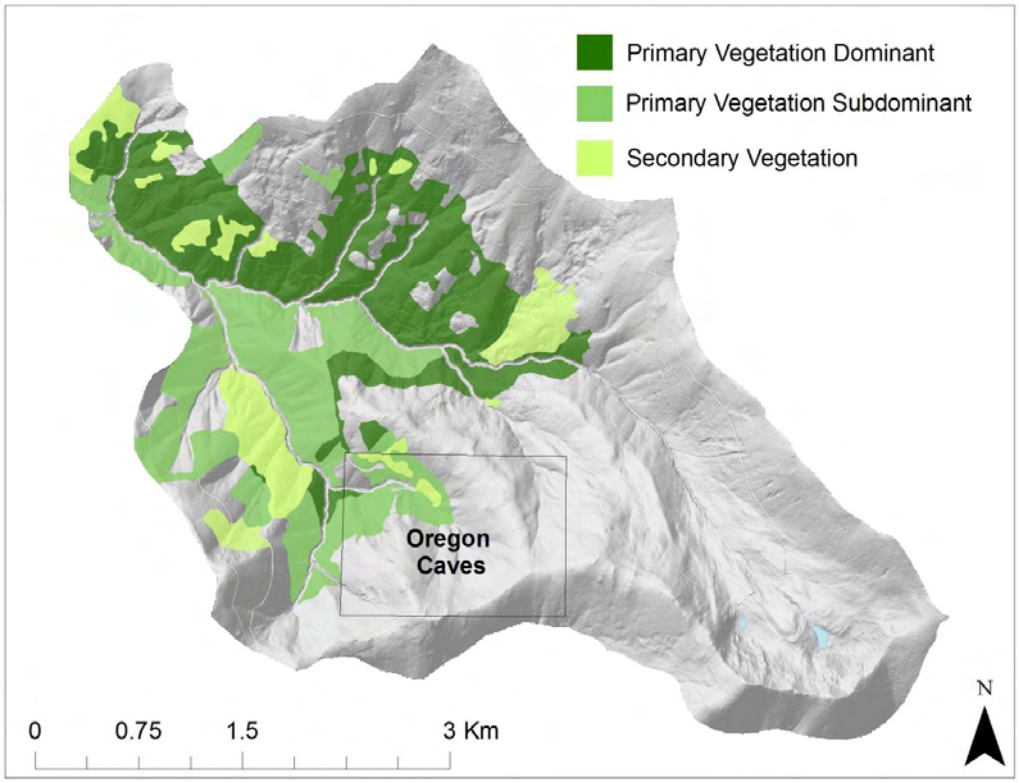
Range: United States.
States/Provinces: CA, OR.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest), BLM (Medford District).

CONSERVATION STATUS
Rank: G4 (01Feb1996).
Reason: G4 - Apparently Secure.
Global Description Author: Western Ecology Group.

Global Description References: Atzet, T., and D. L. Wheeler. 1984, Bourgeron, P. S., and L. D. Engelking, ed. 1994, Driscoll, R. S. et al. 1984, Kagan, J. S. et al. 2000-2004, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 5, 2012).

Association Range and Distribution



Pseudotsuga menziesii / Lithocarpus densiflorus association. Relevé 94, elevation 936 m. The understory is typical of this association with dense *L. densiflorus* (left foreground) and *Quercus chrysolepis* var. *chrysolepis*. Understory shrubs and herbs include *Mahonia nervosa* (right foreground) and *Achlys triphylla* (behind Dennis Odion). The large *Pinus lambertiana* to the left is dead, otherwise this stand would have classified into the *Pinus lambertiana - Lithocarpus densiflorus* association.

COMMON NAME: ***PSEUDOTSUGA MENZIESII / ARBUTUS MENZIESII*** **ASSOCIATION**

SYNONYMS
USNVC English Name: Douglas-fir - Pacific Madrone / Salal Forest

USNVC Scientific Name: ***Pseudotsuga menziesii - Arbutus menziesii / Gaultheria shallon*** **Forest**

USNVC Identifier: CEGL000421

USNVC CLASSIFICATION
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.1 - Warm Temperate Forest
Division: 1.B.1.Nc - Southwestern North American Warm Temperate Forest
Macrogroup: Californian-Vancouverian Foothill & Valley Forest & Woodland
Group: *Pseudotsuga menziesii - Arbutus menziesii* Forest & Woodland Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This upland forest association occurs on southerly aspects on middle to high slopes at low to middle elevations within the Oregon Caves National Monument and proposed expansion area. Soil texture is clay loam or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1174	27	208	57
Range	1017 - 1299	12 - 45	140 - 240	30 - 80

Vegetation Description: This is a moderately tall closed forest vegetation association. Douglas-fir (*Pseudotsuga menziesii*) is dominant in the overstory and both Douglas-fir and white fir (*Abies concolor*) are common in midstory and understory. Pacific madrone (*Arbutus menziesii*) is always present at more than 10% cover. However, Pacific madrone is not exceptionally abundant and is sometimes less abundant than other broad-leaved evergreens present, such as tanoak (*Lithocarpus densiflorus*), common whipplea (*Whipplea modesta*), and/or Cascade barberry (*Mahonia nervosa*) are often present in a low shrub layer with sparse to moderate cover. The herb layer is sparse with sweet after death (*Achlys triphylla*) commonly occurring at low cover.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pseudotsuga menziesii* (Douglas-fir)	2-15	7.75
Shrub/sapling (tall and short)	Broad-leaved evergreen shrub	*Arbutus menziesii* (Pacific madrone)	2-15	8.06
		Lithocarpus densiflorus (tanoak)	0-27	12.19

		Quercus chrysolepis var. *chrysolepis* (canyon live oak)	0-16.5	5.56
		Whipplea modesta (common whipplea)	0-15	2.19
		Mahonia nervosa (Cascade barberry)	0-5	1.44
	Needle-leaved evergreen shrub	*Pseudotsuga menziesii* (Douglas-fir)	0-15	5.75
		Abies concolor (white fir)	0-20	3.75
Herb	Perennial herb	*Achlys triphylla* (sweet after death)	0-5	1.06
	Graminoid	*Melica subulata* var. *subulata* (Alaska oniongrass)	0-15	2.19

Species Richness:

Plot Species Richness Average	30.13
Plot Species Richness Range	19 - 40
Total Species Richness (all plots)	94

Diagnostic species: *Arbutus menziesii* (occurring without *Pinus lambertiana* or *Gaultheria shallon*).
Constant species: *Pseudotsuga menziesii, Arbutus menziesii.*
Other Noteworthy Species: *Lithocarpus densiflorus.*
Local Range: This association occurs within the Oregon Caves National Monument and the proposed expansion area below 1400 m. This association likely occurs elsewhere in the central and western Siskiyou Mountains at middle to low elevations.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevés 8, 24, 74, 76, 79, 80, 81, 96.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association occurs primarily at low elevations in British Columbia, Washington, and Oregon. This association is most frequent within a few miles of the shores of the Georgia Strait and Puget Sound in British Columbia and Washington, and in low hills of the northern end of the Klamath Mountains ecoregion, Oregon. It is infrequent elsewhere in the Puget Trough - Georgia Basin - Willamette Valley ecoregion. In the Willamette Valley it is present only around the margins. It is rare in the eastern and northern Olympic Mountains. It may also extend into northwestern California.

Vegetation Description: This is typically a mixed evergreen needle-leaved-evergreen broad-leaved forest dominated by *Pseudotsuga menziesii* and *Arbutus menziesii*. The understory is dominated by the evergreen broad-leaved shrub *Gaultheria shallon*, very locally codominated by *Vaccinium ovatum*. The taller deciduous shrubs *Holodiscus discolor* or *Corylus cornuta* are often abundant as well. Other frequent species are *Polystichum munitum, Pteridium aquilinum, Mahonia nervosa*, and *Rubus ursinus*. Herbaceous species are typically found in small amounts. This association occurs on dry sites, either due to aspect and slope, or shallow soils. This association is distinguished from similar ones by >20% cover of *Arbutus menziesii* and >10%

cover of *Gaultheria shallon*, combined with <10% cover of *Tsuga heterophylla*, *Thuja plicata*, and *Polystichum munitum*.
Characteristic Species: Not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION
Range: Canada, United States.
States/Provinces: CA?, OR, WA.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest), BLM (Medford District).

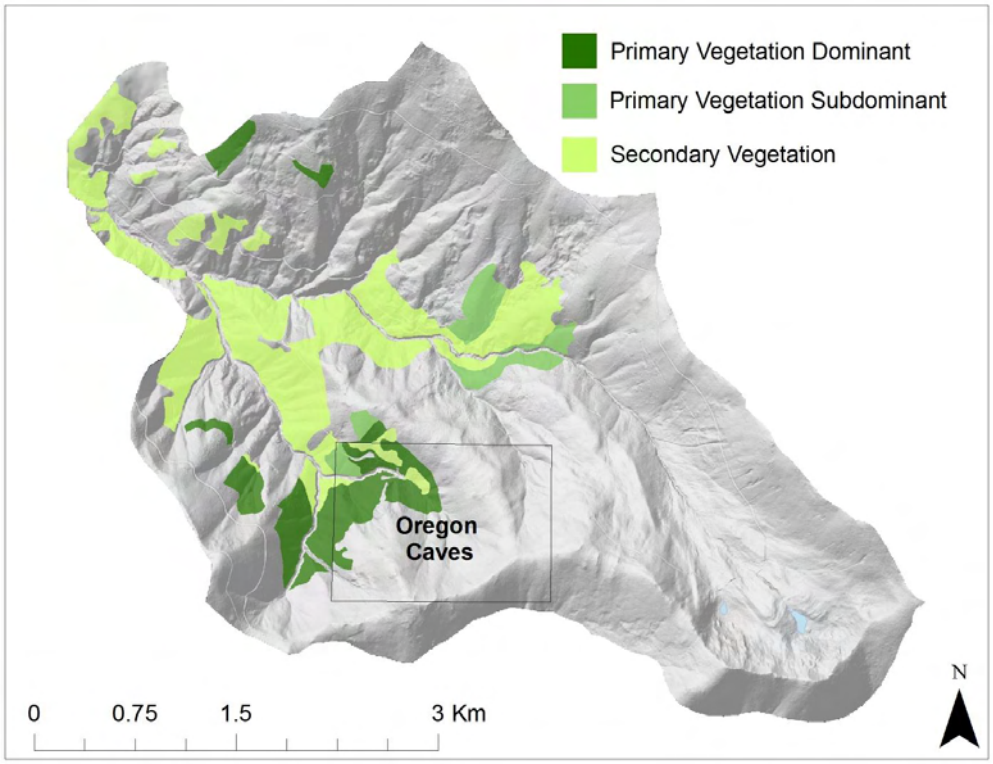
CONSERVATION STATUS
Rank: G3 (06Dec2000).
Reason: G3 – Vulnerable. This association occurs primarily in the Georgia Basin, British Columbia, the Puget Lowland, Washington, and the Klamath Mountains, Oregon, where it occupies small patches on dry sites, especially near saltwater. Very few occurrences are good viability, due to degradation associated with logging, fragmentation, development, fire suppression, and a possibly non-native fungal canker. The association is declining and threatened, primarily by development and its impacts, possibly also by the fungal canker.

Global Description Author: C. B. Chappell

Global Description References: Bourgeron, P. S., and L. D. Engelking, ed. 1994, Chappell, C. 1994, Chappell, C. B. 2006, Chappell, C. B. et al. No date, Chappell, C. B., and D. F. Giglio. 1999, Driscoll, R. S. et al. 1984, Fonda, R. W., and J. A. Bernardi. 1976, Green, R. N., and K. Klinka. 1994, WNHP [Washington Natural Heritage Program]. No date, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 5, 2012).

Association Range and Distribution



***Pseudotsuga menziesii / Arbutus menziesii* association.** Relevé 96, elevation 1019 m. *P. menziesii* and *A. menziesii* dominate the overstory along with *Quercus chrysolepis* var. *chrysolepis* (upper left). The shrub layer includes *Holodiscus discolor*, *Corylus cornuta,* and *Abies concolor*. The understory is

dominated by the ferns *Polystichum munitum* and *P. imbricans* (left of down log in center) as well as *Whipplea modesta*.

***Pseudotsuga menziesii* / *Arbutus menziesii* association.** Relevé 79, elevation 1202 m. This photo shows the same dominants as in the previous photo, but most broadleaved evergreens are post-disturbance resprouts of shorter-stature. Thus, this is an earlier successional phase of the association.

COMMON NAME: *CHAMAECYPARIS LAWSONIANA - PSEUDOTSUGA MENZIESII* **ASSOCIATION**

SYNONYMS
USNVC English Name: White Fir - Port Orford-cedar - Douglas-fir / (Dwarf Oregon-grape) / Sweet After Death Forest

USNVC Scientific Name: ***Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla*** **Forest**

USNVC Identifier: CEGL000041

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Vancouverian Lowland & Montane Rainforest
Group: *Sequoia sempervirens-Chamaecyparis lawsoniana-Pseudotsuga menziesii* Forest Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs at middle elevations on northwest aspects within the Oregon Caves National Monument and proposed expansion area. Topographic positions include high slope, midslope, and low slope. Soil texture is loam, clay loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1369	29	325	80
Range	1195 - 1498	15 - 40	285 - 352	70 - 85

Vegetation Description: This upland conifer forest association has multiple canopy layers with large Port Orford-cedar (*Chamaecyparis lawsoniana*) and Douglas-fir (*Pseudotsuga menziesii*) (average DBH ~120 cm) sharing overstory dominance. Broad-leaved evergreen trees are mostly lacking in the overstory, the elevation restricting most hardwoods except for some individual Pacific madrone (*Arbutus menziesii*) and the broad-leaved deciduous tree bigleaf maple (*Acer macrophyllum*) in some stands. Shrubs are generally lacking and the herbaceous understory is well developed and diverse. The understory is typically dominated by sweet after death (*Achlys triphylla*). Other herb species such as fragrant bedstraw (*Galium triflorum*), broadleaf starflower (*Trientalis borealis* ssp. *latifolia*), drops-of-gold (*Disporum hookeri*), sweetcicely (*Osmorhiza chilensis*), western swordfern (*Polystichum munitum*), Sierra pea (*Lathyrus nevadensis*), bride's bonnet (*Clintonia uniflora*), Pacific trillium (*Trillium ovatum*), starry false lily of the valley

(*Mainanthemum stellatum*), and white insideout flower (*Vancouveria hexandra*), though not particularly abundant, are constant or nearly ubiquitous in this association.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Chamaecyparis lawsoniana* (Port Orford-cedar)	5-25	16.25
		Pseudotsuga menziesii (Douglas-fir)	0.5-15	9.69
		Abies concolor (white fir)	0-15	5.56
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Chamaecyparis lawsoniana* (Port Orford-cedar)	0-27	10.31
		Abies concolor (white fir)	0-15	3.88
	Broad-leaved evergreen shrub	*Mahonia nervosa* (Cascade barberry)	0-15	3.06
	Broad-leaved deciduous shrub	*Rosa gymnocarpa* (wood rose)	0-5	1.69
Herb	Perennial herb	*Achlys triphylla* (sweet after death)	0-15	7.13
		Vancouveria hexandra (white insideout flower)	0.5-50	5.88
		Actaea rubra (red baneberry)	0-25	2.69
		Clintonia uniflora (bride's bonnet)	0-15	2.13
		Trientalis borealis ssp. *latifolia* (broadleaf starflower)	0.5-5	2.13
		Maianthemum stellatum (starry false lily of the valley)	0-5	1.56
		Disporum hookeri (drops-of-gold)	0.5-5	1.5
		Galium triflorum (fragrant bedstraw)	0.5-5	0.88
		Osmorhiza chilensis (sweetcicely)	0.5-5	0.88
	Graminoid	*Festuca subuliflora* (crinkleawn fescue)	0-15	2.25

Species Richness:

Plot Species Richness Average	43.38
Plot Species Richness Range	25 - 53
Total Species Richness (all plots)	113

Diagnostic species: *Chamaecyparis lawsoniana, Acer macrophyllum* (occurring outside of riparian areas).
Constant species: *Chamaecyparis lawsoniana, Pseudotsuga menziesii, Disporum hookeri, Vancouveria hexandra, Galium triflorum, Trientalis borealis* ssp. *latifolia, Osmorhiza chilensis.*
Other Noteworthy Species: *Abies concolor, Mahonia nervosa, Achlys triphylla.*
Local Range: This association occurs within the Oregon Caves National Monument and the proposed expansion area. This association likely occurs elsewhere in the central and western Siskiyou Mountains at middle elevations.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevés 7, 10, 14, 16, 17, 88, 89, 90.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association occurs in a mountainous region (Klamath Mountains Province) of rugged, deeply dissected terrain. Geologically, the province is very complex and of very old deposits. Rock types include volcanic tuffs and sedimentary rocks which have been metamorphosed into schists, gneisses, marbles, and other metavolcanic and metasedimentary rocks. Sandstones, siltstones, and shales have been deposited near the coast. The most notable rock types are granitics and elongated, stringer-like outcrops of serpentine. Elevations of this region vary from sea level to over 1520 m. The climate of the region is maritime, with wet, mild winters, cool, relatively dry summers at higher elevations, and warm to hot summers at lower elevations, prolonged cloudy periods, and high annual precipitation. Precipitation varies from over 150 cm annually near the coast, to less than 75 cm annually on the eastern slope, where a rainshadow effect is pronounced and summers are very dry. This association occurs in scattered localities throughout most of the range of *Chamaecyparis lawsoniana*, particularly in the eastern and southern areas. It is found from 900-1540 m elevation, predominantly on slopes of northerly and westerly aspects. Sites include concave midslopes or valley bottoms, and slope percents vary greatly, from flat to steep (range from 0-60%). Soils are derived from a variety of parent materials, but a large proportion of stands occur on ultramafic colluvium and alluvium. Other parent materials are colluvium of granitics, schists, and metavolcanics. Soil textures are variable, from sandy loams to clay loams, but all horizons have high proportions of gravels and cobbles. Typical depth to the surface of the C horizon ranges from 45-60 cm, and most soils are moist to wet in all horizons, even through much of the summer. Litter covers at least 90% of the ground surface.

Vegetation Description: This association is both structurally and compositionally variable. The tree canopy, usually over 50 m in height, is dominated by a mix of the evergreen needle-leaved *Chamaecyparis lawsoniana, Pseudotsuga menziesii*, and *Abies concolor*. Any one of these three species can be the most abundant in a particular stand, but total canopy cover is typically 70% or higher. Several other conifers can be present, including *Abies magnifica, Picea breweriana*, and *Chamaecyparis nootkatensis*. A lower canopy layer is present, dominated by a mix of conifer regeneration and broad-leaved evergreen species. Conifers important in this layer include *Chamaecyparis lawsoniana, Abies concolor, Taxus brevifolia*, and in some stands *Calocedrus decurrens*. Broad-leaved species can include *Lithocarpus densiflorus* and *Chrysolepis chrysophylla (= Castanopsis chrysophylla)*. The shrub layers are very diverse and variable, with cover ranging from 13% to over 35%. Species include both evergreen and deciduous, tall and short, broad-leaved shrubs, with a pattern of occasional local dominance. The low, evergreen *Mahonia nervosa* has the highest constancy, occurring in nearly all stands and in some quite abundant. Some of the tall-shrub species include *Rhododendron occidentale, Quercus sadleriana*, and *Quercus vacciniifolia*, while short species include *Whipplea modesta, Rubus ursinus, Chimaphila umbellata, Rosa gymnocarpa, Paxistima myrsinites*, and *Vaccinium membranaceum*. The herbaceous layer is very diverse and abundant; most species are perennial forbs. *Achlys triphylla* is always present and often has cover over 10%. Some of the more

constant species include *Adenocaulon bicolor, Clintonia uniflora, Prosartes hookeri (= Disporum hookeri), Goodyera oblongifolia, Linnaea borealis, Tiarella trifoliata, Trientalis borealis* ssp. *latifolia*, and *Trillium ovatum*. Cover of mosses is low, usually less than 5%.

Characteristic Species: *Chamaecyparis lawsoniana, Mahonia nervosa, Achlys triphylla.*
USFWS Wetland System: The USFWS Wetland Inventory (1996 national list) recognizes *Chamaecyparis lawsoniana* as an FACU (Facultative Upland) plant. (Sawyer et al. 2009).

DISTRIBUTION
Range: United States.
States/Provinces: CA, OR.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

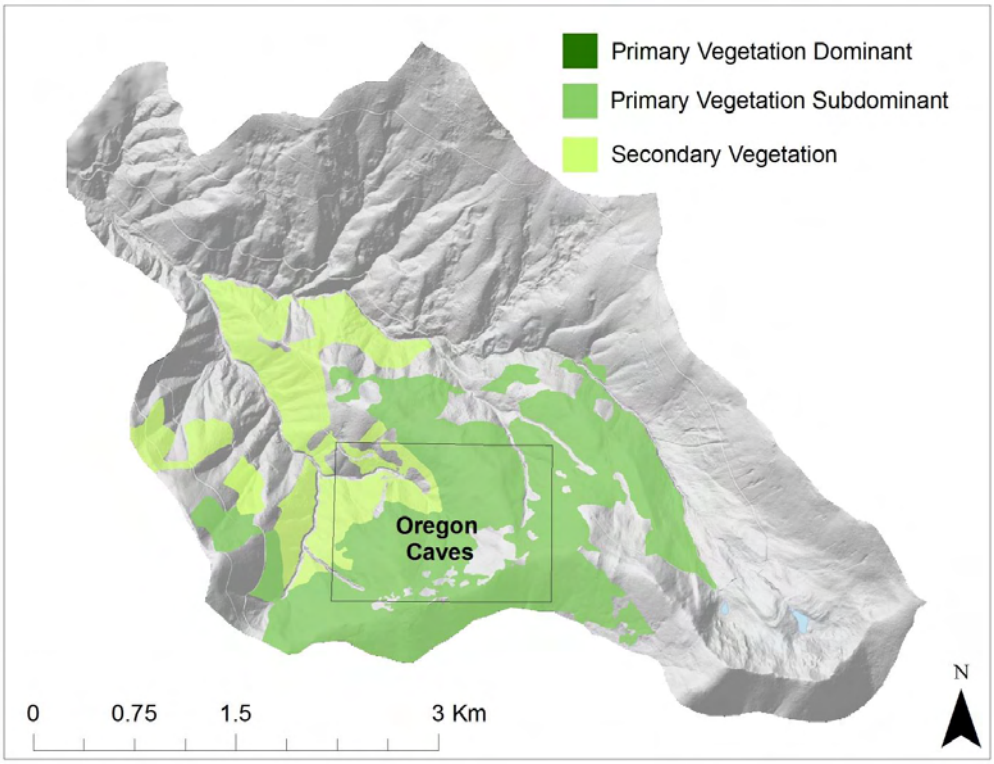
CONSERVATION STATUS
Rank: G2 (14Oct1997).
Reason: G2 – Imperiled. A naturally very restricted range of distribution of *Chamaecyparis lawsoniana* has been compounded by impacts from logging and introduced disease. This community is an old-growth forest assocation, in which stands are generally over 300 years old, and are highly productive. There are few known examples (fewer than 20 stands at less than 10 sites). *Chamaecyparis lawsoniana* is seriously threatened by a root-killing fungus, *Phytophthora lateralis*, which was recently introduced into the natural range of this tree. Spores of the fungus are carried in water, and have been spread in the tires of logging trucks. Many stands have been decimated by this pathogen, and Port Orford-cedar may be considered in the near future for Federal listing as a threatened species under the Endangered Species Act.

Global Description Author: M.S. Reid, mod. M. Schindel, J. S. Kagan

Global Description References: Atzet, T. A. et al. 1996, Atzet, T., and D. L. Wheeler. 1984, Bourgeron, P. S., and L. D. Engelking, ed. 1994, Driscoll, R. S. et al. 1984, Hawk, G. M. 1977, Jimerson, T. J. 1994, Kagan, J. S. et al. 2000-2004, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 6, 2012).

Association Range and Distribution



***Chamaecyparis lawsoniana - Pseudotsuga menziesii* association**. Relevé 14, elevation 1397. The lush understory and abundant, large, down wood typically found in this association are exemplified in this

photo. In addition to the two dominant tree species, *Festuca subuliflora, Athyrium filix-femina,* and *Vancouveria hexandra* are particularly abundant.

