

Ecological site F022BI111CA Cryic Gravelly Or Ashy Sandy Loam Gentle Slopes

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.



Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 022B–Southern Cascade Mountains

Site concept:

Landform: (1) Mountain slope, (2) Moraine, (3) Lava flow

Elevation (feet): 6,470-8,300

Slope (percent): 1-80, but generally 2 to 30 percent

Water Table Depth (inches): n/a

Flooding-Frequency: None

Ponding-Frequency: None

Aspect: North, East, West

Mean annual precipitation (inches): 37.0-111.0

Primary precipitation: Winter months in the form of snow

Mean annual temperature: 38 to 43 degrees F (3.3 to 6 degrees C)

Restrictive Layer: Densic layer or Lithic contact

Temperature Regime: Cryic

Moisture Regime: Xeric

Parent Materials: Tephra over, or mixed, with till from volcanic rocks

Surface Texture: (1) Gravelly ashy sandy loam, (2) Ashy Sandy loam

Surface Fragments <=3" (% Cover): 17-40

Surface Fragments > 3" (% Cover): 0-50

Soil Depth (inches): 20-60+

Vegetation: The subalpine forest is dominated by California red fir (*Abies magnifica*) and mountain hemlock (*Tsuga mertensiana*).

Notes: This ecological site is found on glaciated mountain slopes and lava flows, moraines, or on linear to concave positions on pyroclastic cones.

Classification relationships

Forest Alliance = *Tsuga mertensiana* – Mountain hemlock forest; Association = (no matching species). (Sawyer, John O., Keeler-Wolf, Todd, and Evens, Julie M. 2009. A Manual of California Vegetation. 2nd ed. California Native Plant Society Press. Sacramento, California.)

Associated sites

F022BI104CA	Cryic Coarse Loamy Colluvial Slopes This is a mountain hemlock forest found at higher elevations and sheltered north slopes.
R022BI205CA	Cirque Floor This is a lupine dominated rangeland site found in cirque floors.
R022BI206CA	Cryic Lacustrine Flat This cryic meadow site is found in alluvial flats among the forest.
R022BI207CA	Alpine Slopes This sparsely vegetated alpine range site is found at higher elevations.
R022BI208CA	Cryic Pyroclastic Cones This rangeland site is found on the shoulders of cinder cones in the eastern side of the Park.
R022BI211CA	Spring Complex This site is associated with springs and seeps and is dominated by alders, forbs, and sedges.

Similar sites

F022BI115CA	Frigid And Cryic Gravelly Slopes This red fir-western white pine site merges with this site at lower elevations.
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Table 1. Dominant plant species

Tree	(1) <i>Tsuga mertensiana</i> (2) <i>Abies magnifica</i>
Shrub	Not specified
Herbaceous	(1) <i>Lupinus obtusilobus</i> (2) <i>Eriogonum marifolium</i>

Physiographic features

This ecological site is found on glaciated mountain slopes and lava flows, moraines, or on linear to concave positions on pyroclastic cones. The range in elevation is from 6,470 to 8,300 feet. Slopes range from 1 to 80 percent however slopes of 2 to 30 percent are more common.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Moraine (3) Lava flow
Flooding frequency	None
Ponding frequency	None
Elevation	1,972–2,530 m

Slope	1–80%
Aspect	N, E, W

Climatic features

This ecological site receives most of its annual precipitation during the winter months in the form of snow. The mean annual precipitation ranges from 67 to 111 inches (1,702 to 2,819 mm). Prism models indicate precipitation drops to 37 inches (940 mm) on the upper cinder cones on the eastern side of the Park. The mean annual temperature ranges from 38 to 41 degrees F (3.3 to 5 degrees C). The frost free (>32 degrees F) season is 50 to 85 days. The freeze free (>28 degrees F) season is 60 to 185 days.

There are no representative climate stations for this site.

Table 3. Representative climatic features

Frost-free period (average)	85 days
Freeze-free period (average)	185 days
Precipitation total (average)	2,819 mm

Influencing water features

This ecological site is not influenced by wetland or riparian water features.

Soil features

This ecological site is associated with the Shadowlake soil component, the Terracelake soil component and the Xeric Vitricryands, ash over cinders soil component.

The Shadowlake soils are deep, well drained soils that formed in tephra over, or mixed, with till from volcanic rocks. The surface texture is a gravelly ashy sandy loam. Subsurface textures are similar, but gravel content increases significantly with depth. The lower portion of the profile contains greater than 35 percent rock fragments. A densic layer is present at depths of 40 to 60 inches. These soils are classified as Ashy-skeletal, glassy Xeric Vitricryands. Permeability is rapid to moderately rapid in the upper horizons and very slow through the densic layer. AWC (available water capacity) is very low to low in the upper 60 inches of soil.

The Terracelake soils are moderately deep, well drained soils that formed in tephra over, or mixed, with colluvium and residuum from volcanic rock. The surface texture is a gravelly ashy sandy loam. Subsurface textures are similar, but gravel content increases significantly with depth. Just above the bedrock there is an extremely stony ashy sandy loam textured horizon. Depth to dacite bedrock varies from 20 to 40 inches. There is greater than 35 percent rock fragments throughout most of this soil profile. These soils are classified as Ashy-skeletal, amorphous Xeric Vitricryands. Permeability is rapid to moderately rapid in the upper horizons but impermeable through the bedrock. AWC is very low to moderate in the upper 60 inches of soil.

