Ecological site F022AE013CA
Frigid, Loamy, Volcanic Mountain Slopes

Accessed: 05/18/2024

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, aretes, 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. The soil temperature regime ranges from mesic, frigid, and cryic.

LRU "E" Northern Sierran Upper Montane: This LRU occurs at the mid elevations of the Sierra Nevada, from the Sonora Pass area to the higher mountains in the vicinity of Quincy. Elevations are typically between 5,500 feet to 8,500 feet, with the lower elevations typically on southern aspects, and the higher elevations on northern aspects. The frost-free season is 60 to 125 days, MAAT ranges from 40 to 50 F, and MAP ranges from 35 to 85 inches. The soil temperature regime is mostly frigid, with some cryic soil temperatures at the upper elevations and northern aspects. Soil moisture regimes are mostly xeric, but may be udic where snow persists through spring.

Classification relationships

Ecological site concept

This site occurs on gentle to steep mountain slopes at elevations typically between 6,200 and 7,600 feet. Slopes typically range from 15 to 50 percent. Soils are loamy, moderately deep to deep and derived from andesite. Mid-elevations and loamy fertile soils support a productive mixed conifer forest dominated by white fir (*Abies concolor*) and Jeffrey pine (Pinus Jeffreyi), and sugar pine (*Pinus lambertiana*) and incense cedar (*Calocedrus decurrens*) are important secondary species. These conditions also support a diverse shrub and forb understory, with composition and cover depending on time since fire. Huckleberry oak (Quercus vacciinifolia) and greenleaf manzanita (*Arctostaphylos patula*) are common shrub species. Arrowleaf balsamroot (*Balsamorhiza sagittata*) and Ross' sedge (*Carex rossii*) are common herbaceous species that are especially abundant after ground fire.

Associated sites

F022AC007CA	**North-Facing Cryic Loamy Mountain Slopes** Occurs on higher elevation 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 Sierra lodgepole pine (Pinus contorta var. murrayana).
F022AE008CA	**Frigid Loamy Moraine Slopes** Occurs on adjacent moraine slopes with very deep volcanic soils. The vegetation is red fir (Abies magnifica) - white fir (Abies concolor) forest.
F022AF002CA	**Frigid, Sandy, Or Loamy Outwash** Occurs on adjacent gently sloping outwash, moraines and outwash fans with moderately deep to very deep soils of mixed origin. Vegetation is an open Jeffrey pine (Pinus jeffreyi) forest.
F022AF004CA	**Frigid, Shallow To Deep, Sandy Mountain Slopes** Occurs on adjacent slopes with south-facing aspects and sandy soils. An open Jeffrey pine (Pinus jeffreyi) forest dominates and shrub density may be high, with greenleaf manzanita (Arctostaphylos patula) and antelope bitterbrush (Purshia tridentata) the most common shrub species.
F022AF005CA	**Frigid, Deep To Very Deep, Sandy-Loamy Mountain Slopes** Occurs on adjacent north-facing slopes with coarse sandy soils. Vegetation is Jeffrey pine (Pinus jeffreyi) - white fir (Abies concolor) forest. Herbaceous diversity is low.
F022AF006CA	**Loamy Frigid Metamorphic Slopes** Occurs on adjacent slopes with very deep, fine loamy soils developed from metamorphic parent material. The forest is dominated by a dense, productive Jeffrey pine (Pinus jeffreyi) and white fir (Abies magnifica) forest, and a diverse herbaceous understory is present.
R022AE217CA	**Frigid Volcanic Slopes** Occurs on adjacent slopes with shallow, loamy skeletal soils over strongly cemented andesitic lahar. Vegetation is an open, diverse shrubland with huckleberry oak (Quercus vaccinifolia) and greenleaf manzanita (Arctostaphylos patula) dominant species.
R022AX105CA	**Steep Mountain Drainageways** Occurs on steep mountain drainageways with very deep, frigid, sandy, aquic, alluvial soils, along Rosgen B or A type channels. A complex of community types is present. Aspen (Populus tremuloides), Lemmon's willow (Salix lemmonii) and thinleaf alder (Alnus incana ssp. tenuifolia) are characteristic species.
R022AX107CA	**Frigid C Channel System** This riparian complex occurs along C-B type channels with gravelly to cobbly channel substrates and 2 - 3 percent slopes. The vegetation is characterized by willow (Salix ssp.) - aspen (Populus tremuloides) - cottonwood (Populus balsamifera) communities.

Similar sites

F022AC004CA	**Cryic Very Gravelly Loamy Mountain Slopes** This site occurs at higher elevations on soils with a cryic soil temperature regime. California red fir (Abies magnifica) co-dominates with Jeffrey pine (Pinus jeffreyi).
F022AE007CA	**Frigid, Sandy, Moraines And Hill Slopes** This site occurs on glacial outwash and till from mixed parent materials. California red fir (Abies magnifica) and white fir (Abies concolor) co-dominant the forest canopy, and forest diversity is lower.
F022AE008CA	**Frigid Loamy Moraine Slopes** This site occurs on moraine slopes with very deep soils developed from colluvium over till, weathered from volcanic parent materials. California red fir (Abies magnifica) and white fir (Abies concolor) co-dominate the forest canopy, and forest diversity is lower. Understory species indicate increased soil moisture, and roundleaf snowberry (Symphoricarpos rotundifolius) and creeping snowberry (Symphoricarpos mollis) are dominant shrubs.
F022AF006CA	**Loamy Frigid Metamorphic Slopes** This site occurs in the "AF" lru, where precipitation is lower. The forest canopy is more strongly dominated by Jeffrey pine (Pinus jeffreyi).
F022AF002CA	**Frigid, Sandy, Or Loamy Outwash** This site occurs in the "AF" lru, which receives lower precipitation. It occurs on low-sloping outwash and moraines with soils derived from mixed parent material. Jeffrey pine (Pinus jeffreyi) strongly dominates this open forest.
F022AE025CA	**Loamy Moist Outwash** This site occurs on very deep, gently sloping soils formed in alluvium. They occur in valley bottoms on outwash and on old river and lake terraces. The forest overstory is similar, but has less diversity. The forest understory is more diverse, and species are indicative of increased soil moisture availability. Thimbleberry (Rubus parviflorus) and creeping snowberry (Symphoricarpos mollis) are dominant shrubs.
F022AC008CA	**Cryic Volcanic Mountain Slopes** This site occurs at higher elevations on soils with a cryic soil temperature regime. California red fir (Abies magnifica) co-dominates with white fir (Abies concolor), and the understory is less productive and less diverse, and pinemat manzanita (Arctostaphylos nevadensis) is the dominant shrub.

