USDA Natural Resources Conservation Service

Ecological site F022BI107CA
Frigid Moderately Deep 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) Lava plateau, (2) Ground moraine
Elevation (feet): 5,980-7,600
Slope (percent): 10-65
Water Table Depth (inches): n/a
Flooding-Frequency: None
Ponding-Frequency: None
Aspect: Non-influencing
Mean annual precipitation (inches): 25.0-65.0
Primary precipitation: Winter months in the form of snow.
Mean annual temperature: 41 to 44 degrees F (5 to 7 degrees C)
Restrictive Layer: Indurated bedrock, dense till, or densic material is encountered 20 to 40 inches
Temperature Regime: Frigid
Moisture Regime: Xeric
Parent Materials: Tephra over till or in tephra over residuum from volcanic rocks
Surface Texture: (1) Very gravelly ashy loamy sand, (2) Very gravelly ashy sandy loam (3) Ashy loamy sand
Surface Fragments <=3" (% Cover): 0-55
Surface Fragments > 3" (% Cover): 0-10

Soil Depth (inches): 20-40
Vegetation: California red fir-white fir-Jeffrey pine forest with a common understory of Bush chinquapin (*Chrysolepis sempervirens*).
Notes: Transition zone between the white fir-Jeffrey pine forest types at lower elevations and the red fir forest types at higher elevations.

Classification relationships

Forest Alliance = *Abies magnifica-Abies concolor* – Red fir-white fir forest; Association = *Abies magnifica-Abies concolor-Pinus jeffreyi*. (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

F022BI100CA	**Low Precip Frigid Sandy Tephra Gentle Slopes** This is a Jeffrey pine forest found on lower slopes and flats.
F022BI115CA	**Frigid And Cryic Gravelly Slopes** This is a red fir-western white pine forest found at higher elevations.
F022BI119CA	**Low Precip Frigid Sandy Moraine Slopes** This is a Jeffrey pine-white fir forest found on lower slopes.

Similar sites

F022BI109CA	**Frigid Deep Coarse Sandy Cinder Cone Or Shield Volcano Slopes** This is a red fir-Jeffrey pine forest found at higher elevations on cinder cones and shield volcanoes.

Table 1. Dominant plant species

Tree	(1) *Abies magnifica* (2) *Abies concolor*
Shrub	(1) *Chrysolepis sempervirens*
Herbaceous	Not specified

Physiographic features

This ecological site is situated on glaciated lava plateaus, ground moraines on lava plateaus, and on back slopes of lava plateaus. It occurs between 5,980 and 7,600 feet in elevation. Slopes range from 10 to 65 percent.

Table 2. Representative physiographic features

Landforms	(1) Lava plateau (2) Ground moraine
Flooding frequency	None
Ponding frequency	None
Elevation	5,980–7,600 ft
Slope	10–65%

Climatic features

This ecological site receives most of its annual precipitation in the winter months in the form of snow. The mean annual precipitation ranges from 25 to 65 inches (635 to 1,651 mm) and the mean annual temperature ranges from 41 to 44 degrees F (5 to 7 degrees C). The frost free (>32 degrees F) season is 60 to 90 days. The freeze free (>28 degrees F) season is 75 to 190 days.

There are no representative climate stations for this site. The nearest one is Manzanita Lake.

Table 3. Representative climatic features

Frost-free period (average)	90 days
Freeze-free period (average)	190 days
Precipitation total (average)	65 in

Influencing water features

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

Soil features

Associated with this ecological site are the Cenplat, Sunhoff, and Badgerflat soils. These moderately deep, well drained soils have very low AWC. They have formed in tephra over till or in tephra over residuum from volcanic rocks. The surface textures are ashy loamy sand, very gravelly ashy loamy sand or very gravelly ashy sandy loam. The subsurface textures are primarily loamy sands or sandy loams with extremely gravelly, cobbly or stony modifiers. A root impenetrable layer of indurated bedrock, dense till, or densic material is encountered 20 to 40 inches below the surface. Permeability is very rapid or rapid through the upper horizons and slow to very slow through the densic material and bedrock respectively.