The Xeric Vitricryands, ash over cinders soils are very deep, well drained soils that formed in ash over colluvium from volcanic rocks. The surface texture is ashy sandy loam. Subsurface textures are similar, but gravel content increases significantly with depth. Below 45 inches the soil has 98 percent rock fragments with a gravel texture. Permeability is rapid to moderately rapid in the upper horizons and very rapid through the lower gravel horizon. AWC is very low to low.

This ecological site is associated with the following soil components within the Lassen Volcanic National Park Soil Survey Area (CA789):

Map Unit Component /Percent
 115 Shadowlake /85
 115 Terracelake /10

122 Xeric Vitricryands, ash over cinders /30
 136 Terracelake /45
 144 Shadowlake / 2
 175 Shadowlake /75

Table 4. Representative soil features

Family particle size	(1) Sandy
Drainage class	Well drained
Permeability class	Rapid
Soil depth	51 cm
Surface fragment cover <=3"	17–40%
Surface fragment cover >3"	0–50%
Available water capacity (0-101.6cm)	0.71–13.64 cm
Soil reaction (1:1 water) (0-101.6cm)	5.6–7.3
Subsurface fragment volume <=3" (Depth not specified)	34–61%
Subsurface fragment volume >3" (Depth not specified)	0–55%

Ecological dynamics

This site is associated with moderately deep to very deep soils with greater than 35 percent rock fragments in most of the soil profile. The rock fragments are mostly gravels. The soils are well drained and have very low to moderate water holding capacity. Despite the droughty nature of the soil, this site receives relatively high precipitation and is cool, losing less water to evaporation. This area receives 67 to 110 inches of precipitation, mostly during the winter in the form of snow. The deep snow pack melts gradually and can persist into the early summer months. The soils remain moist due to cool summer air temperatures that are enhanced by high elevations, northern aspects, canopy shade, and cool air drainages coming down the mountain. As snow melts from this site, it continues to receive snow melt from even cooler sites upslope. This site is often found on wind-sheltered slopes and valleys which accumulate rather than divert wind blown snow and water melt-off. The frost-free growing season ranges from 2 to 3 months. The growing season begins approximately 2 weeks after snow melt and lasts until drought conditions set in. The length of the growing season is critical for seedling establishment and annual growth. Conifer species have a variety of variables that need to be met to initiate seasonal growth. Perhaps the most critical factor is a minimum soil and air temperature during the growing season. Conifer species found at lower elevations require warmer temperatures and longer frost free conditions for sustainable growth (Royce and Barbour, 2001).

This is a subalpine forest is dominated by California red fir (*Abies magnifica*) and mountain hemlock (*Tsuga mertensiana*). California red fir is a tall, long-lived conifer with short branches and a narrow crown. It produces single 0.8 to 1.4-inch needles that are distributed along the young branches. Firs produce upright cones that open and fall apart while still attached to the tree, so cones are not often seen on the forest floor unless cut by squirrels or chipmunks in fall. California red fir cones are about 9 inches long. California red fir is adapted to cold wet winters in areas with deep snow accumulation followed by warm summers. The young trees have thin bark and are very susceptible to fire, but as trees mature the bark thickens and fire resistance increases. It is shade tolerant and continues to reproduce under the forest canopy, therefore increasing in dominance in the absence of fire.

Mountain hemlock is a slow-growing native conifer. On this site it grows as a tall tree, with branches on the upper portion of the stem. In open areas the branches are low on the stem and, if touching the soil, may root by layering. It produces single needles, which tightly overlap the twig surfaces. The needles generally curve upward. Trees have a shallow wide-spreading root system. Mountain hemlock is shade tolerant and will reproduce in the understory. (Tesky, 1992). Reestablishment of mountain hemlock after a fire or other disturbance is often slow and, in some areas, it never regains its tree-like stature (Arno and Hammerly, 1984).

Western white pine is also a long-lived conifer with a narrow crown. It has 2 to 4-inch needles in bundles of 5. It produces a deep tap root and extensive lateral roots. Most of the lateral roots are within the upper 2 feet of soil. Young trees have thin bark and are very susceptible to fire due to damage to the cambial tissue. Mature trees develop thicker bark and have higher branches, making them less prone to mortality from fire (Griffith, 1992). Western white pine bark, when damaged by fire, can allow infestations of pathogens that can eventually kill the trees. It is shade intolerant and dependent upon canopy disturbances for regeneration and long-term survival.

Sierra lodgepole pine can be long-lived. Trees nearby were 180 to 200 years old and reached heights of 100 to 120 feet. Sierra lodgepole pine does not usually gain much in girth with time and older trees on this site averaged 20 to 24-inch diameters. Trees grow tall and narrow with short branches and 1.2 to 2.4-inch needles in fascicles of two. Its thin bark and shallow roots make it susceptible to fire. Sierra lodgepole pine is the only non-serotinous lodgepole pine. Therefore it does not need fire to open its cones to release seeds. The roots of Sierra lodgepole pine are generally shallow, which enable it to grow on this site. Sierra lodgepole pine produces a taproot that may atrophy or grow horizontally in cases of high water tables or root restrictive layers. It is shade intolerant and regenerates prolifically after fire or other canopy disturbances (Cope, 1993). Disturbance is needed to maintain Sierra lodgepole pine on this site.

