Ecological site F022AC008CA
Cryic Volcanic Mountain Slopes

Accessed: 05/11/2025

General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

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): 022A–Sierra Nevada and Tehachapi Mountains

Major Land Resource Area 22A, Sierra Nevada Mountains, is located predominantly in California and a small section of western Nevada. The area lies completely within the Sierra Nevada Section of the Cascade-Sierra Mountains Province. The Sierra Nevada range has a gentle western slope, and a very abrupt eastern slope. The Sierra Nevada consists of hilly to steep mountains and occasional flatter mountain valleys. Elevation ranges between 1,500 and 9,000 ft throughout most of the range, but peaks often exceed 12,000 ft. The highest point in the continental US occurs in this MLRA (Mount Whitney, 14,494 ft). Most of the Sierra Nevada is dominated by granitic rock of the Mesozoic age, known as the Sierra Nevada Batholith. The northern half is flanked on the west by a metamorphic belt, which consists of highly metamorphosed sedimentary and volcanic rocks. Additionally, glacial activity of the Pleistocene has played a major role in shaping Sierra Nevada features, including cirques, arêtes, and glacial deposits and moraines. Average annual precipitation ranges from 20 to 80 inches in most of the area, with increases along elevational and south-north gradients. Soil temperature regime ranges from mesic, frigid, and cryic. Due to the extreme elevational range found within this MLRA, Land Resource Units (LRUs) were designated to group the MLRA into similar land units.

LRU "C" Northern Sierra Subalpine: Elevations are typically between 7,800 and 9,800 feet. The frost free period is between 30 and 90 days, MAAT is between 35 and 44 degrees, MAP is between 45 and 65 inches. Soils are typically cryic, but frigid soils may occur at lower elevations on southern aspects. Forests are dominated by whitebark pine (Pinus albicaulis), Sierra lodgepole pine (Pinus contorta spp. murrayana), mountain hemlock (Tsuga mertensiana) and/or California red fir (*Abies magnifica*).

Classification relationships

Forest Alliance = *Abies magnifica-Abies concolor* – Red fir - White fir forest; Association = tentatively Abies magnifica-*Abies concolor* [Sierra Nevada]. (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.)

Ecological site concept

This site occurs on south-facing mountain slopes (and moraines) at elevations of approximately 7,600 to 9,000 feet. Slopes are typically between 15 and 50 percent. Soils are moderately deep to very deep and derived from volcanic parent material. The vegetation is a productive California red fir (*Abies magnifica*) – white fir (*Abies concolor*) forest. California red fir is a slow-growing, long-lived tree that has high frost tolerance and low drought tolerance, and reaches dominance only in cooler and moister upper elevations. White fir has lower frost tolerance and is more drought tolerant, and can co-dominate in this high elevation zone on warmer south-facing aspects. The understory is sparse, with pinemat manzanita (*Arctostaphylos nevadensis*) is the most common shrub species.

Associated sites

F022AC007CA	**North-Facing Cryic Loamy Mountain Slopes** Occurs on adjacent north-facing slopes with moderately deep andic soils. Vegetation is subalpine mixed conifer forest with mountain hemlock (Tsuga mertensiana), red fir (Abies magnifica), western white pine (Pinus monticola), and occassionally lodgepole pine (Pinus contorta var. murrayana).
F022AE013CA	**Frigid, Loamy, Volcanic Mountain Slopes** Occurs on adjacent mountain slopes with loamy, moderately deep to deep andesitic soils. The vegetation is a white fir (Abies concolor) mixed conifer forest. White fir, jeffrey pine (Pinus jeffreyi), sugar pine (Pinus lambertiana) and incense cedar (Calocedrus decurrens) are all important species.
F022AX101CA	**Moist Colluvial Headwater System** Occurs on adjacent headwater swales and first order streams. A complex of vegetation community types is present, and quaking aspen (Populus tremuloides) is a characteristic species.
R022AE217CA	**Frigid Volcanic Slopes** Occurs on lower elevation slopes with shallow, loamy skeletal soils over stongly cemented andesitic lahar. Vegetation is an open, diverse shrubland with huckleberry oak (Quercus vaccinifolia) and greenleaf manzanita (Arctostaphylos patula) dominant species.

