USDA Natural Resources Conservation Service

Ecological site F022AF005CA
Frigid, Deep To Very Deep, Sandy-Loamy Mountain Slopes

Accessed: 05/08/2024

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

LRU "F" Northeast Mixed Conifer: This LRU includes the drier eastside forests of the northern Sierra Nevada that occur north of Bridgeport, the eastern, lower elevations of the Tahoe area, and the northern extent of the Sierra near Susanville, most closely corresponding to EPA ecoregion 5f. Elevations are typically between 5,000 and 8,000 feet. The frost free season is between 50 and 100 days, MAAT is between 40 and 48 degrees F, and MAP is typically between 17 and 35 inches, but may range higher in the northernmost section. This LRU exists in the rain shadow formed by the Sierra Nevada Crest, and consequently has much lower precipitation than equivalent elevations on western slopes. Soil temperature regimes are mostly frigid, with some cryic. Soil moisture regimes are xeric.

Classification relationships

Smith, Sydney. 1994. Ecological Guide to Eastside Pine Associations. USDA Forest Service, Pacific Southwest Region. R5-ECOL-TP-004. PIPO-ABCO/PUTR-ARPA-STOC1

Forest Alliance = *Pinus jeffreyi* – Jeffrey pine forest; Associations = tentatively *Pinus jeffreyi*/*Arctostaphylos patula* and *Pinus jeffreyi*/Ceanothus cordulatus. (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 gentle to steep mountain slopes, primarily on the eastern side of Lake Tahoe in the Carson Range, where precipitation is relatively low. Elevations are typically between 6,200 and 7,600 feet and slopes are typically between 15 and 50 percent. Soils are very deep with coarse sandy textures, and have low available water capacity and nutrients. This site is often north-facing slopes, but can be found on all aspects. Droughty, nutrient poor soils with low precipitation tend to support Jeffrey pine (*Pinus jeffreyi*) over other conifer species, however white fir (*Abies concolor*) can compete with Jeffrey pine on the cooler northerly aspects. The understory is relatively sparse, and bush chinquapin (*Chrysolepis sempervirens*) is the dominant shrub.

Associated sites

F022AC003CA	**Frigid-Cryic Sandy Slopes** Occurs on adjacent higher elevation slopes. It is dominated by red fir (Abies magnifica) and western white pine (Pinus monticola), with pinemat manzanita (Arctostaphylos nevadensis) in the understory.
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** This site occurs on adjacent south-facing mountain slopes. This is an open forest dominated by low cover of Jeffrey pine (Pinus jeffreyi). Antelope bitterbrush (Purshia tridentata) is a dominant shrub in the understory with greenleaf manzanita (Arctostaphylos manzanita).
F022AX100CA	**Frigid, Sandy, Moist, Outwash Fan** This site occurs on gently sloping outwash with very deep, poorly drained soils formed in alluvium from glacial outwash fans. The vegetation is a Sierra lodgepole pine (Pinus contorta var. murrayana) forest with a productive understory of willows and forbs.
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.

Similar sites

F022AF004CA	**Frigid, Shallow To Deep, Sandy Mountain Slopes** This site occurs on south-facing mountain slopes. It supports a very open forest of Jeffrey pine (Pinus jeffreyi) that is less susceptible to white fir (Abies concolor) infilling. The shrub understory may be very dense.
F022AE007CA	**Frigid, Sandy, Moraines And Hill Slopes** This site occurs in the "AE" lru, which receives greater precipitation, on glacial outwash. The forest is more productive, and white fir (Abies concolor) co-dominates with Jeffrey pine (Pinus jeffreyi).
F022AF002CA	**Frigid, Sandy, Or Loamy Outwash** This site occurs on gently sloping outwash slopes. Forest productivity is higher.

Table 1. Dominant plant species

Tree	(1) *Pinus jeffreyi* (2) *Abies concolor*
Shrub	(1) *Chrysolepis sempervirens* (2) *Purshia tridentata*
Herbaceous	(1) *Elymus elymoides*

Physiographic features

This ecological site found on mountain side slopes in the unglaciated areas of the Carson Range, on the eastern side of Lake Tahoe. Slopes may range from 5 to 70 percent, but are typically between 15 and 50 percent. Elevations may range from 6,240 and 8,400 feet, but are typically below 7,600 feet. It is found on all aspects, but is generally orientated on north to northwest aspects.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope
Flooding frequency	None
Ponding frequency	None
Elevation	1,902–2,560 m
Slope	5–70%
Aspect	N, W

Climatic features

The average annual precipitation is 19 to 53 inches, mostly in the form of snow in winter (November through April). The average annual air temperature ranges from 42 to 46 degrees Fahrenheit. The frost-free (>32F) season is 40 to 90 days, and the freeze-free (>28F) season is 70 to 140 days.