COMMON NAME: *ABIES CONCOLOR / AGASTACHE URTICIFOLIA* ASSOCIATION

SYNONYMS
USNVC English Name: Douglas-fir - White Fir - Incense-cedar Forest

USNVC Scientific Name: *Pseudotsuga menziesii - Abies concolor - Calocedrus decurrens* Forest

USNVC Identifier: CEGL005813

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Southern Vancouverian Montane & Foothill Forest
Group: *Calocedrus decurrens - Pinus lambertiana - Pinus jeffreyi* Forest & Woodland Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occupies north to northeast facing aspects on middle and high slopes at high elevations. It occupies only a small area within the Oregon Caves National Monument and proposed expansion area. Soil texture is loam, clay loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1530	17	18	78
Range	1513 - 1550	15 - 20	344 - 70	65 - 93

Vegetation Description: This vegetation association is characterized by young conifer forest established relatively recently in dry meadows in the same general environment as the *Agastache urticifolia - Polygonum phytolaccifolium* association in this classification. This association also occurs in logged areas not converted to timber plantations. White fir (*Abies concolor*) is the dominant tree in the overstory and understory. Douglas-fir (*Pseudotsuga menziesii*) is also common and incense cedar (*Calocedrus decurrens*) is often co-dominant. Broad-leaved evergreens are rare or absent. Large trees are generally absent. The average DBH of overstory trees ranges from 20 to 40 cm. Thimbleberry (*Rubus parviflorus*) is a constant and abundant low shrub. The herbaceous layer is well developed with >1 m tall nettleleaf giant hyssop (*Agastache urticifolia*), hairy brackenfern (*Pteridium aquilinum* var. *pubescens*), poke knotweed (*Polygonum phytolaccifolium*), American vetch (*Vicia americana* ssp. *americana*), and woodland strawberry (*Fragraria vesca*). The non-native herb common St. Johns wort *(Hypericum perforatum*) occurs in several sample plots.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pseudotsuga menziesii* (Douglas-fir)	2-15	6.75
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Abies concolor* (white fir)	0.5-20	8.75
		Pseudotsuga menziesii (Douglas-fir)	2-15	6.5
		Calocedrus decurrens (incense cedar)	0-15	6.38
	Broad-leaved deciduous shrub	*Rubus parviflorus* (thimbleberry)	2-20	10.88
		Rosa gymnocarpa (wood rose)	0.5-1	0.63
Herb	Sub-shrub	*Agastache urticifolia* (nettleleaf giant hyssop)	2-50	13.62
	Perennial herb	*Polygonum phytolaccifolium* (poke knotweed)	0.5-50	11.25
		Iliamna latibracteata (California wild hollyhock)	0-15	3.38
		Hypericum perforatum (common St. Johnswort)	0-5	1.88
		Achillea millefolium (common yarrow)	0.5-5	1.25
		Campanula scouleri (pale bellflower)	0.5-5	1.25
		Fragaria vesca (woodland strawberry)	0.5-5	1.25
		Heracleum maximum (common cowparsnip)	0.5-2	0.75
	Perennial vine	*Vicia americana* ssp. *americana* (American vetch)	0.5-5	2
	Graminoid	*Elymus glaucus* (blue wildrye)	0-15	3.5
	Fern or fern ally	*Pteridium aquilinum* var. *pubescens* (hairy brackenfern)	0.5-25	7.75

Species Richness:

Plot Species Richness Average	47.25
Plot Species Richness Range	38 – 53
Total Species Richness (all plots)	99

Diagnostic species: *Hypericum perforatum* (if site has been logged), *Rubus parviflorus*.
Constant species: *Abies concolor, Pseudotsuga menziesii, Rosa gymnocarpa, Rubus parviflorus, Agastache urticifolia, Achillea millefolium, Campanula scouleri, Fragaria vesca, Heracleum maximum, Polygonum phytolaccifolium, Pteridium aquilinum* var. *pubescens, Vicia americana* ssp. *americana.*
Other Noteworthy Species: None.
Local Range: This association occurs within the Oregon Caves National Monument and the proposed expansion area. This association likely occurs elsewhere in the Siskiyou Mountains at middle to high elevations.
Classification Comments: The USNVC association type *Pseudotsuga menziesii - Abies concolor - Calocedrus decurrens* Forest is selected as analogous to this association because both are similar in overstory floristics. However, the understory floristics and known range in California of this USNVC association do not match the local association type presented here (NatureServe 2011). It is likely that this local type is a successional state of the *Agastache urticifolia - Polygonum phytolaccifolium* association of this classification transitioning to a conifer forest.

Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011.
Plots: Relevés 38, 39, 40, 56.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association occurs throughout the northern Sierra Nevada and southern Cascades of California at least as far south as Yosemite Valley. Stands of this forest are found at low elevations (640-1460 m [2100-4800 feet]) at cool, moist sites with humid air. These sites tend to occur on north- or northeast-facing, gentle to moderately steep (12-80%), lower or mid slopes. Sites are often adjacent to perennial streams generally occupying small areas. Soils are moderately deep to deep in metamorphic or volcanic substrates. Coarse fragments tend to be higher in this association. Fire is infrequent, with low to medium intensities and variable spread (Fites 1994).

Vegetation Description: Stands of this forest form a dense, multi-layered overstory of *Pseudotsuga menziesii, Abies concolor,* and *Calocedrus decurrens*. *Corylus cornuta* is in the shrub layer, and dense patches of both or either *Adenocaulon bicolor* or *Trichostema lanceolatum* are in the herb layer. *Pseudotsuga menziesii* dominates and occasionally codominates with *Abies concolor*. *Calocedrus decurrens, Pinus lambertiana,* and occasionally *Pinus ponderosa* are minor associates. Infrequently, *Taxus brevifolia* and *Torreya californica* are present. *Pseudotsuga menziesii* dominate the regeneration, but *Abies concolor* and *Calocedrus decurrens* can also be high or dominant. *Quercus kelloggii, Pinus lambertiana,* and *Cornus nuttallii* are common in low amounts. *Quercus chrysolepis* occurs in the overstory and midstory on sites with limiting soil conditions, either shallow and stony sites with limited rootability or very high coarse fragments. *Corylus cornuta* forms a tall-shrub layer of variable cover. The herb layer is well-developed with dense patches dominated by *Adenocaulon bicolor* and *Trichostema lanceolatum* (Fites 1994).

Characteristic Species: *Pseudotsuga menziesii, Abies concolor, Calocedrus decurrens, Pinus lambertiana,* and *Pinus ponderosa*.
USFWS Wetland System: The USFWS Wetland Inventory (1996 national list) lists *Abies concolor* as an UPL (obligate upland) plant (Sawyer et al. 2009).

DISTRIBUTION

Range: United States.
States/Provinces: CA.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

CONSERVATION STATUS

Rank: G3? (11Feb2003).

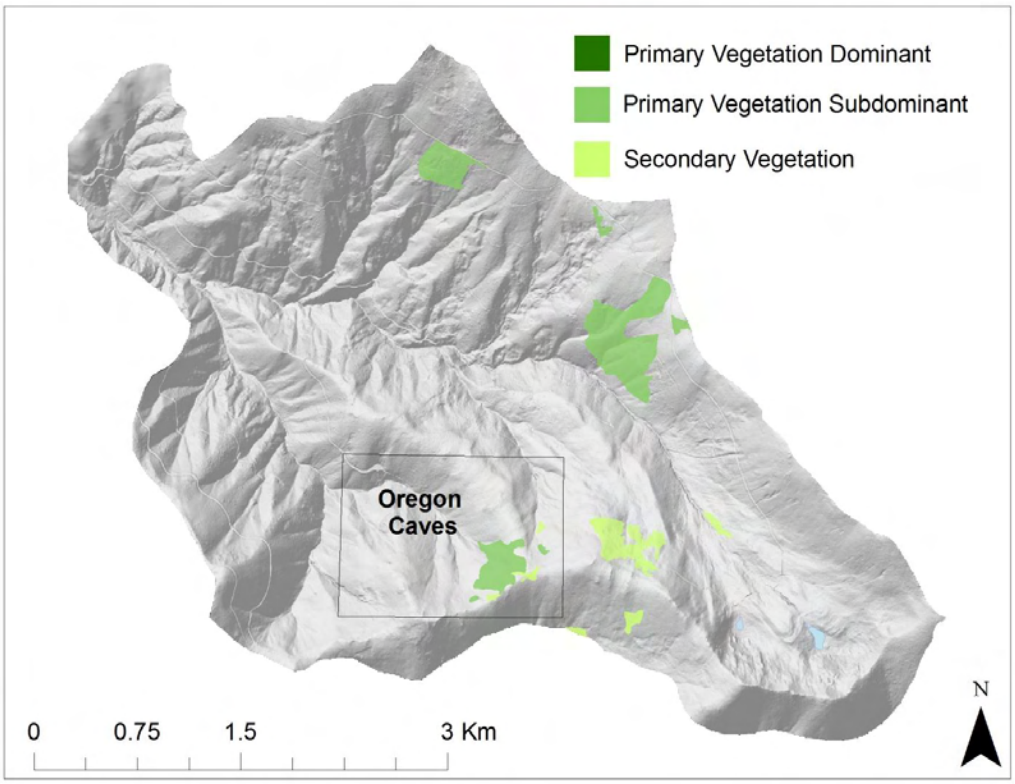
Reason: G3 – Vulnerable. Likely to be widespread in the northern and central Sierra Nevada, but many stands have been logged.

Global Description Author: T. Keeler-Wolf

Global Description References: Fites, J. 1994. Keeler-Wolf, T. et al. 2003a, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 6, 2012).

Association Range and Distribution



***Abies concolor / Agastache urticifolia* association.** Relevé 38**,** elevation 1513 m. This area shows conifer encroachment into herbaceous meadows. Patches of *A. concolor and Pseudotsuga menziesii* are juxtaposed with *A. urticifolia.*

***Abies concolor / Agastache urticifolia* association.** Relevé 56**,** elevation 1540 m. This area shows the interior of a young conifer stand that has established in the herbaceous meadow environment. Foreground species include *Pteridium aquilinum* var. *pubescens* and *Achlys triphylla*.

COMMON NAME: *ABIES CONCOLOR / ACHLYS TRIPHYLLA* ASSOCIATION

SYNONYMS
USNVC English Name: White Fir / Starflower False Solomon's-seal Forest

USNVC Scientific Name: *Abies concolor / Maianthemum stellatum* Forest

USNVC Identifier: CEGL000025

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Southern Vancouverian Montane & Foothill Forest
Group: *Calocedrus decurrens - Pinus lambertiana - Pinus jeffreyi* Forest & Woodland Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs on middle slopes, high slopes, and summits at high elevations within Oregon Caves National Monument and proposed expansion area. Soil texture is loam or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1578	25	275	71
Range	1461 - 1732	1 - 55	184 - 22	25 - 92

Vegetation Description: This upland conifer forest association has a multilayered canopy with white fir (*Abies concolor*) the dominant tree in the overstory and understory. Large emergent Douglas-fir (*Pseudotsuga menziesii*) trees often occur above the canopy of white fir. Broad-leaved evergreen species are rare or absent. Woody species are uncommon in the understory, but the shrub beaked hazelnut (*Corylus cornuta*) is sometimes present. The herbaceous layer has moderately high cover of widespread closed forest species such as red baneberry (*Actea rubra*), American trailplant (*Adenocaulon bicolor*), and sweet after death (*Achlys triphylla*), as well as the grass Chinook brome (*Bromus laevipes*)**.**

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Abies concolor* (white fir)	5-30	21
		Pseudotsuga menziesii (Douglas-fir)	0-20	7.14
		Calocedrus decurrens (incense cedar)	0-20	5.86
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Abies concolor* (white fir)	2-15	8.86
Herb	Perennial herb	*Achlys triphylla* (sweet after death)	1-15	6
		Maianthemum stellatum (starry false lily of the valley)	0.5-15	5.86
		Vancouveria hexandra (white insideout flower)	0.5-15	4.71

	Actaea rubra (red baneberry)	0-15	4.29
	Tiarella trifoliata var. *unifoliata* (oneleaf foamflower)	0-15	3.43
	Adenocaulon bicolor (American trailplant)	0.5-15	3.14
	Osmorhiza chilensis (sweetcicely)	0.5-15	2.43
	Galium triflorum (fragrant bedstraw)	0.5-5	1.36
Graminoid	*Bromus laevipes* (Chinook brome)	0.5-15	3.71

Species Richness:

Plot Species Richness Average	42.14
Plot Species Richness Range	32 - 48
Total Species Richness (all plots)	101

Diagnostic species: *Bromus laevipes.*
Constant species: *Abies concolor, Achlys triphylla, Adenocaulon bicolor, Bromus laevipes, Galium triflorum, Maianthemum stellatum, Osmorhiza chilensis, Vancouveria hexandra.*
Other Noteworthy Species: *Calocedrus decurrens, Actaea rubra.*
Local Range: This association occurs within the proposed expansion area below 1800 m. This association likely occurs elsewhere in the Siskiyou Mountains at middle elevations.
Classification Comments: The selection of the USNVC *Abies concolor / Maianthemum stellatum* Forest association as analogous to this local type may not be accurate. The USNVC association lacks vegetation and environmental information necessary to make an informed determination. This local association may instead be similar to the *Pseudotsuga menziesii - Abies concolor - Calocedrus decurrens* Forest (CEGL005813) in the USNVC database, although the described range does not overlap with that of this local association (NatureServe 2011). This local association is also similar to the *Abies concolor - Pseudotsuga menziesii* Forest Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011, Sawyer et al. 2009.
Plots: Relevés 13, 34, 41, 67, 103, 107, 114.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Not available.
Vegetation Description: Not available.
Characteristic Species: Not available.
USFWS Wetland System: The USFWS Wetland Inventory (1996 national list) lists *Abies concolor* as an UPL (obligate upland) plant (Sawyer et al. 2009).

DISTRIBUTION

Range: United States.
States/Provinces: CA?, OR.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

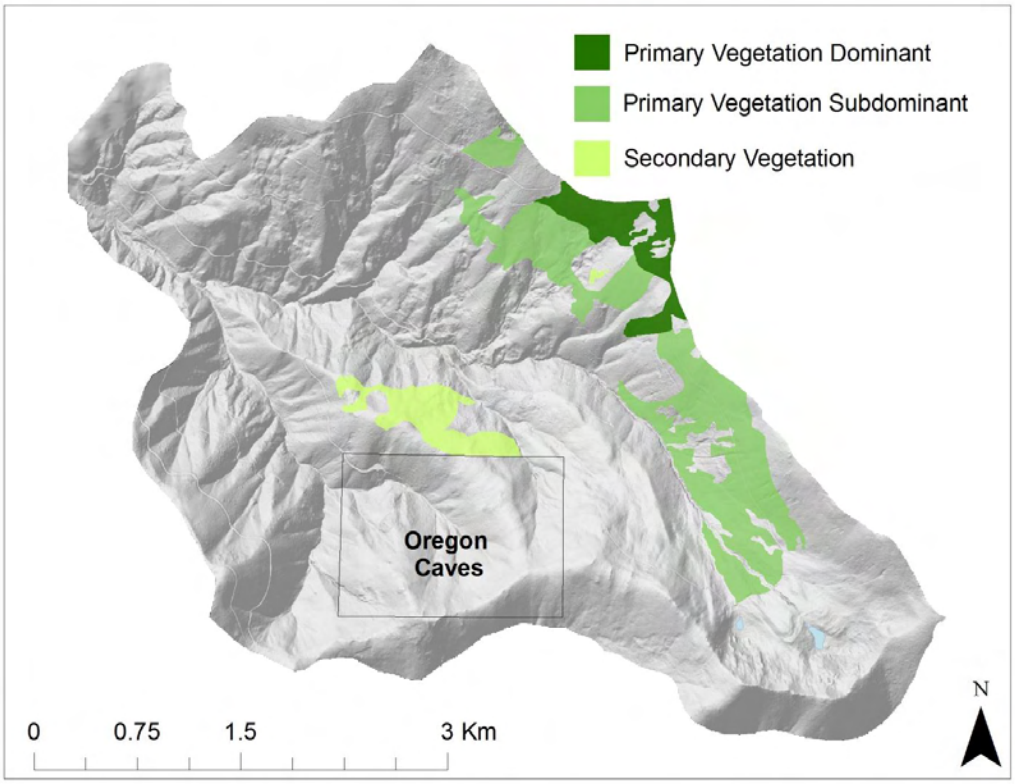
CONSERVATION STATUS
Rank: G3Q (01Feb1996).
Reason: G3 – Vulnerable.

Global Description Author: Western Ecology Working Group

Global Description References: Atzet, T., and D. L. Wheeler. 1984, Bourgeron, P. S., and L. D. Engelking, ed. 1994, Driscoll, R. S. et al. 1984, Kagan, J. S. et al. 2000-2004. Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 7, 2012).

Association Range and Distribution



***Abies concolor / Achlys triphylla* association.** Relevé 107, elevation 1538 m. *A. concolor* and *A. triphylla* dominate this plot in the overstory and understory respectively. *A. concolor* is the only tree species present. *Vancouveria hexandra* is abundant in the understory with *A. triphylla*.

COMMON NAME: ***PSEUDOTSUGA MENZIESII - ABIES CONCOLOR / MAHONIA NERVOSA*** **ASSOCIATION**

SYNONYMS
USNVC English Name: White Fir - Douglas-fir / Dwarf Oregon-grape Forest

USNVC Scientific Name: ***Abies concolor - Pseudotsuga menziesii / Mahonia nervosa*** **Forest**

USNVC Identifier: CEGL000019

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Southern Vancouverian Montane & Foothill Forest
Group: *Calocedrus decurrens - Pinus lambertiana - Pinus jeffreyi* Forest & Woodland Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs on middle and high slopes at middle elevations in the Oregon Caves National Monument and proposed expansion area. Soil texture is loam, clay loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1405	26	74	66
Range	1272 - 1575	12 - 45	300 - 230	45 - 86

Vegetation Description: This association is a closed canopy, dense, multilayered forest with scattered gaps. Emergent Douglas-fir (*Pseudotsuga menziesii*) protrude above a Douglas-fir dominant overstory with white fir (*Abies concolor*) often present. Douglas-fir and white fir are also common in the midstory. Broad-leaved evergreen trees are rare or absent as are shrubs, although wood rose (*Rosa gymnocarpa*) and California hazelnut (*Corylus cornuta* var. *californica*) are sometimes present. The herbaceous layer has moderately high cover with widespread closed forest species such as red baneberry (*Actea rubra*), American trailplant (*Adenocaulon bicolor*), and sweet after death (*Achlys triphylla*). Pale bellflower (*Campanula scouleri*) may be abundant. There is little or no Chinook brome (*Bromus laevipes*) that characterizes the *Abies concolor / Achlys triphylla* association in this classification**.**

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved	*Pseudotsuga menziesii* (Douglas-fir)	0-25	14.77
	evergreen tree	*Abies concolor* (white fir)	0-30	8.5
Shrub/sapling	Needle-leaved	*Abies concolor* (white fir)	2-33.5	14.36
(tall and short)	evergreen shrub	*Pseudotsuga menziesii* (Douglas-fir)	0-23.5	8.81

	Broad-leaved evergreen shrub	*Mahonia nervosa* (Cascade barberry)	0-15	3.55
		Whipplea modesta (common whipplea)	0-5	1.59
	Broad-leaved deciduous shrub	*Rosa gymnocarpa* (wood rose)	0-7	1.68
Herb	Perennial herb	*Achlys triphylla* (sweet after death)	0-50	9.55
		Campanula scouleri (pale bellflower)	0-50	4.09
		Maianthemum stellatum (starry false lily of the valley)	0-15	2.55
		Actaea rubra (red baneberry)	0-15	2.23
		Adenocaulon bicolor (American trailplant)	0-15	1.73
		Vancouveria hexandra (white insideout flower)	0-5	1.5
		Trientalis borealis ssp. *latifolia* (broadleaf starflower)	0.5-5	1.14
	Fern or fern ally	*Polystichum munitum* (western swordfern)	0-15	1.18

Species Richness:

Plot Species Richness Average	35.9
Plot Species Richness Range	29 - 46
Total Species Richness (all plots)	107

Diagnostic species: *Mitella trifida* (uncommon), *Calypso bulbosa* (uncommon).
Constant species: *Abies concolor, Pseudotsuga menziesii, Trientalis borealis* ssp. *latifolia.*
Other Noteworthy Species: *Achlys triphylla, Campanula scouleri.*
Local Range: This association is widespread within the Oregon Caves National Monument and the proposed expansion area below 1800 m. This association likely occurs elsewhere in the Siskiyou Mountains at middle elevations.
Classification Comments: The selection of the USNVC *Abies concolor - Pseudotsuga menziesii / Mahonia nervosa* Forest association as analogous to this local association may not be accurate. The USNVC association lacks vegetation and environmental information necessary to make an informed determination (NatureServe 2011). This local association is similar to the *Abies concolor - Pseudotsuga menziesii* Forest Alliance in A Manual of California Vegetation (Sawyer et al. 2009).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011, Sawyer et al. 2009.
Plots: Relevés 4, 43, 82, 83, 84, 85, 91, 92, 97, 109, 110.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: Not available.
Vegetation Description: Not available.
Characteristic Species: Not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: United States.

States/Provinces: CA?, OR.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

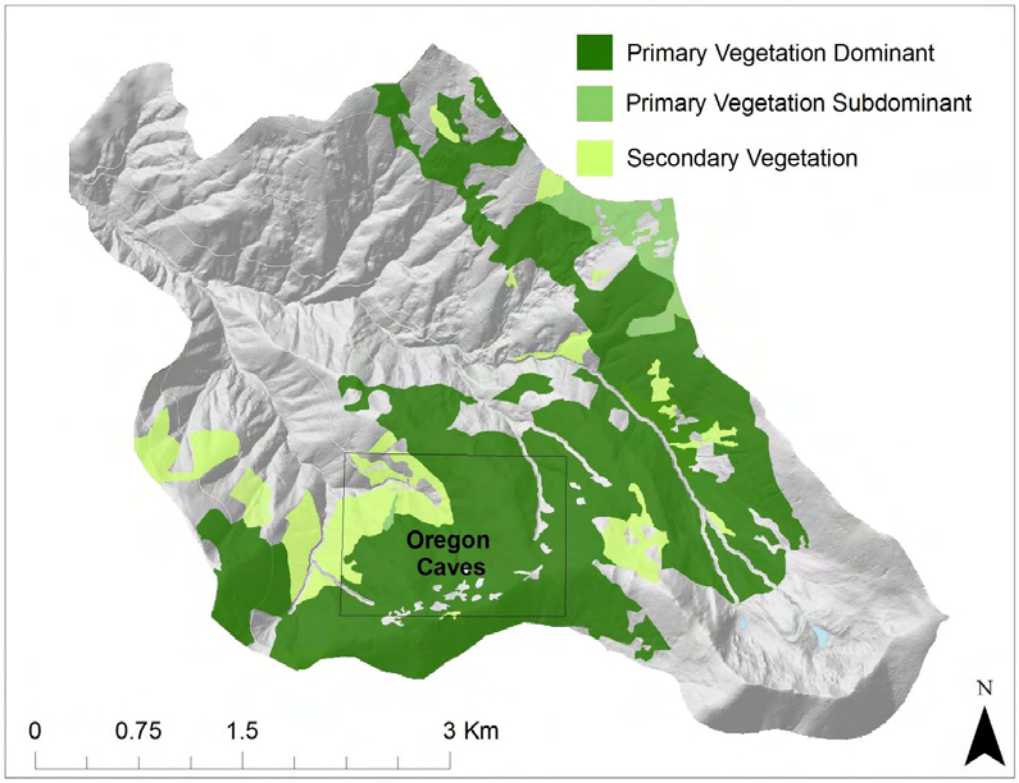
CONSERVATION STATUS
Rank: G4 (01Feb1996).
Reason: G4 - Apparently Secure.

Global Description Author: Western Ecology Working Group

Global Description References: Atzet, T., and D. L. Wheeler. 1984, Bourgeron, P. S., and L. D. Engelking, ed. 1994, Driscoll, R. S. et al. 1984, Kagan, J. S. et al. 2000-2004. Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 7, 2012).

Association Range and Distribution



***Pseudotsuga menziesii - Abies concolor / Mahonia nervosa* association.** Relevé 92, elevation 1531 m. Both dense forest and a typical canopy gap are shown here. The overstory is dominated by both *P. menziesii* and *A. concolor.* The understory is dominated by *Achyls triphylla*, *Anemone deltoidea,* and *Rosa gymnocarpa.* Abundant down wood in various stages of decay is characteristic of this association.

***Pseudotsuga menziesii - Abies concolor / Mahonia nervosa* association.** Relevé 4, elevation 1292 m. *P. menziesii* and *A. concolor* are equally abundant in this plot. The understory is dominated by *Achlys triphylla* and *Adenocaulon bicolor*. Down wood is characteristically abundant.

COMMON NAME: *ABIES MAGNIFICA X PROCERA* ASSOCIATION

SYNONYMS
USNVC English Name: California Red Fir / Sparse Understory Forest

USNVC Scientific Name: *Abies magnifica* / Sparse Understory Forest

USNVC Identifier: CEGL008609

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Vancouverian Subalpine Forest
Group: *Abies magnifica - Abies X shastensis* Forest Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs on middle and high slopes of moderate to steep relief at high elevations. Soils are granitic in origin. Soil texture is loam, sandy loam, silt loam, or loamy sand. Rocks are common.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1823	26	135	66
Range	1667 - 1912	18 - 35	6 - 260	40 - 78

Vegetation Description: This association is a closed, multistory upland coniferous forest. Conifers other than Shasta red fir (Abies magnifica x procera) are rare, but mountain hemlock (*Tsuga mertensiana*) and white fir (*Abies concolor*) are sometimes present. Shrubs are scattered in the understory with deer oak (*Quercus sadleriana*) occasional in openings. Openings around rocks support penstemon species (*Penstemon* spp.). The herbaceous layer under the tree canopy is very sparse, but starry false lily of the valley (*Maianthemum stellatum*) and whiteveined wintergreen (*Pyrola picta*) are frequent.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Abies magnifica x procera* (Shasta red fir)	2-57.5	20.16
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Abies magnifica x procera* (Shasta red fir)	0.5-23.5	9.67
		Abies concolor (white fir)	0.5-10.5	4.67
	Broad-leaved deciduous shrub	*Symphoricarpos albus* (common snowberry)	0-5	1.3
Herb	Sub-shrub	*Agastache urticifolia* (nettleleaf giant hyssop)	0-5	1.3
	Perennial herb	*Osmorhiza chilensis* (sweetcicely)	0-5	1.75

	Maianthemum stellatum (starry false lily of the valley)	0-5	1.5
Fern or fern ally	*Pteridium aquilinum* var. *pubescens* (western brackenfern)	0-5	1.25

Species Richness:

Plot Species Richness Average	22.3
Plot Species Richness Range	7 - 51
Total Species Richness (all plots)	79

Diagnostic species: *Abies magnifica x procera* (at high cover).
Constant species: *Abies magnifica x procera*.
Other Noteworthy Species: None.
Local Range: This association occurs in the proposed expansion area at high elevations (> 1700 m) above the Bigelow Basin. This association likely occurs outside the proposed expansion area near the summits of the highest peaks across the Siskiyou Mountains.
Classification Comments: Recent molecular research by David K. Oline (pers. com.; Oline 2008) reveals a broad region in the Southern Cascade Range, the Klamath, and the Siskiyou mountains at the intersection of the ranges of *Abies procera* and *Abies magnifica* where populations are composed of the hybrid *Abies procera* x *magnifica*. The taxon *A. magnifica* var. *shastensis* had previously been attributed to individuals from this region. The two progenitor species are nearly identical morphologically and occupy very similar ecological zones. As a result, the USNVC *Abies magnifica* / Sparse Understory Forest association is selected as analogous to this local association.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: D. K. Oline. 2008.
Plots: Relevés 45, 59, 61, 64, 122, 125.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association is widespread in the central and southern Sierra Nevada in California. It begins to appear above *Abies concolor - Pinus lambertiana* communities at the upper edge of the lower montane. It becomes dominant in the upper montane and gradually diminishes into the subalpine zone above. This association can occur at all elevations of the upper montane. Stands on the east side of the Sierra Nevada generally occur between 2440 and 2806 m (8000-9200 feet) elevation. Aspects are variable, but often northeast and northwest. Slopes range from gentle to steep. Stands are located on all slope positions, except they seldom occur on ridgetops. Microrelief on most sites is smooth and uniform. Soils are derived primarily from granite, with some volcanic in origin. Other parent materials are rare. Soils are significantly deeper than other sites and are usually sandy loams. Soils are typically well-drained. The environment of this association is characterized by significantly lower levels of bare ground and surface gravel than most other association have, and litter cover and depth are significantly higher, reflecting the characteristic high levels of tree cover and debris on the forest floor.