Table 1. Dominant plant species

Tree	(1) *Abies concolor* (2) *Pinus jeffreyi*
Shrub	(1) *Quercus vacciniifolia* (2) *Arctostaphylos patula*
Herbaceous	(1) *Balsamorhiza sagittata* (2) *Carex rossii*

Physiographic features

This ecological site is on mountain, hill, and moraine slopes that may range from 5 to 70 percent, but are typically between 15 and 50 percent. It is found on all aspects. Elevations may range from 6,200 to 8,220 feet, but are typically below 7,600 feet. Runoff class ranges from very low to high.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Hill (3) Moraine
Flooding frequency	None
Ponding frequency	None
Elevation	1,890–2,505 m

Slope	2–70%

Climatic features

The average annual precipitation ranges from 23 to 63 inches, mostly in the form of snow in the winter months (November through April). The average annual air temperature ranges from 40 to 46 degrees Fahrenheit. The frost-free (>32F) season is 40 to 90 days, and the freeze-free (>28F) season is 80 to 140 days.

Table 3. Representative climatic features

Frost-free period (average)	65 days
Freeze-free period (average)	110 days
Precipitation total (average)	1,092 mm

Influencing water features

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

Soil features

The soils associated with this ecological site are moderately deep to deep, and formed in till, colluvium, and colluvium over residuum weathered from volcanic parent material. They are moderately well to well drained with slow to rapid permeability. The soil moisture regime is typic xeric and the soil temperature regime is frigid. Surface rock fragments smaller than 3 inches in diameter range from 0 to 10 percent, and larger fragments range from 0 to 51 percent. Surface textures include very cobbly and very gravelly fine sandy loam, very cobbly and very gravelly sandy loam, very cobbly loam, gravelly medial sandy loam and very gravelly medial coarse sandy loam. A layer of partially decomposed litter (Oi horizon) may overlay the mineral subsurface horizons. Subsurface textures include very cobbly and very gravelly fine sandy loam, very cobbly, extremely cobbly, gravelly and very gravelly loam, gravelly medial, very cobbly, gravelly, very gravelly and medial gravelly sandy loam, clay loam, extremely cobbly, extremely stony, and gravelly clay loam, and gravelly medial and medial very gravelly coarse sandy loam. Subsurface rock fragments smaller than 3 inches in diameter range from 15 to 39 percent by volume, and larger fragments range from 0 to 66 percent (for a depth of 0 to 80 inches). The soils correlated to this site include Jorge (Loamy-skeletal, isotic, frigid Andic Haploxeralfs), Kneeridge (Medial, mixed, frigid Humic Vitrixerands), Southcamp (Loamy-skeletal, isotic, frigid Ultic Palexeralfs), Tahoma (Fine-loamy, isotic, frigid Ultic Haploxeralfs), Waca (Medial-skeletal, amorphic, frigid Humic Vitrixerands), and minor components of Windy (Medial-skeletal, amorphic, frigid Humic Vitrixerands).

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

Musym ; MUname ; Compname ; Local_phase ; Comp_pct
7151 ; Jorge very cobbly fine sandy loam, 5 to 15 percent slopes, rubbly ; Jorge ; very cobbly fine sandy loam ; 80; ; Tahoma ; ; 5 ; ; Waca ; ; 5 ; Jorge ; very cobbly loam ; 4
7152 ; Jorge very cobbly fine sandy loam, 15 to 30 percent slopes, rubbly ; Jorge ; very cobbly fine sandy loam ; 80; ; Tahoma ; ; 5; ; Waca ; ; 5; Jorge ; very cobbly loam ; 4
7153 ; Jorge very cobbly fine sandy loam, 30 to 50 percent slopes, rubbly ; Jorge ; very cobbly fine sandy loam ; 80; ; Tahoma ; ; 5; ; Waca ; ; 5; Jorge ; very cobbly loam ; 4
7231 ; Waca very gravelly medial coarse sandy loam, 9 to 30 percent slopes ; Waca ; ; 80; Windy ; ; 5; Kneeridge ; well drained ; 2
7232 ; Waca very gravelly medial coarse sandy loam, 30 to 50 percent slopes ; Waca ; ; 80; Windy ; ; 4; Kneeridge ; well drained ; 2
7233 ; Waca very gravelly medial coarse sandy loam, 50 to 70 percent slopes ; Waca ; ; 80; Windy ; ; 5; Kneeridge ; well drained ; 2
7211 ; Southcamp very gravelly fine sandy loam, 50 to 70 percent slopes ; Southcamp ; ; 80
7221 ; Tahoma very cobbly sandy loam, 2 to 15 percent slopes, very stony ; Tahoma ; ; 80; Waca ; ; 10
7154 ; Jorge very cobbly loam, 2 to 15 percent slopes, extremely stony ; Jorge ; very cobbly loam ; 75; Tahoma ; ;