This ecological site has been correlated with the following map units and components within the CA789 Soil Survey Area:

Map Unit/ Component/ Component percent
100 Sunhoff 5
103 Sunhoff 3
106 Badgerflat 7
106 Badgerwash 1
106 Buttelake 2
106 Buttewash 1
106 Sunhoff 5
107 Badgerflat 40
107 Cenplat 35
107 Sunhoff 2
120 Sunhoff 15
172 Cenplat 4

Table 4. Representative soil features

Family particle size	(1) Sandy
Drainage class	Well drained
Permeability class	Very rapid to very slow
Soil depth	20–40 in
Surface fragment cover <=3"	0–55%
Surface fragment cover >3"	0–10%
Available water capacity (0-40in)	0.8–1.5 in
Soil reaction (1:1 water) (0-40in)	5.1–7
Subsurface fragment volume <=3" (Depth not specified)	35–65%

Subsurface fragment volume >3" (Depth not specified)	0–35%

Ecological dynamics

This site is associated with a California red fir-white fir-Jeffrey pine forest. This forest is generally dense and shady with low understory cover and diversity. Bush chinquapin (*Chrysolepis sempervirens*) is the most common understory component, which takes advantage of openings in the forest canopy. This forest type is found in the transition zone between the white fir-Jeffrey pine forest types at lower elevations and the red fir forest types at higher elevations.

The dominance of California red fir (*Abies magnifica*) in this forest type increases with elevation. At lower elevations it is a minor component with a 1 to 5 percent canopy cover that increases to 40 percent at upper elevations. California red fir is a tall, long-lived conifer with short branches and a narrow crown. It produces single needles of 0.8 to 1.4 inches long 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 prefers 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.

White fir (*Abies concolor*) is similar in appearance to California red fir but has slightly longer needles (1.2 to 2.8 inches long) and smaller cones (3 to 5 inches). White fir tends to develop shallow root systems that can graft onto other white fir roots and spread root rots. The bark of mature white fir is visibly lighter in color than that of red fir. Bark chips can confirm the difference of bark color. The internal bark color of white fir is tan while California red fir is dark reddish. With thin bark, low growing branches and shallow root systems, white fir is very susceptible to fire. Older trees are more resistant because the bark thickens and branches can self-thin, increasing the height of the canopy above the forest floor. Fire causes mortality to mature trees if the crowns burn or heat damages the thin barked trunks or shallow roots (Zouhar, 2001).

Jeffrey pine (*Pinus jeffreyi*) is commonly co-dominant with white fir and California red fir. Jeffrey pine produces 3 to 8 inch needles in bundles of three. The female seed cones range from 4.7 to 12 inches in length. Jeffrey pine produces a deep taproot and extensive lateral roots (Gucker, 2007) that are intolerant of wet conditions. Jeffrey pine looks similar to ponderosa pine but has a vanilla-like odor in the bark, which is not as yellow. Jeffrey pine is shade intolerant and can be replaced over time by white fir or California red fir if fire is excluded from the system. Older Jeffrey pines are somewhat adapted to fire because their bark is thick enough to provide protection from moderate intensity fires. Additionally, their branches tend to thin along the lower portion of the tree trunk, leaving the crown 20 to 30 meters above the forest floor.

A study on conifer growth phenology in the Sierra Nevada describes the timing and growth period for several conifer species. The initial growth of California red fir is faster than its associated conifer species, then returns to a slower growth. Temperature is critical in initiating conifer growth after snowmelt. In the study, trees generally started stem growth about 2 weeks after snow melt, a delay that may be related to the warming of soils and roots. If the snow melt was unusually early, the trees did not begin annual growth until specific air temperatures were reached. It was hypothesized that heavy shrub cover delayed the start of annual growth because shade kept the soil from warming. The pines in the study began leader growth when the air temperatures reached -4 degrees C (24.8 degrees F), and the firs responded after temperatures reached 2 to 3 degrees C (35.6 to 37.4 degrees F). Pines have heavily insulated terminal buds, whereas the terminal buds of fir trees are less insulated and more susceptible to frost damage. The length of the leader growth is predetermined by growth conditions of the prior year. Primordia of fir needles and pine fascicles are developed the year before leader growth. The internode length between fir needles or pine fascicles is determinate; therefore the leader length is determined by the number of primordia developed. It appears that some conifers will not start leader growth until a specific photoperiod (a ratio of light hours to dark hours during one 24 hour period) is met, even if the snow has melted and the temperatures are warm enough. If drought conditions set in before the leader has reached its determinate length, growth will be terminated prematurely. If precipitation comes after the snow has melted, it can prolong the growing season. Conifer growth ceases with the onset of drought conditions and the decline of water potentials (Royce and Barbour, 2001).