Table 3. Representative climatic features

Frost-free period (average)	65 days
Freeze-free period (average)	105 days
Precipitation total (average)	914 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 very deep, and formed in colluvium from granodiorite. They somewhat excessively drained with moderately 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 average 10 percent, and larger fragments average 5 percent. The surface texture and subsurface texture is gravelly loamy coarse sand. Subsurface rock fragments smaller than 3 inches in diameter range from 10 to 25 percent by volume, and larger fragments range from 0 to 5 percent (for a depth of 0 to 79 inches). The soils correlated to this site are the Cassenai soils (Mixed, frigid Dystric Xeropsamments).

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
7421 ; Cassenai gravelly loamy coarse sand, 5 to 15 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 78
7423 ; Cassenai gravelly loamy coarse sand, 30 to 50 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 78
7424 ; Cassenai gravelly loamy coarse sand, 50 to 70 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 78
7422 ; Cassenai gravelly loamy coarse sand, 15 to 30 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 73
7411 ; Cagwin-Rock outcrop complex, 5 to 15 percent slopes, extremely stony ; Cassenai ; gravelly loamy coarse sand ; 10
7412 ; Cagwin-Rock outcrop complex, 15 to 30 percent slopes, extremely stony ; Cassenai ; gravelly loamy coarse sand ; 10
7413 ; Cagwin Rock outcrop complex, 30 to 50 percent slopes, extremely stony ; Cassenai ; gravelly loamy coarse sand ; 10
7414 ; Cagwin-Rock outcrop complex, 50 to 70 percent slopes, extremely stony ; Cassenai ; gravelly loamy coarse sand ; 10
7142 ; Inville gravelly coarse sandy loam, 9 to 15 percent slopes, stony ; Cassenai ; gravelly loamy coarse sand ; 10
7143 ; Inville gravelly coarse sandy loam, 15 to 30 percent slopes, stony ; Cassenai ; gravelly loamy coarse sand ; 10
7482 ; Meeks gravelly loamy coarse sand, 5 to 15 percent slopes, stony ; Cassenai ; gravelly loamy coarse sand ; 10
7101 ; Caverock sandy loam, 9 to 50 percent slopes ; Cassenai ; gravelly loamy coarse sand ; 5
7111 ; Deerhill gravelly fine sandy loam, 9 to 30 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 5
7112 ; Deerhill gravelly fine sandy loam, 30 to 50 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 5
7211 ; Southcamp very gravelly fine sandy loam, 50 to 70 percent slopes ; Cassenai ; gravelly loamy coarse sand ; 5
7241 ; Zephyrcove-Southcamp-Genoapeak complex, 9 to 30 percent slopes ; Cassenai ; gravelly loamy coarse sand ; 5
7242 ; Zephyrcove-Southcamp-Genoapeak complex, 30 to 70 percent slopes ; Cassenai ; gravelly loamy coarse sand ; 5
7481 ; Meeks gravelly loamy coarse sand, 0 to 5 percent slopes, stony ; Cassenai ; gravelly loamy coarse sand ; 5
7483 ; Meeks gravelly loamy coarse sand, 0 to 5 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 5
7531 ; Toem-Rock outcrop complex, 9 to 30 percent slopes ; Cassenai ; gravelly loamy coarse sand ; 5
7532 ; Toem-Rock outcrop complex, 30 to 50 percent slopes ; Cassenai ; gravelly loamy coarse sand ; 5
7533 ; Toem-Rock outcrop complex, 50 to 70 percent slopes ; Cassenai ; gravelly loamy coarse sand ; 5
7141 ; Inville gravelly coarse sandy loam, 2 to 9 percent slopes, stony ; Cassenai ; gravelly loamy coarse sand ; 4
7487 ; Meeks gravelly loamy coarse sand, 5 to 15 percent slopes, rubbly ; Cassenai ; gravelly loamy coarse sand ; 2
7488 ; Meeks gravelly loamy coarse sand, 15 to 30 percent slopes, rubbly ; Cassenai ; gravelly loamy coarse sand ; 2
7489 ; Meeks gravelly loamy coarse sand, 30 to 70 percent slopes, rubbly ; Cassenai ; gravelly loamy coarse sand ; 2
7011 ; Beaches ; Cassenai ; gravelly loamy coarse sand ; 1
7522 ; Tallac gravelly coarse sandy loam, 15 to 30 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 1
7523 ; Tallac gravelly coarse sandy loam, 30 to 70 percent slopes, very stony ; Cassenai ; gravelly loamy coarse sand ; 1