5; Waca ; ; 3
7155 ; Jorge very cobbly loam, 15 to 50 percent slopes, extremely stony ; Jorge ; very cobbly loam ; 75; Tahoma ; ; 5; Waca ; ; 3
7157 ; Jorge-Tahoma complex, 30 to 50 percent slopes ; Jorge ; very gravelly sandy loam ; 55; Tahoma ; ; 25 ; Waca ; ; 10
7222 ; Tahoma-Jorge complex, 2 to 15 percent slopes ; Tahoma ; ; 50; Waca ; ; 10
7156 ; Jorge-Tahoma complex, 15 to 30 percent slopes ; Jorge ; very gravelly sandy loam ; 45; Tahoma ; ; 35 ; Waca ; ; 10
7131 ; Ellispeak-Waca complex, 9 to 30 percent slopes ; Waca ; ; 40; Windy ; ; 4
7132 ; Ellispeak-Waca complex, 30 to 50 percent slopes ; Waca ; ; 40; Windy ; ; 4
7133 ; Ellispeak-Waca complex, 50 to 70 percent slopes ; Waca ; ; 40; Windy ; ; 4
7222 ; Tahoma-Jorge complex, 2 to 15 percent slopes ; Jorge ; very gravelly sandy loam ; 30
7171 ; Kneeridge gravelly sandy loam, 2 to 9 percent slopes, extremely stony ; Kneeridge ; extremely stony ; 80; Jorge ; very gravelly sandy loam ; 9; Waca ; ; 5
7172 ; Kneeridge gravelly sandy loam, well drained, 5 to 15 percent slopes, very stony ; Kneeridge ; well drained ; 80 stony ; Jorge ; very gravelly sandy loam ; 9; Waca ; ; 5
7173 ; Kneeridge gravelly sandy loam, 2 to 5 percent slopes, very stony ; Kneeridge ; very stony ; 80; Jorge ; very gravelly sandy loam ; 9; Waca ; ; 5
7174 ; Kneeridge gravelly sandy loam, 5 to 15 percent slopes, very stony ; Kneeridge ; very stony ; 80; Jorge ; very gravelly sandy loam ; 9; Waca ; ; 5
7241 ; Zephyrcove-Southcamp-Genoapeak complex, 9 to 30 percent slopes ; Southcamp ; ; 20
7242 ; Zephyrcove-Southcamp-Genoapeak complex, 30 to 70 percent slopes ; Southcamp ; ; 20
7121 ; Ellispeak-Rock outcrop complex, 9 to 30 percent slopes ; Waca ; ; 10 ; Kneeridge ; well drained ; 2
7122 ; Ellispeak-Rock outcrop complex, 30 to 50 percent slopes ; Waca ; ; 10 ; Kneeridge ; well drained ; 3
7123 ; Ellispeak-Rock outcrop complex, 50 to 70 percent slopes ; Waca ; ; 10 ; Kneeridge ; well drained ; 3
7161 ; Kingsbeach stony sandy loam, 2 to 15 percent slopes ; ; Tahoma ; ; 10 ; Jorge ; very gravelly sandy loam ; 8
7181 ; Paige medial sandy loam, 5 to 15 percent slopes ; Kneeridge ; well drained ; 7; Jorge ; very gravelly sandy loam ; 6; Waca ; ; 2
7182 ; Paige medial sandy loam, 15 to 30 percent slopes ; Jorge ; very gravelly sandy loam ; 5; ; Waca ; ; 5; Tahoma ; ; 5Kneeridge ; well drained ; 4
7183 ; Paige medial sandy loam, 30 to 50 percent slopes ; Jorge ; very gravelly sandy loam ; 5; Waca ; ; 5 Tahoma ; ; 5
9121 ; Watsonlake gravelly sandy loam, 5 to 15 percent slopes, rubbly ; Jorge ; very cobbly fine sandy loam ; 5; Tahoma ; ; 5; Waca ; ; 2
9122 ; Watsonlake gravelly sandy loam, 15 to 30 percent slopes, rubbly ; Jorge ; very cobbly fine sandy loam ; 5; Tahoma ; ; 5; Waca ; ; 2
9123 ; Watsonlake gravelly sandy loam, 30 to 50 percent slopes, rubbly ; Jorge ; very cobbly fine sandy loam ; 5; Tahoma ; ; 5; Waca ; ; 2
7141 ; Inville gravelly coarse sandy loam, 2 to 9 percent slopes, stony ; Jorge ; very gravelly sandy loam ; 3
7142 ; Inville gravelly coarse sandy loam, 9 to 15 percent slopes, stony ; Jorge ; very gravelly sandy loam ; 3
7143 ; Inville gravelly coarse sandy loam, 15 to 30 percent slopes, stony ; Jorge ; very gravelly sandy loam ; 3
7111 ; Deerhill gravelly fine sandy loam, 9 to 30 percent slopes, very stony ; Southcamp ; ; 3
7112 ; Deerhill gravelly fine sandy loam, 30 to 50 percent slopes, very stony ; Southcamp ; ; 3
7101 ; Caverock sandy loam, 9 to 50 percent slopes ; Southcamp ; ; 2
7011 ; Beaches ; Jorge ; very gravelly sandy loam ; 1; Tahoma ; ; 1

Table 4. Representative soil features

Parent material	(1) Colluvium–andesite
Surface texture	(1) Very gravelly fine sandy loam (2) Very gravelly sandy loam (3) Very cobbly loam
Family particle size	(1) Loamy
Drainage class	Moderately well drained to well drained
Permeability class	Slow to rapid

Soil depth	51 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–51%
Available water capacity (0-101.6cm)	5.84–18.29 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Soil reaction (1:1 water) (0-101.6cm)	5.6–7.8
Subsurface fragment volume <=3" (Depth not specified)	15–39%
Subsurface fragment volume >3" (Depth not specified)	0–66%

Ecological dynamics

Abiotic factors
This site occurs on gentle to steep mountain slopes at elevations of approximately 6,200 to 8,200 feet. Soils are loamy, moderately deep to deep and derived from andesite. Mid-elevations and loamy fertile soils support a productive mixed conifer forest dominated by white fir (*Abies concolor*) and Jeffrey pine (Pinus Jeffreyi), and sugar pine (*Pinus lambertiana*) and incense cedar (*Calocedrus decurrens*) are important secondary species. These conditions also support a diverse shrub and forb understory, with composition and cover depending on time since fire. Huckleberry oak (Quercus vacciinifolia) and greenleaf manzanita (*Arctostaphylos patula*) are common shrub species. Arrowleaf balsamroot (*Balsamorhiza sagittata*) and Ross' sedge (*Carex rossii*) are common herbaceous species that are especially abundant after ground fire.

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 composed of large old growth white fir, Jeffrey pine, sugar pine, incense cedar, and occasional California red fir (*Abies magnifica*). This Californian mixed conifer forest is typical of California mountain landscapes at elevations between approximately 2400 and 8200 (e.g. Minnich et al. 2000). This ecological site is at the upper elevations of the mixed conifer zone, and does not include lower elevation species such as Ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*) and California black oak (*Quercus kelloggii*). Canopy in the old-growth forest was relatively open, allowing for a high diversity of shrubs and forbs in the understory (e.g. Beardsley et al. 1999, Minnich et al. 2000, Murphy and Knopp 2000, Barbour et al. 2002, Taylor 2004, Stephens and Fry 2005, Binkley et al. 2007). Historically, this community phase developed with a mixed fire severity regime, with patchy, infrequent to frequent, low to high intensity surface fires, and occasional larger high severity canopy fires, all of which occurred primarily in the fall when fuel moisture was lowest and trees were dormant (e.g. Minnich et al. 2000, Beaty and Taylor 2008). Fire scar analysis indicates the median historic fire return interval for low and moderate severity fires in mixed conifer forests in the Lake Tahoe area was 3 to 9 years, and that larger fires occurred every 12 to 34 years (Beaty and Taylor 2008). This mixed severity fire regime created a forest with a mosaic of age-classes, and provided frequent recruitment opportunities for Jeffrey pine and sugar pine, which require open sites for seedling establishment. Frequent fires kept the understory largely clear of shade-tolerant but fire-intolerant white fir, red fir, and incense cedar, but longer intervals between fires allowed these species to reach sizes where they are less susceptible to fire-induced mortality.