Vegetation Description: Stands are characteristically dense multi-layered forests with little ground cover. Total tree cover is one of the highest in the upper montane of the Sierra Nevada. The overstory is dominated by a single tree species, *Abies magnifica*. Understories are sparse; shrub and herb layers are essentially absent. In rare cases, *Chrysolepis sempervirens, Arctostaphylos nevadensis, Quercus vacciniifolia*, and *Ceanothus cordulatus* may be present in substantial amounts to indicate drier sites. *Ceanothus cordulatus*, while infrequent, is important in the understory due to its ability to rapidly occupy disturbed sites. The herb layer may contain *Corallorhiza maculata, Pedicularis semibarbata*, and *Pyrola picta*. *Abies magnifica* is the major regenerating species.

Characteristic Species: *Abies magnifica.*
USFWS Wetland System: The USFWS Wetland Inventory (1996 national list) recognizes *Abies magnifica* as an FACU (Facultative Upland) plant. (Sawyer et al. 2009).

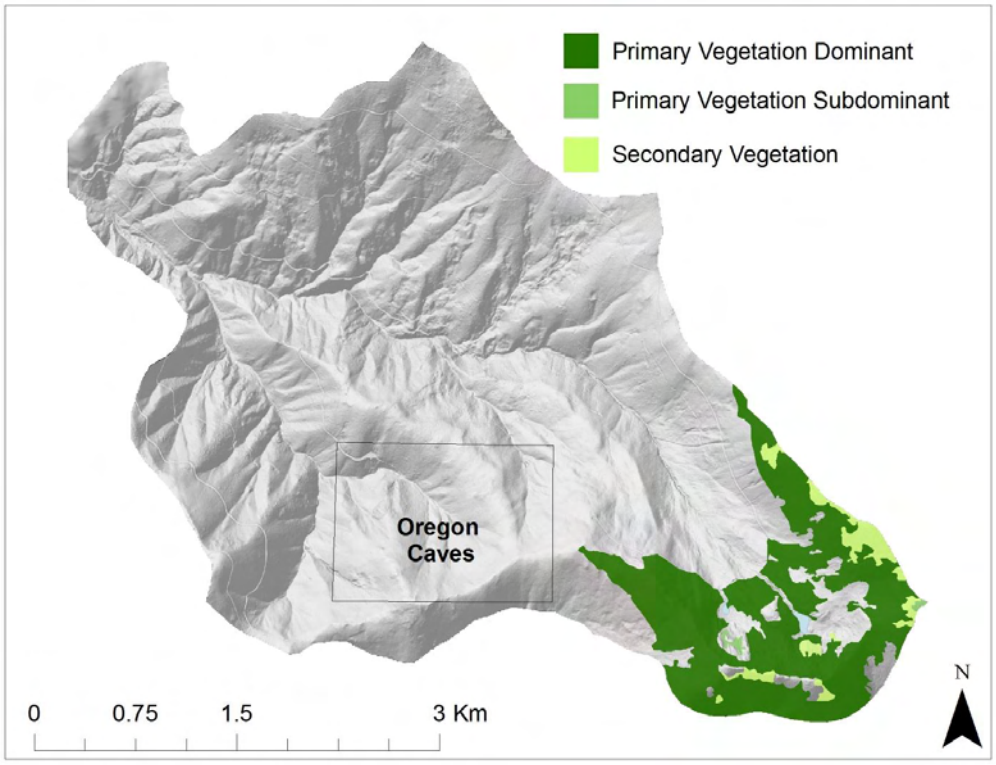
DISTRIBUTION
Range: United States.
States/Provinces: CA.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

CONSERVATION STATUS
Rank: G4 (03May2002).
Reason: G4 - Apparently Secure .
Reasons: This is probably the most extensive association in the *Abies magnifica* alliance. Individual stands range from smaller than 5 acres to extensive tracts covering large areas. Usually, however, single stands are of moderate size with many occupying less than 100 acres.

Global Description Author: T. Keeler-Wolf
Global Description References: Keeler-Wolf, T. 2002, Keeler-Wolf, T. et al. 2003a, Potter, D. A. 1998, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 8, 2012).

Association Range and Distribution



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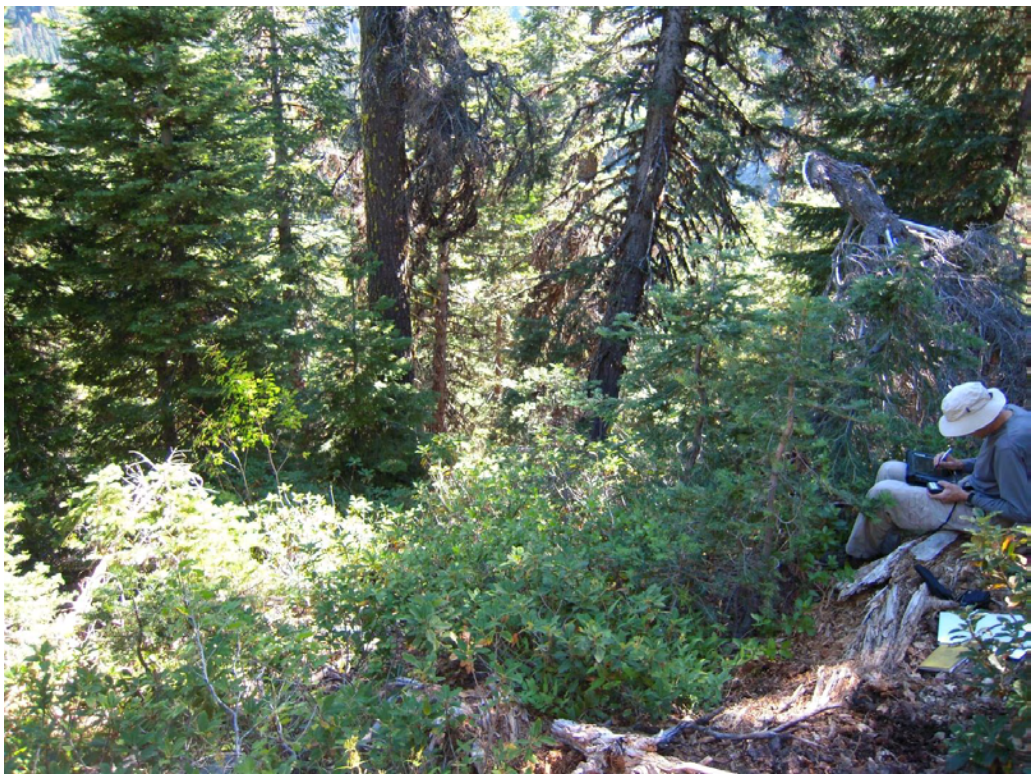


***Abies magnifica x procera* association**. Relevé 122, elevation 1818 m. Small gaps in *A. magnifica x procera* forests, such as the one shown here, are common. This one is dominated by *Quercus sadleriana*. Down wood is also abundant. Low growing vegetation is mostly confined to these gaps.

COMMON NAME: *TSUGA MERTENSIANA - ABIES MAGNIFICA X PROCERA* ASSOCIATION

SYNONYMS
USNVC English Name: Mountain Hemlock / Sparse Understory Forest

USNVC Scientific Name: *Tsuga mertensiana* / Sparse Understory Forest

USNVC Identifier: CEGL008685

USNVC CLASSIFICATION:
Formation Class: 1 - Forest & Woodland
Formation Subclass: 1.B - Temperate & Boreal Forest
Formation: 1.B.2 - Cool Temperate Forest
Division: 1.B.2.Nb - Western North American Cool Temperate Forest
Macrogroup: Vancouverian Subalpine Forest
Group: *Tsuga mertensiana - Pinus contorta* var. *murrayana* Forest Group
Alliance: Alliances are under review.

LOCAL INFORMATION

Environmental Description: This association occurs on high slopes with north to northeast aspects and on summits at high elevations in the Oregon Caves National Monument and proposed expansion area. Soil texture is loam, sandy loam, or silt loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1859	26.5	21	62
Range	1811 - 1922	12 - 40	320 - 75	48 - 80

Vegetation Description: This association is a mostly dense, closed-canopy forest with an average overstory DBH of 70 cm. Mountain hemlock (*Tsuga mertensiana*) is generally about three times more abundant than its main overstory associate, Shasta red fir (*Abies magnifica* x *procera*). There is little or no shrub layer except the low shrub ground gooseberry (*Ribes binominatum*). The sparse herb layer is dominated by broadleaf arnica (*Arnica latifolia*), Sitka valerian (*Valeriana sitchensis*), sidebells wintergreen (*Orthilla secunda*), and roughfruit berry (*Rubus lasiococcus*).

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Tsuga mertensiana* (mountain hemlock)	5-20	12.5
		Abies magnifica x *procera* (Shasta red fir)	0-15	5
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Abies magnifica* x *procera* (Shasta red fir)	0.5-30	14
		Tsuga mertensiana (mountain hemlock)	4-22	13.25
	Broad-leaved evergreen shrub	*Quercus sadleriana* (deer oak)	0-15	3.5
	Broad-leaved deciduous shrub	*Ribes binominatum* (ground gooseberry)	0.5-15	3.88

Herb	Sub-shrub	*Pedicularis racemosa* (sickletop lousewort)	0-15	5.13
		Rubus lasiococcus (roughfruit berry)	0.5-15	4.75
		Orthilia secunda (sidebells wintergreen)	0-15	3
		Nothochelone nemorosa (woodland beardtongue)	1-5	2.5
		Pyrola picta (whiteveined wintergreen)	0.5-5	1.25
	Perennial herb	*Hieracium albiflorum* (white hawkweed)	0-15	3.5
		Valeriana sitchensis (Sitka valerian)	0-15	3.25
		Campanula scouleri (pale bellflower)	0-15	2.63
		Moehringia macrophylla (largeleaf sandwort)	0-15	2.63
		Arnica latifolia (broadleaf arnica)	0-5	1.13

Species Richness:

Plot Species Richness Average	26.5
Plot Species Richness Range	16 - 36
Total Species Richness (all plots)	61

Diagnostic species: *Tsuga mertensiana, Arnica latifolia, Valeriana sitchensis.*
Constant species: *Tsuga mertensiana, Abies procera, Nothochelone nemorosa, Pyrola picta, Ribes binominatum, Rubus lasiococcus.*
Other Noteworthy Species: *Orthilla secunda.*
Local Range: This association occurs in the proposed expansion area at high elevations (> 1700 m) above the Bigelow Basin. This association likely occurs outside the proposed expansion area near the summits of the highest peaks in the central and eastern Siskiyou Mountains.
Classification Comments: The USNVC *Tsuga mertensiana* / Sparse Understory Forest association is selected as analogous to this local association, however, the range of the USNVC association does not overlap with the local association and the characteristic species *Pinus contorta* var. *murrayana* of the USNVC association is absent in the local association. This local association is similar to the *Tsuga mertensiana / Quercus sadleriana / Orthilia secunda* Forest (CEGL000123) in the USNVC database due to it having a limited range overlapping with the project area and the association of *T. mertensiana* and *O. secunda*. However, it is not selected as analogous to the association type presented here because the associated species *Q. sadleriana*, while abundant, is not frequent across sample plots. This *Tsuga mertensiana / Quercus sadleriana / Orthilia secunda* Forest USNVC type lacks vegetation and environmental information necessary to make an informed determination (NatureServe 2011).
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Local Description References: NatureServe. 2011.
Plots: Relevés 48, 49, 119, 124.
Oregon Caves National Monument Inventory Notes: None.

GLOBAL INFORMATION

GLOBAL DESCRIPTION

Environmental Description: This association is found at mid to high elevations (2255-2990 m [7400-9800 feet]) on gentle to somewhat steep (2-29%) slopes. Aspect varies but is often on northeast-facing slopes. Microrelief is usually broken and hummocky. Sites are found on lower to upper portions of slopes and rarely, are on ridgetops. Soils are typically from granitic parent

material, however, some stands to the north are derived from volcanic or mixed lithology. These soils are typically greater that 63.5 cm (25 inches) and occasionally greater than 89 cm (35 inches). Very little bare soil is usually exposed. Soil depths range from 35-100 cm (14-40 inches). Soil textures range from sand to loam and are excessively drained to well drained (Potter 1994, 1998).

Vegetation Description: Stands form a dense forest with an open understory. The tree layer is dominated by *Tsuga mertensiana* mixed with *Abies magnifica*. *Pinus contorta* var. *murrayana* and *Pinus monticola* are also important overstory tree species. The understory layers are typically open. Occasional shrub species may include *Ribes roezlii (= Grossularia roezlii)* and *Ribes montigenum*. Herb species may include *Eucephalus breweri (= Chrysopsis breweri), Hieracium albiflorum, Poa bolanderi*, and *Carex rossii*. Conifer regeneration is high at this association and is dominated by *Abies magnifica* with significantly lower amounts of *Tsuga mertensiana* (Potter 1994, 1998).

Characteristic Species: *Tsuga mertensiana, Abies magnifica, Pinus contorta* var. *murrayana.* USFWS Wetland System: The USFWS Wetland Inventory (1996 national list) recognizes *Tsuga mertensiana* as an FACU+ (Facultative Upland) plant. (Sawyer et al. 2009).

DISTRIBUTION
Range: United States. Stands of this forest are found throughout the Sierra Nevada, however, predominantly north of the Kings River (Potter 1994, 1998).
States/Provinces: CA.
Federal Lands: NPS (Oregon Cave National Monument), USFS (Rogue River-Siskiyou National Forest).

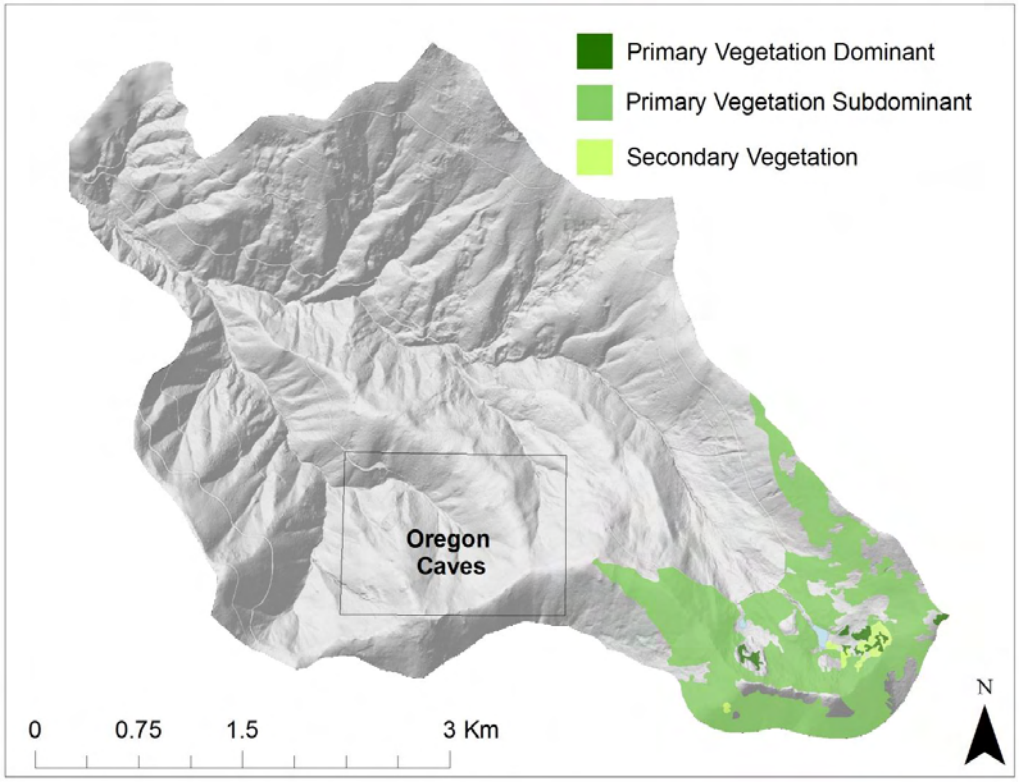
CONSERVATION STATUS
Rank: G3G4 (15Jul2002).
Reason: G3 – Vulnerable. Probably relatively widespread in the subalpine of the northern and central Sierra Nevada.

Global Description Author: T. Keeler-Wolf, mod. M. J. Russo.

Global Description References: Keeler-Wolf, T. 2002, Keeler-Wolf, T. et al. 2003a, Potter, D. A. 1994, Potter, D. A. 1998, Western Ecology Working Group of NatureServe. No date.

All global information from: NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 8, 2012).

Association Range and Distribution



***Tsuga mertensiana - Abies magnifica x procera* association.** Relevé 119, elevation 1922 m. Large *T. mertensiana* with an herbaceous understory (foreground) of *Rubus lasiococcus*, *Vancouveria hexandra*, *Osmorhiza chilensis*, and *Maianthemum racemosum* ssp. *racemosum*.

COMMON NAME: *PSEUDOTSUGA MENZIESII PLANTATION* **ASSOCIATION**

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs over generally large areas (several to many ha) across a variety of elevations and aspects. Topographic positions include lower and middle slopes. Soil texture is loam, sandy loam, silt loam, or clay loam.

	Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
Average	1119	34	134	69
Range	936 - 1438	18 - 49	11 - 250	39 - 90

Vegetation Description: Past clearcutting and replanting of cultivars of even-aged, evenly spaced Douglas-fir (*Pseudotsuga menziesii*) has modified natural vegetation patterns and genetic diversity of this early seral Douglas-fir forest association. Tree heights range from about 5 cm in young plantations up to 50 m in sampled stands having the largest trees. In some areas the plantings have been thinned and the developing forest structure appears more like that of unmanaged stands. In addition to the planted trees, plantations are dominated by resprouting broad-leaved evergreens, particularly tanoak (*Lithocarpus densiflorus*). The shrub layer is also well developed, with a wide variety of species possible, such as canyon live oak (*Quercus chrysolepis* var. *chrysolepis*) and, at low elevations, Ericaceous species such as salal (*Gaultheria shallon*). Wet areas are often dominated by thimbleberry (*Rubus parviflorus*). The herb layer is often well developed and can be quite variable. In wetter areas it is dominated by western swordfern (*Polystichum munitum*) while in drier areas common whipplea (*Whipplea modesta*) predominates. Sweet after death (*Achlys triphylla*) and white insideout flower (*Vancouveria hexandra*) are widespread. The non-native herb common St. Johnswort (*Hypericum perforatum*) is abundant in some areas.

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pseudotsuga menziesii* (Douglas-fir)	0-25	5.71
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Pseudotsuga menziesii* (Douglas-fir)	2-24	13.36
		Abies concolor (white fir)	0-15	3.71
	Broad-leaved evergreen shrub	*Lithocarpus densiflorus* (tanoak)	0-40	24.43
		Quercus chrysolepis var. *chrysolepis* (canyon live oak)	0-20	8.71
		Arbutus menziesii (Pacific madrone)	0-24	7.21
		Gaultheria shallon (salal)	0-20	5.29
		Chrysolepis chrysophylla (giant chinquapin)	0-15	2.43
		Whipplea modesta (common whipplea)	0-5	2.14
	Broad-leaved deciduous shrub	*Amelanchier alnifolia* (Saskatoon serviceberry)	0-15	2.14

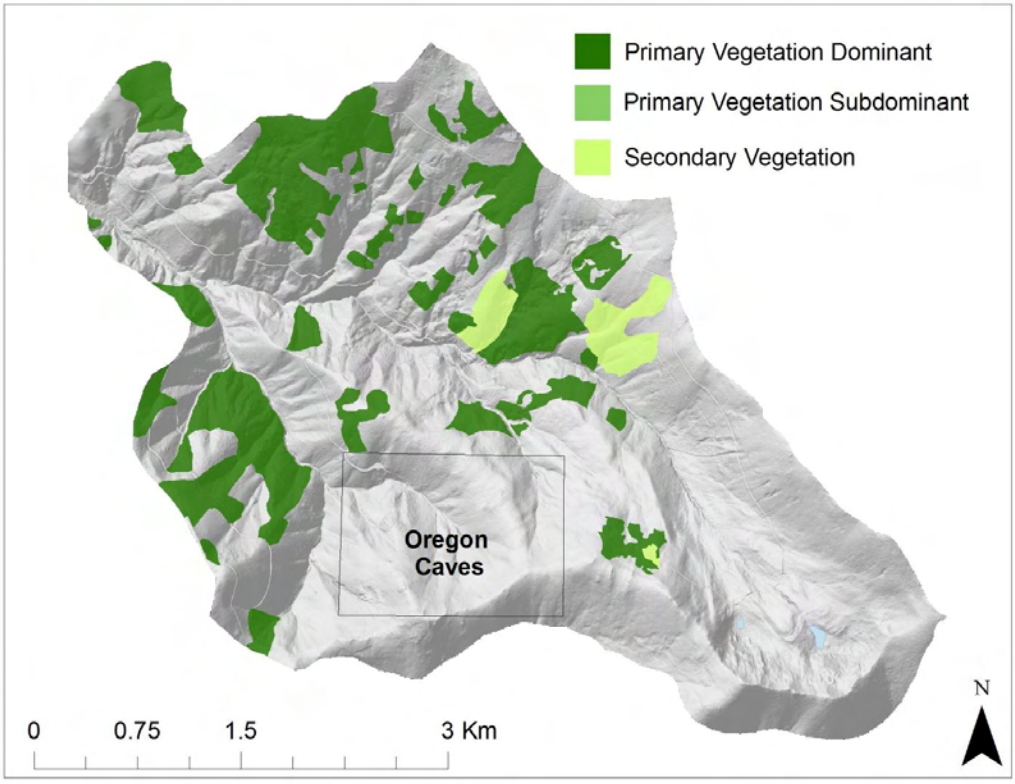
Species Richness:

Plot Species Richness Average	33.29
Plot Species Richness Range	15 - 41
Total Species Richness (all plots)	97

Diagnostic species: None (however, stumps from former forest trees are diagnostic).
Constant species: *Pseudotsuga menziesii*.
Other Noteworthy Species: *Lithocarpus densiflorus.*
Local Range: This association is distributed across the proposed expansion area generally below 1700 m and is widespread in the surrounding region on USFS, BLM and private lands at middle elevations that support dense conifer growth.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevés 3, 22, 23, 28, 30, 33, 104.

Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association present elsewhere in the region. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Pseudotsuga menziesii* plantation association.** Relevé 30, elevation 1126 m. A relatively young *P. menziesii* plantation showing even spacing and consistent size of planted Douglas-fir trees. Resprouting stems of *Lithocarpus densiflorus* are in the immediate foreground.

***Pseudotsuga menziesii* plantation association.** Relevé 54, elevation 1524 m. Interior of a relatively young *P. menziesii* plantation.

***Pseudotsuga menziesii* plantation association.** Relevé 28, elevation 948 m. Interior of a *P. menziesii* plantation. Broad-leaved evergreens include *Arbutus menziesii* and *Lithocarpus densiflorus*.

COMMON NAME: *PINUS PONDEROSA* PLANTATION ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: This vegetation association occurs on previously cut-over lands. Topographic position is midslope. Soil texture is clay loam. This association is characterized from only one sample plot.

Altitude (m)	Slope (degrees)	Aspect (degrees)	Litter Cover (%)
1161	14	226	55

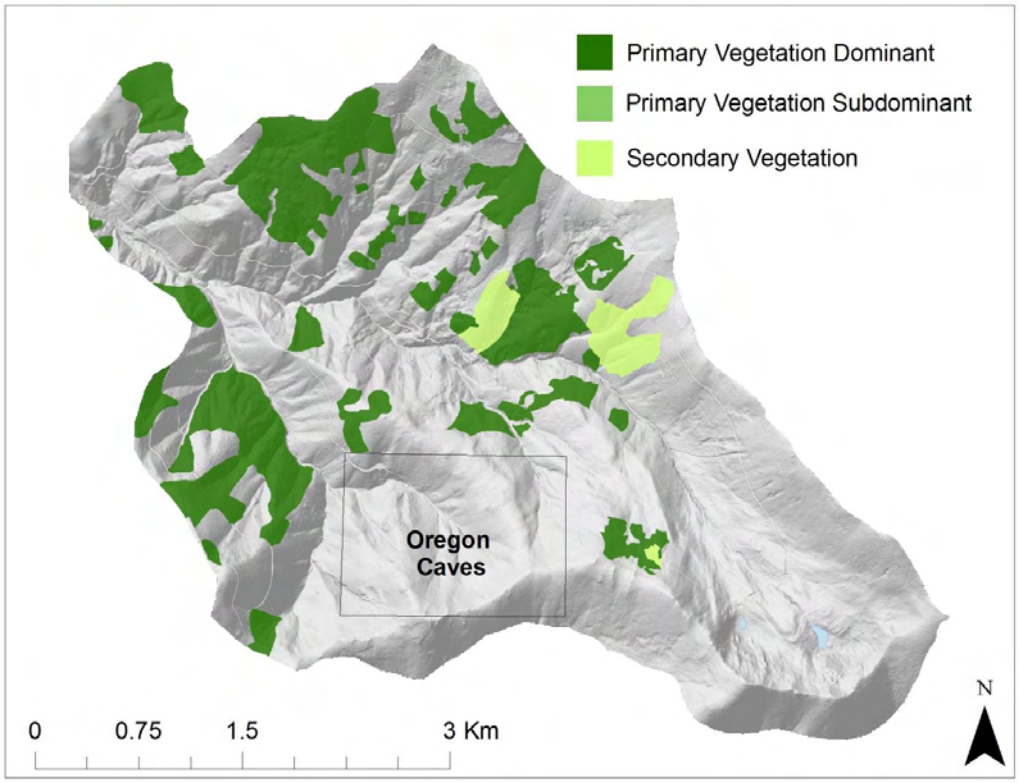
Vegetation Description: This association occurs on previously cut-over lands that now support a relatively open forest with even-aged ponderosa pine (*Pinus ponderosa*) in the overstory. Resprouting broad-leaved evergreen trees, most commonly tanoak (*Lithocarpus densiflorus*) are also in the overstory. The shrub layer may be well developed. Herbs are common. Native grasses such as western fescue (*Festuca occidentalis*), blue wildrye (*Elymus glaucus*), and Alaska oniongrass (*Melica subulata* var. *subulata*) dominate the herbaceous layer along with the creeping shrub, common whipplea (*Whipplea modesta*).