This site receives 45 inches average annual precipitation, mostly in the form of snow in winter. As the snow melts it fills macropores in the soil with water. Soil characteristics such as depth and texture determine how much water the soil can hold and how long it will remain before filtering through, evaporating away, or being lost to evapotranspiration. The soils associated with this site have very low to low water holding capacities. Under the same climatic conditions, drought would come earlier to these soils than those with higher water holding capacities. These trees have a short growing season due to early drought conditions.

Most of the forest within the present park boundary was never logged, but fire suppression has created a change in the stand structure and composition. With a natural fire regime the presence of Jeffrey pine is encouraged. Low to moderate intensity fires maintain an open forest with patches of montane shrubs and forbs in the canopy openings. In the absence of fire, firs continue to regenerate in the understory, increasing forest density and fuels. Today the forest is multilayered, dense and shady, dominated by firs. Vegetation on the forest floor is almost nonexistent.

Fire regime studies, using tree rings and fire scars, report historic median fire return intervals in white fir-red fir forests of 12, 24, and 41 years (Skinner and Chang, 1996; Bekker and Taylor, 2000; Taylor and Solem, 2001 respectively). Beaty and Taylor report that fire frequency and intensity is additionally associated with slope position, aspect, and climatic fluctuations. Fire return intervals are longer on north facing slopes than on south facing slopes, and fire intensity increases from lower slope to upper slope positions. Their study also indicates a slightly later burn season in the Southern Cascades than in the Sierra Nevada. The fire scars in the Southern Cascade are primarily found at the annual tree ring boundary, indicating the trees were dormant at the time of the fire, whereas in the Sierra Nevada fires scars are often found in the late-season wood. This timing shift may be due to the timing of summer drought conditions, which begin earlier in the south. In July and August, thunderstorms are common in Lassen Volcanic National Park and the summer drought conditions begin, initiating the fire season. Large fires and multiple small fires in the same season are associated with dry and very dry years. Beaty and Taylor report that 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 (Beaty and Taylor, 2001). After a stand-replacing fire, evenly aged forests are formed. The current management practice of fire suppression has shifted forest density and composition. Fire suppression creates a change in species composition by allowing the fire intolerant and shade tolerant firs to increase in cover and density, eventually out-competing the fire tolerant and shade intolerant pines (Taylor and Solem, 2001).

Tree pathogens and insect infestations can have significant impacts on the composition and structure of mid and upper montane coniferous forests. Small infestations may affect just a few trees but large outbreaks may kill the dominant trees over large areas of forest, creating large canopy openings and stand regeneration. Most of these pathogens are a natural cycle of regulation and can push the 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.

Jeffrey Pine is susceptible to several diseases and insect infestations, especially in periods of drought or when overcrowded. Pathogens that affect Jeffrey pine in this area are the dwarf mistletoe (Arceuthobium campylopodium), root disease (Phaeoleus schweinitzii), needle cast (Elytroderma deformans), Jeffrey pine bark beetle (Dendroctonus jeffreyi), Red turpentine beetle (D. valens), and pine engravers (Ips species). The most threatening of these are the dwarf mistletoe and the Jeffrey pine bark beetle (Bohne, 2006; Jenkinson, 1990).