The old-growth phase is currently 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, Beaty and Taylor 2008). Young forests that have subsequently developed have higher density and basal area, and are comprised of younger and smaller trees with a more even age-class distribution, with most canopy trees 80 to 120 years old (Minnich et al. 2000, Taylor 2004, Stephens and Fry 2005, Beaty and Taylor 2008). A long-term policy of fire suppression has impacted both these second-growth forests, and the few remaining contemporary stands of old-growth forest (Barbour et al. 2002, Stephens and Fry 2005, Beaty and Taylor 2008). Shade tolerant firs and incense cedar have increased in the understory, and light-requiring pines have decreased, leading to densely stocked forests with increasing canopy closure, and a build-up of coarse woody debris (e.g.Minnich et al. 2000). The lack of canopy openings limits recruitment opportunities for Jeffrey pine and sugar pine, which decline in importance in these infilled forests (e.g. Minnich et al. 2000). Increasing canopy cover, and lack of bare ground and nutrient cycling also reduces the abundance and richness of the understory in forests with a long duration of fire suppression (e.g. Huisinga et al. 2005, Laughlin et al. 2005, Binkley et al. 2007). Understory trees provide ladder fuels, and the accumulation of highly flammable downed wood increases the likelihood of large high severity canopy fire, and reduces the likelihood that the natural fire regime, which includes frequent low to moderate severity, small to medium-sized fires, can occur (Minnich et al. 2000). However, management practices such as thinning with prescribed fire can mimic natural processes and help restore these forests back to a more natural condition.

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). Bark beetles (Dedroctonus spp.) are significant disease agents for Jeffrey pine and sugar pine. Fire damage increases the likelihood of bark beetle infestation and mortality (Bradley and Tueller 2001, Maloney et al. 2008, Fettig et al. 2010). Drought also increases the likelihood of mortality. Barbour et al. (2002) found that most of the mortality of old-growth Jeffrey pine in the Lake Tahoe Basin was due to severe drought from 1988-1992, and all dead trees were infected by bark beetle. Nitrogen deposition and ozone pollution have been shown to contribute to Jeffrey pine susceptibility to pathogens and mortality in Southern California (e.g.Peterson et al. 1987), but equivalent studies have not been done in the northern Sierra. White pine blister rust (Cronartium ribicola) is a serious threat to sugar pine (*Pinus lambertiana*) (Murphy and Knopp 2000). White pine blister rust kills old, young, and seedling trees. It can severely inhibit regeneration in infested areas by greatly reducing the sugar pine population. In this ecological site where sugar pine is already present at low abundances, white pine blister rust could eliminate sugar pine altogether. These pathogens may also have played a role in diminishing the importance of pines relative to fir species in contemporary forests (Beardsley et al. 1999).

The reference state consists of the pre-settlement, most successionally advanced community phase (numbered 1.1), and the community phases that 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 reconstruction 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 modal 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), they do not represent the absolute range of characteristics or an exhaustive listing of all species that may occur in that phase over the geographic range of the ecological site.