Forest communities of this site have evolved with fire over the centuries. They are relatively slow growing and accumulate fuels slowly. Therefore fire spreads across this site less frequently than lower elevation conifer forests. Fire ecology for this subalpine forest type is poorly studied. The point fire return interval for the red fir-western white pine forest on Prospect Peak ranges from 26 to 109 years, with a mean of 70 (Taylor, 2000). In the Caribou Wilderness the mean is 66 years (Taylor and Solem, 2001). In the Thousand Lakes Wilderness the point fire return interval ranges from 9 to 91 years, with a mean of 20 for red fir-mountain hemlock forests (Bekker and Taylor, 2001). Fire return intervals may be between 400 to 800 years in a pure mountain hemlock forest (Tesky, 1992). In a separate study, Beaty and Taylor report that fire return intervals are longer on north facing slopes than on south facing slopes. Stand-replacing fire is more common on upper slopes, while low to moderate intensity fires occur only along lower slopes. This is probably due to the tendency of fire to burn upslope, preheating the fuels as it goes. Large fires and multiple small fires in the same season are associated with dry and very dry years (Beaty and Taylor, 2001). This forest is fairly continuous and can become dense with heavy fuel accumulations. Severe fires are likely at certain stages of development. Since the fire frequency at this site is probably more common at the lower elevations than the upper elevations, where mountain hemlock becomes more prevalent than California red fir, the natural fire return interval may range from 20 years to longer than 100 years.

Evidence of fire suppression is evident in this forest type. Shade tolerant California red fir and mountain hemlock seedlings and saplings are common in the understory. Some areas are further along than others in understory development. As the canopy cover increases, the shade intolerant western white pine and Sierra lodgepole pine decline.

Tree pathogens and insect infestations can have significant impacts on the composition and structure of upper montane coniferous forests. Small infestations may affect just a few trees but large outbreaks can kill the dominant trees over large areas of forest, creating large canopy openings and stand regeneration. Most of these pathogens represent natural cycles of regulation that can push closed forest types into more open forest types. Large outbreaks are often associated with drought years or overstocked forests. Fuel loads are frequently high after outbreaks, creating ideal conditions for high intensity fires.

The major pathogens that affect California red fir in this area are red fir dwarf mistletoe (*Arceuthobium abietinum* f. sp. *magnificae*), fir broom rust (*Melampsorella caryophyllacearum*), annosus root rot (*Heterobasidion annosum*), and the fir engraver (*Scolytus ventralis*). Other diseases that can affect red fir are the heart rots, including yellow cap fungus (*Pholiota limonella*), Indian paint fungus (*Echinodontium tinctorium*), cone maggots (*Earomyia* spp.), several chalcids (*Megastigmus* spp.), and cone moths (*Barbara* spp. and *Eucosma* spp.) (Burns and Honkala, 1990).

Several pathogens affect mountain hemlock, but epidemics are rare. The major pathogens that affect mountain hemlock are laminated root rot (*Phellinus weirii*), such heart rots as Indian paint fungus (*Echinodontium tinctorium*), a number of needle diseases, snow mold (*Herpotrichia nigra*), and dwarf-mistletoe (*Arceuthobium tsugense*) (Tesky, 1992).

The mountain pine beetle (*Dendroctonus ponderosae*) is the most serious pest for Sierra lodgepole pine and

outbreaks can kill acres forests. Pathogens that affect Sierra lodgepole pine include other insects such as the pine engraver (*Ips pini*), weevil (*Magdalis gentiles*), lodgepole terminal weevil (*Pissodes terminalis*), Warren's collar weevil (*Hylobius warreni*), pine needle scale (*Chionaspis pinifoliae*), black pineleaf scale (*Nuculaspis californica*), spruce spider mite (*Oligonychus ununguis*), lodgepole sawfly (*Neodiprion burkei*), lodgepole needle miner (*Coleotechnites milleri*), sugar pine tortrix (*Choristoneura lambertiana*), pine tube moth (*Argyrotaenia pinatubana*), and pandora moth (*Coloradia pandora*). *Ips* commonly develops in logging slash, especially slash that is shaded and does not dry quickly. Prompt slash disposal is an effective control measure. *Ips* also can build-up in windthrows. Fungal diseases that affect lodgepole pine productivity include stem cankers caused by *atropelius* canker (*Atropellis piniphilia*), comandra blister rust (*Cronartium comandrae*), and western gall rust (*Peridermium harknessii*). The honey mushroom (*Armillaria mellea*) and annosus root disease (*Heterobasidion annosum*) are sources of root rot, and wood decay is caused by such fungi as red rot (*Phellinus pini*) and red heart wood stain (*Peniophora pseudo-pini*). Dwarf mistletoe (*Arceuthobium americanum*) is a common parasite that affects large areas of lodgepole pine (Lotan and Critchfield, 1990).