Similar sites

F022AE008CA	**Frigid Loamy Moraine Slopes** This site is found at lower elevations on moraine slopes. Soils are very deep soils, and developed from colluvium over till, from volcanic parent materials. The overstory is similar, but the understory species are more indicative of soil mosisture, with creeping snowberry (Symphoricarpos mollis) an important shrub species.

Table 1. Dominant plant species

Tree	(1) *Abies magnifica* (2) *Abies concolor*
Shrub	(1) *Arctostaphylos nevadensis*
Herbaceous	Not specified

Physiographic features

This ecological site is found on mountain and moraine slopes that range from 5 to 50 percent, but are typically above 15 percent. It is generally on southern aspects. Elevations may range from 7,300 to 9,040 feet, but are typically above 7,600 feet.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Moraine
Flooding frequency	None
Ponding frequency	None
Elevation	7,300–9,040 ft
Slope	5–50%
Aspect	SE, S, SW

Climatic features

The average annual precipitation ranges from 35 to 57 inches, mostly in the form of snow in the winter months (November through April). The average annual air temperature ranges from 36 to 42 degrees Fahrenheit. The frost-free (>32F) season is 25 to 75 days, and the freeze-free (>28F) season is 60 to 110 days.

Maximum and minimum monthly climate data for this ESD were generated using PRISM data (PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, created 4 Feb 2004.) and the ArcGIS ESD extract tool.

Table 3. Representative climatic features

Frost-free period (average)	50 days
Freeze-free period (average)	85 days
Precipitation total (average)	46 in

Influencing water features

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

Soil features

The soils associated with this ecological site are moderately deep to very deep and developed from colluvium over residuum weathered from andesite or tuff breccia, or glacial till from mixed sources (Stumpatil). These soils are well drained with slow to moderately rapid permeability. The soil moisture regime is xeric and the soil temperature regime is cryic. Surface rock fragments smaller than 3 inches in diameter range from 0 to 35 percent and larger fragments range from 1 to 51 percent. Surface textures are gravelly sandy loam, gravelly peaty sandy loam, and very gravelly coarse sandy loam. Partially decomposed organic matter overlies the mineral horizons (Oi horizon). Subsurface textures are gravelly sandy loam, very gravelly sandy loam, very gravelly sandy clay loam, very gravelly coarse sandy loam, and stony loam. Subsurface rock fragments smaller than 3 inches in diameter range from 25 to 47 percent by volume, and larger fragments range from 0 to 13 percent (for a depth of 0 to 77 inches). The soils that are correlated to this ecological site include Watsonlake (Loamy-skeletal, isotic Andic Haplocryalfs), Florand (Loamy-skeletal, isotic Xeric Humicryepts), Lostridge (Loamy-skeletal, isotic Xeric Humicryepts), and minor components of Stumpatil (Loamy-skeletal, isotic Umbric Xeric Haplocryalfs).

This ecological site has been correlated with the following mapunits and soil components in the Tahoe Basin soil survey area (CA693):

Area_sym ; Musym ; MUname ; Compname ; Local_phase ; Comp_pct
9121 ; Watsonlake gravelly sandy loam, 5 to 15 percent slopes, rubbly ; Watsonlake ; ; 80
9122 ; Watsonlake gravelly sandy loam, 15 to 30 percent slopes, rubbly ; Watsonlake ; ; 80
Watsonlake gravelly sandy loam, 30 to 50 percent slopes, rubbly ; Watsonlake ; ; 80
9111 ; Florand-Lostridge-Fishsnooze association, 15 to 50 percent slopes ; Florand ; ; 40; Lostridge ; ; 30; ; Stumpatil ; ; 3