Most Abundant Species:

Stratum	Lifeform	Species	Cover Range (%)	Average Cover (%)
Tree	Needle-leaved evergreen tree	*Pinus ponderosa* (ponderosa pine)	5-15	10
		Abies concolor (white fir)	1-2	1.5
Shrub/sapling (tall and short)	Needle-leaved evergreen shrub	*Pinus ponderosa* (ponderosa pine)	2-5	3.5
		Pseudotsuga menziesii (Douglas-fir)	2-5	3.5
	Broad-leaved evergreen shrub	*Lithocarpus densiflorus* (tanoak)	5-15	10
	Broad-leaved deciduous shrub	*Whipplea modesta* (common whipplea)	5-15	10
		Rubus ursinus (California blackberry)	2-5	3.5
Herb	Perennial vine	*Vicia americana* ssp. *americana* (American vetch)	2-5	3.5
	Graminoid	*Elymus glaucus* (blue wildlye)	5-15	10
		Festuca occidentalis (western fescue)	5-15	10
		Melica subulata var. *subulata* (Alaska oniongrass)	5-15	10
		Dactylis glomerata ssp. *glomerata* (orchardgrass)	2-5	3.5

Diagnostic species: *Pinus ponderosa* (in overstory).
Constant species: *Pinus ponderosa, Lithocarpus densiflorus, Whipplea modesta, Festuca occidentalis, Elymus glaucus, Melica subulata* var. *subulata*.
Other Noteworthy Species: None.
Species Richness of Sample Plot: 25
Local Range: This association is distributed across the proposed expansion area generally below 1700 m and is widespread in the surrounding region on USFS, BLM, and private lands at middle elevations that support dense conifer growth.
Classification Comments: This association is not common in Oregon Caves National Monument and proposed expansion area. Only one stand was sampled. More sample plots are needed to adequately describe this association.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: Relevé 75.
Oregon Caves National Monument Inventory Notes: Not treated in the USNVC database. This is potentially a distinct vegetation association. Further investigation is recommended to determine if this is a distinct vegetation association.

Association Range and Distribution



***Pinus ponderosa* plantation association.** Relevé 75, elevation 1161 m. Open pine stand. Graminoids in the understory include *Melica subulata* var. *subulata* and *Festuca occidentalis.* Also abundant in the ground layer is *Whipplea modesta.*

COMMON NAME: LANDING AREA ASSOCIATION

SYNONYMS
USNVC English Name: Park specific vegetation association.

USNVC Scientific Name: N/A

USNVC Identifier: N/A

USNVC CLASSIFICATION: Not treated in the USNVC database.

LOCAL INFORMATION

Environmental Description: A few small, barren areas graded for use by log trucks and for stacking cut trees onto log decks.

Vegetation Description: This association is dominated by non-native herbaceous species such as common St. Johns wort (*Hypericum perforatum*) and cheatgrass (*Bromus tectorum*). Native species are also present and scattered, such as young greenleaf manzanita (*Arctostaphylos patula*) and snowbush ceanothus (*Ceanothus velutinus* var. *velutinus*).

Diagnostic species: Dominance by non-native species.
Constant species: *Hypericum perforatum.*
Other Noteworthy Species: None.
Local Range: This association is distributed across the proposed expansion area generally below 1700 m and is widespread in the surrounding region on USFS, BLM, and private lands at middle elevations that support dense conifer growth.
Classification Comments: None.
Other Comments: None.
Local Description Authors: D. A. DiPaolo and D. C. Odion.
Plots: 0 (Species list prepared).
Oregon Caves National Monument Inventory Notes: None.

NO RANGE MAP AVAILABLE

Appendix D. Species List

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Abies concolor	white fir	Pinaceae	Native	88
Abies grandis	grand fir	Pinaceae	Native	4
Abies procera	Shasta red fir	Pinaceae	Native	23
Acer circinatum	vine maple	Aceraceae	Native	2
Acer glabrum	Rocky Mountain maple	Aceraceae	Native	19
Acer macrophyllum	bigleaf maple	Aceraceae	Native	19
Achillea millefolium	common yarrow	Asteraceae	Native	51
Achlys triphylla	sweet after death	Berberidaceae	Native	66
Achnatherum lemmonii	Lemmon's needlegrass	Poaceae	Native	3
Achnatherum occidentale	western needlegrass	Poaceae	Native	3
Aconitum columbianum ssp. *viviparum*	Columbian monkshood	Ranunculaceae	Native	7
Actaea rubra	red baneberry	Ranunculaceae	Native	27
Adenocaulon bicolor	American trailplant	Asteraceae	Native	40
Adiantum aleuticum	Aleutian maidenhair	Pteridaceae	Native	2
Agastache urticifolia	nettleleaf giant hyssop	Lamiaceae	Native	27
Agoseris grandiflora	bigflower agoseris	Asteraceae	Native	3
Agrostis humilis	alpine bentgrass	Poaceae	Native	2
Aira caryophyllea	silver hairgrass	Poaceae	Introduced	3
Allium validum	Pacific onion	Liliaceae	Native	2
Allotropa virgata	sugarstick	Monotropaceae	Native	3
Alnus incana ssp. *tenuifolia*	thinleaf alder	Betulaceae	Native	9
Alnus rhombifolia	white alder	Betulaceae	Native	3
Alnus viridis ssp. *sinuata*	Sitka alder	Betulaceae	Native	2
Amelanchier alnifolia	Saskatoon serviceberry	Rosaceae	Native	29

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Anaphalis margaritacea	western pearly everlasting	Asteraceae	Native	5
Anemone deltoidea	Columbian windflower	Ranunculaceae	Native	28
Angelica arguta	Lyall's angelica	Apiaceae	Native	6
Antennaria argentea	silver pussytoes	Asteraceae	Native	2
Apocynum androsaemifolium	spreading dogbane	Apocynaceae	Native	11
Aquilegia formosa	western columbine	Ranunculaceae	Native	11
Arabis drummondii	Drummond's rockcress	Brassicaceae	Native	2
Arabis glabra	tower rockcress	Brassicaceae	Native	1
Arabis holboellii var. *retrofracta*	second rockcress	Brassicaceae	Native	2
Arbutus menziesii	Pacific madrone	Ericaceae	Native	33
Arctostaphylos canescens	hoary manzanita	Ericaceae	Native	2
Arctostaphylos nevadensis	pinemat manzanita	Ericaceae	Native	5
Arctostaphylos patula	greenleaf manzanita	Ericaceae	Native	18
Arctostaphylos viscida	sticky whiteleaf manzanita	Ericaceae	Native	4
Arenaria congesta	ballhead sandwort	Caryophyllaceae	Native	6
Arnica latifolia	broadleaf arnica	Asteraceae	Native	4
Artemisia douglasiana	Douglas' sagewort	Asteraceae	Native	5
Asarum caudatum var. *caudatum*	British Columbia wildginger	Aristolochiaceae	Native	24
Asarum hartwegii	Hartweg's wildginger	Aristolochiaceae	Native	6
Asarum marmoratum	marbled wildginger	Aristolochiaceae	Native	6
Aspidotis densa	Indian's dream	Pteridaceae	Native	2
Aster breweri	Brewer's aster	Asteraceae	Native	6
Aster foliaceus	alpine leafybract aster	Asteraceae	Native	7
Aster integrifolius	thickstem aster	Asteraceae	Native	4
Aster radulinus	roughleaf aster	Asteraceae	Native	18
Athyrium filix-femina	common ladyfern	Dryopteridaceae	Native	10

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Boschniakia hookeri	Vancouver groundcone	Orobanchaceae	Native	2
Boschniakia strobilacea	California groundcone	Orobanchaceae	Native	8
Botrychium multifidum	leathery grapefern	Ophioglossaceae	Native	1
Boykinia major	large boykinia	Saxifragaceae	Native	6
Boykinia occidentalis	coastal brookfoam	Saxifragaceae	Native	2
Bromopsis suksdorfii	Suksdorf's brome	Poaceae	Native	1
Bromopsis vulgaris	Columbia brome	Poaceae	Native	2
Bromus carinatus	California brome	Poaceae	Native	7
Bromus inermis	smooth brome	Poaceae	Native	2
Bromus laevipes	Chinook brome	Poaceae	Native	22
Bromus orcuttianus	Orcutt's brome	Poaceae	Native	1
Bromus pacificus	Pacific brome	Poaceae	Native	2
Bromus suksdorfii	Suksdorf's brome	Poaceae	Native	1
Bromus tectorum	cheatgrass	Poaceae	Native	4
Calocedrus decurrens	incense cedar	Cupressaceae	Native	37
Calochortus elegans	elegant mariposa lily	Liliaceae	Native	3
Caltha leptosepala	white marsh marigold	Ranunculaceae	Native	10
Calypso bulbosa	fairy slipper	Orchidaceae	Native	5
Calyptridium umbellatum	Mt. Hood pussypaws	Portulacaceae	Native	3
Calystegia occidentalis	chaparral false bindweed	Convolvulaceae	Native	2
Campanula prenanthoides	California harebell	Campanulaceae	Native	16
Campanula scouleri	pale bellflower	Campanulaceae	Native	40
Cardamine oligosperma	little western bittercress	Brassicaceae	Native	7
Carex aquatilis var. *dives*	Sitka sedge	Cyperaceae	Native	6
Carex athrostachya	slenderbeak sedge	Cyperaceae	Native	1
Carex brainerdii	Brainerd's sedge	Cyperaceae	Native	2

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Carex echinata ssp. *echinata*	star sedge	Cyperaceae	Native	5
Carex exsiccata	western inflated sedge	Cyperaceae	Native	2
Carex geyeri	Geyer's sedge	Cyperaceae	Native	1
Carex hoodii	Hood's sedge	Cyperaceae	Native	1
Carex jonesii	Jones' sedge	Cyperaceae	Native	0
Carex lenticularis	lakeshore sedge	Cyperaceae	Native	2
Carex leptopoda	taperfruit shortscale sedge	Cyperaceae	Native	12
Carex luzulina	woodrush sedge	Cyperaceae	Native	7
Carex mertensii	Mertens' sedge	Cyperaceae	Native	1
Carex multicostata	manyrib sedge	Cyperaceae	Native	1
Carex pachystachya	chamisso sedge	Cyperaceae	Native	3
Carex preslii	Presl's sedge	Cyperaceae	Native	1
Carex rossii	Ross' sedge	Cyperaceae	Native	1
Carex spectabilis	showy sedge	Cyperaceae	Native	3
Carex subfusca	brown sedge	Cyperaceae	Native	4
Castilleja ambigua	johnny-nip	Scrophulariaceae	Native	1
Castilleja applegatei	wavyleaf Indian paintbrush	Scrophulariaceae	Native	5
Castilleja arachnoidea	cobwebby Indian paintbrush	Scrophulariaceae	Native	4
Castilleja miniata ssp. *miniata*	giant red Indian paintbrush	Scrophulariaceae	Native	25
Ceanothus integerrimus	deerbrush	Rhamnaceae	Native	5
Ceanothus sanguineus	redstem ceanothus	Rhamnaceae	Native	1
Ceanothus velutinus var. *velutinus*	snowbrush ceanothus	Rhamnaceae	Native	10
Centaurea solstitialis	yellow star-thistle	Asteraceae	Introduced	1
Cephalanthera austiniae	phantom orchid	Orchidaceae	Native	6
Cerastium arvense	field chickweed	Caryophyllaceae	Introduced	1
Cerastium glomeratum	sticky chickweed	Caryophyllaceae	Introduced	1

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Chamaecyparis lawsoniana	Port Orford-cedar	Cupressaceae	Native	20
Cheilanthes gracillima	lace lipfern	Pteridaceae	Native	9
Chimaphila menziesii	little prince's pine	Pyrolaceae	Native	15
Chimaphila umbellata ssp. *occidentalis*	pipsissewa	Pyrolaceae	Native	30
Chrysolepis chrysophylla	giant chinquapin	Fagaceae	Native	18
Circaea alpina	small enchanter's nightshade	Onagraceae	Native	27
Claytonia perfoliata	miner's lettuce	Portulacaceae	Native	5
Claytonia sibirica	Siberian springbeauty	Portulacaceae	Native	20
Clintonia uniflora	bride's bonnet	Liliaceae	Native	20
Collinsia parviflora	maiden blue eyed Mary	Scrophulariaceae	Native	15
Collinsia rattanii ssp. *rattanii*	sticky blue eyed Mary	Scrophulariaceae	Native	3
Collomia grandiflora	grand collomia	Polemoniaceae	Native	11
Collomia heterophylla	variableleaf collomia	Polemoniaceae	Native	13
Collomia linearis	tiny trumpet	Polemoniaceae	Native	1
Collomia tinctoria	staining collomia	Polemoniaceae	Native	2
Corallorrhiza maculata	summer coralroot	Orchidaceae	Native	14
Corallorrhiza mertensiana	Pacific coralroot	Orchidaceae	Native	11
Corallorrhiza striata	hooded coralroot	Orchidaceae	Native	2
Cornus nuttallii	Pacific dogwood	Cornaceae	Native	5
Corylus cornuta var. *californica*	California hazelnut	Betulaceae	Native	33
Crepis acuminata	tapertip hawksbeard	Asteraceae	Native	1
Cryptogramma acrostichoides	American rockbrake	Pteridaceae	Native	1
Cynosurus echinatus	bristly dogstail grass	Poaceae	Introduced	1
Cystopteris fragilis	brittle bladderfern	Dryopteridaceae	Native	14
Dactylis glomerata ssp. *glomerata*	orchardgrass	Poaceae	Introduced	8
Danthonia californica	California oatgrass	Poaceae	Native	8

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Delphinium depauperatum	slim larkspur	Ranunculaceae	Native	1
Delphinium glaucum	Sierra larkspur	Ranunculaceae	Native	6
Deschampsia cespitosa	tufted hairgrass	Poaceae	Native	10
Deschampsia elongata	slender hairgrass	Poaceae	Native	6
Dicentra formosa ssp. *formosa*	Pacific bleeding heart	Fumariaceae	Native	23
Disporum hookeri	drops-of-gold	Liliaceae	Native	47
Dodecatheon jeffreyi	Sierra shootingstar	Primulaceae	Native	2
Draba verna	spring draba	Brassicaceae	Introduced	4
Eleocharis acicularis	needle spikerush	Cyperaceae	Native	3
Elymus elymoides	squirreltail	Poaceae	Native	7
Elymus elymoides ssp. *brevifolius*	squirreltail	Poaceae	Native	4
Elymus glaucus	blue wildrye	Poaceae	Native	53
Elymus glaucus ssp. *jepsonii*	Jepson's blue wildrye	Poaceae	Native	1
Epilobium angustifolium	fireweed	Onagraceae	Native	8
Epilobium brachycarpum	tall annual willowherb	Onagraceae	Native	13
Epilobium ciliatum ssp. *ciliatum*	fringed willowherb	Onagraceae	Native	4
Epilobium ciliatum ssp. *glandulosum*	fringed willowherb	Onagraceae	Native	3
Epilobium minutum	chaparral willowherb	Onagraceae	Native	24
Equisetum arvense	field horsetail	Equisetaceae	Native	3
Ericameria nauseosa	rubber rabbitbrush	Asteraceae	Native	1
Erigeron aliceae	Alice Eastwood's fleabane	Asteraceae	Native	16
Erigeron peregrinus	subalpine fleabane	Asteraceae	Native	2
Eriogonum nudum	naked buckwheat	Polygonaceae	Native	6
Eriogonum ovalifolium	cushion buckwheat	Polygonaceae	Native	2
Eriogonum umbellatum	sulphur-flower buckwheat	Polygonaceae	Native	16
Eriophyllum lanatum	common woolly sunflower	Asteraceae	Native	19

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Erysimum capitatum	sanddune wallflower	Brassicaceae	Native	3
Erythronium hendersonii	Henderson's fawnlily	Liliaceae	Native	1
Festuca idahoensis	Idaho fescue	Poaceae	Native	1
Festuca occidentalis	western fescue	Poaceae	Native	30
Festuca roemeri	Roemer's fescue	Poaceae	Native	1
Festuca subuliflora	crinkleawn fescue	Poaceae	Native	16
Fragaria vesca	woodland strawberry	Poaceae	Native	44
Fragaria vesca ssp. *bracteata*	woodland strawberry	Poaceae	Native	2
Fritillaria affinis var. *affinis*	checker lily	Liliaceae	Native	1
Galium aparine	stickywilly	Rubiaceae	Native	35
Galium bifolium	twinleaf bedstraw	Rubiaceae	Native	3
Galium bolanderi	Bolander's bedstraw	Rubiaceae	Native	1
Galium oreganum	Oregon bedstraw	Rubiaceae	Native	3
Galium porrigens	graceful bedstraw	Rubiaceae	Native	1
Galium triflorum	fragrant bedstraw	Rubiaceae	Native	49
Garrya fremontii	bearbrush	Garryaceae	Native	1
Gaultheria ovatifolia	western teaberry	Ericaceae	Native	2
Gaultheria shallon	salal	Ericaceae	Native	17
Gayophytum diffusum	spreading groundsmoke	Onagraceae	Native	2
Gentiana plurisetosa	bristly gentian	Gentianaceae	Native	2
Glyceria elata	fowl mannagrass	Poaceae	Native	2
Glyceria occidentalis	northwestern mannagrass	Poaceae	Native	4
Glyceria striata	fowl mannagrass	Poaceae	Native	1
Goodyera oblongifolia	western rattlesnake plantain	Orchidaceae	Native	37
Hackelia micrantha	Jessica sticktight	Boraginaceae	Native	9
Helenium bigelovii	Bigelow's sneezeweed	Asteraceae	Native	17

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Heracleum maximum	common cowparsnip	Apiaceae	Native	25
Heuchera micrantha	crevice alumroot	Saxifragaceae	Native	3
Hieracium albiflorum	white hawkweed	Asteraceae	Native	39
Hieracium scouleri	Scouler's woollyweed	Asteraceae	Native	2
Hierochloe occidentalis	California sweetgrass	Poaceae	Native	1
Holodiscus discolor	oceanspray	Rosaceae	Native	51
Hydrophyllum fendleri var. *albifrons*	white waterleaf	Hydrophyllaceae	Native	13
Hydrophyllum occidentale	western waterleaf	Hydrophyllaceae	Native	1
Hydrophyllum tenuipes	Pacific waterleaf	Hydrophyllaceae	Native	2
Hypericum anagalloides	tinker's penny	Clusiaceae	Native	8
Hypericum perforatum	common St. Johnswort	Clusiaceae	Introduced	16
Hypochaeris radicata	hairy cat's ear	Asteraceae	Introduced	1
Iliamna latibracteata	California wild hollyhock	Malvaceae	Native	3
Iris chrysophylla	yellowleaf iris	Iridaceae	Native	30
Isoetes occidentalis	western quillwort	Isoetaceae	Native	1
Juncus effusus	common rush	Juncaceae	Native	2
Juncus ensifolius	swordleaf rush	Juncaceae	Native	5
Juncus parryi	Parry's rush	Juncaceae	Native	2
Juncus patens	spreading rush	Juncaceae	Native	2
Juncus tenuis	poverty rush	Juncaceae	Native	2
Kelloggia galioides	milk kelloggia	Rubiaceae	Native	2
Lactuca serriola	prickly lettuce	Asteraceae	Introduced	1
Lathyrus nevadensis	Sierra pea	Fabaceae	Native	25
Lathyrus polyphyllus	leafy pea	Fabaceae	Native	2
Lewisia nevadensis	Nevada lewisia	Portulacaceae	Native	1
Ligusticum grayi	Gray's licorice-root	Apiaceae	Native	7

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Lilium columbianum	Columbia lily	Liliaceae	Native	3
Lilium parvum	Sierra tiger lily	Liliaceae	Native	1
Linanthus harknessii	Harkness' flaxflower	Polemoniaceae	Native	1
Linnaea borealis ssp. *longiflora*	longtube twinflower	Caprifoliaceae	Native	16
Listera caurina	northwestern twayblade	Orchidaceae	Native	7
Lithocarpus densiflorus	tanoak	Fagaceae	Native	45
Lomatium macrocarpum	bigseed biscuitroot	Apiaceae	Native	6
Lomatium triternatum	nineleaf biscuitroot	Apiaceae	Native	1
Lonicera ciliosa	orange honeysuckle	Caprifoliaceae	Native	1
Lonicera conjugialis	purpleflower honeysuckle	Caprifoliaceae	Native	7
Lonicera hispidula	pink honeysuckle	Caprifoliaceae	Native	10
Lotus crassifolius var. *crassifolius*	big deervetch	Fabaceae	Native	5
Lotus pinnatus	meadow bird's-foot trefoil	Fabaceae	Native	1
Lupinus albicaulis var. *albicaulis*	sicklekeel lupine	Fabaceae	Native	3
Luzula comosa	Pacific woodrush	Juncaceae	Native	5
Luzula parviflora	smallflowered woodrush	Juncaceae	Native	15
Machaeranthera canescens ssp. *canescens*	hoary tansyaster	Asteraceae	Native	4
Madia bolanderi	Bolander's madia	Asteraceae	Native	5
Madia exigua	small tarweed	Asteraceae	Native	3
Madia gracilis	grassy tarweed	Asteraceae	Native	4
Madia madioides	woodland madia	Asteraceae	Native	8
Mahonia aquifolium	hollyleaved barberry	Berberidaceae	Native	3
Mahonia nervosa	Cascade barberry	Berberidaceae	Native	54
Maianthemum racemosum ssp. *racemosum*	feathery false lily of the valley	Liliaceae	Native	21
Maianthemum stellatum	starry false lily of the valley	Liliaceae	Native	58

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Melica harfordii	Harford's oniongrass	Poaceae	Native	5
Melica subulata var. *subulata*	Alaska oniongrass	Poaceae	Native	33
Mimulus alsinoides	wingstem monkeyflower	Scrophulariaceae	Native	1
Mimulus breweri	Brewer's monkeyflower	Scrophulariaceae	Native	2
Mimulus guttatus	seep monkeyflower	Scrophulariaceae	Native	2
Mimulus moschatus var. *moschatus*	muskflower	Scrophulariaceae	Native	5
Minuartia douglasii	Douglas' stitchwort	Caryophyllaceae	Native	1
Mitella caulescens	slightstemmed miterwort	Saxifragaceae	Native	1
Mitella ovalis	coastal miterwort	Saxifragaceae	Native	1
Mitella pentandra	fivestamen miterwort	Saxifragaceae	Native	1
Mitella trifida var. *trifida*	threeparted miterwort	Saxifragaceae	Native	7
Moehringia macrophylla	largeleaf sandwort	Caryophyllaceae	Native	21
Monardella glauca	pale monardella	Lamiaceae	Native	2
Monardella odoratissima	mountain monardella	Lamiaceae	Native	10
Montia parviflora	streambank springbeauty	Portulacaceae	Native	7
Navarretia intertexta ssp. *intertexta*	needleleaf navarretia	Polemoniaceae	Native	1
Nemophila parviflora	smallflower nemophila	Hydrophyllaceae	Native	24
Nothochelone nemorosa	woodland beardtongue	Scrophulariaceae	Native	7
Nuphar lutea ssp. *polysepala*	Rocky Mountain pond-lily	Nymphaeaceae	Native	2
Orobanche pinorum	conifer broomrape	Orobanchaceae	Native	1
Orobanche uniflora	oneflowered broomrape	Orobanchaceae	Native	2
Orthilia secunda	sidebells wintergreen	Pyrolaceae	Native	9
Orthocarpus cuspidatus ssp. *cuspidatus*	Siskiyou Mountain owl's-clover	Scrophulariaceae	Native	1
Osmorhiza chilensis	sweetcicely	Apiaceae	Native	43
Osmorhiza occidentalis	western sweetroot	Apiaceae	Native	18