The major pathogen affecting western white pine is the white pine blister rust (*Cronartium ribicola*). It is a non-native disease that was introduced from Europe and Asia in the 1920s. Some strains of western white pine have shown resistance to the disease. Other pathogens that affect western white pine are the needle cast fungi (*Lophodermella arcuata* and *L. nitens*) and (*Bifusella linearis*). Wood decay is caused by red rot (*Phellinus pini*), red-brown butt rot (*Phaeolus schweinitzii*), annosus root disease (*Heterobasidion annosum*), and honey mushroom (*Armillaria* spp.). Significant insect pests include mountain pine beetle (*Dendroctonus ponderosae*), emarginate ips (*Ips emarginatus*), and ips beetle (*Ips montanus*) (Taylor and Halpern, 1991).

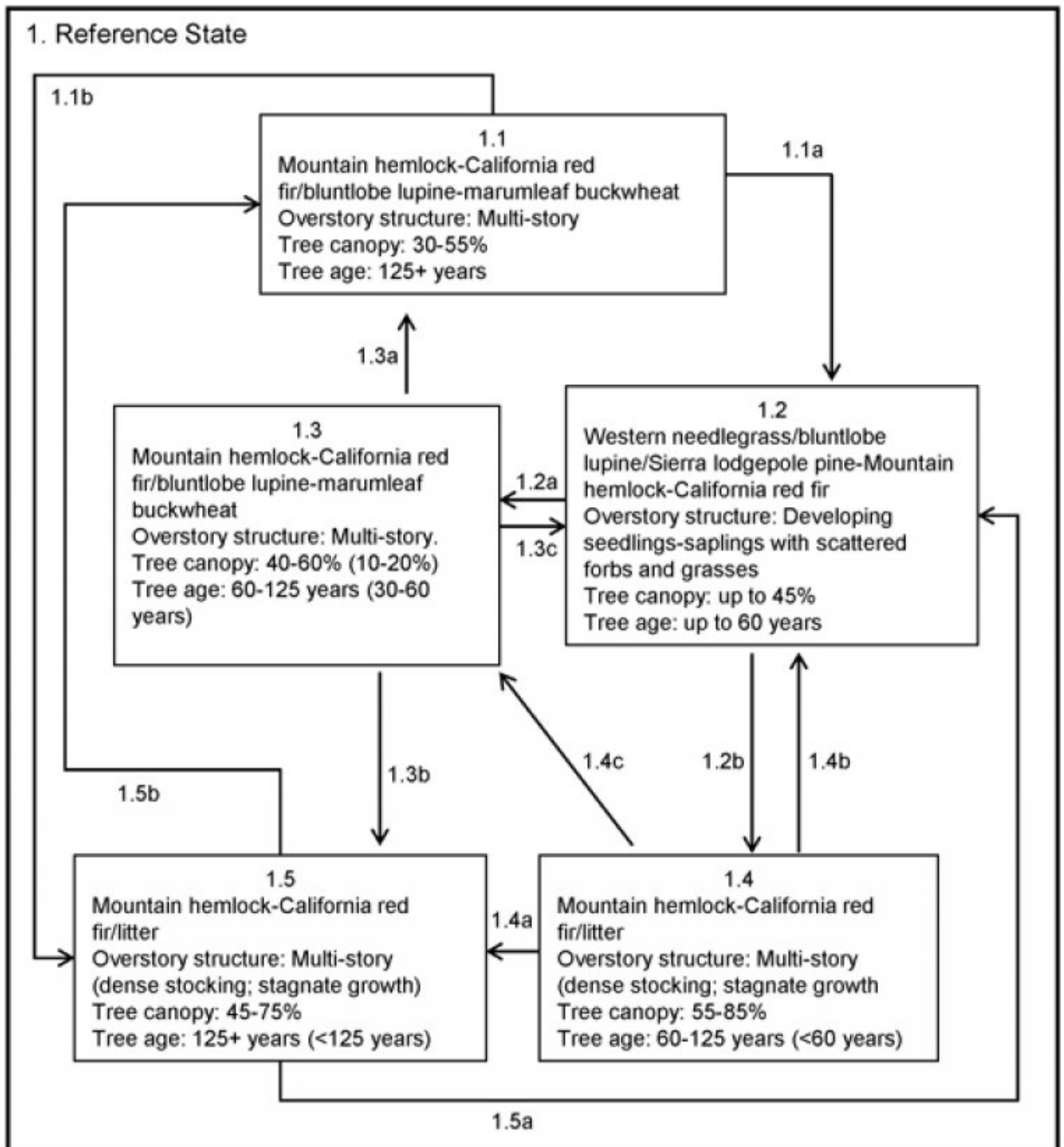
The reference state consists of the most successional advanced community phase (numbered 1.1) as well as other community phases which result from natural and human disturbances. Community phase 1.1 is deemed the phase representative of the most successional advanced pre-European plant/animal community including periodic natural surface fires that influenced its composition and production. Because this phase is determined from the oldest modern day remnant forests and/or historic literature, some speculation is necessarily involved in describing it.

All tabular data listed for a specific community phase within this ecological site description represent a summary of one or more field data collection plots taken in communities within the community phase. Although such data are valuable in understanding the phase (kinds and amounts of ground and surface materials, canopy characteristics, community phase overstory and understory species, production and composition, and growth), it typically does not represent the absolute range of characteristics nor an exhaustive listing of species for all the dynamic communities within each specific community phase.