7524 ; Tallac gravelly coarse sandy loam, moderately well drained, 0 to 5 percent slopes ; Callat ; ; 4
7525 ; Tallac gravelly coarse sandy loam, moderately well drained, 5 to 9 percent slopes ; Callat ; ; 4
7401 ; Burnlake-Roadcat association, 4 to 30 percent slopes ; Stumpatil ; ; 2
9431 ; Sofgran-Klauspeak-Temo association, 15 to 50 percent slopes ; Stumpatil ; ; 2

Table 4. Representative soil features

Parent material	(1) Colluvium–andesite (2) Residuum–tuff breccia
Surface texture	(1) Gravelly sandy loam (2) Very gravelly coarse sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderately rapid
Soil depth	20 in
Surface fragment cover <=3"	0–35%
Surface fragment cover >3"	1–51%
Available water capacity (0-40in)	3.5–5.2 in
Soil reaction (1:1 water) (0-40in)	4.5–6.5
Subsurface fragment volume <=3" (Depth not specified)	25–47%
Subsurface fragment volume >3" (Depth not specified)	0–13%

Ecological dynamics

Abiotic factors
This site occurs on south-facing mountain slopes (and rarely moraines) at elevations of approximately 7,000 to 9,000 feet. Soils are moderately deep to very deep and derived from volcanic parent material. The vegetation is a productive California red fir (*Abies magnifica*) – white fir (*Abies concolor*) forest. California red fir is a slow-growing, long-lived tree that has high frost tolerance and low drought tolerance, and reaches dominance only in cooler and moister upper elevation. White fir has lower frost tolerance and is more drought tolerant, and can co-dominate in this high elevation zone on warmer south-facing aspects. The understory is sparse, with pinemat manzanita (*Arctostaphylos nevadensis*) the most common shrub species.

Ecological/disturbance factors
Fire and fire suppression, logging, drought and pathogens are the primary disturbance factors affecting the dynamics of this ecological site. Pre-European settlement, the most successionally advanced community phase was most likely dominated by large old growth California red fir and white fir. The understory was less dense than today's forests, allowing for a higher diversity of shrubs, forbs and grasses in the understory than is present today (e.g.Beardsley et al. 1999, Murphy and Knopp 2000, Barbour et al. 2002, Taylor 2004, Stephens and Fry 2005, Binkley et al. 2007). Bekker and Tayler (2001) report a point median fire return interval for a California red fir-white fir forest in the southern Cascades of 24 years and a composite median of 9.5 years. Average time for a fire rotation was 50.4 years. Fire size was reported to average 373 acres with a range of 84 to 919 acres. Moderate to high severity fires were more common than surface fires. As elevation increases and red fir becomes more dominant, the fire return interval becomes longer and less severe. At lower elevations the fire return interval decreases. Other variables such as slope, aspect, location on landscape, moisture, and litter accumulation also affect the frequency and severity of fire.

The pre-settlement phase is rare due to either fire suppression or clear-cutting. This ecological site was almost entirely clear-cut during the 1870s to 1890s during the period known as the Comstock Era (Elliot-Fisk et al. 1996, Murphy and Knopp 2000, Barbour et al. 2002, Taylor 2004), and forests that have developed since have higher density and basal area (Taylor 2004, Stephens and Fry 2005) A long-term policy of fire suppression has impacted these second-growth forests, as well as the few contemporary stands of old-growth forest (Barbour et al. 2002, Stephens and Fry 2005). Shade tolerant firs establish in the understory, increasing forest density and basal area. Understory trees provide ladder fuels, increasing the likelihood of large high severity fire.

Contemporary forests, with more crowded conditions and a higher frequency of drought (e.g.Jones et al. 2004) are more susceptible to pathogen induced mortality (Barbour et al. 2002). California red fir and white fir are susceptible to several pathogens that can cause extensive stand mortality if they reach epidemic levels. Epidemic levels of disease and insect outbreaks can shift the state of the forest by killing large patches of forest or scattered individual trees. These pathogens are part of the natural cycle of regulation and can push the closed forest types to a more open forest. However, fuel loads are high after insect outbreaks, and fire may be more likely.