Pathogens that affect white fir are the dwarf mistletoe (*Arceuthobium abietinum* f. sp. concoloris), Cytospora canker (Cytospora abietis), broom rust (Melamsporella caryophyllacearum), annosus root disease (Heterobasidium annosum), armillaria root disease (Armillaria sp.), trunk rot (Echinodontium tinctorium) and the fir engraver (Scotylus ventralis). The most threatening of these is the combination of the fir engraver and annosus root disease. These pathogens can kill large areas of white fir (Bohne, 2006; Laacke, 1990). This ecological site has evolved with natural disturbances such as fire, wind throw and disease that create canopy gaps which allow for tree regeneration.

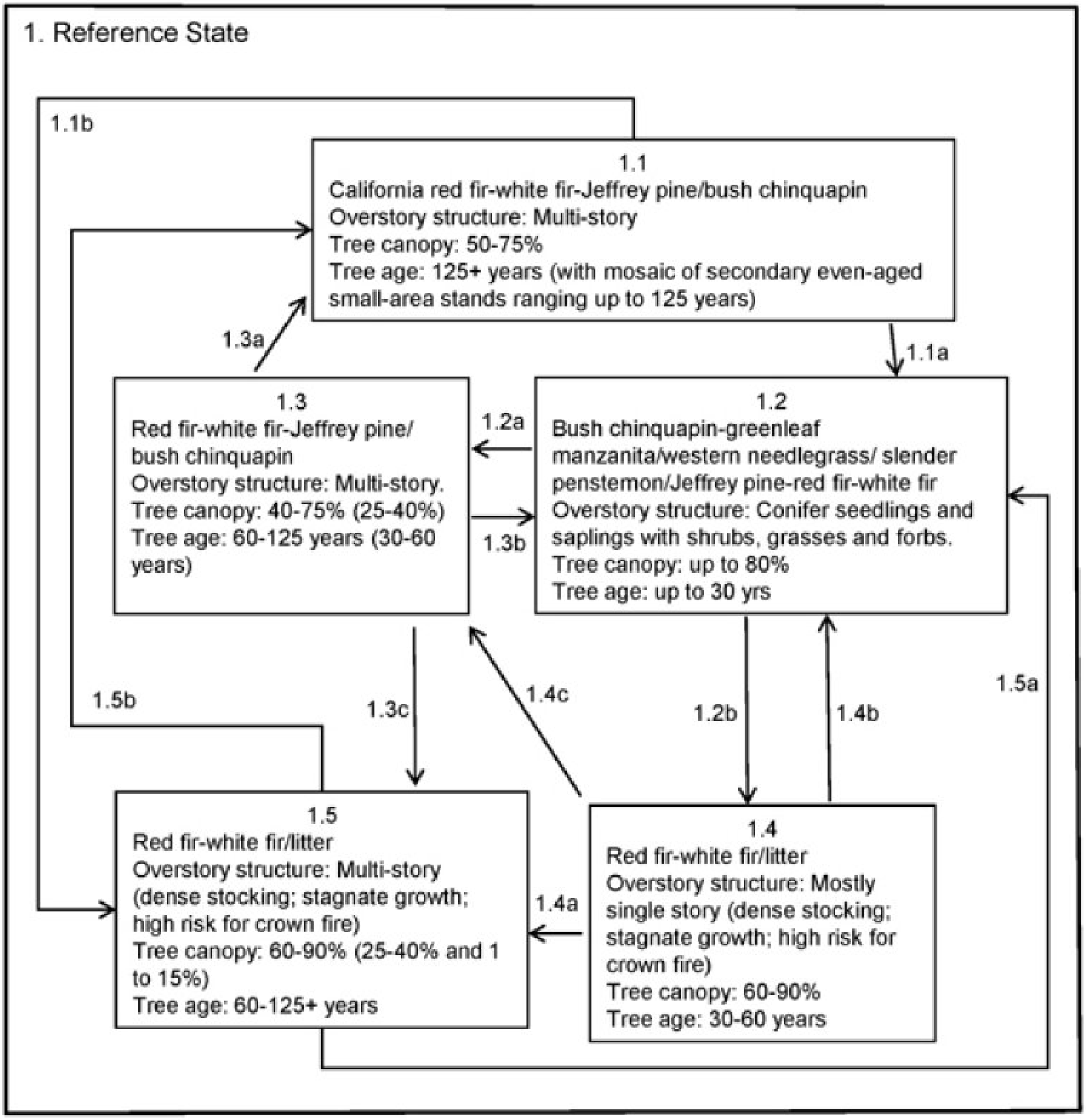
The major pathogens that affect California red fir in this area are red fir dwarf mistletoe (*Arceuthobium abietinum* f. sp. magnificae), fir broom rust (Melampsorella caryophyllacearum), annosus root rot (Heterobasidium annosum), and the fir engraver (Scolytus ventralis) (Murphy et al., 2000). Other diseases that can affect red fir are the heart rots: yellow cap fungus (Pholiota limonella) and Indian paint fungus (Echinodontium tinctorium). Insects that can affect red fir are cone maggots (Earomyia spp.), several chalcids (Megastigmus spp.) and cone moths (Barbara spp. and Eucosma spp.) (Russell, et al., 1990).