State and transition model

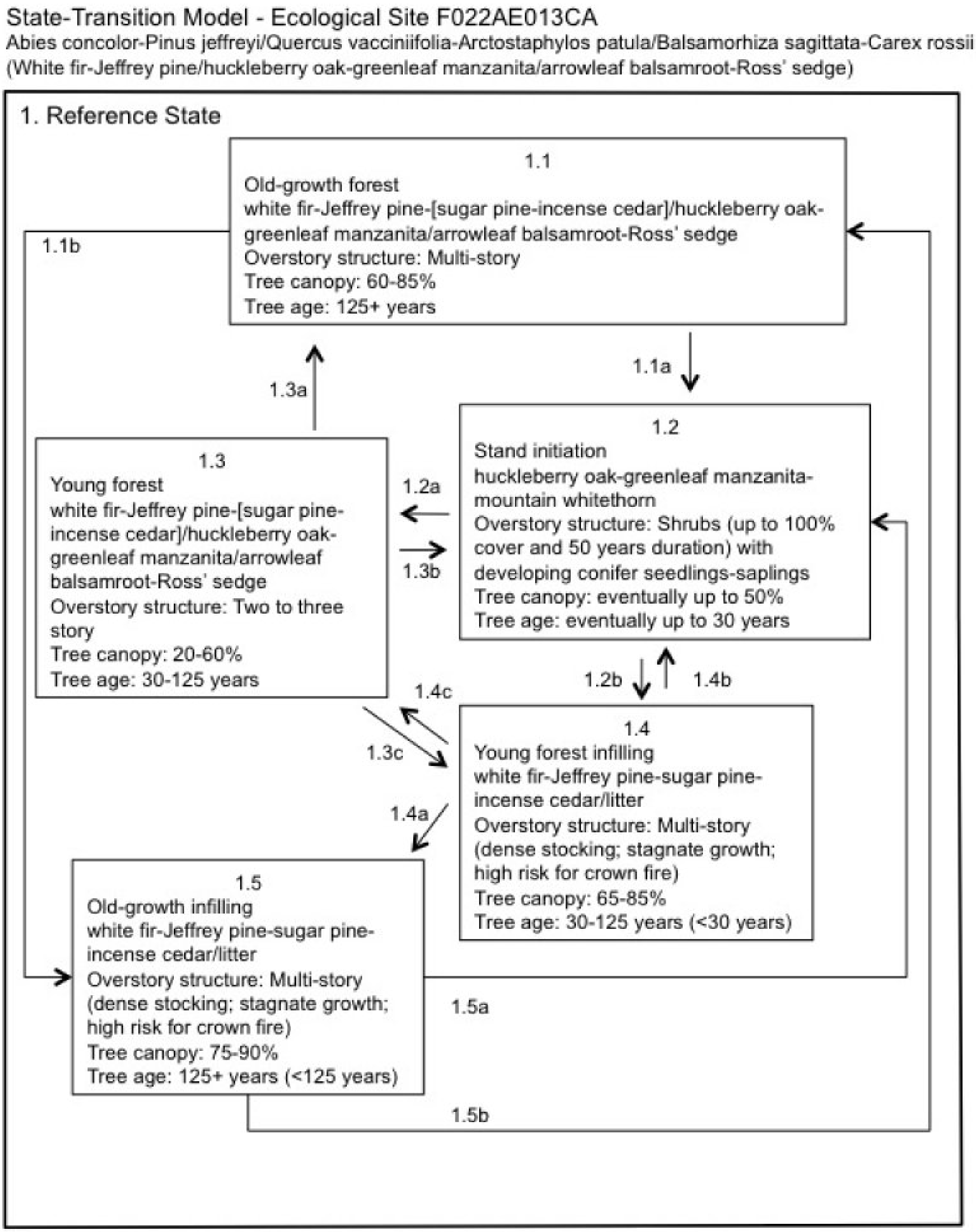

Figure 6. F022AE013CA

State 1
Reference

Community 1.1
Old-growth forest

The most successionally advanced community phase is characterized by multi-layered forest of white fir, Jeffrey pine, sugar pine, and incense cedar. The structure in an old growth mixed conifer forest is complex with either scattered or clumped large (>30 in diameter) and tall (>120 feet) trees. Among the tall trees are several understory layers of trees. White fir and incense cedar are the most common in the understory and mid-canopy. Sugar pine and Jeffrey pine tend to establish after a fire or other disturbance that creates canopy openings. The age for this community phase may range from 150 to 300 years after a major disturbance event such as fire.

Community 1.2
Stand initiation

A productive and diverse shrub and forb community that thrives in the openings created by large fires that burn the forest canopy characterizes the stand initiation phase. Although most canopy trees are killed by canopy fire, occasional remnant mature trees may remain. Annual and perennial forbs and perennial grasses dominate the first one to three years after severe fire. Annual forbs including maiden blue-eyed Mary (*Collinsia parviflora*) and spreading gunsmoke (*Gayophytum diffusum*) may be productive and abundant in bare, open patches in the first several years following fire (Wright 1985, Schoennagel et al. 2004, Dhaemers 2006, Wayman and North 2007). Lupines (Lupinus ssp.), thistles (*Cirsium andersonii*), and mountain monordella (Monordella odoratissima) colonize from seed. Perennials that are only top-killed by fire and that spread by rootstocks such as fireweed (*Chamerion angustifolium*), Nevada pea (*Lathyrus nevadensis*), lambstongue ragwort (Senecio intigerrimus), woolly mules-ears (*Wyethia mollis*), arrowleaf balsamroot (*Balsamorhiza sagittata*), and naked buckwheat (*Eriogonum nudum*) will increase in abundance by the second or third season after fire. Squirreltail (*Elymus elymoides*) is top killed by fire and will resprout from the root crown (Simonin 2001). Ross' sedge (*Carex rossii*) is a colonizer after fire, and can regenerate from surviving rhizomes or from heat-activated seed stored in the soil (Anderson 2008). Shrubs will begin to resprout and germinate from seed as early as the first year post-fire, gaining dominance with time. Fire dependent shrubs such as huckleberry oak, greenleaf manzanita, Utah serviceberry (*Amelanchier utahensis*), mountain whitethorn (*Ceanothus cordulatus*), and snowbrush ceanothus (*Ceanothus velutinus*) resprout and/or germinate from seed vigorously after a fire. Huckleberry oak is highly flammable and vigorously resprouts from the root crown after fire (Howard 1992, Nagal and Taylor 2005, Odion et al. 2009). Greenleaf manzanita vigorously resprouts from underground lignotubers, and regerates from heat scarified seeds that may survive in the soil for more than 400 years (Nagal and Taylor 2005, Hauser 2007). Whitethorn ceanothus will resprout following light to moderate severity fire, and after severe intensity fire regenerates from heat activated seed that may survive in the soil for more than 200 years (Nagal and Taylor 2005, Reeves 2006). Mountain whitethorn is an obligate resprouter after low to medium intensity fire, and seeds require heat for germination (Reeves 2006). Scouler's willow (*Salix scouleriana*) is a disturbance-adapted species that will resprout from the root crown after fire or mechanical disturbance, and colonize from off-site seed sources, being especially successful where fire or disturbance has exposed mineral soil (Anderson 2001). Fire intolerant shrubs such as antelope bitterbrush (*Purshia tridentata*) will be killed by fire, and are generally not present or are very minor species in the stand initiation phase. Jeffrey pine and sugar pine require bare soil and an open canopy to regenerate, and seedlings will sprout following fire, but may take 30 years to begin to dominate over the shrubland community phase (Smith 1994, Azuma et al. 2004). Incense cedar can establish in bare mineral soil with partial shade or in full shade under heavy tree or shrub cover (Tollefson 2008). White fir seedlings are most successful with full shade (Zouhar 2001), and begin to establish once shrub and other tree cover is well established.

Forest overstory. A sparse overstory of remnant white fir and Jeffrey pine may be present.

Forest understory. The shrub species dominate the site and may cover up to 100 percent. Infill of trees occurs over time.

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 fire clears the understory and removes fuel before it reaches hazardous levels, although severe high intensity canopy fires are also possible. If Jeffrey pine and sugar pine established during stand initiation they will have a fair percentage of cover in the upper canopy, but Jeffrey pine and sugar pine will have difficulty regenerating and growing well in the understory of the canopy. Their growth and presence is dependent upon fire or other disturbances to maintain an open canopy forest structure. The young forest community phase is a heavily managed forest. Manual thinning and prescribed burns reduce the white fir component, reduce fuel loads, and create canopy openings in the forest. Natural fires are, for the most part, quickly extinguished in this forest because of its proximity to urban areas.

Forest overstory. This is a young forest co-dominated by Jeffrey pine and white fir, and sugar pine and incense cedar are important secondary species. California red fir (Abies magnifica) is occasionally present. This community phase begins with 10 to 20-foot tall pole-sized trees and matures to 120-foot tall tress with diameters ranging from 20 to 30 inches. Canopy cover ranges from 20 to 60 percent, with an average of 40 percent cover.

Forest understory. The understory cover and diversity is highly variable with time since disturbance. Forb and grass cover increases after recent low severity fire, giving way to shrubs with time without fire. Overall understory diversity and cover decreases as the overstory canopy increases. Huckleberry oak is the most abundant and frequently present shrub. Other common shrubs include greenleaf manzanita, mountain whitethorn prostrate ceanothus (Ceanothus prostratus), creeping snowberry (Symphoricarpos mollis), roundleaf snowberry (Symphoricarpos rotundifolia), bush chinquapin (Chrysolepis sempervirens), snowbrush ceanothus (Ceanothus velutinus), antelope bitterbrush (Purshia tridentata), Utah serviceberry (Amelanchier utahensis) and Scouler's willow (Salix scouleriana). A diverse forb community may be present, especially after more recent ground fire. Arrowleaf balsamroot and woolly mules-ears may be abundant. Grasses may have up to 18 percent cover, and are also more abundant after recent ground fire. Common species include Ross' sedge, squirreltail (Elymus elymoides), and Sandberg bluegrass (Poa secunda).