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

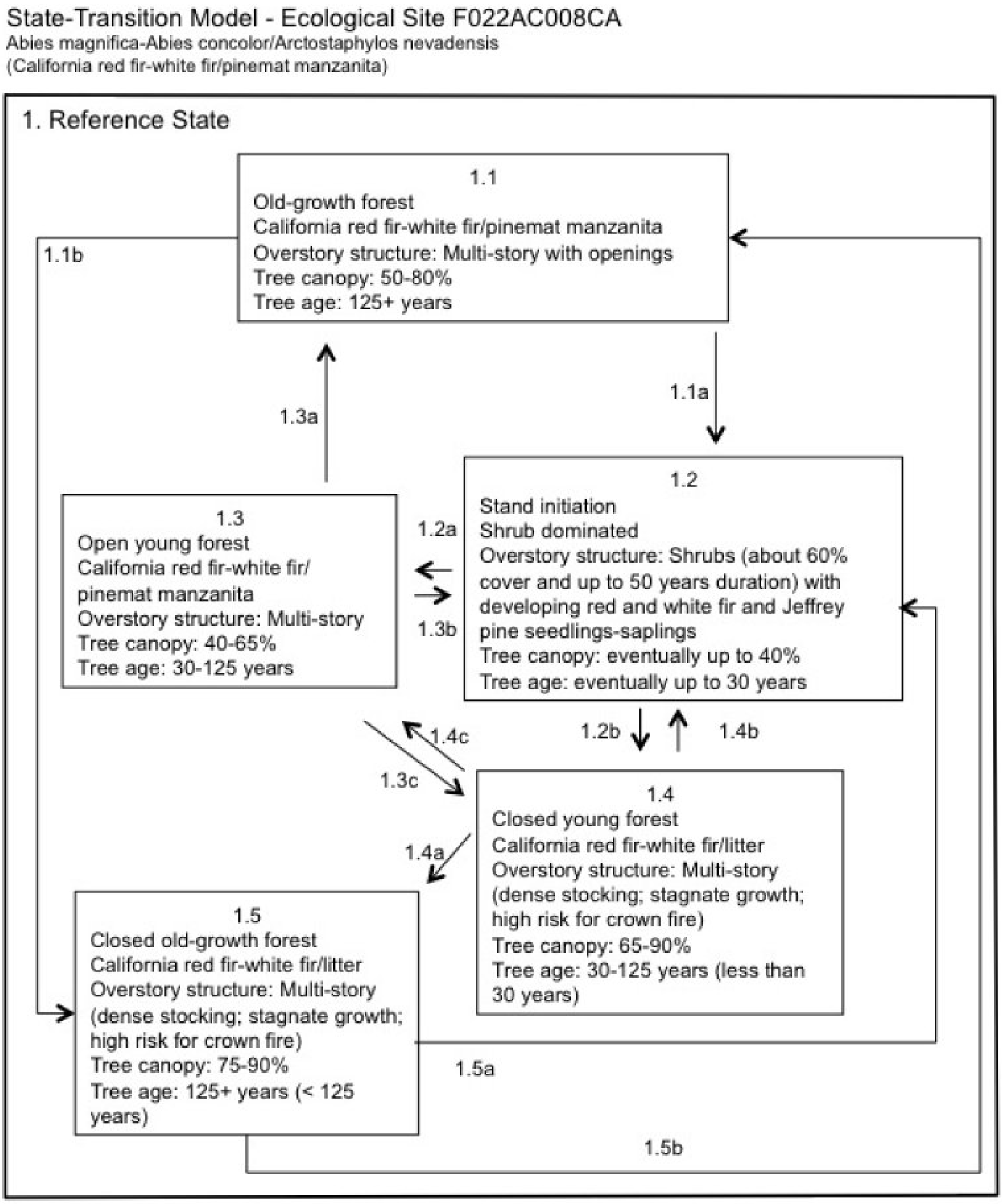

Figure 6. F022AC008CA

State 1
Reference

Community 1.1
Old-growth forest

This community phase was characterized by a multi-tiered forest composed of California red fir and white fir. Canopy cover may have been as high as 80 percent, but was from fewer, large mature trees rather than many tall, small-diameter trees that are present in most areas today (Beardsley et al. 1999).