State and transition model

State-Transition Model - Ecological Site F022BI111CA

Tsuga mertensiana-*Abies magnifica*/*Lupinus obtusilobus*-*Eriogonum marifolium*
(Mountain hemlock-California red fir/bluntlobe lupine-marumleaf buckwheat)



State 1 Reference

Community 1.1 Mountain hemlock-California red fir/bluntlobe lupine-marumleaf buckwheat

This is an upper elevation mixed conifer forest. California red fir (*Abies magnifica*), western white pine (*Pinus*

monticola), Sierra lodgepole pine (*Pinus contorta* var. *murrayana*) and mountain hemlock (*Tsuga mertensiana*) all coexist, providing 30 to 55 percent canopy cover. The understory contains scattered grasses and dryland sedges, with pinemat manzanita (*Arctostaphylos nevadensis*) and bluntlobe lupine (*Lupinus obtusilobus*) in open areas. This community phase has developed with occasional low to moderate intensity fire or other canopy disturbances, such as disease. Understory burns cause high mortality to understory trees and some of the overstory trees, reducing forest density and cover. Localized mortality from forest pathogens also opens the forest canopy. Canopy openings create opportunities for the shade intolerant western white pine and Sierra lodgepole pine to regenerate within the forest, creating a more diverse and multi-aged forest.

Forest overstory. This forest is dominated by California red fir with mountain hemlock second in importance. Western white pine and Sierra lodgepole pine are also common. The upper tree canopy is 100 to 120 feet tall, providing 30 to 55 percent cover. Dbh (diameter at breast height) is greater than 30 inches for some of the larger red fir trees. Basal areas range from 150 to approximately 200 ft²/acre.

Forest understory. The understory exhibits a high cover of litter and duff with a low to moderate cover of grasses and forbs. Pinemat manzanita (*Arctostaphylos nevadensis*) is present in canopy openings. Bluntlobe lupine (*Lupinus obtusilobus*) has high cover in some areas. Other common plants are western needlegrass (*Achnatherum occidentale*), pioneer rockcress (*Arabis platysperma*), sedge (*Carex* spp.), Mt. Hood pussypaws (*Cistanthe umbellata* var. *umbellata*), squirreltail (*Elymus elymoides*), marumleaf buckwheat (*Eriogonum marifolium*), and Davis' knotweed (*Polygonum davisiae*).

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Forb	—	31	118
Shrub/Vine	1	26	94
Grass/Grasslike	6	25	53
Tree	—	25	50
Total	7	107	315

Community 1.2

Western needlegrass/bluntlobe lupine/Sierra lodgepole pine-Mountain hemlock-California red fir

This community phase develops after a stand-replacing fire or in small gaps created by a canopy disturbance. Fire intensity and size, and the season of burn and timing in relation to cone crops affect the composition and structure of conifer regeneration. Large high intensity fires, which remove most of the overstory canopy, may favor Sierra lodgepole pine and western white pine regeneration as these seedlings establish better in open sunlight. Smaller fires, which provide shade from surviving trees, and other small gap-creating disturbances such as windthrow or mortality from pest infestation may have all tree species successfully regenerating including California red fir and mountain hemlock. In addition to shade, smaller fires may establish conifer seedlings earlier and at higher densities than larger fires because of the close proximity to a seed source. Seed availability after a fire is related to cone production cycles. The conifers associated with this site have cone crop cycles ranging from 1 to 6 years. Seedling establishment may be delayed a few years, due to crop cycles and climatic variables. California red fir produces mature cones in 2 to 6-year intervals (Chappell and Agee 1996). The seeds germinate best in bare soil or in light litter, in full sun to partial shade. Initial growth of California red fir is best in dense shade, but as the seedlings get older they grow better in full sun. Winged red fir seeds are wind dispersed at 1 to 1.5 times the height of the parent tree. The seeds generally germinate the spring after they are shed and are not stored in the soil. It may take 10 to 25 years for California red fir to reach 4.5 feet (Cope, 1993). Mountain hemlock seedlings are adapted to partial shade. Seeds are winged and wind dispersed. Mountain hemlock produces cones in 3-year intervals with almost no cone production between intervals. For the seeds to establish, a good seed crop is needed with favorable temperature and moisture conditions. Mountain hemlock establishes well during years of lower than normal April snowpack depths, which provides a longer snow-free growing season (Taylor, 1995). Adequate summer moisture is also important. Growth of the seedlings is very slow at first. In a study of mountain hemlock recruitment in Lassen Volcanic Park, 30 cm tall seedlings were 29 years old (Taylor, 1995). Sierra lodgepole pine produces good seed crops every 1 to 3 years, and seeds are dispersed from late August to mid-October. Although seeds can be stored

in the soil for several years, seedlings tend to regenerate from wind dispersed seeds after fire. Western white pine produces good seed crops every 3 to 4 years. The seeds of western white pine can be dispersed over 2,000 feet by wind. Seeds can remain viable in litter for up to 4 years, but viability decreases quickly after that period of time (Griffith, 1992). Birds, squirrels and other rodents will cache some of these seeds in the soil, which can germinate in bunches if not consumed. Pinemat manzanita is killed by fire. It does not resprout from the root crown but re-establishes itself from seed. It colonizes disturbed sites and continues to grow well under an open canopy as long as there is sufficient sunlight (Howard, 1993). Other forbs and grasses germinate from on-site stored seed or wind dispersed seed from adjacent areas. Some of the understory species may resprout after low to moderate intensity fires.