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	22	168	336
Forb	–	67	129
Tree	–	50	101
Grass/Grasslike	–	8	17
Total	**22**	**293**	**583**

Table 6. Soil surface cover

Tree basal cover	2-6%
Shrub/vine/liana basal cover	0.1-2.0%

Grass/grasslike basal cover	0.25-1.00%
Forb basal cover	0.5-1.5%
Non-vascular plants	0%
Biological crusts	0%
Litter	50-65%
Surface fragments >0.25" and <=3"	2-10%
Surface fragments >3"	1-45%
Bedrock	0%
Water	0%
Bare ground	1-10%

Table 7. Woody ground cover

Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	0-5%
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	0-10%
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	0-10%
Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels)	0-10%
Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels)	0-5%
Tree snags** (hard***)	–
Tree snags** (soft***)	–
Tree snag count** (hard***)	
Tree snag count** (hard***)	

*** Decomposition Classes: N - no or little integration with the soil surface; I - partial to nearly full integration with the soil surface.**

**** >10.16cm diameter at 1.3716m above ground and >1.8288m height--if less diameter OR height use applicable down wood type; for pinyon and juniper, use 0.3048m above ground.**

***** Hard - tree is dead with most or all of bark intact; Soft - most of bark has sloughed off.**

Table 8. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-2%	0-10%	0-15%	0-15%
>0.15 <= 0.3	0-3%	0-15%	0-20%	0-20%
>0.3 <= 0.6	0-10%	0-30%	0-10%	0-30%
>0.6 <= 1.4	0-10%	0-25%	–	0-10%
>1.4 <= 4	0-10%	0-5%	–	–
>4 <= 12	5-15%	–	–	–
>12 <= 24	5-30%	–	–	–
>24 <= 37	15-30%	–	–	–
>37	0-5%	–	–	–

Community 1.4
Young forest infilling

This community phase is defined by a dense canopy and high basal area of mixed conifers. Canopy cover ranges from 65 to 85 percent. The trees are overcrowded and often diseased and stressed due to the competition for water and nutrients. This stress makes the trees more susceptible to death from pests and drought. Fire hazard is high in this community phase due to the deep accumulation of litter, the standing dead and downed trees, and dense multi-layered structure of the forest.

Forest overstory. Young white fir, Jeffrey pine, sugar pine and incense cedar are mixed in the developing canopy. This community begins with young pole-sized trees increasing with age to mature 100-foot tall trees. Combined canopy cover begins at 25 percent and increases to a range between 65 and 85 percent. Tree regeneration continues throughout this period and if the trees are not removed by fire, the stand density will continue to increase. White fir and incense cedar reproduce and grow better in the understory than Jeffrey pine and sugar pine, so with time this forest may be more like a white fir forest rather than a mixed conifer.

Forest understory. The understory is densely shaded and covered with woody debris. It's nearly barren, with a low cover of white fir and incense cedar seedlings.

Community 1.5
Old-growth forest infilling

The mature, closed white fir-mixed conifer forest develops with the continued exclusion of fire, causing the tree density to increase to unhealthy levels. Competition for water and sunlight continue and tree health and vigor declines. An estimated age for this community phase ranges from approximately 100 to more than 200 years.

Forest overstory. Mature white fir dominates this community phase with Jeffrey pine and some sugar pine and incense cedar intermixed in the upper canopy. Total canopy cover ranges from 75 to 90 percent.

Forest understory. The understory is nearly barren under the dense forest canopy. White fir is common in the regeneration layer.

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 community phase 1.2.

Pathway 1.1b
Community 1.1 to 1.5

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

Pathway 1.2a
Community 1.2 to 1.3

Time and growth of canopy species advances the forest to a somewhat more closed-canopy, larger diameter forest (community phase 1.3. A natural low to moderate intensity fire regime is assumed, which influences infill of additional species such as shade-tolerant white fir and incense cedar. In the absence of recurring low to moderate intensity fires, manual thinning with prescribed burns can progress the forest to community phase 1.3.

Pathway 1.2b
Community 1.2 to 1.4

If low to moderate periodic fires are excluded from this community phase, tree density will continue to increase favoring high stocking of shade-tolerant species (white fir and incense cedar) in lower and eventually mid-level canopy layers (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 moderately severe fires, 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 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 forest stand initiation (community phase 1.2).

Pathway 1.3c
Community 1.3 to 1.4

If fire does not occur, the density of the forest increases slowly over time favoring white fir and incense cedar over Jeffrey pine and sugar pine, shifting the community to the young forest infilling phase, 1.4.

Pathway 1.4b
Community 1.4 to 1.2

The density of ground and ladder fuels creates conditions for a high intensity canopy fire. A severe fire would initiate stand regeneration (community phase 1.2). This can shift the community back to its natural state, but further treatments may be needed to eventually achieve the relatively open forest community (phase 1.3).

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 or prescribed burns could thin out the white fir, as well as the fuels in the understory. This would shift this forest back to its natural state of a young, relatively open white fir-Jeffrey pine-mixed conifer 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 old-growth infilling phase develops, 1.5.

Pathway 1.5b
Community 1.5 to 1.1

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 relatively open forest conditions that should exist in this forest if it had developed with fire over time. Manual treatment or prescribed burns could thin out the white fir, as well as the fuels in the understory. This would shift this forest back to its natural state of a relatively open white fir-mixed conifer 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 regeneration (community phase 1.2).

Additional community tables

Table 9. Community 1.2 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	1–5	–	–
white fir	ABCO	*Abies concolor*	Native	–	0–1	–	–

Table 10. Community 1.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Shrub/Subshrub					
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	20–30
whitethorn ceanothus	CECO	*Ceanothus cordulatus*	Native	–	20–30
huckleberry oak	QUVA	*Quercus vacciniifolia*	Native	–	10–15
Tree					
white fir	ABCO	*Abies concolor*	Native	–	2–7
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	2–7