Community 1.2
Stand initiation

This shrubland community phase thrives in the new openings created by high severity fires that burn the forest canopy and kill the majority of overstory trees. Remnant overstory trees may be present in limited numbers. Greenleaf manzanita (*Arctostaphylos patula*), snowbrush ceanothus (*Ceanothus velutinus*), bush chinquapin (*Chrysolepis sempervirens*), and pinemat manzanita are likely to be the most abundant shrubs after high severity fire in this site (Chappell and Agee 1996, Crotteau et al. 2013). All of these shrubs can resprout after fire and have heat scarified seeds (except bush chinquapin) that will emerge from a long-lived seed bank after fire (Knapp et al. 2012). Grasses and forbs not present in the mature forest phases of this site are also likely to become abundant after fire. Annuals such as spreading groundsmoke (*Gayophytum diffusum*) and Torrey's blue-eyed Mary are likely to become very abundant in the first season after fire (Wright 1985, Schoennagel et al. 2004, Wayman and North 2007). Lupine species such as silvery lupine (*Lupinus argenteus*) and longspur lupine (*L. arbustus*) are likely to colonize new mineral soils. Grasses may include California brome (*Bromus carinatus*), squirreltail (*Elymus elymoides*), needlegrass (Achnatherum spp.), and Ross' sedge (*Carex rossii*). Young red fir and white fir seedlings are scattered throughout the area, but become more abundant as shade cover is established. Once established, it may take more than 50 years for the trees to begin dominate over the shrub community (Azuma et al. 2004, Sydney 1994). The shrubs will eventually die in the shade of the tree canopy. Sierra lodgepole pine may establish and persist post-fire in drier sites.

Community 1.3
Young forest

Figure 7. Community Phase 1.3

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. Severe high-intensity canopy fires are also possible and would lead to stand initiation. The density of California red fir and white fir was historically maintained with re-occurring fires every 3 to 37 years that would burn at low to moderate intensity (Bekker and Tayler 2001). California red fir and white fir are shade tolerant and continue to regenerate under the multi-layered canopy. These young trees and seedlings have a high mortality rate even after low intensity fires, which help maintain the open canopy.

Forest overstory. This forest community phase is dominated by a multi-layered forest of California red fir and white fir. Jeffery pine is rarely present with low cover. The trees range from 50 to 100 years old. Canopy cover ranges from 40 to 65 percent cover, with an average of 55 percent.

Forest understory. This forest has a sparse, low diversity understory. Pinemat manzanita is typically present, with cover ranging from 6 to 10 percent. Greenleaf manzanita (Arctostaphylos patula), snowbrush ceanothus (Ceanothus velutinus), and bush chinquapin (Chrysolepis sempervirens) may be present. Forb cover is low, at only 1 percent, and grasses are typically not present.

Community 1.4
Closed young forest

The closed California red fir-white fir forest develops in the prolonged absence of fire. This lack of fire allows dense stands of multi-layered, pole to medium-sized California red fir and white fir trees (5 to 16 inches dbh) to develop. The understory vegetation is barren due to the lack of sunlight, heavy litter, and woody debris accumulations. As this forest matures (16+ inches dbh) the trees become tall, develop shortened crowns, and become physiologically stressed for water, nutrients, and sunlight. This stress, combined with insect and disease infestation, creates a high level of tree mortality.

Forest overstory. California red fir and white fir co-dominate in this forest with a dense canopy and multiple tree layers. Remnant Jeffrey pine is present in limited numbers.

Forest understory. There is little to no understory under the dense canopy of white fir. White fir is common in the regeneration layer.

Community 1.5
Closed old-growth forest

The closed old-growth California red fir-white fir forest develops with the continued exclusion of fire, allowing the tree density to reach unhealthy levels. Competition for water and sunlight continue, and tree health and vigor declines. An estimated age for this community ranges from 125 to more than 200 years.

Forest overstory. Mature California red fir and white fir co-dominate this community phase. Total canopy cover ranges from 75 to 90 percent.