Community 1.3

Mountain hemlock-California red fir/bluntlobe lupine-marumleaf buckwheat

This community phase develops with small scale disturbances or low intensity fires. Fire removes understory trees, reducing density. Windthrow and localized disease create canopy openings that enable shade intolerant species to regenerate and persist in this forest. The trees reach reproductive maturity in this phase. California red fir begins producing cones at 35 to 40 years, mountain hemlock at 20 years, western white pine at 10 years, and Sierra lodgepole pine as early as 4 to 8 years (Cope, 1993, Griffith, 1992, and Tesky, 1992). California red fir and mountain hemlock will slowly continue to regenerate under the forest canopy, while Sierra lodgepole pine and western white pine will utilize the canopy openings.

Community 1.4

Mountain hemlock-California red fir/litter

The development of this community phase within this ecological site is relatively common. Trees may be pole-sized and evenly aged at first but will develop into a mature forest over time. Density increases as California red fir and mountain hemlock continue to establish, creating multiple canopy layers. This forest is defined by a dense canopy and high basal area of California red fir, Sierra lodgepole pine, and mountain hemlock. Canopy cover ranges from 55 to 85 percent. The overstory trees may be up to 125 years old. The trees are overcrowded and often diseased and stressed due to competition for water and nutrients. This stress makes the trees more susceptible to death from infestation and drought. Crown fire hazard increases in this community, a result of the deep accumulation of litter, standing dead and downed trees, and the dense multi-layered structure of the forest.

Community 1.5

Mountain hemlock-California red fir/litter

The mature closed mountain hemlock-red fir forest develops with the continued exclusion of fire and other canopy disturbances, allowing tree density to increase to unhealthy levels. Competition for water and sunlight continue, and tree health and vigor decreases. The overstory trees are over 125 years old. Sierra lodgepole pine and western white pine decline over time, due to their inability to regenerate under the dense forest canopy.

Forest overstory. California red fir and mountain hemlock dominate this dense forest. There is heavy recruitment of red fir and mountain hemlock in the understory. There may be 3 to 4 canopy layers. Basal areas range from 200 to 460 ft² / acre.

Forest understory. There is sparse cover of grasses and forbs in the understory. The cover of litter and woody debris is high.

Pathway 1.1a

Community 1.1 to 1.2

Wind throw, stand-replacing fire, or tree die off from disease on areas greater than 0.25 acre creates suitable conditions for forest regeneration (Community Phase 1.2).

Pathway 1.1b

Community 1.1 to 1.5

If fire is excluded from this community, tree density continues to increase in the understory and shifts the community toward the closed mountain hemlock-red fir forest (Community Phase 1.5).

Pathway 1.2a

Community 1.2 to 1.3

With time, growth and canopy disturbances, the mountain hemlock-red fir forest develops (Community Phase 1.3).

Pathway 1.2b

Community 1.2 to 1.4

An alternate pathway is created when fire and other disturbances are absent from the system, which leads to a closed mountain hemlock-red fir forest (Community Phase 1.4).

Pathway 1.3a

Community 1.3 to 1.1

This is the natural pathway for this community phase, which evolved with a historic fire regime of small low to moderate intensity surface fires, and/or partial tree mortality from a pest outbreak. This pathway leads to an open subalpine mountain hemlock-red fir forest (Community Phase 1.1).

Pathway 1.3c

Community 1.3 to 1.2

In the event of a canopy fire, this community phase would return to Community Phase 1.2, forest regeneration.

Pathway 1.3b

Community 1.3 to 1.5

In the absence of fire or other canopy disturbance, forest density increases. The increased density shifts this community phase toward the closed mountain hemlock-red fir forest (Community Phase 1.5).

Pathway 1.4b

Community 1.4 to 1.2

At this point, the density of ground fuels and ladder fuels formed in the mid-canopy create conditions for a high intensity canopy fire. A severe fire would initiate forest regeneration (Community Phase 1.2).

Pathway 1.4c

Community 1.4 to 1.3

The natural event of a moderate or surface fire in this forest is unlikely due to the high accumulation of fuels. Considerable management efforts would be needed to create the open forest conditions that should exist in this forest had it developed with fire over time. Manual treatments to thin trees and other fuels in the understory, and/or prescribed burns, could be implemented to shift this forest back to its natural state of a more open mountain hemlock-red fir forest (Community Phase 1.3). A partial mortality disease or pest infestation could also create a shift toward Community Phase 1.3.

Pathway 1.4a

Community 1.4 to 1.5

If fire continues to be excluded from this system, the mature closed mountain hemlock-red fir forest develops (Community Phase 1.5).

Pathway 1.5b

Community 1.5 to 1.1

The natural event of a moderate or surface fire in this forest is unlikely due to the high accumulation of fuels. Considerable management efforts would be needed to create the open forest conditions that should exist in this forest had it had developed with fire and other disturbances over time. Manual treatments to thin the understory trees and other fuels, and/or prescribed burns, could be implemented to shift this forest back to its natural state of a more open mountain hemlock-red fir forest (Community Phase 1.1). A partial mortality disease or pest infestation could also create a shift toward Community Phase 1.1.

Pathway 1.5a

Community 1.5 to 1.2

At this point, a severe fire is likely and would initiate forest regeneration (Community Phase 1.2).