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Packera bolanderi	Bolander's ragwort	Asteraceae	Native	5
Panicum capillare	witchgrass	Poaceae	Native	2
Parnassia californica	California grass of Parnassus	Saxifragaceae	Native	3
Paxistima myrsinites	Oregon boxleaf	Celastraceae	Native	16
Pedicularis bracteosa	bracted lousewort	Scrophulariaceae	Native	1
Pedicularis racemosa	sickletop lousewort	Scrophulariaceae	Native	6
Penstemon anguineus	Siskiyou beardtongue	Scrophulariaceae	Native	10
Penstemon deustus	scabland penstemon	Scrophulariaceae	Native	10
Penstemon laetus	mountain blue penstemon	Scrophulariaceae	Native	1
Penstemon laetus ssp. *sagittatus*	mountain blue penstemon	Scrophulariaceae	Native	3
Penstemon newberryi	mountain pride	Scrophulariaceae	Native	2
Perideridia gairdneri	Gardner's yampah	Apiaceae	Native	6
Perideridia oregana	Oregon yampah	Apiaceae	Native	1
Petasites frigidus var. *palmatus*	arctic sweet coltsfoot	Asteraceae	Native	4
Phacelia corymbosa	serpentine phacelia	Hydrophyllaceae	Native	1
Phacelia hastata	silverleaf phacelia	Hydrophyllaceae	Native	16
Phacelia heterophylla	varileaf phacelia	Hydrophyllaceae	Native	8
Phacelia procera	tall phacelia	Hydrophyllaceae	Native	4
Philadelphus lewisii	Lewis' mock orange	Hydrangeaceae	Native	1
Phleum alpinum	alpine timothy	Poaceae	Native	5
Phlox adsurgens	northern phlox	Polemoniaceae	Native	35
Phlox diffusa	spreading phlox	Polemoniaceae	Native	10
Phlox gracilis	slender phlox	Polemoniaceae	Native	14
Phoenicaulis cheiranthoides	wallflower phoenicaulis	Brassicaceae	Native	1
Pinus jeffreyi	Jeffrey pine	Pinaceae	Native	1
Pinus lambertiana	sugar pine	Pinaceae	Native	14

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Pinus monticola	western white pine	Pinaceae	Native	1
Pinus ponderosa	ponderosa pine	Pinaceae	Native	3
Platanthera hyperborea	northern green orchid	Orchidaceae	Native	3
Platanthera leucostachys	Sierra bog orchid	Orchidaceae	Native	6
Platanthera stricta	slender bog orchid	Orchidaceae	Native	1
Pleuropogon refractus	nodding semaphoregrass	Poaceae	Native	1
Poa annua	annual bluegrass	Poaceae	Introduced	1
Poa compressa	Canada bluegrass	Poaceae	Introduced	1
Poa pratensis	Kentucky bluegrass	Poaceae	Introduced	4
Poa secunda	Sandberg bluegrass	Poaceae	Native	4
Polygonum bistortoides	American bistort	Polygonaceae	Native	10
Polygonum davisiae	Davis' knotweed	Polygonaceae	Native	2
Polygonum douglasii	Douglas' knotweed	Polygonaceae	Native	11
Polygonum minimum	broadleaf knotweed	Polygonaceae	Native	2
Polygonum phytolaccifolium	poke knotweed	Polygonaceae	Native	24
Polystichum imbricans ssp. *imbricans*	narrowleaf swordfern	Dryopteridaceae	Native	10
Polystichum munitum	western swordfern	Dryopteridaceae	Native	41
Potentilla drummondii	Drummond's cinquefoil	Rosaceae	Native	6
Potentilla glandulosa	sticky cinquefoil	Rosaceae	Native	19
Potentilla gracilis	slender cinquefoil	Rosaceae	Native	9
Prunus emarginata	bitter cherry	Rosaceae	Native	23
Pseudotsuga menziesii	Douglas-fir	Pinaceae	Native	83
Pteridium aquilinum var. *pubescens*	hairy brackenfern	Dennstaedtiaceae	Native	49
Pyrola picta	whiteveined wintergreen	Pyrolaceae	Native	25
Quercus chrysolepis var. *chrysolepis*	canyon live oak	Fagaceae	Native	38
Quercus garryana var. *breweri*	Oregon white oak	Fagaceae	Native	3

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Quercus sadleriana	deer oak	Fagaceae	Native	9
Quercus vacciniifolia	huckleberry oak	Fagaceae	Native	1
Ranunculus hebecarpus	delicate buttercup	Ranunculaceae	Native	1
Ranunculus parviflorus	smallflower buttercup	Ranunculaceae	Introduced	1
Ranunculus uncinatus	woodland buttercup	Ranunculaceae	Native	8
Rhododendron macrophyllum	Pacific rhododendron	Ericaceae	Native	11
Ribes binominatum	ground gooseberry	Grossulariaceae	Native	26
Ribes cruentum	shinyleaf currant	Grossulariaceae	Native	6
Ribes lacustre	prickly currant	Grossulariaceae	Native	13
Ribes lobbii	gummy gooseberry	Grossulariaceae	Native	17
Ribes sanguineum	redflower currant	Grossulariaceae	Native	26
Ribes viscosissimum	sticky currant	Grossulariaceae	Native	9
Rosa gymnocarpa	dwarf rose	Rosaceae	Native	68
Rubus lasiococcus	roughfruit berry	Rosaceae	Native	5
Rubus leucodermis	whitebark raspberry	Rosaceae	Native	15
Rubus nivalis	snow raspberry	Rosaceae	Native	10
Rubus parviflorus	thimbleberry	Rosaceae	Native	27
Rubus ursinus	California blackberry	Rosaceae	Native	44
Rudbeckia occidentalis	western coneflower	Asteraceae	Native	14
Rumex acetosella	common sheep sorrel	Polygonaceae	Introduced	15
Rumex obtusifolius	bitter dock	Polygonaceae	Introduced	1
Rumex salicifolius var. *mexicanus*	Mexican dock	Polygonaceae	Native	3
Salix eastwoodiae	mountain willow	Salicaceae	Native	6
Salix lasiolepis	arroyo willow	Salicaceae	Native	3
Salix lucida	shining willow	Salicaceae	Native	2
Salix scouleriana	Scouler's willow	Salicaceae	Native	4

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Sambucus mexicana	blue elderberry	Caprifoliaceae	Native	11
Sambucus racemosa var. *microbotrys*	red elderberry	Caprifoliaceae	Native	11
Sanicula graveolens	northern sanicle	Apiaceae	Native	5
Satureja douglasii	yerba buena	Lamiaceae	Native	4
Saussurea americana	American saw-wort	Asteraceae	Native	5
Scirpus congdonii	Congdon's bulrush	Cyperaceae	Native	9
Scirpus microcarpus	panicled bulrush	Cyperaceae	Native	1
Sedum oregonense	cream stonecrop	Crassulaceae	Native	8
Sedum spathulifolium	broadleaf stonecrop	Crassulaceae	Native	3
Sedum stenopetalum	wormleaf stonecrop	Crassulaceae	Native	2
Selaginella wallacei	Wallace's spikemoss	Selaginellaceae	Native	1
Senecio bolanderi	Bolander's ragwort	Asteraceae	Native	4
Senecio integerrimus var. *major*	lambstongue ragwort	Asteraceae	Native	5
Senecio triangularis	arrowleaf ragwort	Asteraceae	Native	26
Sidalcea malviflora ssp. *asprella*	dwarf checkerbloom	Malvaceae	Native	3
Sidalcea oregana	Oregon checkerbloom	Malvaceae	Native	5
Silene campanulata ssp. *glandulosa*	Red Mountain catchfly	Caryophyllaceae	Native	12
Sonchus asper	spiny sowthistle	Asteraceae	Introduced	2
Sorbus sitchensis	western mountain ash	Rosaceae	Native	2
Spiraea douglasii	rose spirea	Rosaceae	Native	1
Stachys ajugoides var. *ajugoides*	bugle hedgenettle	Lamiaceae	Native	7
Stachys rigida	rough hedgenettle	Lamiaceae	Native	9
Stellaria crispa	curled starwort	Caryophyllaceae	Native	5
Stellaria media ssp. *media*	common chickweed	Caryophyllaceae	Introduced	1
Stenanthium occidentale	western featherbells	Liliaceae	Native	1
Streptopus amplexifolius	claspleaf twistedstalk	Liliaceae	Native	3

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Symphoricarpos albus	common snowberry	Caprifoliaceae	Native	39
Symphoricarpos rotundifolius	roundleaf snowberry	Caprifoliaceae	Native	1
Synthyris reniformis	snowqueen	Scrophulariaceae	Native	26
Taraxacum officinale	common dandelion	Asteraceae	Introduced	2
Taxus brevifolia	Pacific yew	Taxaceae	Native	11
Tellima grandiflora	bigflower tellima	Saxifragaceae	Native	17
Tiarella trifoliata var. *unifoliata*	oneleaf foamflower	Saxifragaceae	Native	16
Tofieldia glutinosa	sticky tofieldia	Liliaceae	Native	5
Tolmiea menziesii	youth on age	Saxifragaceae	Native	6
Tragopogon dubius	yellow salsify	Asteraceae	Introduced	4
Trautvetteria caroliniensis	Carolina bugbane	Ranunculaceae	Native	2
Trientalis borealis ssp. *latifolia*	broadleaf starflower	Primulaceae	Native	54
Trifolium eriocephalum	woollyhead clover	Fabaceae	Native	1
Trifolium howellii	canyon clover	Fabaceae	Native	3
Trifolium longipes	longstalk clover	Fabaceae	Native	10
Trillium ovatum ssp. *ovatum*	Pacific trillium	Liliaceae	Native	35
Trisetum canescens	tall trisetum	Poaceae	Native	4
Triteleia hyacinthina	white brodiaea	Liliaceae	Native	2
Tsuga mertensiana	mountain hemlock	Pinaceae	Native	11
Urtica dioica ssp. *gracilis*	California nettle	Urticaceae	Native	3
Vaccinium membranaceum	thinleaf huckleberry	Ericaceae	Native	4
Vaccinium parvifolium	red huckleberry	Ericaceae	Native	12
Vaccinium uliginosum	bog blueberry	Ericaceae	Native	3
Valeriana sitchensis	Sitka valerian	Valerianaceae	Native	8
Vancouveria hexandra	white insideout flower	Berberidaceae	Native	54
Veratrum californicum	California false hellebore	Liliaceae	Native	12

Scientific Name	Common Name	Family	Origin	# of Plots in Which Species Occurs
Veratrum insolitum	Siskiyou false hellebore	Liliaceae	Native	4
Veratrum viride	green false hellebore	Liliaceae	Native	8
Verbascum thapsus	common mullein	Scrophulariaceae	Introduced	1
Veronica americana	American speedwell	Scrophulariaceae	Native	3
Vicia americana ssp. *americana*	American vetch	Fabaceae	Native	31
Viola glabella	pioneer violet	Violaceae	Native	41
Viola praemorsa	canary violet	Violaceae	Native	1
Viola sempervirens	evergreen violet	Violaceae	Native	13
Vulpia bromoides	brome fescue	Poaceae	Introduced	4
Whipplea modesta	common whipplea	Hydrangeaceae	Native	42
Xerophyllum tenax	common beargrass	Liliaceae	Native	9

Appendix E: Photo-Interpretation Mapping Conventions and Visual Key

This appendix describes the physiognomic vegetation classes mapped for the Oregon Caves National Monument Vegetation Inventory (Classification and Mapping) Project. For each mapped vegetation class we provide:

- A brief description of the vegetation, including the USNVC associations that characterize the vegetation class (if published by NatureServe or others), and the associations we classified that characterize the physiognomic vegetation class;
- The cumulative areal extent of each vegetation where mapped as a primary vegetation or a secondary vegetation;
- A representative ground photograph/image for each map unit;
- A range map for each physiognomic 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.

The vegetation classes mapped were the following:

1. Physiognomic classes as seen on the digital aerial photos (NAIP imagery);

2. Physiognomic classes that could not be separated on imagery, but were separated by elevation based on plot sampling and the work of Whittaker (1960). These elevation definitions are described for each physiognomic vegetation class described below in the sections on photo-signature and mapping considerations;

3.Physiognomic classes that were distinguished from neighboring classes by having a different primary association within them (for example, areas of Mixed Evergreen Forest that were dominated by the *Pseudotsuga menziesii – Lithocarpus densiflorus* association vs. the *Pinus lambertiana - Lithocarpus densiflorus* association); and

4. Management units on public land managed by the Rogue River-Siskiyou National Forest.

The vegetation described in this section reflects the classification designed specifically for this project. Non-vegetated and land-use map units are not described in this key. For more information on the development of the mapping scheme for Oregon Caves 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 forest classes.

Map Unit (Physiognomic Class) Descriptions

A. Herbaceous

1. Lake (Aquatic Vegetation)

Common Species: *Nuphar lutea* ssp. *polysepala* (Rocky Mountain pond-lily).

USNVC Associations:

Nuphar polysepala Herbaceous Vegetation

Classified Associations included:

Nuphar polysepala

Cumulative area occupied (ha)*	
Primary vegetation	1.4
Secondary vegetation	0
Total	1.4

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

Description: There are two lakes that are shallow tarns scoured by glaciers that shaped the Bigelow Basin. In both lakes, *Nuphar lutea* ssp. *polysepala* grows at moderate to high density throughout. No other aquatic vascular plants have appreciable cover. The other aquatic and emergent herbs that may be present in this physiognomic vegetation class may include *Isoetes* spp. *Menyanthes* spp., *Potamogeton* spp., *Glyceria* spp., *Eleocharis* spp., *Carex* spp. *Equisetum* spp., *Typha* spp., and *Lemna* spp. Many of these associates are in shallower, adjacent water.

Range and Distribution: A total of 1.4 ha in the eastern, glaciated basin in the expansion area.

Representative Ground Photo

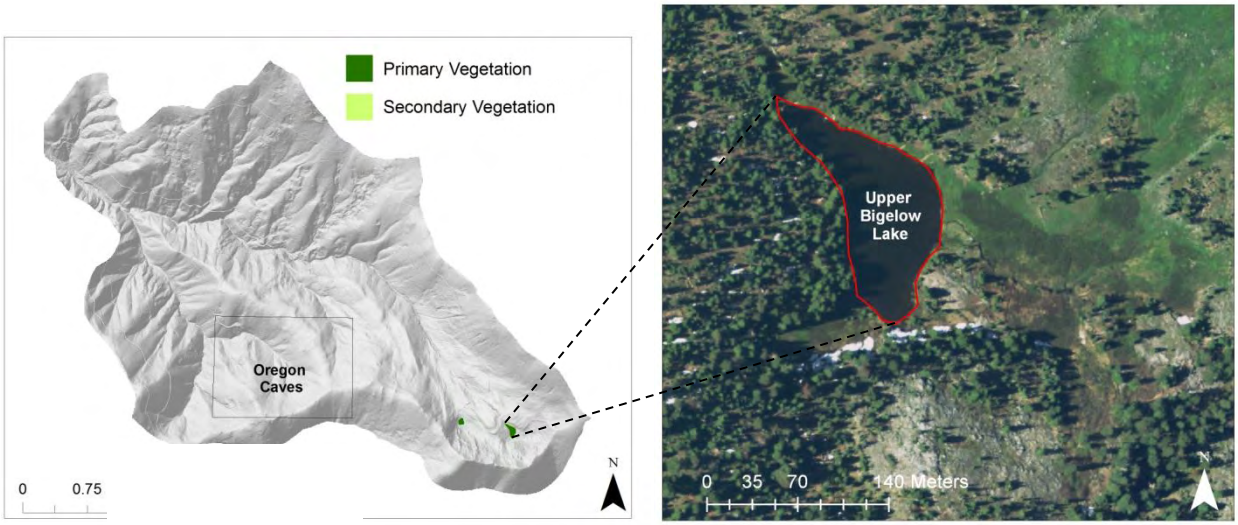


Photo Signature and Mapping Considerations

Dark green bodies of water evident on aerial imagery and shown in USGS coverages. *Nuphar lutea* ssp. *polysepala* is mostly not visible in aerial imagery. Field work confirmed its presence throughout both lakes.

2. Subalpine Wet Meadow

Common Species: *Carex aquatilis* var. *dives* (Sitka sedge), *Scirpus congdonii* (Congdon's bulrush), *Carex lenticularis* (lakeshore sedge), *Carex echinata* (star sedge), *Deschampsia cespitosa* (tufted hairgrass), *Eleocharis acicularis* (needle spikerush), *Carex luzulina* (woodrush sedge), *Caltha leptosepala* (white marsh marigold), *Epilobium ciliatum* ssp. *glandulosum* (fringed willowherb), *Platanthera leucostachys* (Sierra bog orchid), *Polygonum bistortoides* (American bistort).

USNVC Associations:

Carex aquatilis var. *dives* Herbaceous Vegetation
Carex vesicaria Herbaceous Vegetation

Classified associations:

Carex aquatilis
Carex luzulina
Carex exsiccata-Caltha leptosepala

Cumulative area occupied (ha)*	
Primary vegetation	4.6
Secondary vegetation	2.4
Total	6.9

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

Description: This mountain meadow vegetation comprises dense swards of emergent wetland vegetation (*Carex* associations) occupying the shallow wet zone along the edge of the Bigelow Lakes as well as non-flooded, but perennially wet or saturated areas around the basin floor upslope from Bigelow Lakes. Soil texture is muck. Transition to Subalpine Seasonally Dry Meadow is complex and difficult to define. Some areas of seasonally dry meadow are included in wet meadow polygons due to fine-scale variation.

Range and distribution: The glaciated Bigelow Basin in the southeastern portion of the proposed expansion area.

Representative Ground Photos

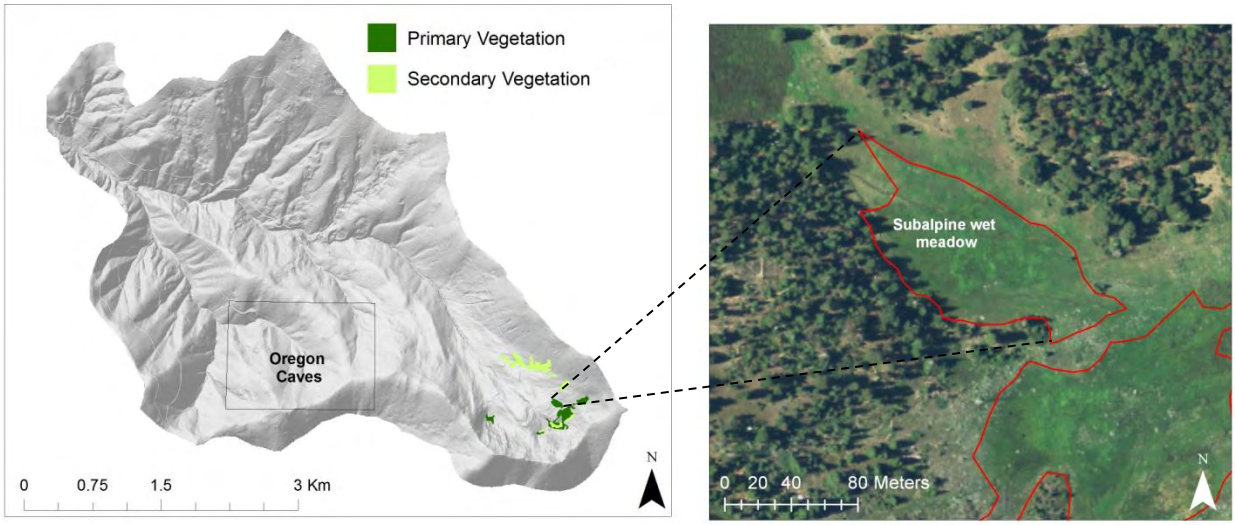


Photo Signature and Mapping Considerations

Bright green herbaceous vegetation. The green areas have an absence of texture indicative of shrubs or more brown tones from seasonally dry meadow. Subalpine Wet Meadows were mapped as bright green meadows occurring above 1700 m. Wet meadows below 1700 m were mapped as Montane Seasonally Dry Meadow. Some areas of seasonally dry meadow are included in wet meadow polygons due to fine-scale variation.

3. Subalpine Seasonally Dry Meadow

Common Species: *Potentilla glandulosa* (sticky cinquefoil), *Potentilla gracilis* (slender cinquefoil), *Senecio triangularis* (arrowleaf ragwort), *Helenium bigelovii* (Bigelow's sneezeweed), *Veratrum californicum* (California false hellebore), *Achillea millefolium* (common yarrow), *Trifolium longipes* (longstalk clover), *Potentilla drummondii* (Drummond's cinquefoil), *Castilleja miniata* ssp. *miniata* (giant red Indian paintbrush), *Danthonia californica* (California oatgrass), *Deschampsia cespitosa* (tufted hairgrass).

USNVC Associations:

Not treated in the USNVC database.

Classified associations:

Helenium-Potentilla
Agastache-Polygonum
Pteridium aquilinum

Cumulative area occupied (ha)*	
Primary vegetation	11.0
Secondary vegetation	0.2
Total	11.2

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

Elevations: 1784-1885 m. Lower elevation meadows are dominated by Montane Seasonally Dry Meadow.

Description: Dense, low-growing herbaceous vegetation dominated by perennial graminoids and forbs. Soils are seasonally saturated. A wide range of variation, from dry meadows to meadows nearly wet enough to be included with Subalpine Wet Meadow are included within this map unit. Occasional small patches of wet meadow or shrublands are included in polygons.

Range and Distribution: The glaciated Bigelow Basin in the southeastern portion of the proposed expansion area. Occurs in the zone between wet meadows on the basin floor and gradual slopes and the drier slopes dominated by tree and shrub vegetation or rock.

Representative Ground Photos

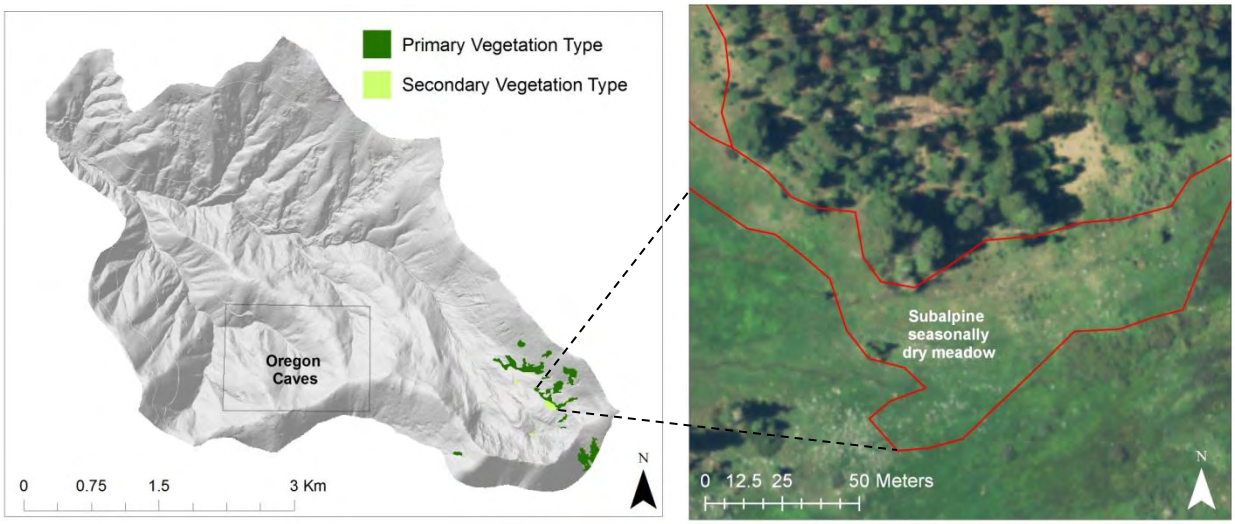


Photo Signature and Mapping Considerations

Moderately green herbaceous vegetation. Smooth texture.,Subalpine Seasonally Dry Meadow was mapped as bright green meadows occurring above 1700 m. Seasonally dry meadows below 1700 m were mapped as Montane Seasonally Dry Meadow. Occasional small patches of wet meadow or shrublands are included in polygons.

4. Montane Seasonally Dry Meadow

Common Species: *Agastache urticifolia* (nettleleaf giant hyssop), *Erigeron aliceae* (Alice Eastwood's fleabane), *Polygonum phytolaccifolium* (poke knotweed), *Pteridium aquilinum* var. *pubescens* (western brackenfern), *Senecio triangularis* (arrowleaf ragwort), *Prunus emarginata* (bitter cherry), *Achillea millefolium* (common yarrow), *Heracleum maximum* (common cowparsnip), *Castilleja miniata* ssp. *miniata* (giant red Indian paintbrush), *Hypericum perforatum* (common St. Johnswort), *Osmorhiza occidentalis* (western sweetroot), *Artemisia douglasiana* (Douglas' sagewort), *Rumex acetosella* (common sheep sorrel), *Rudbeckia occidentalis* (western coneflower), *Danthonia californica* (California oatgrass), *Poa pratensis* (Kentucky bluegrass), *Lathyrus nevadensis* (Sierra pea), *Polygonum douglasii* (Douglas' knotweed).

USNVC Associations:

Under review

Classified Associations:

Agastache-Polygonum

Pteridium aquilinum

Cumulative area occupied (ha)*	
Primary vegetation	13,0
Secondary vegetation	2.6
Total	15.6

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

Elevations: 1500-1800 m.

Description: Dense, low-growing herbaceous vegetation dominated by perennial graminoids and forbs. Soils are seasonally saturated. Included in this physiognomic vegetation type is a wide range of vegetation, from dry meadows to meadows nearly wet enough to be included with Subalpine Wet Meadow. Fine-scale variation includes patches or individuals of *Holodiscus discolor* and *Abies concolor*.

Range and Distribution: Generally upper slopes between 1500 and1800 m in the proposed expansion area.