Forest understory. The understory cover is sparse to none due to the high tree canopy cover and deep litter accumulations on the forest floor.

Pathway 1.1a
Community 1.1 to 1.2

In the event of a severe canopy fire, or a clear-cut and prescribed burn, the old growth forest would transition to the shrub dominated stand initiation phase, community phase, 1.2.

Pathway 1.1b
Community 1.1 to 1.5

If fire is excluded from the old growth community phase, tree density will continue to increase, shifting this community phase towards the closed old-growth forest, community phase 1.5.

Pathway 1.2a
Community 1.2 to 1.3

The natural pathway is to community phase 1.3, the young open California red fir-white fir forest. This pathway is dependent on a natural fire regime of low to moderate severity fires occurring at intervals of approximately 25 years. Manual thinning with prescribed burns can imitate the natural cycle and lead to a similar open forest 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 the young closed California red fir-white fir forest, 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, or partial tree mortality from a pest outbreak. Manual thinning or prescribed burning can be implemented to replace the natural disturbances to keep this forest open. This pathway leads to community phase 1.1.

Pathway 1.3b
Community 1.3 to 1.2

In the event of a canopy fire this community phase would quickly transition to community phase 1.2.

Pathway 1.3c
Community 1.3 to 1.4

If fire does not occur, then the density of the forest increases, shifting the community towards the closed young California red fir-white fir forest, community phase 1.4.

Pathway 1.4b
Community 1.4 to 1.2

The density of ground and mid-canopy fuels create conditions for a high intensity canopy fire. A severe fire would initiate stand regeneration, community phase 1.2.

Pathway 1.4c
Community 1.4 to 1.3

A naturally occurring moderate or surface fire in this forest is unlikely due to the high fuels. Considerable management efforts would be needed to create the open forest conditions that should exist in this forest if it had developed with fire over time. Manual treatment to thin out the white fir and fuels in the understory or prescribed burns could be implemented to shift this forest back to its natural state of an open red fir-white fir forest (community phase 1.3). A partial mortality disease or pest infestation could also create a shift towards community phase 1.3.

Pathway 1.4a
Community 1.4 to 1.5

If fire continues to be excluded from this system, the closed old-growth California red fir-white fir forest develops, community phase 1.5.

Pathway 1.5b
Community 1.5 to 1.1

The event of a naturally occurring moderate or surface fire in this forest is unlikely due to the high fuels. Considerable management efforts would be needed to create the open forest conditions that should exist in this forest if it had developed with fire over time. Manual treatment to thin out the white fir and fuels in the understory or prescribed burns could be implemented to shift this forest back to its natural state of an open red fir-white fir forest (community phase 1.1). A partial mortality disease or pest infestation could also create a shift towards community phase 1.1.

Pathway 1.5a
Community 1.5 to 1.2

At this point, a severe fire is likely and would initiate stand initiation, community phase 1.2.

Additional community tables

Table 5. Community 1.3 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
California red fir	ABMA	*Abies magnifica*	Native	–	20–35	–	–
white fir	ABCO	*Abies concolor*	Native	–	20–30	–	–

Table 6. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
needlegrass	ACHNA	*Achnatherum*	Native	–	0–1
Forb/Herb					
whiteveined wintergreen	PYPI2	*Pyrola picta*	Native	–	0–1
waterleaf phacelia	PHHY	*Phacelia hydrophylloides*	Native	–	0–1
Shrub/Subshrub					
pinemat manzanita	ARNE	*Arctostaphylos nevadensis*	Native	–	6–10
snowbrush ceanothus	CEVE	*Ceanothus velutinus*	Native	–	0–8
bush chinquapin	CHSE11	*Chrysolepis sempervirens*	Native	–	0–5
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	0–3
Tree					
white fir	ABCO	*Abies concolor*	Native	–	1–3
California red fir	ABMA	*Abies magnifica*	Native	–	0–2

Animal community

This forest provides food and shelter for squirrels, birds, deer and bear. The Jeffrey pine seeds are eaten by birds, and the roots and young stems are eaten by small mammals. The standing dead and down trees provide habitat for nesting birds and shelter for cavity dwellers (Habeck 1992).