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
0	Tree (understory only)			0–50	
	mountain hemlock	TSME	<i>Tsuga mertensiana</i>	0–22	0–5
	California red fir	ABMA	<i>Abies magnifica</i>	0–17	0–5
	western white pine	PIMO3	<i>Pinus monticola</i>	0–7	0–3
	Sierra lodgepole pine	PICOM	<i>Pinus contorta</i> var. <i>murrayana</i>	0–4	0–2
Shrub/Vine					
0	Shrub			1–94	
	pinemat manzanita	ARNE	<i>Arctostaphylos nevadensis</i>	0–90	0–20
	marumleaf buckwheat	ERMA4	<i>Eriogonum marifolium</i>	1–4	1–4
Grass/Grasslike					
0	Grass/Grasslike			6–53	
	western needlegrass	ACOC3	<i>Achnatherum occidentale</i>	6–28	2–10
	sedge	CAREX	<i>Carex</i>	0–17	0–5
	squirreldtail	ELEL5	<i>Elymus elymoides</i>	0–8	0–2
Forb					
0	Forb			0–118	
	bluntlobe lupine	LUOB	<i>Lupinus obtusilobus</i>	0–110	0–14
	Mt. Hood pussypaws	CIUMU	<i>Cistanthe umbellata</i> var. <i>umbellata</i>	0–3	0–3
	pioneer rockcress	ARPL	<i>Arabis platysperma</i>	0–2	0–2
	Davis' knotweed	PODA	<i>Polygonum davisiae</i>	0–2	0–2

Table 7. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
California red fir	ABMA	<i>Abies magnifica</i>	Native	–	15–30	–	–
mountain hemlock	TSME	<i>Tsuga mertensiana</i>	Native	–	10–12	–	–
Sierra lodgepole pine	PICOM	<i>Pinus contorta</i> var. <i>murrayana</i>	Native	–	3–9	–	–
western white pine	PIMO3	<i>Pinus monticola</i>	Native	–	2–4	–	–

Table 8. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
western needlegrass	ACOC3	<i>Achnatherum occidentale</i>	Native	–	2–10
sedge	CAREX	<i>Carex</i>	Native	–	0–5
squirreltail	ELEL5	<i>Elymus elymoides</i>	Native	–	0–2
Forb/Herb					
bluntlobe lupine	LUOB	<i>Lupinus obtusilobus</i>	Native	–	0–14
Mt. Hood pussypaws	CIUMU	<i>Cistanthe umbellata</i> var. <i>umbellata</i>	Native	–	0–3
pioneer rockcress	ARPL	<i>Arabis platysperma</i>	Native	–	0–2
Davis' knotweed	PODA	<i>Polygonum davisiae</i>	Native	–	0–2
Shrub/Subshrub					
pinemat manzanita	ARNE	<i>Arctostaphylos nevadensis</i>	Native	–	0–20
marumleaf buckwheat	ERMA4	<i>Eriogonum marifolium</i>	Native	–	1–4
Tree					
mountain hemlock	TSME	<i>Tsuga mertensiana</i>	Native	–	0–5
California red fir	ABMA	<i>Abies magnifica</i>	Native	–	0–5
western white pine	PIMO3	<i>Pinus monticola</i>	Native	–	0–3
Sierra lodgepole pine	PICOM	<i>Pinus contorta</i> var. <i>murrayana</i>	Native	–	0–2

Animal community

Animals that use California red fir forests include martin, fisher, wolverine, black bear, squirrel, chickadee, pileated woodpecker, great gray owl, Williamson's sapsucker, mountain beaver, and pocket gopher.

Deer browse the leaves of these conifers in winter and the new growth in the spring. Birds forage for insects in the foliage of mature conifers. Spruce grouse feed on Sierra lodgepole pine needles during the winter (Cope, 1993).

The California red fir cones are cut and cached by squirrels. Western white pine seeds are eaten by red squirrels and deer mice (Griffith, 1992). The seeds of Sierra lodgepole pine are eaten by squirrels, chipmunks, birds, and mice (Cope, 1993). Some birds consume mountain hemlock seeds. In some areas the understory provides decent forage (Tesky, 1992).

The fruit of pinemat manzanita is eaten by black bear, deer, coyote, and various birds and rodents. After fire, young foliage is browsed by deer, but older foliage is not desirable.

Grasses provide forage for deer and small rodents.

Recreational uses

This area is suitable for trails and provides scenic views.

Wood products

The wood from California red fir is straight-grained and light. California red fir is soft, but it is stronger than the wood of other firs and has a low specific gravity. The wood is used for fuel, coarse lumber, quality veneer, solid framing, plywood, printing paper and high-quality wrapping paper; it is the preferred wood for pulping (Cope, 1993).

Western white pine wood is straight-grained, light, and highly valued. The wood is used to make window and door sashes, doors, paneling, dimension stock, matches, wood carvings and toothpicks (Griffin, 1992).

Sierra lodgepole pine wood is used for framing, paneling, trim, posts, and other construction products. The forests are often uniform in size, which makes harvesting easier. The wood tends to be light, straight-grained and of consistent texture (Cope 1993).

If harvested, mountain hemlock is usually sold with western hemlock. The wood is moderately strong and used as small lumber, pulp, interior finish, cabinetry, crates, flooring and ceilings (Tesky, 1992).

Other products

California red fir is used for Christmas trees (Cope, 1993).