Table 4. Representative soil features

Parent material	(1) Colluvium–granodiorite

Surface texture	(1) Gravelly loamy coarse sand
Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained
Permeability class	Moderately rapid
Soil depth	152 cm
Surface fragment cover <=3"	10%
Surface fragment cover >3"	5%
Available water capacity (0-101.6cm)	7.11–9.4 cm
Soil reaction (1:1 water) (0-101.6cm)	5.6–6.5
Subsurface fragment volume <=3" (Depth not specified)	10–25%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

Abiotic factors
This site occurs on gentle to steep mountain slopes, primarily on the eastern side of Lake Tahoe in the Carson Range, where precipitation is relatively low. Soils are very deep with coarse sandy textures, and have low available water capacity and nutrients. This site is often north-facing slopes, but can be found on all aspects. Droughty, nutrient poor soils with low precipitation tend to support Jeffrey pine (*Pinus jeffreyi*) over other conifer species, however white fir (*Abies concolor*) can compete with Jeffrey pine on the cooler northerly aspects(Vasek 1978, Burns and Honkala 1990, Gray et al. 2005, North et al. 2005). The understory is relatively sparse, and bush chinquapin (*Chrysolepis sempervirens*) is the dominant shrub. The most successionally advanced community phase was most likely composed of large, old growth Jeffrey pines, with an open canopy allowing for the growth of shrubs, graminoids, and forbs in the understory (Beardsley et al. 1999, Murphy and Knopp 2000).

Ecological/Disturbance factors
Fire and fire suppression, logging, drought and insect pathogens are the primary disturbance factors affecting the dynamics of this ecological site. Pre-European settlement, the most successionally advanced community phase was composed of large, old growth Jeffrey pine and lesser amounts of old-growth white fir, with a multiple age class distribution and an open canopy, allowing for a diversity of shrubs, grasses 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 patchy, frequent, low intensity surface fires that occurred primarily in the fall when fuel moisture was lowest and trees were dormant (Taylor 2004, North et al. 2005). Fire scar analysis indicates the average historic fire return interval was approximately 11 years for this community (Taylor 2004), with a range from 5 to 39 years (Skinner and Chang 1996, Murphy and Knopp 2000, Stephens 2001). These frequent patchily distributed fires kept the understory open and clear of shade-tolerant and fire-intolerant white fir. Frequent fire also provided bare mineral soil and canopy openings necessary for Jeffrey pine recruitment. This spatially and temporally variable recruitment maintained a multiple age-class forest structure. Frequent fire would have limited ladder fuel development and the accumulation of course woody debris, thus reducing the occurrence of high severity, stand-clearing fire, although such fires did infrequently occur.

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 (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). Fire suppression has caused an increase of white fir in the understory, leading to densely stocked forests with increasing canopy closure, and a build-up of coarse woody debris. Increasing canopy cover, and lack of bare ground and nutrient cycling has reduced the abundance and diversity and changed the composition 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 of low severity fire can occur. However, management practices such as thinning with prescribed fire can mimic natural processes and 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.

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 of stumps (Taylor 2004), comparison of modern day remnant forests to equivalent old-growth forest in Baja that has never been subject to fire suppression (Barbour et al. 2002, Stephens and Fry 2005), 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