Table 11. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			0–101	
	white fir	ABCO	*Abies concolor*	0–101	1–26
	Jeffrey pine	PIJE	*Pinus jeffreyi*	0–11	8–32
	sugar pine	PILA	*Pinus lambertiana*	0–6	0–28
	incense cedar	CADE27	*Calocedrus decurrens*	0–6	0–25
	California red fir	ABMA	*Abies magnifica*	0–1	0–3
Shrub/Vine					
2	**Shrubs**			22–336	
	huckleberry oak	QUVA	*Quercus vacciniifolia*	28–286	1–10
	Scouler's willow	SASC	*Salix scouleriana*	0–22	0–5
	creeping snowberry	SYMO	*Symphoricarpos mollis*	0–22	0–5
	roundleaf snowberry	SYRO	*Symphoricarpos rotundifolius*	0–22	0–5
	greenleaf manzanita	ARPA6	*Arctostaphylos patula*	0–22	0–2
	snowbrush ceanothus	CEVE	*Ceanothus velutinus*	0–11	0–1
	bush chinquapin	CHSE11	*Chrysolepis sempervirens*	0–11	0–1
	antelope bitterbrush	PUTR2	*Purshia tridentata*	0–11	0–1
	Utah serviceberry	AMUT	*Amelanchier utahensis*	0–11	0–1
	whitethorn ceanothus	CECO	*Ceanothus cordulatus*	0–6	0–2
	prostrate ceanothus	CEPR	*Ceanothus prostratus*	0–6	0–2
Forb					
3	**Forbs**			0–129	
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	0–101	0–18
	woolly mule-ears	WYMO	*Wyethia mollis*	0–45	0–10
	Brewer's fleabane	ERBR4	*Erigeron breweri*	0–7	0–1
	Sierra pea	LANE3	*Lathyrus nevadensis*	0–4	0–1
	maiden blue-eyed Mary	COPA3	*Collinsia parviflora*	0–3	0–5

	maiden blue eyed Mary	COPA3	*Collinsia parviflora*	0–3	0–5
	nodding microseris	MINU	*Microseris nutans*	0–3	0–1
	slender phlox	MIGRG4	*Microsteris gracilis var. gracilis*	0–2	0–1
	mountain monardella	MOOD	*Monardella odoratissima*	0–1	0–1
	silverleaf phacelia	PHHA	*Phacelia hastata*	0–1	0–1
	lambstongue ragwort	SEIN2	*Senecio integerrimus*	0–1	0–1
	naked buckwheat	ERNU3	*Eriogonum nudum*	0–1	0–1
	Virginia strawberry	FRVI	*Fragaria virginiana*	0–1	0–1
	spreading dogbane	APAN2	*Apocynum androsaemifolium*	0–1	0–1
	Holboell's rockcress	ARHO2	*Arabis holboellii*	0–1	0–1
	wavyleaf Indian paintbrush	CAAP4	*Castilleja applegatei*	0–1	0–1
	fireweed	CHANC	*Chamerion angustifolium ssp. circumvagum*	0–1	0–1
	rose thistle	CIAN	*Cirsium andersonii*	0–1	0–1
Grass/Grasslike					
4	**Grasses and Grasslike**			0–17	
	Sandberg bluegrass	POSE	*Poa secunda*	0–11	0–2
	Ross' sedge	CARO5	*Carex rossii*	1–3	1–10
	squirreltail	ELEL5	*Elymus elymoides*	0–2	0–1

Table 12. Community 1.3 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
white fir	ABCO	*Abies concolor*	Native	–	20–40	–	–
sugar pine	PILA	*Pinus lambertiana*	Native	–	10–15	–	–
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	6–12	–	–
incense cedar	CADE27	*Calocedrus decurrens*	Native	–	4–8	–	–

Table 13. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
Sandberg bluegrass	POSE	*Poa secunda*	Native	–	0–10
Ross' sedge	CARO5	*Carex rossii*	Native	–	1–3
squirreltail	ELEL5	*Elymus elymoides*	Native	–	0–2
Forb/Herb					
arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	Native	–	0–18
woolly mule-ears	WYMO	*Wyethia mollis*	Native	–	0–10
maiden blue eyed Mary	COPA3	*Collinsia parviflora*	Native	–	0–5
spreading dogbane	APAN2	*Apocynum androsaemifolium*	Native	–	0–1
wavyleaf Indian paintbrush	CAAP4	*Castilleja applegatei*	Native	–	0–1
fireweed	CHANC	*Chamerion angustifolium ssp. circumvagum*	Native	–	0–1
rose thistle	CIAN	*Cirsium andersonii*	Native	–	0–1
Brewer's fleabane	ERBR4	*Erigeron breweri*	Native	–	0–1
naked buckwheat	ERNU3	*Eriogonum nudum*	Native	–	0–1
Virginia strawberry	FRVI	*Fragaria virginiana*	Native	–	0–1
Sierra pea	LANE3	*Lathyrus nevadensis*	Native	–	0–1
nodding microseris	MINU	*Microseris nutans*	Native	–	0–1
silverleaf phacelia	PHHA	*Phacelia hastata*	Native	–	0–1
lambstongue ragwort	SEIN2	*Senecio integerrimus*	Native	–	0–1
slender phlox	MIGRG4	*Microsteris gracilis var. gracilis*	Native	–	0–1
Shrub/Subshrub					
huckleberry oak	QUVA	*Quercus vacciniifolia*	Native	–	0–10
Scouler's willow	SASC	*Salix scouleriana*	Native	–	0–5
creeping snowberry	SYMO	*Symphoricarpos mollis*	Native	–	0–5
roundleaf snowberry	SYRO	*Symphoricarpos rotundifolius*	Native	–	0–5
whitethorn ceanothus	CECO	*Ceanothus cordulatus*	Native	–	1–3
mountain monardella	MOOD	*Monardella odoratissima*	Native	–	0–2
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	0–2
prostrate ceanothus	CEPR	*Ceanothus prostratus*	Native	–	0–2
snowbrush ceanothus	CEVE	*Ceanothus velutinus*	Native	–	0–2
Utah serviceberry	AMUTU	*Amelanchier utahensis var. utahensis*	Native	–	0–1
bush chinquapin	CHSE11	*Chrysolepis sempervirens*	Native	–	0–1
antelope bitterbrush	PUTR2	*Purshia tridentata*	Native	–	0–1
Tree					
white fir	ABCO	*Abies concolor*	Native	–	1–2
incense cedar	CADE27	*Calocedrus decurrens*	Native	–	1–2

Table 14. Community 1.5 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
white fir	ABCO	*Abies concolor*	Native	–	65–75	–	–
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	7–10	–	–
incense cedar	CADE27	*Calocedrus decurrens*	Native	–	1–2	–	–
western white pine	PIMO3	*Pinus monticola*	Native	–	1–2	–	–
lodgepole pine	PICO	*Pinus contorta*	Native	–	1	–	–

Table 15. Community 1.5 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
squirreltail	ELEL5	*Elymus elymoides*	Native	–	0–2
needlegrass	ACHNA	*Achnatherum*	Native	–	0–2
Forb/Herb					
milk kelloggia	KEGA	*Kelloggia galioides*	Native	–	0–2
lambstongue ragwort	SEIN2	*Senecio integerrimus*	Native	–	0–0.5
Shrub/Subshrub					
creeping snowberry	SYMO	*Symphoricarpos mollis*	Native	–	0–0.5
Tree					
white fir	ABCO	*Abies concolor*	Native	–	4–6
incense cedar	CADE27	*Calocedrus decurrens*	Native	–	0–2

Animal community

This forest provides food and shelter for a variety of animals including squirrels, bears, birds and deer. Tree seeds are eaten by birds, and the roots and young stems are eaten by small mammals. The standing dead and downed trees provide habitats for nesting birds and shelter for cavity dwellers (Gucker 2007).