Native Americans chewed the resin of western white pine, wove baskets from the bark, concocted a poultice for dressing wounds from the pitch, and collected the cambium in the spring for food (Griffith, 1992).

Cones of western white pine are collected for novelty items. The wood is good for carving. The tree is also planted as an ornamental (Griffin, 1992).

Other information

Additional information on forest pathogens:

Red fir dwarf mistletoe (*Arceuthobium abietinum* f. sp. *magnificae*) is a parasitic plant commonly found in the survey area, as evident by witches brooms, top kill, stem cankers and swellings. The vegetative shoots of the dwarf mistletoe are often present from spring to fall.

Infestation of the red fir dwarf mistletoe can cause reduced growth and vigor. The fungus (*Cytospora abietis*) kills those branches that are infected with dwarf mistletoe. Dwarf mistletoe will weaken trees by generating cankers that create entry points for diseases such as heart rots (Burns and Honkala, 1990) and other pathogens.

Fir broom rust (*Melampsorella caryophyllacearum*) is a disease that causes dense witches brooms with stunted yellow needles. The infected branch sheds its needles in fall, leaving a barren dead-looking branch. The alternate host for this rust is the chickweeds (*Stellaria* spp. and *Cerastium* spp.) (Hagle et al., 2003). Fir broom rust can damage tree growth by reducing crown development. Mortality is less common in mature trees than in the younger regeneration trees.

Annosus root rot (*Heterobasidion annosum*) can affect large acres of fir forest. It spreads from infected roots to healthy roots. It slowly decays the roots, the root collar and the stem butt for many years, causing structural weaknesses and making the tree vulnerable to windthrow. Annosus root rot can also be spread aerially, infecting freshly cut stumps or other fresh tree wounds. Painting borax on the freshly cut stumps restricts the entry of the fungus. In all management activities it is important to reduce damage to the bark. The rot itself does not often kill red fir directly, but it weakens the tree and makes it easier for bark beetles (*Scolytus* spp.) to infest the tree (Burns and Honkala, 1990).

The fir engraver (*Scolytus ventralis*) can cause extensive damage to red fir forests; outbreaks can cause mortality to several acres of trees. It can reach epidemic levels when trees are stressed due to drought, annosus root rot, dwarf

mistletoe, or from fire damage. (Burns and Honkala, 1990).

White pine blister rust (*Cronartium ribicola*) causes cankers on 5-needled pines and eventually kills most of the infected trees. Visible symptoms are swollen cankers with an abundance of pitch flowing down the branch or stem. The cankers can eventually girdle the tree, killing those portions above. Leaves on the upper portions turn red and fall (Hagle et al., 2003). Pruning cankers off infected stems has been shown to be beneficial.

SITE INDEX DOCUMENTATION:

Schumacher (1928) and Barnes (1962) were used to determine forest site productivity for red fir and mountain hemlock respectively. Barnes site curves and yield estimates for western hemlock were used to roughly approximate forest site productivity for mountain hemlock. Low to High values of Site index and CMAI (culmination of mean annual increment) give an indication of the range of inherent productivity of this ecological site. Site index relates to height of dominant trees over a set period of time and CMAI relates to the average annual growth of wood fiber in the boles/trunks of trees. Site index and CMAI listed in the Forest Site Productivity section are in units of feet and cubic feet/acre/year, respectively. Both site index and CMAI are estimates; on-site investigation is recommended for specific forest management units for each soil classified to this ecological site. The historical and actual basal area of trees within a growing stand will greatly influence CMAI.

Conifer trees appropriate for site index measurement typically occur in community phases 1.3 and 1.4. They are selected according to guidance listed in the site index publications.

Table 9. Representative site productivity

Common Name	Symbol	Site Index Low	Site Index High	CMAI Low	CMAI High	Age Of CMAI	Site Index Curve Code	Site Index Curve Basis	Citation
California red fir	ABMA	40	42	135	142	140	050	—	
California red fir	ABMA	40	42	135	142	—	—	100TA	Barnes, George H. 1962. Yield of even-aged stands of western hemlock. USDA, Forest Service. Pacific Northwest Forest and Range Experiment Station Technical Bulletin 1273.
mountain hemlock	TSME	67	85	72	110	65	990	—	
mountain hemlock	TSME	67	85	78	108	—	—	100TA	Barnes, George H. 1962. Yield of even-aged stands of western hemlock. USDA, Forest Service. Pacific Northwest Forest and Range Experiment Station Technical Bulletin 1273.
Sierra lodgepole pine	PICOM	60	60	49	49	100	520	—	

Inventory data references

The following NRCS vegetation plots were used to describe this ecological site:

789150
789199
789262-site location
789274
789300
789327
789338
789372
789373
789375
789396

Type locality

Location 1: Shasta County, CA	
Township/Range/Section	T30 N R5 E S8
UTM zone	N
UTM northing	4482229
UTM easting	630656
General legal description	The type location is about 0.5 miles east of Shadow Lake in Lassen Volcanic National Park.

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

-
9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**
-
10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**
-
11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**
-
12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**
- Dominant:
- Sub-dominant:
- Other:
- Additional:
-
13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**
-
14. **Average percent litter cover (%) and depth (in):**
-
15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**
-
16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**
-
17. **Perennial plant reproductive capability:**
-