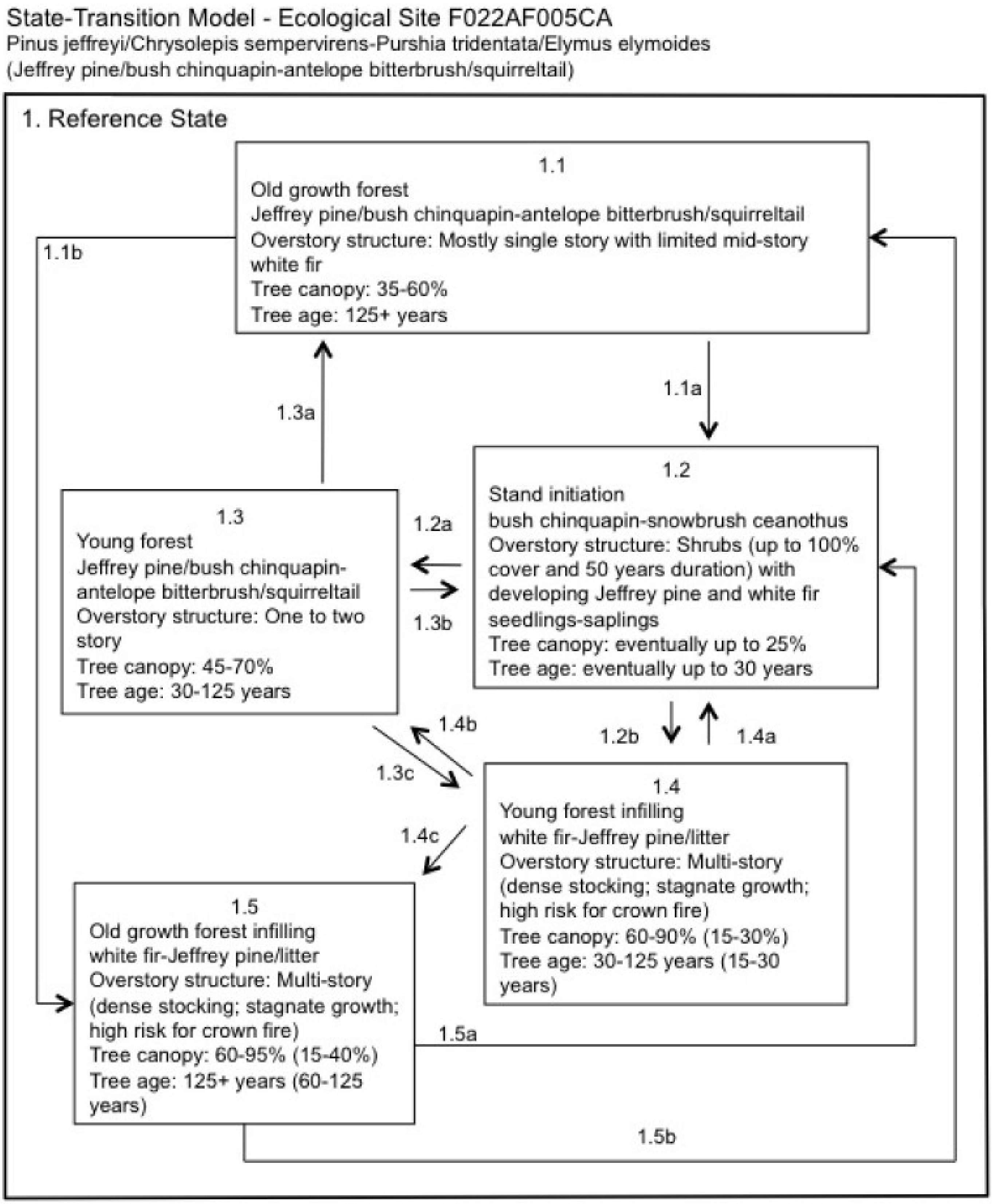

Figure 6. F022AF005CA

State 1
Reference

Community 1.1
Old-growth forest

This community phase represents the most successionally advanced community for this ecological site and is characterized by an open forest of Jeffrey pine with white fir as an occasional associate. There is moderate cover of shrubs and forbs where the canopy is open. The forest canopy cover is usually less than 60 percent and shrub cover is less than 30 percent. Sites representative of this phase are difficult to find, due to past logging or fire suppression.

Community 1.2
Stand initiation

This shrubland community phase thrives in the new openings created by large fires burning the forest canopy and killing the majority of the overstory trees. Remnant overstory trees may be present in limited numbers. Fire dependent shrubs such as snowbrush ceanothus (*Ceanothus velutinus*), greenleaf manzanita (*Arctostaphylos patula*), bush chinquapin, and prostrate ceanothus (*Ceanothus prostratus*) resprout and germinate from seed vigorously after a fire. Greenleaf manzanita vigorously resprouts from underground lignotubers, and regenerates from heat scarified seeds that may survive in the soil for more than 400 years (Nagal and Taylor 2005, Hauser 2007). Prostrate ceanothus recruits from long-lived seed that is stimulated by fire, and forms large mats that stabilize soils and fix nitrogen, enhancing soils for colonization by other species (Skau et al. 1970, Brown et al. 1971). Snowbrush ceanothus is an obligate resprouter after low to medium intensity fire, and seeds require heat for germination (Anderson 2001). Pinemat manzanita is killed by fire, but likely has fire-adapted seeds that will germinate in the first year post-fire (Howard 1993). Antelope bitterbrush and mountain big sagebrush (*Artemisia tridentata* ssp. vaseyana) are killed by fire, and will be slower to recruit back into this community. The shrub community can be perpetuated by frequent fire or other disturbances such as grazing, human intervention, or heavy foot traffic. Young Jeffrey pine and white fir are scattered throughout the area, but need an opening in the shrubs to establish. Once established, it may take more than 50 years for the trees to begin to dominate over the shrub community phase. The shrubs eventually die back in shade of the canopy.