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 is can be a scenic forest. If slopes are appropriate, it provides suitable camping and picnicking areas. Trails for walking, biking and cross-country skiing are found along the lake and upslope throughout this site.

Wood products

Jeffrey pine is a high-grade lumber important for raw material and used for creating molding, mill work, cabinets, doors, and windows (Gucker 2007).

White fir is used extensively for solid construction framing and plywood, pulpwood, poles and pilings. It requires large amounts of preservatives because the heartwood decays rapidly. It is poorly suited for firewood because of its low specific gravity and heat production (Zouhar 2001).

Sugar pine lumber is valued because it is easy to mill and can be used for molding, window and door frames, doors and other specialty items (Habeck 1992).

The wood from incense cedar is valued because is resistant to rot. It is used as mud sills, window sashes, sheathing under stucco or brick veneer construction, greenhouse benches, fencing, poles, and trellises. It is also widely used for exterior and interior siding. Much of the top quality incense cedar is used in the manufacture of pencils (Tollefson 2008).

Other products

Jeffrey pine and sugar pine cones are used for arts and crafts.

Jeffrey pine pitch was distilled for turpentine early in the century; however the terpenes were found to contain high amounts of the explosive chemical heptane (Gucker 2007).

Other information

Site index documentation:
Schumacher (1926), Dolph (1983), Meyer (1961) and Dunning (1942) were used to determine forest site productivity for white fir, incense cedar, Jeffrey pine and sugar 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. (CMAI values are not available for incense cedar, so zeros were used to indicate the lack of data.) 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 reference publications. Please refer to the Tahoe Basin Soil Survey for detailed site index information by soil component.

Forest pathogen information:
In the Lake Tahoe Basin, many pathogens are found on white fir (*Abies concolor*). These include: white fir 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).

White fir dwarf mistletoe (Arceuthobium abietinum f. sp. concoloris) is a parasitic plant common in the survey area and is evident by witches brooms, top kill, stem cankers and swellings. The vegetative shoots of the white fir dwarf mistletoe are often present from spring to fall. Cytospora abietis, a fungus, kills the branches that are infected with the mistletoe. The reduced vigor caused by the parasite makes the tree more susceptible to bark beetles and disease. The mistletoe cankers create cracks in the bark and provide an entry point for other diseases such as heart rots (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. Tree death 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). This disease can damage tree growth by reducing crown development. Mortality is less common in mature trees than in the younger, regenerating 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 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 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 conifer forest and outbreaks can cause mortality to several acres of trees. 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).

Jeffrey Pine is susceptible to several diseases and insect infestations, especially in periods of drought or when overcrowded. The most threatening of these are the western dwarf mistletoe and the Jeffrey pine bark beetle (Murphy and Knopp, 2000; USDA, 2003). Other pathogens that affect Jeffrey pine in this area include: western dwarf mistletoe (Arceuthobium campylopodium), root disease (Phaeoleus schweinitzii), needle cast (Elytroderma deformans), Jeffrey pine bark beetle (Dedroctonus jeffreyi), Red turpentine beetle (D. valens) and pine engravers (Ips species).

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).

Jeffrey pine bark beetles (Dedroctonus jeffreyi) are native beetles that can only reproduce in Jeffrey pine. They are part of the natural cycle and help maintain a healthy forest. They generally attack older trees that have been weakened by drought, lightning, fire, or other disturbances. However, in times of severe disturbance, epidemic levels can breakout and cause extensive damage to the forest. These beetles infest the lower stem and bole of the trees usually after a 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 change in color of the pine needles from green to yellow to reddish brown, beginning from the top and moving down the tree (Hagle et al. 2003).

The major pathogens in this area for sugar pine (*Pinus lambertiana*) are white pine blister rust (Cronartium ribicola) and bark beetles (Dedrococtonus ponderosae and Ips species) (Murphy and Knopp, 2000). White pine blister rust is an introduced fungus that causes cankers that girdle the tree, eventually killing it. This fungus is a serious threat to all 5 needle pines, but especially sugar pine. White pine blister rust kills old, young, and seedling trees. It can severely inhibit regeneration in infested areas by greatly reducing the sugar pine population.

The mountain pine beetle (Dedrococtonus ponderosae) can also cause widespread mortality as well. The beetles generally infest trees that are weakened by drought or other stress and usually kill the tree. They feed on the phloem layer in the inner bark of the tree, eventually girdling the tree. A blue stain fungus is inoculated into the tree by the beetles and reduces the flow of water. The engraver beetles (Ips spp.) are a secondary bark beetle, coming in after the mountain pine beetle. They eat the inner bark of the tree and inoculate the same blue stain fungus as mentioned above, but they have a lower mortality rate. These beetles can be distinguished by their feeding patterns in the wood, and by the shape of the adults.

Table 16. 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
white fir	*ABCO*	30	55	51	109	70	030	–	
sugar pine	*PILA*	90	110	70	89	70	605	–	
Jeffrey pine	*PIJE*	60	92	46	88	50	600	–	
incense cedar	*CADE27*	25	25	0	0	0	300	–	

Inventory data references

The following NRCS TEUI plots were used to describe this ecological site.

Jtd04004 - Type location
JwD04051
JwD04052
JwF04060
Msg04031
Mxf04204
Umf02
Umf031032

Type locality

Location 1: El Dorado County, CA	
Township/Range/Section	T15N R17E S6
UTM zone	N
UTM northing	4340460
UTM easting	746616
General legal description	From Tahoe City head east on highway 28. Take a left on Hack Pine Road, just past Tahoe City. Continue on forest service road to old gravel pit. Plot about 1000 feet to the west of gravel pit.

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Contributors

Alice Miller
Lyn Townsend
Marchel M. 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:**