The reference state consists of the most successionally 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 successionally 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 F022BI107CA
Abies magnifica - Abies concolor /Chrysolepis sempervirens
(California red fir -white fir/bush chinquapin)



State 1
Reference

Community 1.1
California red fir-white fir-Jeffrey pine/bush chinquapin

This community phase is considered to be the likely future reference or most successionally advanced community phase. It is dominated by mature white fir, California red fir and Jeffrey pine. Bush chinquapin (*Chrysolepis sempervirens*) is present in canopy openings. This community phase is maintained by low and moderate intensity fires that remove fire intolerant seedlings and saplings from the understory. Moderate intensity fires can kill overstory trees as well, leaving canopy openings that are favorable for Jeffrey pine and shrub regeneration. The moderate intensity fires therefore breakup the uniformity of the older stands with pockets of young forests intermixed.

Forest overstory. The upper canopy is a mix of white fir, California red fir and Jeffrey pine. California red fir and white fir are present in the understory. The average overstory canopy cover is 60 percent, with a range of 50 to 75 percent. White fir is generally dominant, with red fir and Jeffrey pine varying in cover from 1 to 20 percent. Canopy heights range from 90 to 120 feet with diameters ranging from 25 to 35 inches at breast height. The largest and oldest trees were not measured. Basal area for this community type ranged from 120 to 180 ft2/ acre.

Forest understory. The understory is generally sparse, although there is more cover and diversity in canopy openings. Bush chinquapin (Chrysolepis sempervirens) is consistently present, with about 8 percent cover. Other associated species are greenleaf manzanita (Arctostaphylos patula), western needlegrass (Achnatherum occidentale), and slender penstemon (Penstemon gracilentus).

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	30	420	785
Tree	20	65	115
Grass/Grasslike	0	5	10
Total	**50**	**490**	**910**

Community 1.2
Bush chinquapin-greenleaf manzanita/western needlegrass/ slender penstemon/pine-firs

This community phase develops when the majority of the overstory trees succumb to a high intensity canopy fire. There may be a few surviving overstory trees, which become an important seed source for regeneration. Mature Jeffrey pines have thicker bark and higher tree branches than California red fir or white fir and are more likely to survive a fire and supply seed for regeneration. Because Jeffrey pine seedlings germinate well in full sun and mineral soils after fire and white fir and California red fir prefer partial shade, Jeffrey pine may have an advantage in early phases of regeneration which assures their existence and sometime prevalence in older stands. Bush chinquapin (*Chrysolepis sempervirens*) can resprout from the roots, root crown or the stump after it has been top-killed by fire. It can also regenerate from seed, but there is little data about seed dormancy or storage. Greenleaf manzanita (*Arctostaphylos patula*) is a fire dependent shrub because its seeds remain dormant in the soil until the heat from fire scarifies the seed coat. The presence or absence of greenleaf manzanita may be an indicator of fire history. Bush chinquapin is more shade tolerant than greenleaf manzanita and could persist longer as the forest canopy encloses this site. This area does not seem to have the tendency to create dense shrub lands after a fire but recent post-fire data is lacking. A flush of native perennial grasses and forbs is possible for the first several years after a burn.