Community 1.3
Young forest

Figure 7. Community Phase 1.3

There are currently some portions of this ecological site that are functioning properly and fit into this plant community phase. However, most of this ecological site has substantial white fir encroachment and is better described in the closed white fir-Jeffrey pine communities. Historically, this community would have developed naturally with frequent surface fires, but manual thinning and prescribed burns now replace the natural fire regime. Manual thinning and prescribed burns remove the white fir component and help maintain the dominance of Jeffrey pine. The removal of the understory trees creates a more open forest structure that reduces the competition between trees and lowers the potential for severe canopy fires.

Forest overstory. Jeffrey pine dominates the tree canopy with 20 to 30 percent cover. Tree height reaches 120 feet and the DBH averages 20 inches. White fir is found at lower cover, ranging from 10 to 15 percent.

Forest understory. The understory is sparse except in canopy openings where shrubs, forbs, and grasses are found. Shrub cover ranges from 1 to 15 percent, generally in canopy openings. Common species include: bush chinquapin, antelope bitterbrush, pinemat manzanita, snowbrush ceanothus, greenleaf manzanita, prostrate ceanothus, and mountain big sagebrush. Grasses and forbs provide 1 to 3 percent cover each. Grasses include squirreltail, and Ross' sedge (Carex rossii). Forbs may include spreading groundsmoke (Gayophytum diffusum), milk kelloggia (Kelloggia galioides), lambstongue ragwort (Senecio integerrimus), and whiteveined wintergreen (Pyrola picta), although a variety of other forb species may be present in low amounts at a given site.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	17	28	39
Tree	–	–	6
Forb	–	–	6
Grass/Grasslike	–	3	6
Total	**17**	**31**	**57**

Table 6. Soil surface cover

Tree basal cover	1.5-3.0%
Shrub/vine/liana basal cover	0-1%
Grass/grasslike basal cover	0%
Forb basal cover	0%
Non-vascular plants	0%
Biological crusts	0%
Litter	50-80%
Surface fragments >0.25" and <=3"	3-20%
Surface fragments >3"	2-4%
Bedrock	0-2%
Water	0%
Bare ground	3-15%

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)	0-15%
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	0-1%	0-3%	0-3%	0-3%
>0.15 <= 0.3	0-1%	0-10%	0-3%	0-3%
>0.3 <= 0.6	0-1%	0-15%	0-3%	0-3%
>0.6 <= 1.4	0-2%	0-10%	–	0-1%
>1.4 <= 4	0-2%	0-5%	–	–
>4 <= 12	0-5%	–	–	–
>12 <= 24	15-40%	–	–	–
>24 <= 37	3-15%	–	–	–
>37	0-5%	–	–	–

Community 1.4
Young forest infilling

This community phase is defined by a dense canopy and high basal area of white fir and Jeffrey pine. Canopy cover ranges from 60 to 90 percent. The trees are often overcrowded and stressed due to the competition for water and nutrients, which makes them 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 down trees, and dense multi-layered structure of the forest. Forest age ranges from 30 to 125 years for the main stand.

Forest overstory. This is a multi-tiered forest with up to 4 canopy layers dominated by Jeffrey pine and white fir. Over time white fir will become more prevalent. Total canopy cover ranges from 60 to 90 percent. The upper canopy height is around 100 feet and the trees are densely spaced with an average DBH of 18 to 20 inches.

Forest understory. The understory is densely shaded and covered with woody debris, which inhibits most vegetative growth.

Community 1.5
Old-growth forest infilling

This community phase is defined by a dense canopy and high basal area of white fir. Canopy cover ranges from 60 to 95 percent. The trees are often overcrowded and stressed due to the competition for water and nutrients, which makes them more susceptible to death from disease and drought. The understory is almost absent due to the lack of sunlight on the forest floor. Fire hazard is high in this community phase due to the deep accumulation of litter, the standing dead and down trees, and dense multi-layered structure of the forest. An estimated age for this community phase ranges from 125 to 300 years.