Representative Ground Photos

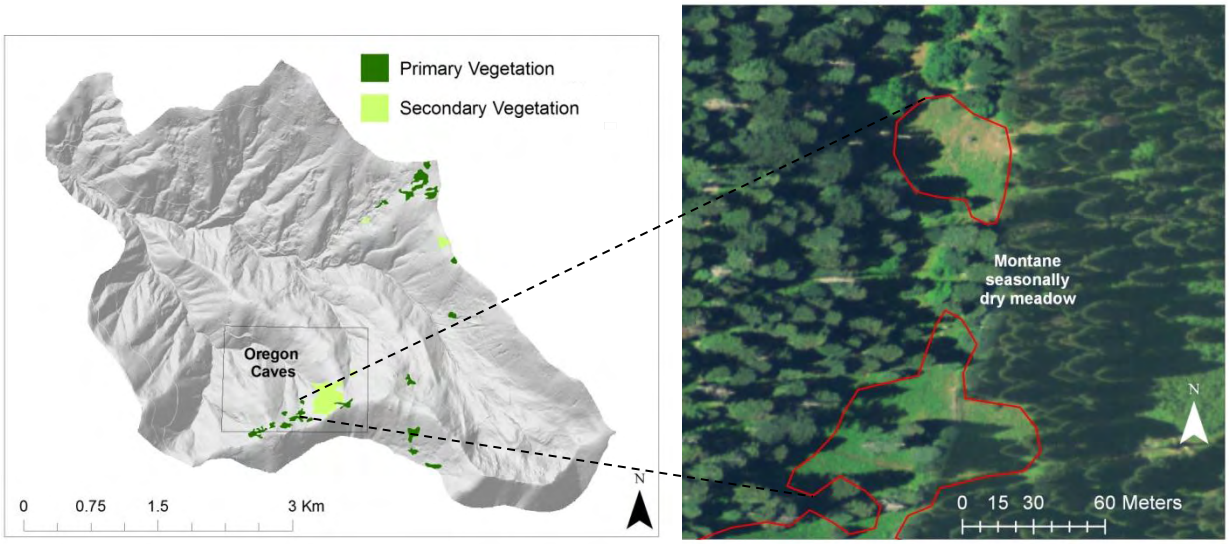


Photo Signature and Mapping Considerations

Bright green herbaceous vegetation below 1700 m was mapped as Montane Seasonally Dry Meadow. Sometimes a more brown photo-signature was visible on meadow margins due to sparser vegetation that dries out sooner in the growing season. Polygons of this physiognomic vegetation type occasionally include very small areas of *Holodiscus discolor* and *Abies-Agastache* associations.

B. Shrub Vegetation

5. Alder Thicket

Common Species: *Alnus incana* (gray alder), *Sambucus racemosa* var. *microbotrys* (red elderberry), *Senecio triangularis* (arrowleaf ragwort), *Circaea alpina* (small enchanter's nightshade), *Dicentra formosa* ssp. *formosa* (Pacific bleeding heart), *Stachys ajugoides* var. *ajugoides* (bugle hedgenettle), *Heracleum maximum* (common cowparsnip).

USNVC Associations:

Alnus incana / Mesic Forbs Shrubland

Classified Associations:

Alnus-Heracleum

Cumulative area occupied (ha)*	
Primary vegetation	23.7
Secondary vegetation	8.7
Total	32.4

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

Elevations: 1500-1800 m.

Description: Dense copses of thinleaf alder (*Alnus incana*) with a variety of robust forbs present. Alder thickets are associated primarily with subalpine wet meadows and willow thickets. The thickets commonly occur as discreet patches.

Range and Distribution: Middle to upper elevations, mainly in the proposed expansion area to the east of the existing monument. Occurs in one-several ha stands in moist areas at higher elevations, mainly meadow margins in the proposed expansion area. Also occurs in select wet rock outcrops in the upper reaches of the Bigelow Basin cirque in the eastern part of the project area.

Representative Ground Photo

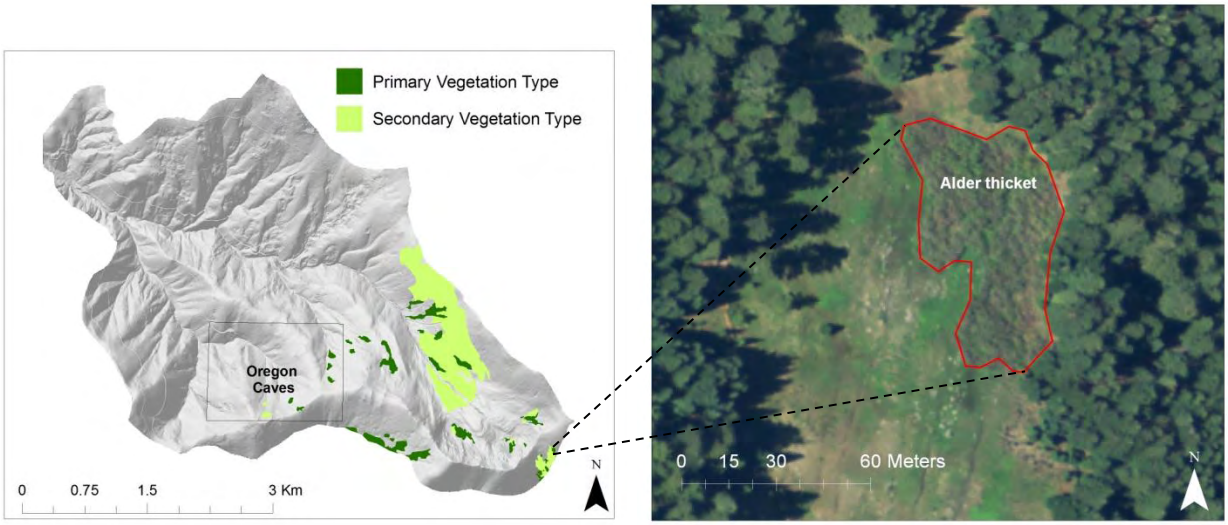


Photo Signature and Mapping Considerations

The map unit photo-signature is a dense, bright green shrubland when fully leafed-out that is lighter tone than the willow thicket photo-signature. Where leafing-out is incomplete (above), a light gray color is present. Alder thickets are also taller than willow thickets, which can be seen in the shadowing and coarser texturing on the imagery. Alder thickets occur in denser stands than another shrubland with which they may be associated, bitter cherry. Alder thickets cannot be accurately distinguished from Rocky Mountain maple thickets in the imagery. Many stands were mapped in the field to ensure accuracy. Field work determined that no Rocky Mountain maple thickets were large enough to map separately, so *Acer glabrum* individuals and thickets are a subcomponent of Alder Thicket. Small patches of *Alnus* sp. often occur within Montane and Subalpine Forest physiognomic vegetation types and are included as secondary vegetation types in these polygons. Very small areas of several associations other than *Alnus-Heracleum* may occur at a fine-scale in polygons, but these amount to very little area.

6. Willow Thicket

Common Species: *Salix eastwoodiae* (mountain willow), *Senecio triangularis* (arrowleaf ragwort), *Helenium bigelovii* (Bigelow's sneezeweed), *Viola glabella* (pioneer violet), *Caltha leptosepala* (white marsh marigold), *Stachys rigida* (rough hedgenettle), *Circaea alpine* (small enchanter's nightshade), *Castilleja miniata* ssp. *miniata* (giant red Indian paintbrush), *Carex luzulina* (woodrush sedge), *Carex spectabilis* (showy sedge).

USNVC Associations:

Salix eastwoodiae / Deschampsia cespitosa Shrubland

Classified associations:

Salix eastwoodiae

Cumulative area occupied (ha)*	
Primary vegetation	2.8
Secondary vegetation	1.1
Total	3.9

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

Elevations: 1500-1800 m.

Description: Dense copses of Eastwood's or mountain willow (*Salix eastwoodiae*) with a variety of robust forbs present, generally at very low abundance. Very small patches of subalpine wet meadow may occur within the copses/thickets. The thickets are relatively discreet. They occur in one-several ha stands in seasonally saturated, perennially moist areas at higher elevations, mainly meadow margins or in large patches in meadows and often on the margin of alder thickets.

Range and Distribution: Willow thickets occur in one-several ha patches at higher elevations, mainly at the margins of subalpine wet meadow or the margin of alder thickets. These areas are in the proposed expansion area to the east of the existing monument.

Representative Ground Photos

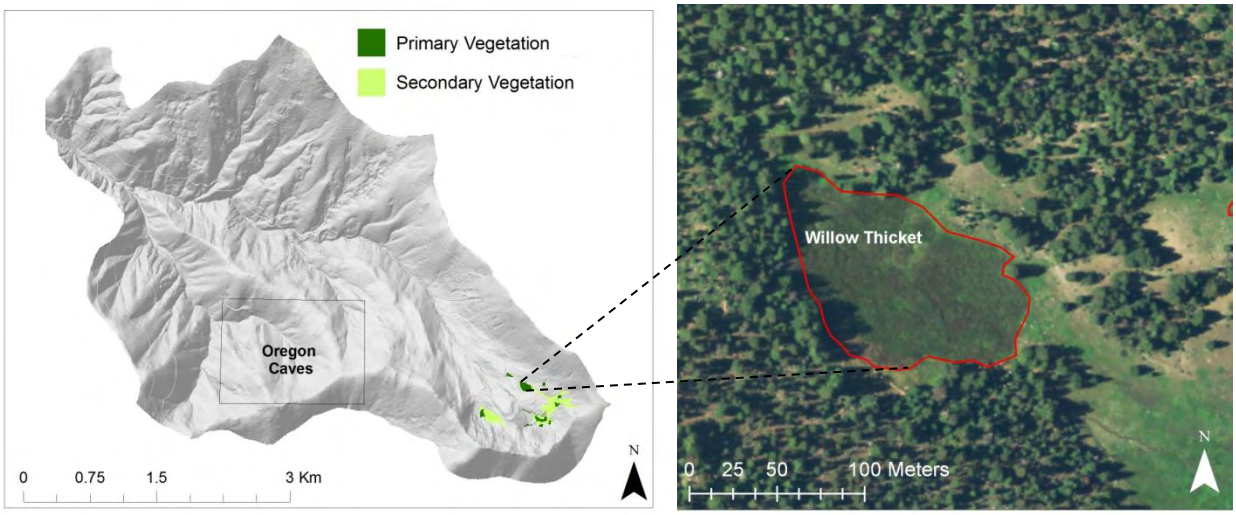


Photo Signature and Mapping Considerations

The map unit photo-signature is a mottled green-brown from fairly uniform height, and very dense shrub vegetation. Willow thickets are shorter than alder, bitter cherry, or Rocky Mountain maple thickets, and greener than montane chaparral**.** Many stands were mapped in the field to ensure accuracy.

7. Bitter Cherry Thicket

Common Species: *Prunus emarginata* (bitter cherry), *Salix eastwoodiae* (mountain willow), *Senecio triangularis* (arrowleaf ragwort), *Helenium bigelovii* (Bigelow's sneezeweed), *Viola glabella* (pioneer violet), *Castilleja miniata* ssp. *miniata* (giant red Indian paintbrush), *Agastache urticifolia* (nettleleaf giant hyssop), *Erigeron aliceae* (Alice Eastwood's fleabane), *Achillea millefolium* (common yarrow), *Rumex acetosella* (common sheep sorrel), *Rudbeckia, occidentalis* (western coneflower), *Danthonia californica* (California oatgrass), *Poa pratensis* (Kentucky bluegrass), *Lathyrus nevadensis* (Sierra pea).

USNVC Associations:

None

Classified associations:

Prunus emarginata

Cumulative area occupied (ha)*	
Primary vegetation	0.1
Secondary vegetation	0.1
Total	0.2

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

Elevations: 1500-1800 m.

Description: Dense copses of bitter cherry (*Prunus emarginata*) with an understory of forbs and grasses from the *Helenium-Potentilla* association. Occurs in relatively small stands, along drier edges of seasonally dry meadows. It often forms a narrow band between the meadow vegetation and the adjacent montane or subalpine conifer vegetation, or between willow and alder thickets and adjacent montane or subalpine conifer vegetation.

Range and Distribution: Rare in middle to upper elevations, mainly in the proposed expansion area to the east of the existing monument. Stands are mostly too small to map or be included in polygon data.

Representative Ground Photo

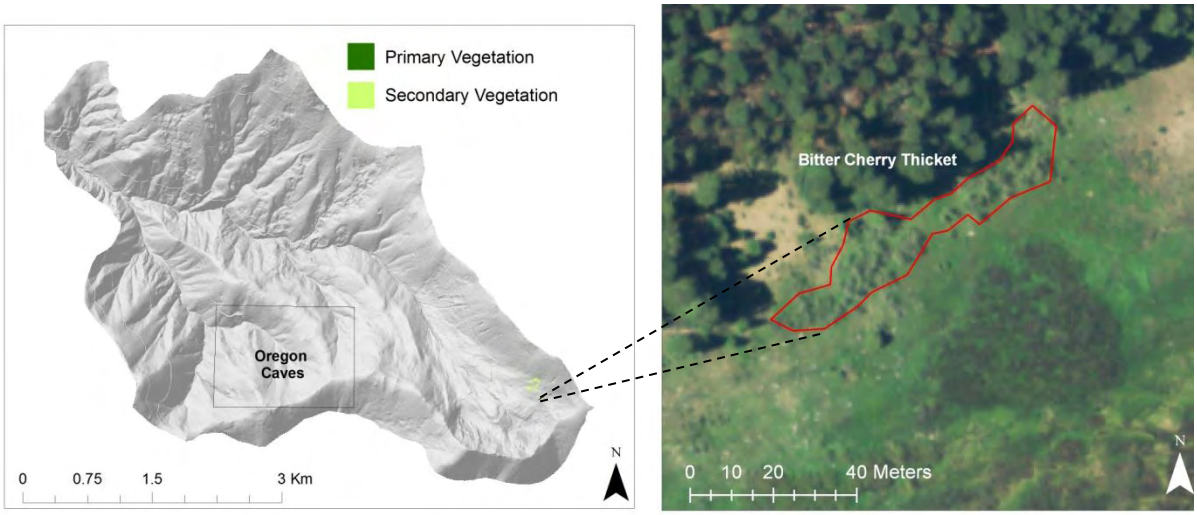


Photo Signature and Mapping Considerations

The map unit photo-signature is a highly textured gray-green resulting from uneven *Prunus emarginata* canopy height and density. Dry meadow inter-shrub inclusions are mapped within this type due to very fine scale variation. Bitter cherry thickets are taller than willow thickets, and grayer-green than the other shrublands**.** Stands were identified in the field to ensure accuracy. Stands were mostly too small to map or be included in polygon data.

8. Montane Chaparral

Common Species: *Arctostaphylos patula* (greenleaf manzanita), *Ceanothus velutinus* var. *velutinus* (snowbush ceanothus), *Prunus emarginata* (bitter cherry), *Amelanchier alnifolia* (Saskatoon serviceberry), *Holodiscus discolor* (oceanspray), *Abies concolor* (white fir), *Penstemon deustus* (scabland penstemon), *Eriophyllum lanatum* (common woolly sunflower), *Phlox diffusa* (spreading phlox), *Cheilanthes gracillima* (lace lipfern).

USNVC Associations:

None. USNVC Group**:** *Arctostaphylos patula - Arctostaphylos nevadensis - Ceanothus velutinus* Montane Sclerophyll Scrub Group [Provisional]

Classified Associations:

Arctostaphylos-Ceanothus

Cumulative area occupied (ha)*	
Primary vegetation	24.1
Secondary vegetation	6.6
Total	30.7

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

Elevations: 1500-2000 m.

Description: This map unit is typically composed of moderately dense to dense, medium-sized shrubs with greenleaf manzanita (*Arctostaphylos patula*) and tobacco brush (*Ceanothus velutinus*) being the most frequent and abundant. Deciduous shrub components such as Saskatoon serviceberry (*Amelanchier alnifolia*) and bitter cherry (*Prunus emarginata*) are often common in openings, which may be associated with rock outcrops. This vegetation can establish where edaphic conditions are harsh (e.g., rocky soils), or following disturbance by fire or logging. The composition varies in these different cases. After logging the sclerophylls may not be as common as after fire and *Holodiscus discolor* may be more common; the overall shrub cover would be lower. Small conifers including Shasta red fir (*Abies magnifica* x *procera*), white fir (*Abies concolor*), and Douglas-fir (*Pseudotsuga menziesii*) are typically scattered throughout the map unit polygons in low cover.

Range and Distribution: Montane Chaparral may occur almost anywhere within the monument or proposed expansion area, depending on the combination of disturbance history and edaphic conditions. It is most common at higher elevations and along ridges, where rocky soils are more prevalent. The unit is also scattered in areas that were clear-cut in the expansion area that have not regenerated as densely with conifers or broad-leaved trees.

Representative Ground Photo

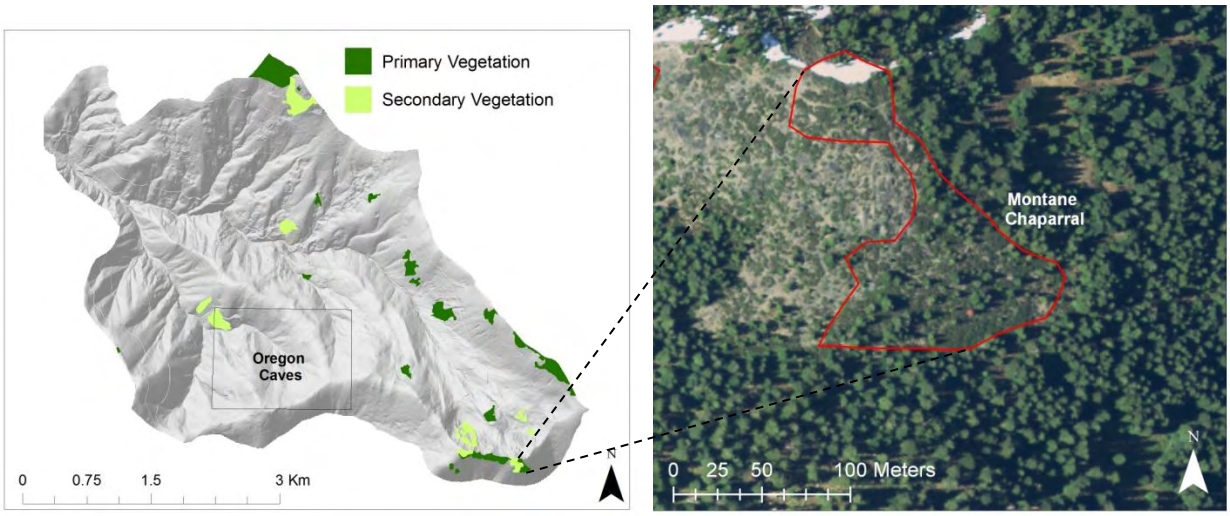


Photo Signature and Mapping Considerations

The relatively fine texture and muted green color is indicative of dense, uniform-height shrub vegetation and often little or no spacing between shrub crowns. If shrub cover was < 50%, shrub vegetation was mapped as Montane Open Shrubland. Montane chaparral areas at ORCA mostly have scattered individual trees or groups of trees intermixed at a fine scale. Thus, most Montane Chaparral polygons were mapped as a combination of montane chaparral and montane or subalpine forest. For example, the polygon in the figure immediately above was 70% montane chaparral and 30% subalpine forest.

C. Herbaceous and Subshrub Vegetation

9. Montane Open Shrubland

Common Species: *Eriogonum umbellatum* (sulphur-flower buckwheat), *(Arctostaphylos patula* (greenleaf manzanita), *Ceanothus velutinus* var. *velutinus* (snowbush ceanothus), *Prunus emarginata* (bitter cherry), *Amelanchier alnifolia* (Saskatoon serviceberry), *Holodiscus discolor* (oceanspray), *Quercus garryana* var. *breweri* (Oregon white oak), *Lomatium macrocarpum* (bigseed biscuitroot), *Abies concolor* (white fir), *Penstemon deustus* (scabland penstemon), *Eriophyllum lanatum* (common woolly sunflower), *Phlox diffusa* (spreading phlox), *Cheilanthes gracillima* (lace lipfern), *Silene campanulata* ssp. *glandulosa* (Red Mountain catchfly), *Elymus glaucus* (blue wildrye).

USNVC Associations:

None. USNVC Group**:** *Arctostaphylos patula - Arctostaphylos nevadensis - Ceanothus velutinus* Montane Sclerophyll Scrub Group [Provisional]

Classified associations:

Holodiscus discolor
Arctostaphylos-Ceanothus
Eriogonum-Lomatium

Cumulative area occupied (ha)*	
Primary vegetation	11.6
Secondary vegetation	6.4
Total	18.0

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

Elevations: 1500-2000 m.

Description: This map unit was defined to capture open shrub vegetation on relatively harsh, rocky substrata. It may include two associations in which the shrub cover is naturally open (*Eriogonum-Lomatium* and *Holodiscus discolor*) and a third association where the shrubs are more typically dense (*Arctostaphylos-Ceanothus*). Open *Arctostaphylos-Ceanothus* occurs in this type in some logged areas that are regenerating to tree vegetation (woody shrublands) poorly. Small conifers including Shasta red fir (*Abies magnifica* x *procera*), white fir (*Abies concolor*), and Douglas-fir (*Pseudotsuga menziesii*) are typically scattered throughout the map unit in low to sparse cover. In all cases, soils are rocky or non-existent.

Range and Distribution: May occur almost anywhere within the monument or proposed expansion area, depending on the combination of disturbance history and edaphic conditions. Most common along ridges where rocky soils are more prevalent. Also scattered in areas that were clear-cut in the proposed expansion area, particularly where clear-cuts were more recent.

Representative Ground Photo

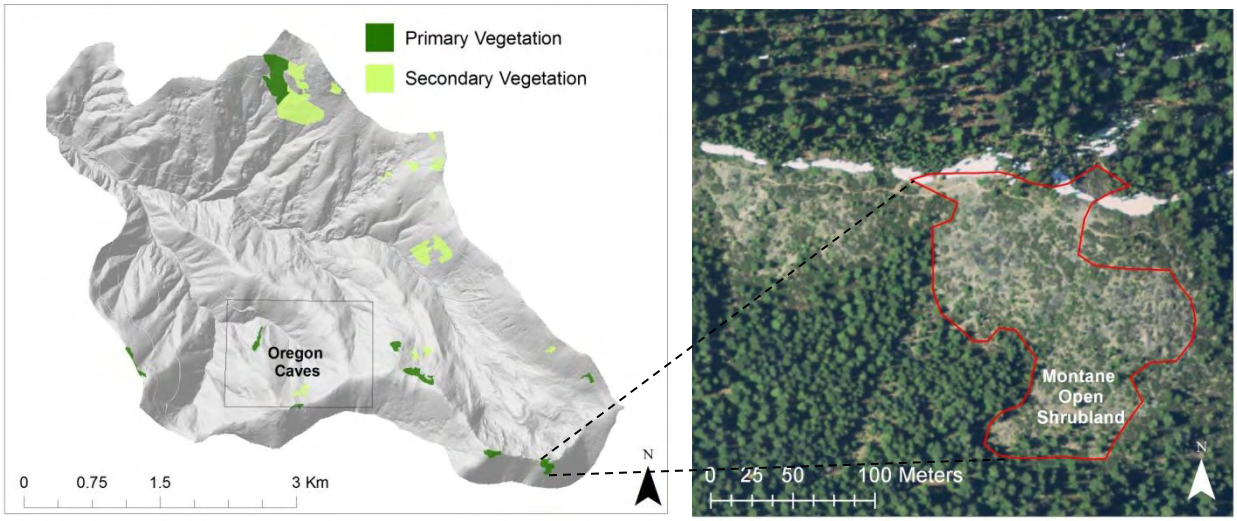


Photo Signature and Mapping Considerations

Open shrub vegetation with 10-50% cover by shrubs and conspicuous spacing between shrub crowns, often showing gray rocky substrata. Open shrubland areas in the project area mostly have trees intermixed at a fine scale. These areas were mapped as a combination of montane open shrubland and montane or subalpine forest. The polygon in the figures immediately above was 80% Montane Open Shrubland and 20% Montane Chaparral.

D. Herbaceous / Low Shrub / Cushion Plant Mix

10. Subalpine Rock Field / Outcrop

Common Species: *Sedum oregonense* (cream stonecrop), *Phlox diffusa* (spreading phlox), *Abies magnifica x procera* (Shasta red fir), *Arctostaphylos nevadensis* (pinemat manzanita), *Arctostaphylos patula* (greenleaf manzanita), *Quercus sadleriana* (deer oak), *Prunus emarginata* (bitter cherry), *Arenaria congesta* (ballhead sandwort), *Eriophyllum lanatum* (common woolly sunflower), *Eriogonum umbellatum* (sulphur-flower buckwheat), *Achillea millefolium* (common yarrow), *Elymus elymoides* (squirreltail).

USNVC Associations:

None

Classified associations:

Sedum-Phlox
Bare rock
Eriogonum-Lomatium

Cumulative area occupied (ha)*	
Primary vegetation	7.4
Secondary vegetation	4.2
Total	11.6

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

Elevations: 1700-2000 m.

Description: This map unit was defined to capture mixed herb and shrub vegetation with sparse tree cover where a combination of rock and prostrate herb/shrub vegetation occurs. Cover of rock in a map unit is typically >50%, but much of the area occupied by this physiognomic type is a fine scale patchwork of rock and vegetation, as shown in the photograph below. The rock is mostly affected by glaciation. It may be talus-like, morainal, or bedrock. The *Sedum-Phlox* association, which itself is characterized by significant rock, is the main association in this map unit. In many cases the percent cover of bare rock is also listed for a polygon. Bare rock areas are where *Sedum-Phlox* or other vegetation is generally absent (total vegetation cover < 5%) over an area the size of one plot in this vegetation (10 m x 10 m).

Range and Distribution: Scattered along the high points of moraines in the floor of Bigelow Basin. Most common on the ridges surrounding the Basin in the southeast portion of the proposed expansion area.