Community 1.3
Red fir-white fir-Jeffrey pine/bush chinquapin

This forest community phase develops with the natural fire regime, or with manual thinning and prescribed fires. Low to moderate intensity fires clear the understory and remove fuels before they reach hazardous levels, although severe high-intensity canopy fires are also possible. Since Jeffrey pine establishes early during stand regeneration it has a fair percentage of cover in the upper canopy, but it has difficulty regenerating and growing well in the understory of the canopy. Its growth and presence is dependent upon fire or other disturbances to maintain an open forest structure with canopy openings.

Community 1.4
Red fir-white fir/litter

This community phase is defined by a dense canopy and high basal area of California red fir and white fir. Canopy cover ranges from 60 to 90 percent. 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 disease and drought. Fire hazard is high in this community, a result of the deep accumulation of litter, standing dead and down trees, and the dense multi-layered structure of the forest.

Community 1.5
Red fir-white fir/litter

The mature closed red fir-white fir forest develops with the prolonged exclusion of fire, allowing tree density to increase to unhealthy levels. Competition for water and sunlight continues, and tree health and vigor decreases.

Pathway 1a
Community 1.1 to 1.2

In the event of a severe fire there may be significant tree mortality, leaving a barren landscape with many standing dead trees. This creates community phase 1.2.

Pathway 1b
Community 1.1 to 1.5

If fire is excluded from the old growth community phase, red fir and white fir continue to regenerate in the understory, increasing tree density and shifting this community phase toward the community phase 1.5.

Pathway 1.2a
Community 1.2 to 1.3

The natural pathway is to community phase 1.3, a young open red fir-white fir-Jeffrey pine forest. This pathway is followed with natural fire regime. Manual thinning with prescribed burns can emulate the natural cycle and lead to the same open community phase.

Pathway 1.2b
Community 1.2 to 1.4

An alternate pathway is created when fire is excluded from the system and leads to a young closed red fir-white 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 relatively frequent surface and moderate severity fires, and/or partial tree mortality from a pest outbreak. Manual thinning or prescribed burning can be implemented to replace the natural disturbances that keep this forest open. This pathway leads to the reference community phase (Community Phase 1.1).

Pathway 1.3b
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 1.3c
Community 1.3 to 1.5

If fire does not occur, forest density increases. This may favor California red fir and white fir over Jeffrey pine. The increased density shifts this community phase toward the closed red fir-white fir 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 fuel accumulation. 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 out the white fir and fuels in the understory, and/or prescribed burns, could be implemented to shift this forest back to its natural state of an open red fir-white fir-Jeffrey pine 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 red fir-white fir forest community phase 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 fuel accumulation. 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 out the understory trees and fuels, and/or prescribed burns, could be implemented to shift this forest back to its natural state of an open red fir-white fir-Jeffrey pine forest community phase 1.1. A partial mortality disease or pest infestation could also create a shift toward Community Phase 1.1 but tree mortality will increase the already high fuel amounts.

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 (Lb/Acre)	Foliar Cover (%)
Tree					
0	**Tree (understory only)**			20–115	
	white fir	ABCO	*Abies concolor*	10–50	1–5
	California red fir	ABMA	*Abies magnifica*	10–50	1–5
	Jeffrey pine	PIJE	*Pinus jeffreyi*	0–15	0–3
Shrub/Vine					
0	**Shrub**			30–785	
	greenleaf manzanita	ARPA6	*Arctostaphylos patula*	0–400	0–10
	bush chinquapin	CHSE11	*Chrysolepis sempervirens*	30–375	1–12
	slender penstemon	PEGR4	*Penstemon gracilentus*	0–10	0–1
Grass/Grasslike					
0	**Grass/Grasslike**			0–10	
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–10	0–2

Table 7. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
white fir	ABCO	*Abies concolor*	Native	–	30–40	–	–
California red fir	ABMA	*Abies magnifica*	Native	–	10–20	–	–
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	10–15	–	–