Forest overstory. White fir dominates this forest with a dense canopy and multiple tree layers. Jeffrey pine is still a common associate, but is not regenerating well in the shade of the white fir canopy.

Forest understory. With the exception of white fir, there is little to no understory.

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 quickly to the stand initiation 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 closed white fir-mixed conifer 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 Jeffrey pine forest. This pathway is facilitated with a natural fire regime. Manual thinning with prescribed burns can imitate the natural cycle and lead to the same open community phase.

Pathway 1.2b
Community 1.2 to 1.4

An alternate pathway is created when fire is excluded from the system, and leads to the young, closed white fir-Jeffrey pine forest (community phase 1.4).

Pathway 1.3a
Community 1.3 to 1.1

This is the natural pathway for this community phase, which evolved with a historic fire regime of relatively frequent surface and moderate severity fires, and 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 Community phase 1.2, stand initiation.

Pathway 1.3c
Community 1.3 to 1.4

If fire does not occur, the density of the forest increases. This favors white fir over Jeffrey pine, and shifts this community phase towards the closed white fir-Jeffrey pine community phase 1.4.

Pathway 1.4b
Community 1.4 to 1.2

At this point, the density of ground and mid-canopy fuels create conditions for a high intensity canopy fire. A severe fire would initiate stand initation (community phase 1.2).

Pathway 1.4c
Community 1.4 to 1.3

The natural event of a moderate or surface fire in this forest is unlikely due to the high 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 a young open Jeffrey pine 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 closed white fir-Jeffrey pine forest community phase develops (community phase 1.5).

Pathway 1.5b
Community 1.5 to 1.1

The natural event of a moderate or surface fire in this forest is unlikely due to the high 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 understory trees and fuels or prescribed burns could be implemented to shift this forest back to its natural state of an open Jeffrey pine forest community (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

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*	–	–	3–7	–	–
white fir	ABCO	*Abies concolor*	Native	–	0–2	–	–

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	–	30–50
whitethorn ceanothus	CECO	*Ceanothus cordulatus*	Native	–	30–50
huckleberry oak	QUVA	*Quercus vacciniifolia*	Native	–	20–30

Table 11. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			0–6	
	Jeffrey pine	PIJE	*Pinus jeffreyi*	0–33	0–1
	white fir	ABCO	*Abies concolor*	0–3	0–16
	sugar pine	PILA	*Pinus lambertiana*	0–1	0–2
Shrub/Vine					
2	**Shrubs**			17–39	
	bush chinquapin	CHSE11	*Chrysolepis sempervirens*	9–45	1–5
	antelope bitterbrush	PUTR2	*Purshia tridentata*	0–17	0–3
	snowbrush ceanothus	CEVE	*Ceanothus velutinus*	0–17	0–3
	greenleaf manzanita	ARPA6	*Arctostaphylos patula*	0–17	0–2
	pinemat manzanita	ARNE	*Arctostaphylos nevadensis*	0–6	0–2
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	0–3	0–1
	prostrate ceanothus	CEPR	*Ceanothus prostratus*	0–3	0–1
Forb					
3	**Forbs**			0–6	
	spreading groundsmoke	GADI2	*Gayophytum diffusum*	0–1	0–1
	milk kelloggia	KEGA	*Kelloggia galioides*	0–1	0–1
	whiteveined wintergreen	PYPI2	*Pyrola picta*	0–1	0–1
	lambstongue ragwort	SEIN2	*Senecio integerrimus*	0–1	0–1
Grass/Grasslike					
4	**Grasses and Grasslike**			0–6	
	Ross' sedge	CARO5	*Carex rossii*	0–3	0–1
	squirreltail	ELEL5	*Elymus elymoides*	0–3	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							
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	20–30	–	–
white fir	ABCO	*Abies concolor*	Native	–	10–15	–	–
sugar pine	PILA	*Pinus lambertiana*	Native	–	0–2	–	–

Table 13. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
squirreltail	ELEL5	*Elymus elymoides*	Native	–	0–1
Ross' sedge	CARO5	*Carex rossii*	Native	–	0–1
Forb/Herb					
spreading groundsmoke	GADI2	*Gayophytum diffusum*	Native	–	0–1
milk kelloggia	KEGA	*Kelloggia galioides*	Native	–	0–1
whiteveined wintergreen	PYPI2	*Pyrola picta*	Native	–	0–1
lambstongue ragwort	SEIN2	*Senecio integerrimus*	Native	–	0–1
Shrub/Subshrub					
bush chinquapin	CHSE11	*Chrysolepis sempervirens*	Native	–	1–5
snowbrush ceanothus	CEVE	*Ceanothus velutinus*	Native	–	0–3
antelope bitterbrush	PUTR2	*Purshia tridentata*	Native	–	0–3
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	0–2
pinemat manzanita	ARNE	*Arctostaphylos nevadensis*	Native	–	0–2
mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	Native	–	0–1
prostrate ceanothus	CEPR	*Ceanothus prostratus*	–	–	0–1
Tree					
white fir	ABCO	*Abies concolor*	Native	–	0–1
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	0–1