Representative Ground Photo

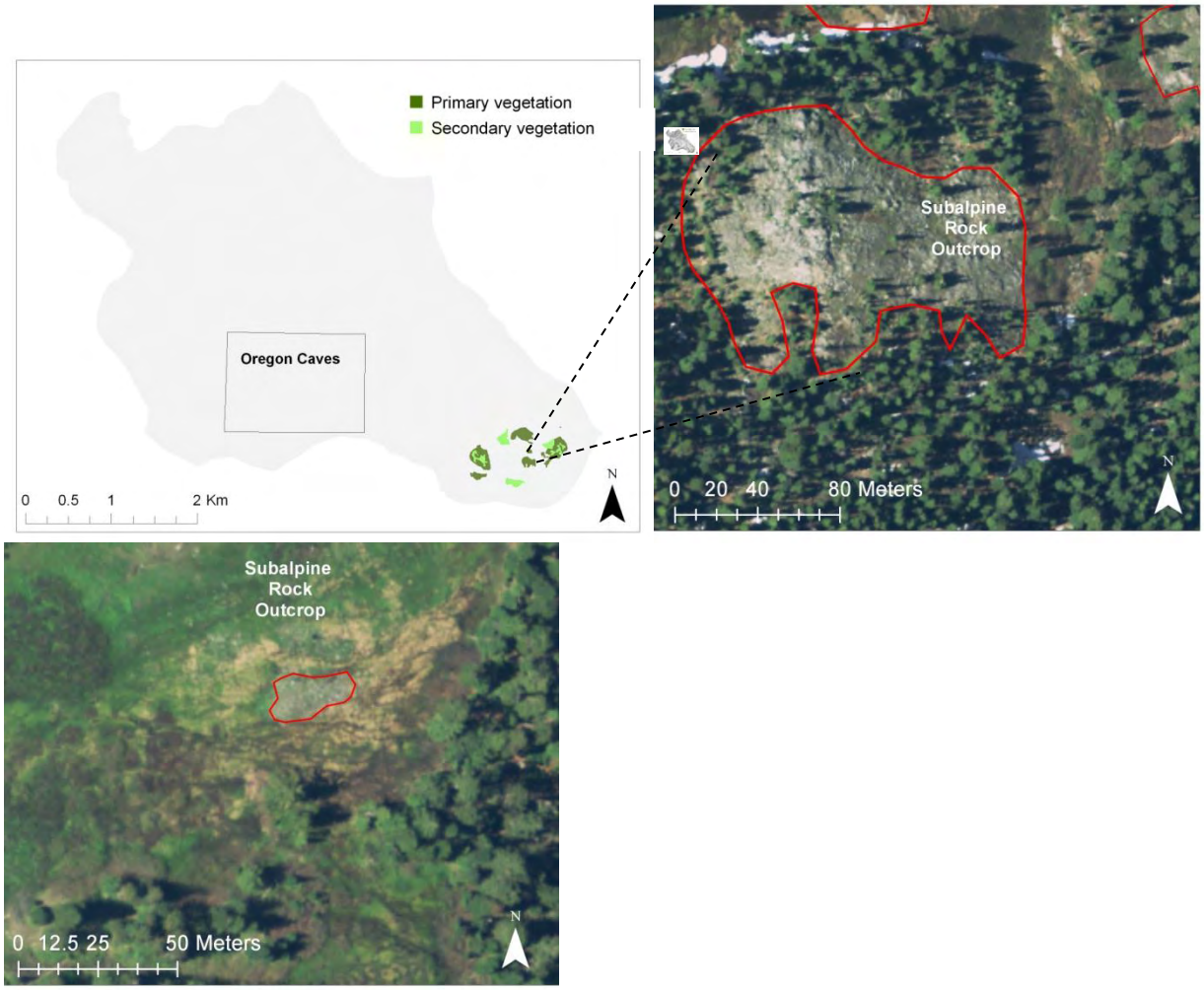


Photo Signature and Mapping Considerations

Light-colored rock (mainly diorite) generally dominates the photo-signature. In small moraine fields, boulders are conspicuous. The boulder fields were mapped as Subalpine Rock Field, while the large bedrock areas are mapped as Subalpine Rock Outcrop.

11. Cushion Buckwheat Gravel Field

Common Species: *Eriogonum ovalifolium* (cushion buckwheat), *Castilleja arachnoidea* (cobwebby Indian paintbrush), *Elymus elymoides* (squirreltail grass), *Abies magnifica x procera* (Shasta red fir), *Calocedrus decurrans* (incense cedar).

USNVC Associations:

None

Classified associations:

Eriogonum ovalifolium

Cumulative area occupied (ha)*	
Primary vegetation	1.4
Secondary vegetation	0
Total	1.4

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

Elevations: ~2000 m.

Description: A subalpine area of coarse gravel dominated by sparse cover of cushion plants and scattered conifer seedlings, saplings, and an occasional small tree or tree thicket.

Range and Distribution: Very limited in project area. One ridgeline location in the extreme eastern portion of the project area along the boundary.

Representative Ground Photo

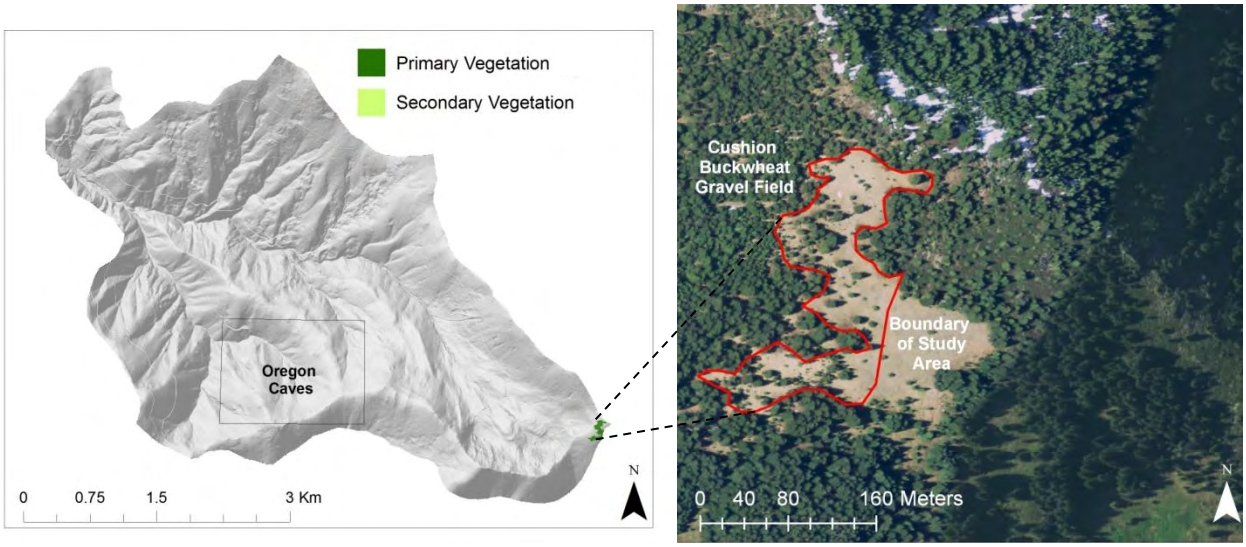


Photo Signature and Mapping Considerations

Color is a distinctive gray-white and scattered small trees are apparent. Cushion plants (*Eriogonum ovalifolium*) cannot be discerned on aerial photos, but presumably contribute to the whitish hue in the photo-signature. Only one location in the project area with one polygon mapped.

D. Forests

12. Riparian Forest

Common Species: *Pseudotsuga menziesii* (Douglas-fir), *Chamaecyparis lawsoniana* (Port Orford-cedar),*Taxus brevifolia* (Pacific yew), *Alnus rhombifolia* (white alder), *Corylus cornuta* var. *californica* (California hazelnut), *Acer macrophyllum* (bigleaf maple), *Salix lasiolepis* (arroyo willow), *Salix lucida* (shining willow), *Salix scouleriana* (Scouler's willow), *Mahonia nervosa* (Cascade barberry), *Achlys triphylla* (sweet after death), *Tiarella trifoliata* var. *unifoliata* (oneleaf foamflower), *Polystichum munitum* (western swordfern), *Rubus parviflorus* (thimbleberry), *Vaccinium parvifolium* (red huckleberry), *Boykinia occidentalis* (coastal brookfoam), *Fragaria vesca* (woodland strawberry), *Adenocaulon bicolor* (American trailplant), *Petasites frigidus* var. *palmatus* (arctic sweet coltsfoot), *Adiantum aleuticum* (Aleutian maidenhair), *Equisetum arvense* (field horsetail)

USNVC Associations:

Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla Forest

Classified associations

Chamaecyparis-Alnus

Non-forested Riparian

Cumulative area occupied (ha)*	
Primary vegetation	57.8
Secondary vegetation	
Total	57.8

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

Elevations: 800-1700 m.

Description: This map unit is dominated by dense streamside forests of tall, multicanopy coniferous and broad-leaved, deciduous trees with exceptionally rich understory. It occurs in the project area along perennial streams having a steep gradient in the montane and mixed evergreen forest zones. Most of the trees from the adjacent conifer-forested uplands are found in the streamside forests. Two species, white alder (*Alnus rhombifolia*) and western yew (*Taxus brevifolius*) are restricted to the streamside vegetation. Down wood of many forms is abundant.

Range and Distribution: Along larger streams in the project area up to 15 m from the centerpoint of the stream channel.

Representative Ground Photos

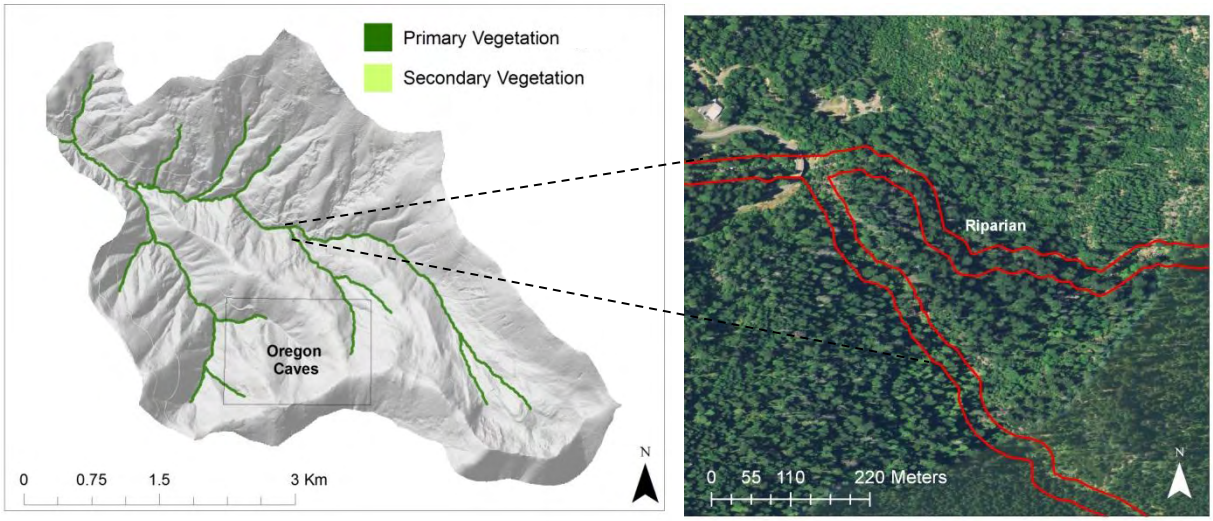


Photo Signature and Mapping Considerations

Riparian areas in the project area are not distinguishable based only on the tree cover on aerial photos because conifer and broad-leaved tree canopies are too similar to those in the adjacent forest vegetation. Therefore, we used the USGS perennial streams coverage to identify riparian areas. We used a buffer of 15 m on either side of the stream.

13. Sclerophyll Forest

Common Species: *Lithocarpus densiflorus* (tanoak), *Arbutus menziesii* (Pacific madrone), *Quercus chrysolepis* (canyon live oak), *Mahonia nervosa* (Cascade barberry), *Pseudotsuga menziesii* (Douglas-fir), *Abies concolor* (white fir), *Achlys triphylla* (sweet after death), *Whipplea modesta* (common whipplea), *Boschniakia strobilacea* (California groundcone), *Disporum hookeri* (drops-of-gold), *Pteridium aquilinum* var. *pubescens* (hairy brackenfern).

USNVC Associations:

Pseudotsuga menziesii - *Quercus chrysolepis* Forest

Classified associations:

Lithocarpus-Arbutus
Quercus chrysolepis

Cumulative area occupied (ha)*	
Primary vegetation	25.3
Secondary vegetation	17.6
Total	42.9

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

Elevations: 900-1300 m.

Description: This map unit is dominated by broad-leaved evergreen forests lacking conifer trees in the overstory. Conifers do often occur in the understory. Tree heights may average about 30 m. Canopy is multilayered and saplings and seedlings of all the conifer and broad-leaved trees from the *Lithocarpus-Arbutus* and *Quercus chrysolepis* associations occur in the understory. Shrubs and a rich herb layer are also present.

Range and Distribution: On south-facing and dry slopes at low elevations. Restricted to the northwestern portion of the project area.

Representative Ground Photos

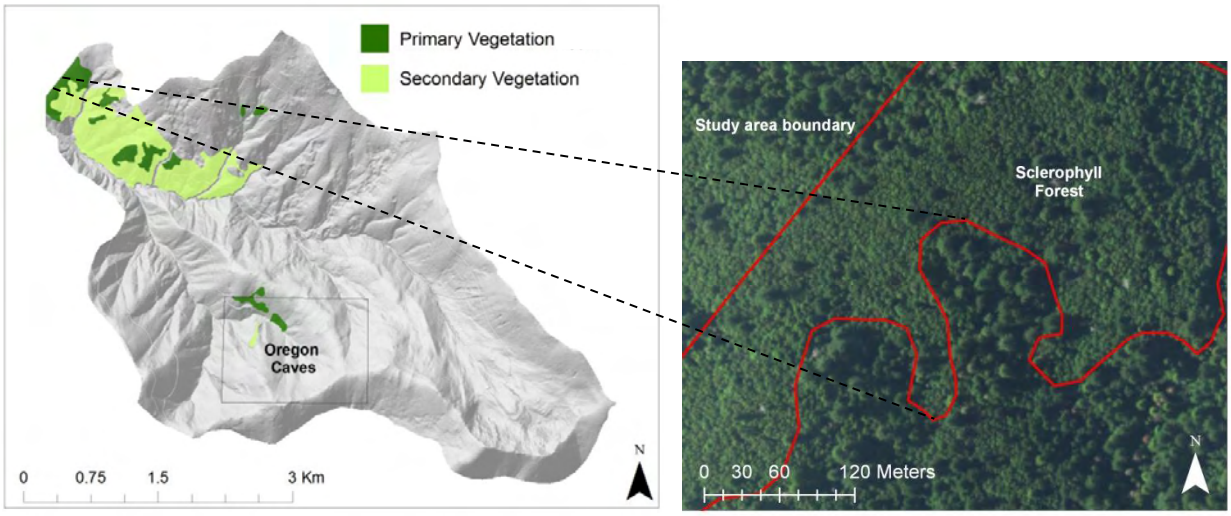


Photo Signature and Mapping Considerations

A relatively fine textured, and uniform height tree canopy is visible. There are very few emergent conifers above the broad-leaved trees. Broad-leaved trees have a slightly lighter hue of green than conifers. Because inclusions of Mixed Evergreen Forest occur at a relatively fine scale, polygons were mapped as a mixture of types. The above example was 90% sclerophyll and 10% Mixed Evergreen Forest.

14. Mixed Evergreen Forest

Common Species: *Pseudotsuga menziesii* (Douglas-fir), *Abies concolor* (white fir), *Lithocarpus densiflorus* (tanoak), *Arbutus menziesii* (Pacific madrone), *Quercus chrysolepis* (canyon live oak), *Pinus lambertiana* (sugar pine), *Calocedrus decurrens* (incense cedar), *Chrysolepis chrysophylla* (giant chinquapin), *Gaultheria shallon* (salal), *Rhododenron macrophyllum* (Pacific rhododendron), *Vaccinium ovatum* (huckleberry), *Mahonia nervosa* (Cascade barberry), *Achlys triphylla* (sweet after death), *Whipplea modesta* (common whipplea), *Boschniakia strobilacea* (California groundcone), *Disporum hookeri* (drops-of-gold), *Trientalis borealis* ssp. *latifolia* (broadleaf starflower), *Pteridium aquilinum* var. *pubescens* (hairy brackenfern), *Goodyera oblongifolia* (western rattlesnake plantain), *Polystichum munitum* (western swordfern), *Melica subulata* var. *subulata* (Alaska oniongrass), *Lonicera hispidula* (pink honeysuckle).

USNVC Associations:

Pseudotsuga menziesii - Arbutus menziesii / Gaultheria shallon Forest
Pseudotsuga menziesii / Lithocarpus densiflorus / Gaultheria shallon Forest
Pseudotsuga menziesii / Lithocarpus densiflorus / Gaultheria shallon Forest
Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla Forest

Classified Associations:

Pseudotsuga-Lithocarpus
Pseudotsuga-Gaultheria
Pseudotsuga-Arbutus
Pinus-Lithocarpus
Chamaecyparis-Pseudotsuga

Cumulative area occupied (ha)*	
Primary vegetation	373.5
Secondary vegetation	47.4
Total	420.9

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

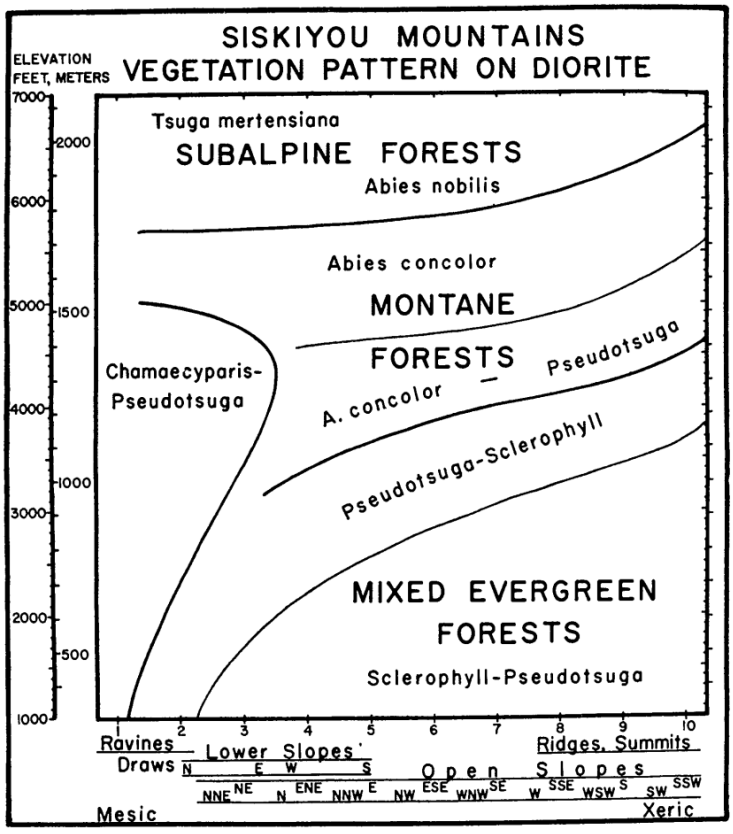
Elevations: 900-1400 m.

Description: A lush and complex group of forests composed of a mix of conifers and broad-leaved evergreen trees and several broadly overlapping and intermixing associations. The overstory of old stands, like most that occur in the project area, is of large to very large (to 75 m tall), well-spaced, emergent *Pseudotsuga menziesii* and occasionally *Pinus lambertiana*, particularly on Gabbro. The middle canopy consists of a mix of conifers and broad-leaved trees, especially *Lithocarpus densiflorus*. Lower layers have these same species, with the exceptionally phenotypically-plastic, broad-leaved trees having a shrub form in the lower vegetation layers. At elevations below 1000-1200 m, a dense understory of Ericaceous shrubs (*Gaultheria shallon*,

Vaccinium spp., and *Rhododenron macrophyllum*) occurs. Above 1000-1200 m, the Ericaceous understory drops out and is replaced by a wide variety of exceptionally rich understory of broad-leaved trees in shrub form, as well as vines, forbs and grasses. Down wood is abundant.

Range and Distribution: Mixed Evergreen Forests occur throughout the project area at elevations below 1000-1400 m depending on aspect. On more north-facing aspects, broad-leaved trees cannot establish and the transition to montane forests of pure conifers occurs at elevations around 1200 m, while the transition occurs at about 1400 m on south-facing slopes. The relationships are shown elegantly on the diagram below from Whittaker (1960), who studied these particular forests in his classic study of the vegetation of the Siskiyou Mountains. Whittaker's *Pseudotsuga*-Sclerophyll zone is included within Mixed Evergreen Forests as treated here.

Representative Ground Photos



Vegetation Diagram from Whittaker (1960), used to help guide mapping of the transitions among *Pseudotsuga menziesii* forest types.

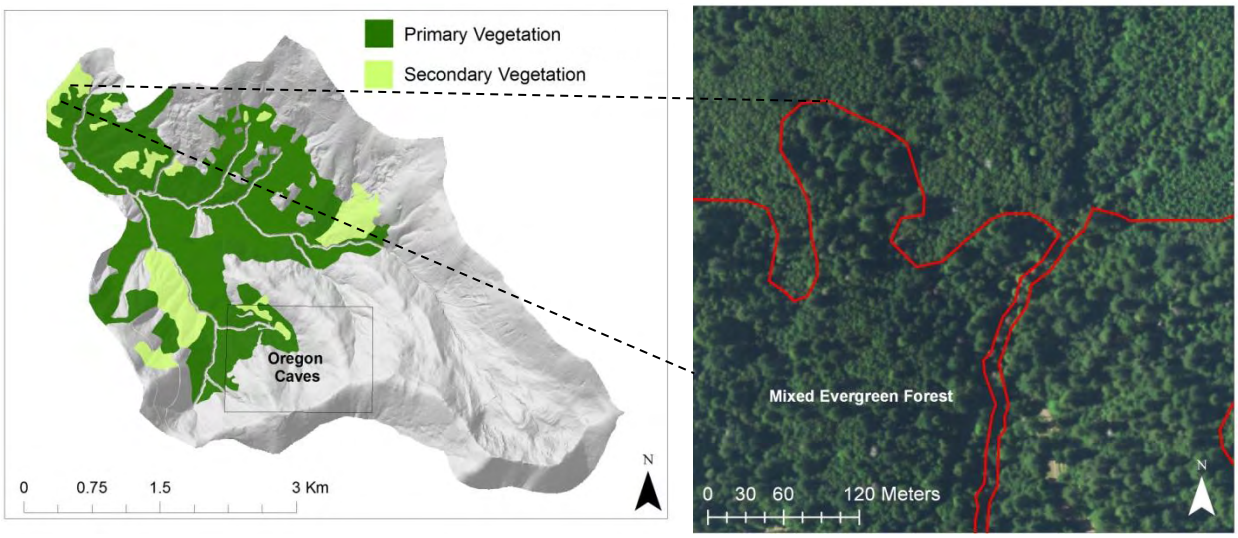


Photo Signature and Mapping Considerations

Much of the variation within these forests cannot be assessed accurately from the aerial photography. In particular, the substantial differences in understory cannot be discerned. Mixed evergreen forests were therefore divided at 1050-1200 m elevation depending on aspect. Stands below this elevation range were mapped (coded) as being dominated by the *Pseudotsuga-Gaultheria* association, per plot sampling. Those above 1050 m and below 1200-1400 m, the elevation at which the transition to Montane Forests (described below) occurs, were mapped (coded) as dominated by *Pseudotsuga-Lithocarpus*, *Pseudotsuga-Arbutus*, or *Pinus-Lithocarpus* based on field observations and geology (*Pinus lambertiana* mainly occurs on Gabbro). Fieldwork also confirmed, consistent with Whittaker (1960) summarized above, that the upper elevational limit of Mixed Evergreen Forest and the lower limit of Montane Forest was 1200-1400 m.

15. Montane Forest

Common Species: *Pseudotsuga menziesii* (Douglas-fir), *Abies concolor* (white fir), *Chamaecyparis lawsoniana* (Port Orford-cedar), *Calocedrus decurrens* (incense cedar), *Mahonia nervosa* (Cascade barberry), *Rubus parviflorus* (thimbleberry), *Rosa gymnocarpa* (wood rose), *Achlys triphylla* (sweet after death), *Bromus laevipes* (Chinook brome), *Agastache urticifolia* (nettleleaf giant hyssop), *Vancouveria hexandra* (white insideout flower), *Actaea rubra* (red baneberry), *Clintonia uniflora* (bride's bonnet), *Trientalis borealis* ssp. *latifolia* (broadleaf starflower), *Fragaria vesca* (woodland strawberry), *Maianthemum stellatum* (starry false lily of the valley), *Disporum hookeri* (drops-of-gold), *Campanula scouleri* (pale bellflower), *Galium triflorum* (fragrant bedstraw), *Osmorhiza chilensis* (sweetcicely), *Festuca subuliflora* (crinkleawn fescue), *Achillea millefolium* (common yarrow).

USNVC Associations:

Abies concolor / Maianthemum stellatum Forest
Pseudotsuga menziesii - Abies concolor - Calocedrus decurrens Forest
Abies concolor - Chamaecyparis lawsoniana - Pseudotsuga menziesii / (Mahonia nervosa) / Achlys triphylla Forest

Classified associations:

Pseudotsuga-Abies
Chamaecyparis-Pseudotsuga
Abies-Achlys
Abies-Agastache

Cumulative area occupied (ha)*	
Primary vegetation	574.2
Secondary vegetation	48.3
Total	622.5

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

Elevations: 1200-1700 m.

Description: A lush and complex group of dense, intermixing forests composed of conifers, sometimes very large (to 75 m tall and the *Pseudotsuga menziesii* with the largest known diameter of its species anywhere (aka, Big Tree)), with a diverse herbaceous understory. Some shrubs occur in the understory as well, but generally not sclerophylls. The largest cohorts of overstory trees are well-spaced, emergent *Pseudotsuga menziesii* and occasionally *Abies concolor*. A middle canopy consists of medium-sized conifers. Exceptionally large quantities of down wood in large size classes occur. Associations are differentiated mostly on the basis of dominant understory herbs, such as *Achlys triphylla, Bromus laevipes,* and *Mahonia nervosa*.

Range and Distribution: The most abundant forest vegetation in the project area. It occurs on all aspects and is very dominant from 1200-1700 m. This distribution includes most of the existing monument and a large central portion of the proposed expansion area.