Table 8. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
western needlegrass	ACOC3	*Achnatherum occidentale*	Native	–	0–2
Shrub/Subshrub					
bush chinquapin	CHSE11	*Chrysolepis sempervirens*	Native	–	1–12
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	0–10
slender penstemon	PEGR4	*Penstemon gracilentus*	Native	–	0–1

Animal community

Red fir-white fir-Jeffrey pine forests provide browse, cover and nesting sites for a variety of wildlife species. Mature open forests, closed dense forests, young forests and shrub lands provide different habitats and forage for wildlife. The type and quality of the wildlife habitat varies with the community type. Douglas squirrels cut and cache fir cones before the cones are fully mature. Cavity-nesting birds utilize holes in snags and dying trees for their nests while ground-nesting birds and animals find homes in the fallen trees. Deer and bear browse the needles of these conifers. Porcupines eat the bark of fir and can kill saplings. Rodents feed on the white fir cambial tissue. Birds forage for insects in the foliage of mature conifers

This forest type intergrades between the lower elevation white fir and Jeffrey pine forests and the upper elevation red fir forests. It is difficult to find specific data about animal use in this mixed forest.

There are about 33 species of mammals commonly present in the white fir forest type in California and, of these, 7 are generally associated with mature forests. About 123 species of birds are found in the white fir forest type of California and southern Oregon, about 50 of which are associated primarily with mature forests. Many of these birds use mature white fir trees and snags for foraging, roosting, nesting and/or breeding. Included are bald eagle,

California spotted owl, brown creeper, pileated woodpecker, white-headed woodpecker and, when near lakes or streams, osprey. Reptiles in white fir forests are represented by 17 species, mostly at lower elevations, 8 of which are associated with mature forests (Zouhar, 2001).
Animals that use California red fir forests include martin, fisher, wolverine, black bear, squirrels, chickadee, pileated woodpecker, great gray owl, Williamson's sapsucker, mountain beaver, and pocket gopher (Cope, 1993).

American black bears and a diversity of small mammals and bird species, as well as insects, amphibians, and reptiles utilize Jeffrey pine for habitat or use the seeds and needles for food. Animals that eat the seeds include California quail, northern flickers, American crows, Clark's nutcrackers, western gray squirrels, Douglas's squirrels, California ground squirrels, deer mice, yellow-pine chipmunks, and lodgepole chipmunks (Gucker, 2007).

Recreational uses

This area is suitable for hiking and backpacking trails. Trails may be used primarily for passing through since dense forests and slopes do not easily accommodate campsites.

Wood products

White fir wood is used for framing, plywood and, sometimes, pulpwood. The heartwood of white fir decays rapidly if not properly preserved. White fir wood has a low specific gravity and heat production, hence it provides poor firewood compared to other conifers (Zouhar, 2001).

Jeffrey pine wood is used for lumber. No commercial distinction is made between ponderosa pine and Jeffrey pine lumber (Gucker, 2007).

The wood from California red fir is straight-grained and light. California red fir wood is soft but 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, and is preferred for pulping (Cope, 1993).

Site index and CMAI (culmination of mean annual increment) in the Forest Site Productivity section above are in units of feet and cubic feet/acre/year, respectively.

Other products

Jeffrey pine seeds are edible. Native Americans used Jeffrey pine sap as a remedy for pulmonary disorders. Later, heptane was distilled from the sap and sold as a treatment for pulmonary problems and tuberculosis. Jeffrey pine heptane was also utilized in developing the octane scale used to rate petroleum for automobiles (Gucker, 2007).

Other information

Additional information

Common white fir pathogens:

White fir dwarf mistletoe (*Arceuthobium abietinum* f. sp. concoloris) is a parasitic plant common 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. A fungus (Cytospora abietis) kills the branches that are infected with dwarf mistletoe. The reduced vigor makes the tree more susceptible to bark beetle and other diseases. The mistletoe cankers, by creating cracks in the bark, create an entry point for other diseases such as heart rots (Burns and Honkala, 1990).