Table 14. Community 1.4 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	–	45–65	–	–
white fir	ABCO	*Abies concolor*	Native	–	15–25	–	–

Table 15. Community 1.4 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
squirreltail	ELEL5	*Elymus elymoides*	Native	–	0–3
needlegrass	ACHNA	*Achnatherum*	Native	–	0–2
Sandberg bluegrass	POSE	*Poa secunda*	Native	–	0–0.5
Forb/Herb					
arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	Native	–	0–0.5
spreading groundsmoke	GADI2	*Gayophytum diffusum*	Native	–	0–0.5
lambstongue ragwort	SEIN2	*Senecio integerrimus*	Native	–	0–0.5
catchfly	SILEN	*Silene*	Native	–	0–0.5
woolly mule-ears	WYMO	*Wyethia mollis*	Native	–	0–0.5
milk kelloggia	KEGA	*Kelloggia galioides*	Native	–	0–0.5
silverleaf phacelia	PHHA	*Phacelia hastata*	Native	–	0–0.5
Shrub/Subshrub					
roundleaf snowberry	SYRO	*Symphoricarpos rotundifolius*	Native	–	0–2
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	0–2
mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	Native	–	0–2
pinemat manzanita	ARNE	*Arctostaphylos nevadensis*	Native	–	0–0.5
wax currant	RICE	*Ribes cereum*	Native	–	0–0.5
mountain monardella	MOOD	*Monardella odoratissima*	Native	–	0–0.5
antelope bitterbrush	PUTR2	*Purshia tridentata*	Native	–	0–0.5
Tree					
white fir	ABCO	*Abies concolor*	Native	–	0–6
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	0–3

Table 16. 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	–	55–75	–	–
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	15–30	–	–
incense cedar	CADE27	*Calocedrus decurrens*	Native	–	0–0.5	–	–
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	0–0.5	–	–

Table 17. 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	–	0–1
needlegrass	ACHNA	*Achnatherum*	Native	–	0–0.5
Forb/Herb					
milk kelloggia	KEGA	*Kelloggia galioides*	Native	–	0–1
lambstongue ragwort	SEIN2	*Senecio integerrimus*	Native	–	0–0.5
Shrub/Subshrub					
creeping snowberry	SYMO	*Symphoricarpos mollis*	Native	–	0–0.5
spreading dogbane	APAN2	*Apocynum androsaemifolium*	Native	–	0–0.5
Tree					
white fir	ABCO	*Abies concolor*	Native	–	0.5–3
incense cedar	CADE27	*Calocedrus decurrens*	Native	–	0–0.5

Animal community

This forest provides food and shelter for squirrel, deer, bear, and many species of bird. The Jeffrey pine seeds are eaten by birds, and the roots and young stems are eaten by small mammals. The standing dead and downed trees provide habitat 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 area is suitable for trails for hiking, biking, and cross-country skiing. Several roads provide access to this area.

Wood products

Jeffrey pine and white fir provide many different timber products. Thinning projects would increase the health of the forest, reduce extreme fire hazards, and maintain the natural dominance of Jeffrey pine.

Other products

Jeffrey pine cones are suitable for arts and craft stores, and the thin layer of pine needles could be a source of litter and duff for environmental restoration projects.

Other information

Site index documentation:

Schumacher (1926) and Meyer (1961) were used to determine forest site productivity for white fir and Jeffrey pine, respectively. Low to High values of Site index and CMAI (culmination of mean annual increment) give an indication of the range of inherent productivity of this ecological site. Site index relates to height of dominant trees over a set period of time and CMAI relates to the average annual growth of wood fiber in the boles/trunks of trees. Site index and CMAI listed in the Forest Site Productivity section are in units of feet and cubic feet/acre/year, respectively. Both site index and CMAI are estimates; on-site investigation is recommended for specific forest management units for each soil classified to this ecological site. The historical and actual basal area of trees within a growing stand will greatly influence CMAI.