Hydrological functions

The hydrology of this site is characterized by heavy snowmelt in the spring, with very little precipitation in the summer months.

Recreational uses

This ecological site has trails for walking, biking and cross-country skiing.

Wood products

The wood of California red fir has a low specific gravity, is straight-grained, light and soft, but stronger than the wood of other firs. It 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).

Historically, white fir was not a desirable timber species, but it is used more today. It is a general all-purpose, construction-grade wood used for framing, plywood, poles, pilings, and pulpwood. It requires large amounts of preservatives since the heartwood decays rapidly. It can be used as firewood, but it produces less heat than wood from other trees (Zouhar 2001).

Other information

Site index documentation:

Schumacher (1928) and Schumacher (1926) were used to determine forest site productivity for red fir and white fir, 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.

Trees appropriate for site index measurement typically occur in stands of community phases 1.3 and 1.4. Site trees are selected according to guidance in their respective publications. Please refer to the Tahoe Basin Soil Survey for detailed site index information by soil component.

Forest Pathogen Information:
California red fir and white fir are susceptible to several pathogens that can cause extensive stand mortality if they reach epidemic levels. Epidemic levels of disease and insect outbreaks can shift the state of the forest. They can kill patches of whole forest, or just scattered trees. These pathogens are part of they natural cycle of regulation and can push the closed forest types to a more open forest. However, fuel loads are high after outbreaks and fire may be more likely.

In the Lake Tahoe Basin, many pathogens are found on white fir (*Abies concolor*). These include: dwarf mistletoe (Arceuthobium abietinum f. sp. concoloris), broom rust (Melamsporlla caryophyllacearum), annosus root disease (Heterobasidium annosum), 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 (Murphy and Knopp 2000).

The major pathogens that affect California red fir in this area include: 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) (Murphy and Knopp 2000).
Other diseases also affecting red fir are known as heart rots, which cause the centers of limbs and trunks to decay. Commonly seen heart rots include: yellow cap fungus (Pholiota limonella) and Indian paint fungus (Echinodontium tinctorium). Common pests affecting red fir are: cone maggots (Earomyia spp.), several chalcids (Megastigmus spp.) and cone moths (Barbara spp. and Eucosma spp.) (Burns and Honkala 1990).

Red fir dwarf mistletoe (Arceuthobium abietinum f. sp. magnificae) is a parasitic plant common in the survey area. Visible symptoms include 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 which 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 and the cytospora canker (Cytospora abietis) (Burns and Honkala 1990).

Fir broom rust (Melampsorella caryophyllacearum) causes dense witches brooms with stunted yellow needles, and can damage tree growth by reducing crown development. Mortality is less common in mature trees than in the younger regeneration trees. 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).

Annosus root rot (Heterobasidion annosum) can affect large acres of fir forest. 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 spread from infected roots to healthy roots as well as aerially by 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 because the rot itself does not often kill red fir directly, but it weakens the tree and makes it easier for bark beetles (Scolytus spp), annosus root rot, or dwarf mistletoe to infect the tree (Burns and Honkala 1990).

The fir engraver (Scolytus ventralis) can cause extensive damage to a red fir forest and outbreaks can cause several acres of trees to die. It can reach epidemic levels when the trees are stressed due to annosus root rot, dwarf mistletoe, drought, or fire damage (Burns and Honkala 1990).

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

Table 7. 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*	30	30	104	104	140	050	–	
white fir	*ABCO*	40	40	64	64	70	030	–	

Inventory data references

The following NRCS TEUI plots provide data on this ecological site and plant community:

FUD0201 - Type location
ra03h176

Type locality

Location 1: Placer County, CA	
Township/Range/Section	T16N R17E S17
UTM zone	N
UTM northing	4346263
UTM easting	748775
General legal description	Take HW 267 to Brockway Summit. Take Fiberboard Road to intersection of Forest Service Road 16N49. The plot is located about 230 degrees from the gate at about 150ft.