Representative Ground Photos

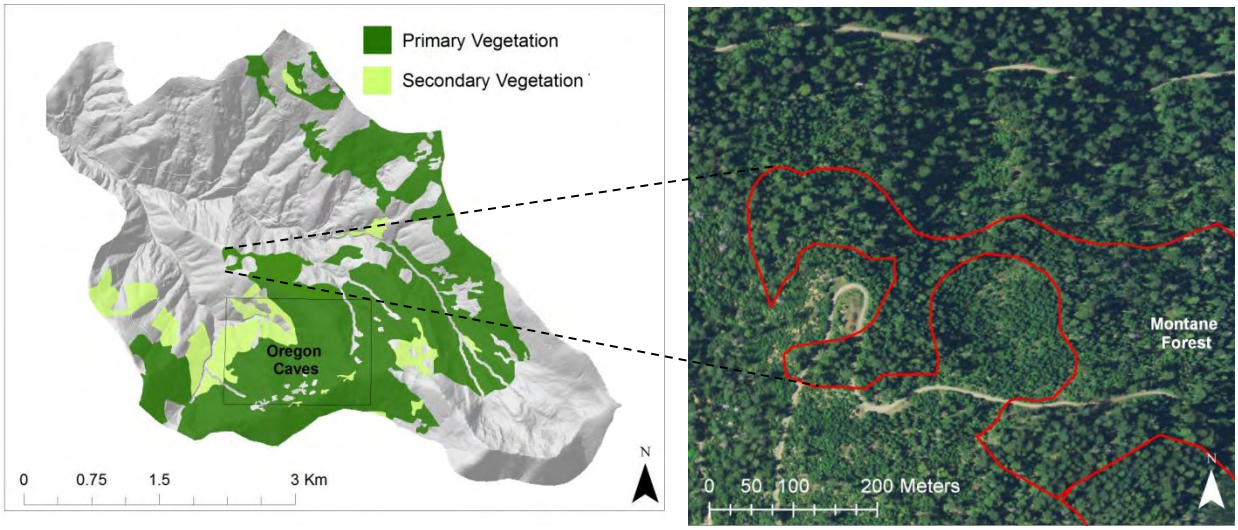
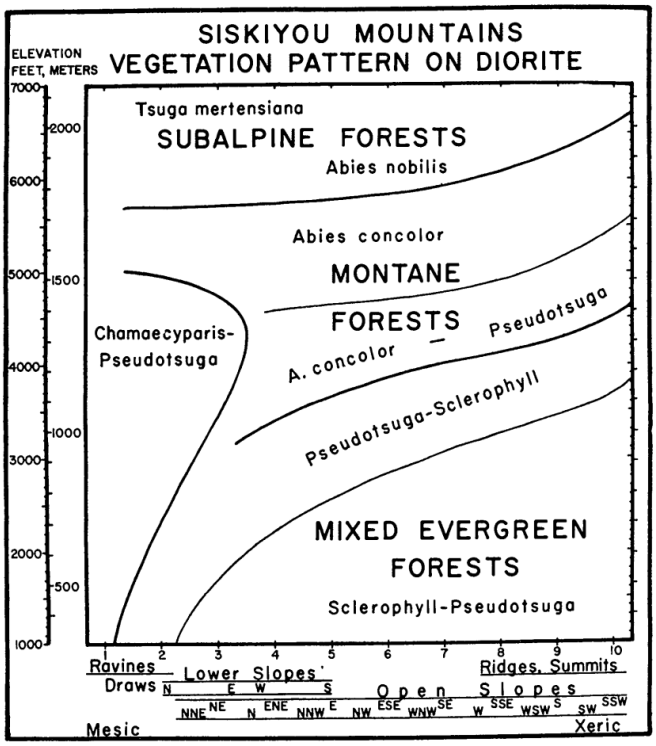


Photo Signature and Mapping Considerations

Montane forest cannot be accurately distinguished on the aerial photography from either Mixed Evergreen Forest or Subalpine Forest. We used the plot data and the diagram presented below (Whittaker 1960) to establish elevation thresholds. The elevations were lower on north-facing slopes and higher on south-facing slopes. The different forest types were delineated along varying contours according to these criteria. The Montane Forest/Mixed Evergreen Forest varied from 1200-1400 m. The Montane Forest/Subalpine Forest boundary was narrower (1650-1750 m). In the above image, the montane forest was separated from Mixed Evergreen forest to the north of the polygon along the 1219 m contour (near the minimum) because this is a north-facing slope. The other boundaries to the southeast were defined by management units depicted in the USFS Rogue River-Siskiyou National Forest Managed Stands Layer.



Vegetation Diagram from Whittaker (1960), used to help guide mapping of the transitions among *Pseudotsuga menziesii* forest types.

16. Subalpine Forest

Common Species: *Abies magnifica x procera* (Shasta red fir), *Tsuga mertensiana* (mountain hemlock), *Abies concolor* (white fir), *Calocedrus decurrens* (incense cedar), *Quercus sadleriana* (deer oak), *Symphoricarpos albus* (common snowberry), *Ribes binominatum* (ground gooseberry), *Rubus lasiococcus* (roughfruit berry), *Agastache urticifolia* (nettleleaf giant hyssop), *Osmorhiza chilensis* (sweetcicely), *Orthilia secunda* (sidebells wintergreen), *Nothochelone nemorosa* (woodland beardtongue), *Maianthemum stellatum* (starry false lily of the valley), *Pedicularis racemosa* (sickletop lousewort), *Pyrola picta* (whiteveined wintergreen), *Hieracium albiflorum* (white hawkweed), *Valeriana sitchensis* (Sitka valerian), *Moehringia macrophylla* (largeleaf sandwort), *Arnica latifolia* (broadleaf arnica), *Pteridium aquilinum* var. *pubescens* (western brackenfern).

USNVC associations:

Abies magnifica / Sparse Understory Forest
Tsuga mertensiana / Sparse Understory Forest

Classified associations:

Abies procera
Tsuga-Abies

Cumulative area occupied (ha)*	
Primary vegetation	191.3
Secondary vegetation	5.2
Total	196.4

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

Elevations: 1700-2040 m.

Description: An open to dense forest of generally medium to large overstory conifers (averaging 35m tall), mostly with a relatively sparse understory, except in openings. Where the understory is well-developed, it is often due to the presence of *Quercus sadleriana*, which occurs in dense patches but is very discontinuous. The two main associations are differentiated based on the presence of *Tsuga mertensiana*. This tree becomes increasingly more dominant at higher elevations. However, the highest elevations of the project area are often dominated by *Abies procera*, especially north-facing slopes.

Range and Distribution: In the project area, subalpine forests are mostly found on mountaintops and ridgetops. However, they also descend into the Bigelow Basin on north-facing slopes. Thus, these forests are restricted the easternmost portion of the expansion area at the uppermost elevations.

Representative Ground Photos

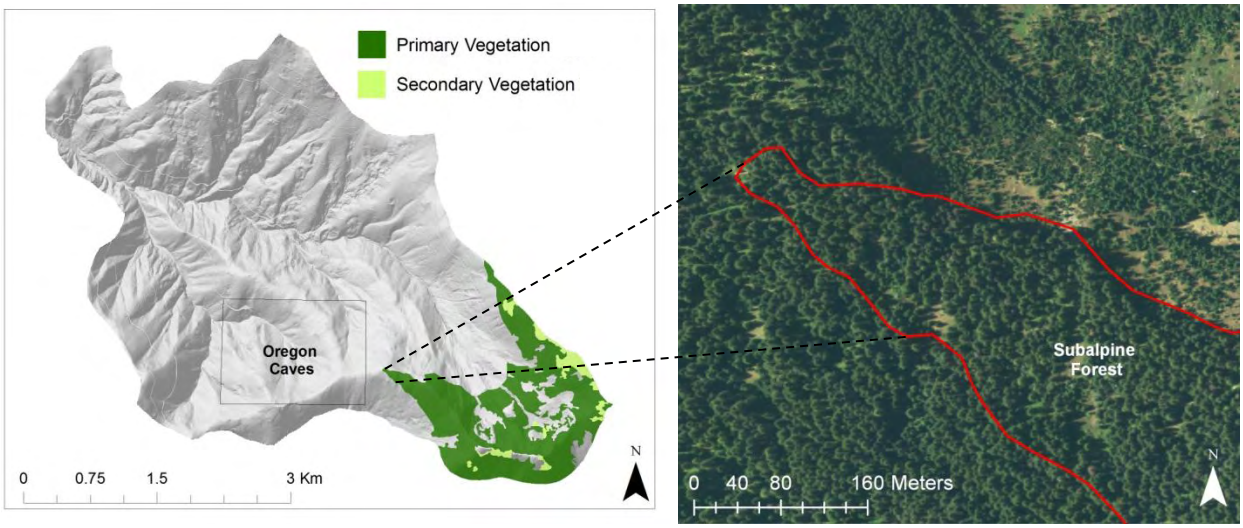


Photo Signature and Mapping Considerations
This forest intergrades with montane forests, which can have an identical photo-signature (closed conifer forest). We therefore separated the two types based on elevation. Our plot data, and Figure 11 from Whittaker (1960, see description for Montane Forest) indicate that the transition from the two forests occurs relatively consistently at about 1700 m, so we used this contour to separate Subalpine and Montane Forest.

E. Anthropogenic Vegetation (from human land-uses)

17. Plantations

Common Species: *Pseudotsuga menziesii* (Douglas-fir), *Abies concolor* (white fir), *Lithocarpus densiflorus* (tanoak), *Quercus chrysolepis* var. *chrysolepis* (canyon live oak), *Arbutus menziesii* (Pacific madrone), *Gaultheria shallon* (salal), *Chrysolepis chrysophylla* (giant chinquapin), *Whipplea modesta* (common whipplea), *Amelanchier alnifolia* (Saskatoon serviceberry).

USNVC Associations:
None

Classified Associations:
Pseudotsuga plantation

Cumulative area occupied (ha)*	
Primary vegetation	274.2
Secondary vegetation	13.3
Total	287.5

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

Elevations: 900-1700 m.

Description: Clear-cut areas that were replanted with dense, evenly-spaced Douglas-fir (*Pseudotsuga menziesii*). The clear-cuts were mostly conducted in the 1970s and early 1980s, and the clear-cut date, from the Rouge-Siskiyou National Forest managed stands layer, was coded in the polygons. A wide variety of other vegetation may occur in the plantations. Resprouting *Lithocarpus densiflorus* or other broad-leaved trees are sometimes common, as are many of the other species from the Mixed Evergreen, Sclerophyll, and Montane Forest types. There were no clear-cut areas in the Subalpine Forest zone. A few clear-cut areas that were found to not support dense plantings were mapped as Young Forest (logged). These stands have a mix of young forest, Montane Open Shrubland, and Ruderal vegetation.

Range and Distribution: On slopes throughout the lower to mid-elevations of the project area.

Representative Ground Photos

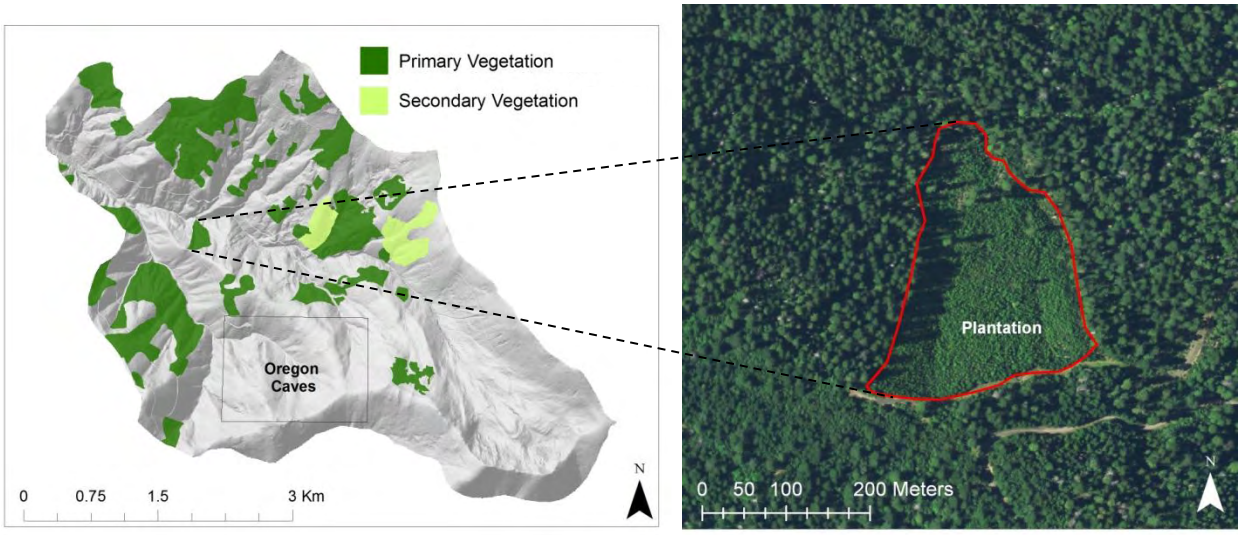


Photo Signature and Mapping Considerations

Plantations are conspicuous as a dense green color with very fine texture due to the uniform tree height. Maps of plantations from the USFS Rogue River-Siskiyou National Forest Managed Stands Layer were used to map plantations, with slight refinements made based on the aerial photography.

18. Young Montane Forests (Logged)

Common Species: *Pseudotsuga menziesii* (Douglas-fir), *Abies concolor* (white fir), *Pseudotsuga menziesii* (Douglas-fir), *Calocedrus decurrens* (incense cedar), *Rubus parviflorus* (thimbleberry), *Rosa gymnocarpa* (wood rose), *Agastache urticifolia* (nettleleaf giant hyssop), *Arctostaphylos patula* (greenleaf manzanita), *Ceanothus velutinus* (tobacco brush), *Polygonum phytolaccifolium* (poke knotweed), *Iliamna latibracteata* (California wild hollyhock), *Hypericum perforatum* (common St. Johnswort), *Achillea millefolium* (common yarrow), *Campanula scouleri* (pale bellflower), *Fragaria vesca* (woodland strawberry), *Heracleum maximum* (common cowparsnip), *Vicia americana* ssp. *americana* (American vetch), *Elymus glaucus* (blue wildrye), *Pteridium aquilinum* var. *pubescens* (hairy brackenfern), *Hypericum perforatum** (St. Johnswort), *Bromus tectorum** (cheatgrass), *Dactylis glomerata** (orchardgrass), *Gnaphalium canescens* (slender cudweed), *Galium aparine** (bedstraw), *Lotus corniculatus** (birdsfoot trefoil), *Lotus crassifolius* (big deervetch), *Rubus leucodermis** (blackcap), *Vulpia bromoides** (six-weeks fescue).
*non-native species

USNVC associations:

Pseudotsuga menziesii - Abies concolor - Calocedrus decurrens Forest

Classified associations:

Pseudotsuga-Abies
Abies-Agastache
Pseudotsuga plantation
Abies-Achlys

Cumulative area occupied (ha)*	
Primary vegetation	29.2
Secondary vegetation	20.1
Total	49.3

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

Elevations: 1100-1600 m.

Description: This physiognomic vegetation type occurs in areas that were shelterwood or clear-cut logged (as shown on the Rogue River-Siskiyou National Forest managed stands layer) in which plantations were not established. There are many small trees and some larger trees scattered in open forests to woodlands. An understory of mostly herbaceous vegetation is well developed. Non-native species are common in the understory, as are many species from the Montane Seasonally Dry Meadow Association. This type was generally intermixed with plantations.

Range and Distribution: Throughout the proposed expansion area.

Representative Ground Photo

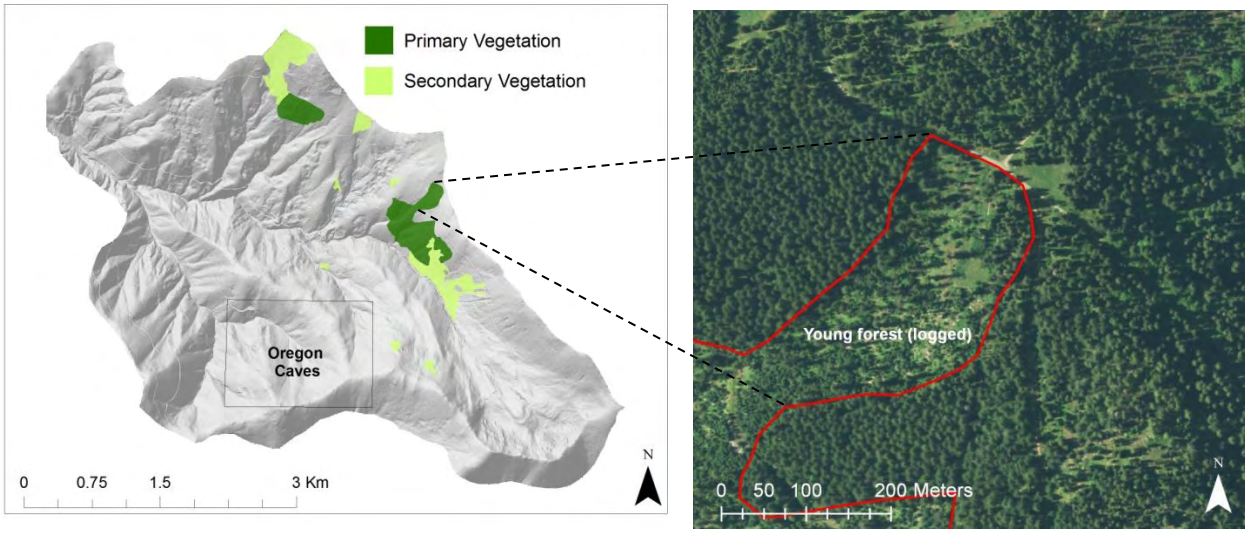


Photo Signature and Mapping Considerations

Open conifer forest or woodland in areas identified as having been clear-cut or shelterwood-logged on the Rogue-Siskiyou National Forest managed stands layer, but lacking dense plantations.

19. Ruderal

Common Species: *Hypericum perforatum** (St. Johnswort), *Bromus tectorum** (cheatgrass), *Dactylis glomerata** (orchardgrass), *Arctostaphylos patula** (greenleaf manzanita, generally small individuals) and (*Ceanothus velutinus* var. *velutinus*) *(*tobacco brush*), Gnaphalium canescens* (slender cudweed), *Galium aparine** (bedstraw), *Lotus corniculatus** (birdsfoot trefoil), *Lotus crassifolius* (big deervetch), *Rubus leucodermis** (blackcap), *Vulpia bromoides** (six-weeks fescue). *non-native species

USNVC Associations:

None

Classified associations:

Ruderal

Abies-Agastache

Pteridium aquilinum-Holodiscus discolor

Cumulative area occupied (ha)*	
Primary vegetation	3.2
Secondary vegetation	7.1
Total	10.3

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

Elevations: 900-1700 m.

Description: Landing areas that were used for logging, and other highly disturbed areas where a mix of native species and invasive grasses and forbs currently grow.

Range and Distribution: At a few locations scattered across the proposed expansion area.

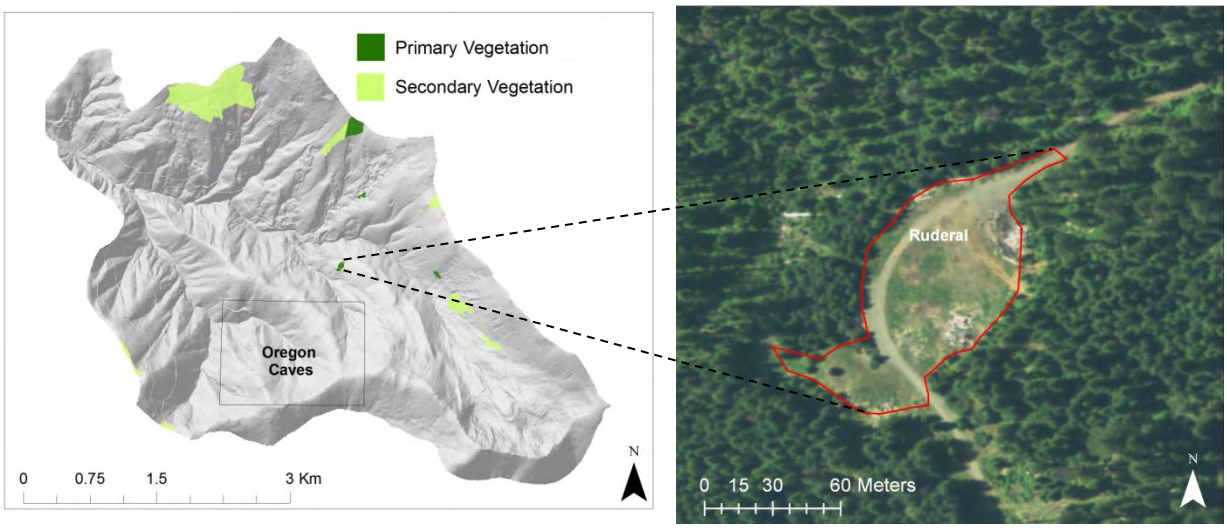


Photo Signature and Mapping Considerations

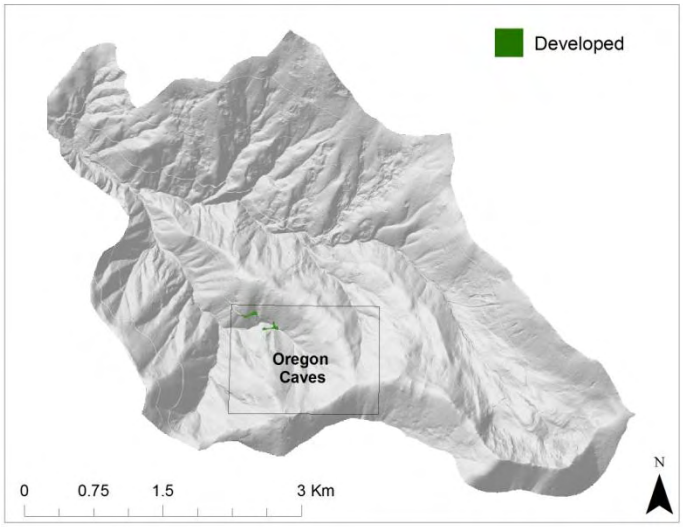
Areas of greenish or brownish grassland, typically where the USFS Rogue River-Siskiyou National Forest managed stands layer indicated clear cut. Ruderal areas occur as relatively fine scale inclusions in clearcut areas, such as the polygon where it is mapped as a secondary vegetation type in the northwest portion of the project area.

20. Developed

Description: Paved parking lots and the visitor center.

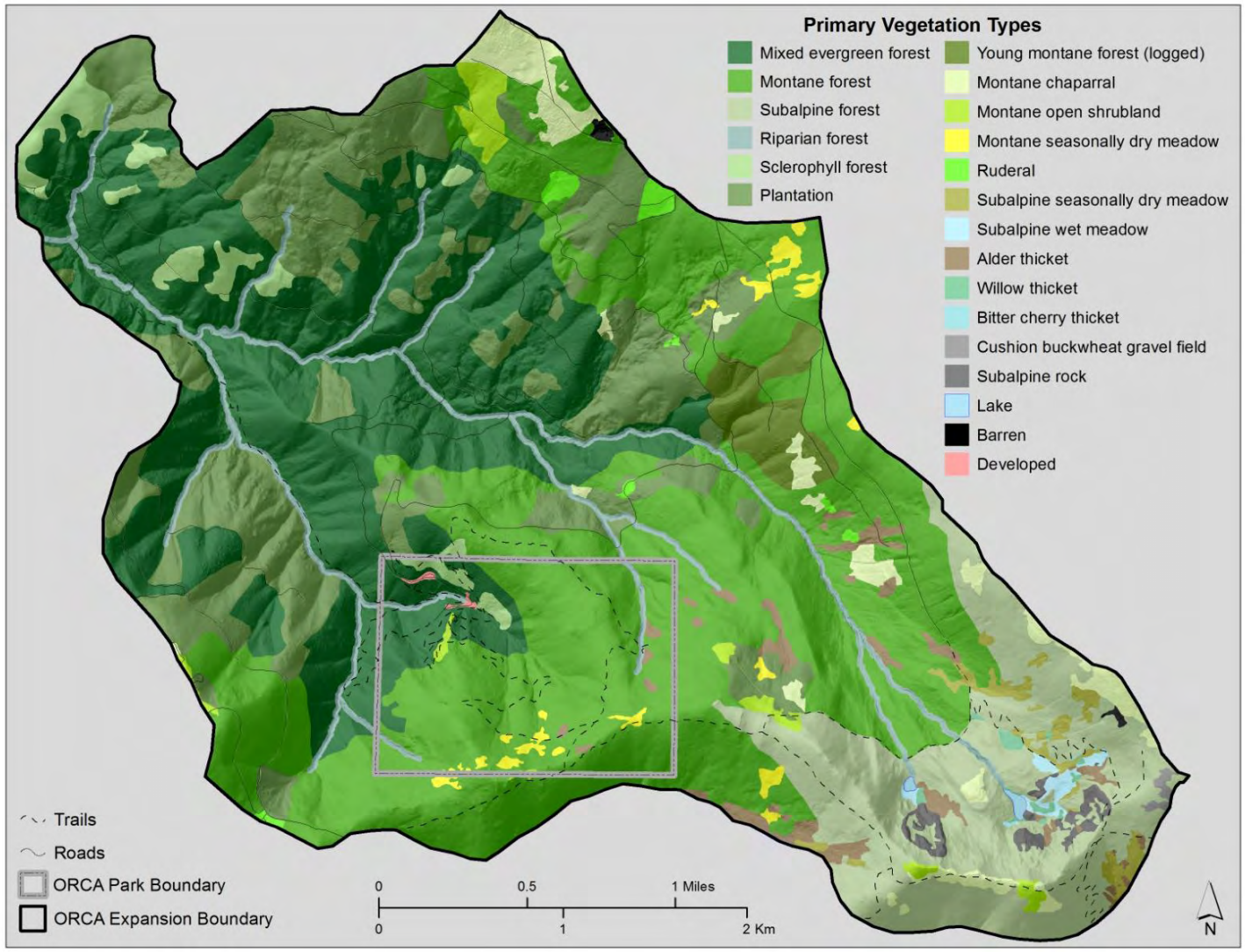
Cumulative area occupied (ha)*	
Primary vegetation	0.9
Secondary vegetation	0
Total	0.9

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



Range and Distribution

Appendix F. Vegetation Map of the Oregon Caves National Monument and the Proposed Expansion Area



The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 150/121793, July 2013

National Park Service
U.S. Department of the Interior

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