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.). This disease can damage tree growth by reducing crown development. Mortality is less common in mature trees than in younger regeneration trees. Secondary infection is possible from heart rots entering through openings in the infected areas (Burns and Honkala, 1990).

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 wind throw. 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 beetle (Scolytus ventralis) can cause extensive damage to white fir forests. Outbreaks can cause mortality to several acres of trees. It can reach epidemic levels when the trees are stressed due to drought, annosus root rot, dwarf mistletoe, or fire damage.

Additional information on Jeffrey pine pathogens:

Infections from western dwarf mistletoe (Arceuthobium campylopodium) cause witches brooms, reduced growth and tree mortality. Sticky seeds are spread in fall and infest nearby and understory trees. In years of severe drought dwarf mistletoe has induced 60 to 80 percent of the Jeffery pine mortality (Burns and Honkala, 1990).

Jeffrey pine bark beetles (Dendroctonus jeffreyi) are native beetles that can only reproduce in Jeffrey pine. They are a natural cycle in maintaining forest health. They generally attack older weaker trees, but in times of drought or other disturbances such as lightning or fire, epidemic levels can break out and cause extensive damage to the forest. These beetles infest the lower stem and bole of the trees, usually after pine engraver (Ips pini) infestation in the upper portion of the tree. The beetles slowly destroy the cambium, inhibiting the flow of nutrients. A sign of infestation is the changing color of the pine needles from green to yellow or reddish brown, beginning from the top down (Hagle et al., 2003; Smith, 1971).

Forest Pathogens that affect Red fir:
The parasitic red fir dwarf mistletoe (*Arceuthobium abietinum* f. sp. magnificae) is common in the survey area, as evident by witches brooms, top kill, stem cancers and swellings. The vegetative shoots of the dwarf mistletoe are also often present from spring to fall. Infestation of the red fir dwarf mistletoe can cause reduced growth and vigor. A fungus, (Cytospora abietis), kills the branches that are infected with dwarf mistletoe. Dwarf mistletoe weakens the tree and allows other pathogens to infest the tree. The mistletoe cankers create an entry point for other diseases, such as heart rots (Russell, et al., 1990).

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). This disease can damage tree growth by reducing crown development. Mortality is less common in mature trees than in 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 wind throw. Annosus root rot can also be spread aerially, infecting freshly cut stumps or other fresh tree wounds. Painting Borax on 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 (Russell, et al., 1990).

The fir engraver (Scolytus ventralis) can cause extensive damage to red fir forests and outbreaks can cause mortality to several acres of trees. It can get to epidemic levels when the trees are stressed due to drought, annosus root rot, dwarf mistletoe, or fire damage. (Russell, et al., 1990).

Site index documentation:

Schumacher (1928), Schumacher (1926) and Meyer (1961) were used to determine forest site productivity for red fir, white fir and Jeffrey pine, respectively. 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 phase 1.3. 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*	42	53	142	184	140	050	–	
California red fir	*ABMA*	42	53	142	184	–	–	100TA	Meyer, Walter H. 1961. Yield of even-aged stands of ponderosa pine. USDA Technical Bulletin 630. (1938 version revised in 1961).
white fir	*ABCO*	37	47	60	83	70	030	–	
white fir	*ABCO*	37	47	60	83	–	–	100TA	Meyer, Walter H. 1961. Yield of even-aged stands of ponderosa pine. USDA Technical Bulletin 630. (1938 version revised in 1961).
Jeffrey pine	*PIJE*	56	56	43	43	57	600	–	
Jeffrey pine	*PIJE*	56	56	42	42	–	–	100TA	Meyer, Walter H. 1961. Yield of even-aged stands of ponderosa pine. USDA Technical Bulletin 630. (1938 version revised in 1961).

Inventory data references

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

789107- Site location
789362

Type locality

Location 1: Lassen County, CA	
Township/Range/Section	T31 N R6 E S11
UTM zone	N
UTM northing	4491392
UTM easting	645930
General legal description	The type locality is above Butte Lake and north of Sunrise Peak.

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Contributors

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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):

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

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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):**

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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:**