Other references

Barbour, M., E. Kelly, P. Maloney, D. Rizzo, E. Royce, and J. Fites-Kaufmann. 2002. Present and past old-growth forests of the Lake Tahoe Basin, Sierra Nevada, US. Journal of Vegetation Science 13:461-472.

Beardsley, D., C. Bolsinger, and R. Warbington. 1999. Old-growth forest in the Sierra Nevada: By type in 1945 and 1993 and ownership in 1999. PNW-RP-516, USDA Forest Service, Pacific Northwest Research Station.

Binkley, D., T. Sisk, C. Chambers, J. Springer, and W. Block. 2007. The role of old-growth forests in frequent-fire landscapes. Ecology and Society 12:18-35.

Burns, R. M. and B. H. Honkala. 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. U.S Department of Agriculture, Forest Service, Washington, DC.

Chappell, C. B. and J. K. Agee. 1996. Fire severity and tree seedling establishment in *Abies magnifica* forests, Southern Cascades, Oregon. Ecological Applications 6:628-640.

Cope, A. B. 1993. *Abies magnifica*. Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Crotteau, J. S., J. M. V. III, and M. W. Ritchie. 2013. Post-fire regeneration across a fire severity gradient in the southern Cascades. Forest Ecology and Management 287:103-112.

Elliot-Fisk, D. L., R. Harris, R. A. Rowntree, T. C. Cahill, R. Kattelmann, P. Rucks, O. K. Davis, R. Lacey, D. A. Sharkey, L. Duan, D. Leisz, S. L. Stephens, C. R. Goldman, S. Lindstrom, D. S. Ziegler, G. E. Gruell, and D. Machida. 1996. Lake Tahoe Case Study. Pages 217-276 Sierra Nevada Ecosystem Project. University of California, Centers for Water and Wildland Resources, Davis, CA.

Habeck, R. J. 1992. Pinus lambertiana. Fire Effects Information System [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Hagle, S. K., K. E. Gibson, and S. Tunnock. 2003. Field guide to diseases and insect pests of northern and central Rocky Mountain conifers. U.S. Department of Agriculture, Forest Service, State and Private Forestry, Intermountain Region.

Jones, M. E., T. D. Paine, M. E. Fenn, and M. A. Poth. 2004. Influence of ozone and nitrogen deposition on bark beetle activity under drought conditions. Forest Ecology and Management 200:67-76.

Knapp, E. E., C. P. Weatherspoon, and C. N. Skinner. 2012. Shrub seed banks in mixed conifer forests of northern California and the role of fire in regulating abundance. Fire Ecology 8.

Murphy, D. D. and C. M. Knopp. 2000. Lake Tahoe Basin Watershed Assessment. PSW-GTR-175, USDA Forest Service, Pacific Southwest Research Station.

Schoennagel, T., D. M. Waller, M. G. Turner, and W. H. Romme. 2004. The effect of fire interval on post-fire understorey communities in Yellowstone National Park. Journal of Vegetation Science 15:797-806.

Stephens, S. L. and D. L. Fry. 2005. Spatial distribution of regeneration patches in an old-growth Pinus jeffrey-mixed conifer forest in northwestern Mexico. Journal of Vegetation Science 16:693-702.

Smith, S. 1994. Ecological Guide to Eastside Pine Associations. USDA Forest Service, Pacific Southwest Region, R5-ECOL-TP-004.

Taylor, E. H. 2004. Identifying forest reference conditions on early cut-over lands, Lake Tahoe Basin, USA. Ecological Applications 14:1903-1920.

Wayman, R. B. and M. North. 2007. Initial response of a mixed-conifer understory plant community to burning and thinning restoration treatments. Forest Ecology and Management 239:32-44.

Wright, H. A. 1985. Effects of fire on grasses and forbs in sagebrush-grass communities. Pages 12-21 in Rangeland Fire Effects; A symposium. USDI-Bureau of Land Management, Boise, ID.
Zouhar, K. 2001. *Abies concolor*.in O. Fire Effects Information System, editor. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Contributors

Alice Miller
Lyn Townsend
Marchel M. Munnecke
Marchel Munnecke

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:**