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:
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). The most threatening of these are the western dwarf mistletoe and the Jeffrey pine bark beetle (Murphy and Knopp 2000).

Many pathogens are found on white fir (*Abies concolor*) in the Lake Tahoe Basin. 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 insects and diseases can kill large areas of white fir (Murphy and Knopp 2000).

Table 18. 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*	41	45	67	77	75	030	–	
Jeffrey pine	*PIJE*	77	80	65	69	40	600	–	

Inventory data references

The following plots describe this plant community:

CaF04129 - Type location
CaE04100
trf03038

Type locality

Location 1: Douglas County, NV	
Township/Range/Section	T14N R18E S23
UTM zone	N
UTM northing	4325656
UTM easting	245904
General legal description	Take HW 50 towards Spooner Summit. Turn east on Logan Creek Road. Park at end of road, and head south upslope.

Other references

Anderson, M. D. 2001. *Ceanothus velutinus*. Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

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.

Beaty, R. M. and A. H. Taylor. 2008. Fire history and the structure and dynamics of a mixed conifer forest landscape in the northern Sierra Nevada, Lake Tahoe Basin, California, USA. Forest Ecology and Management 255:707-719.

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.

Bradley, T. and P. Tueller. 2001. Effects of fire on bark beetle presence on Jeffrey pine in the Lake Tahoe Basin. Forest Ecology and Management 142:205-214.

Brown, R. W., R. H. R. Jr., and E. E. Farmer. 1971. Suitability of *Ceanothus prostratus* Benth. for the revegetation of harsh sites. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

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.

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.

Fettig, C. J., S. R. McKelvey, D. R. Cluck, S. L. Smith, and W. J. Otrosina. 2010. Effects of prescribed fire and season of burn on direct and indirect levels of tree mortality in Ponderosa and Jeffrey Pine forests in California, USA. Forest Ecology and Management 260:207-218.

Gray, A. N., H. S. Zald, R. A. Kern, and M. North. 2005. Stand conditions associated with tree regeneration in Sierran mixed-conifer forests. Forest Science 51:198-210.

Gucker, C. L. 2007. *Pinus jeffreyi*. Fire Effects Information System,[Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Hauser, A. S. 2007. *Arctostaphylos patula*. Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Howard, J. L. 1993. Arctostaphylos nevadensis. Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Huisinga, K. D., D. C. Laughlin, P. Z. Fule, J. D. Springer, and C. M. McGlone. 2005. Effects of an intense prescribed fire on understory vegetation in a mixed conifer forest. Journal of the Torrey Botanical Society 132:590-601.

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.

Laughlin, D. C., J. D. Bakker, and P. Z. Fule. 2005. Understorey plant community structure in lower montane and subalpine forests, Grand Canyon National Park, USA. Journal of Biogeography 32:2083-2102.

Maloney, P. E., T. F. Smith, C. E. Jensen, J. Innes, D. M. Rizzo, and M. P. North. 2008. Initial tree mortality and insect and pathogen response to fire and thinning restoration treatments in an old-growth mixed-conifer forest of the Sierra Nevada, California. Canadian Journal of Forest Research 38:3011-3020.

Minnich, R. A., M. G. Barbour, J. H. Burk, and J. Sosa-Ramirez. 2000. Californian mixed-conifer forests under unmanaged fire regims in the Sierra San Pedro Martir, Baja California, Mexico. Journal of Biogeography 1:105-129.

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

Nagal, T. A. and A. H. Taylor. 2005. Fire and persistence of montane chaparral in mixed conifer forest landscapes in the northern Sierra Nevada, Lake Tahoe Basin, California, USA. Journal of the Torrey Botanical Society 132:442-457.

North, M., M. Hurteau, R. Fiegener, and M. Barbour. 2005. Influence of fire and El Nino on tree recruitment varies by species in Sierran Mixed Conifer. Forest Science 51:187-197.

Peterson, D. L., M. J. Arbaugh, V. A. Wakefield, and P. R. Miller. 1987. Evidence of growth reduction in Ozone-injured Jeffrey pine (*Pinus jeffreyi* Grev. and Balf.) in Sequoia and Kings Canyon National Parks. JAPCA 37:906-912.

Skau, C. M., R. O. Meeuwig, and T. W. Townsend. 1970. Ecology of eastside Sierra chaparral, a literature review. Max C. Fleischmann College of Agriculture, University of Nevada Reno, Reno, NV.

Skinner, C. N. and C.-R. Chang. 1996. Fire regimes, past and present. Pages 1041-1069 Status of the Sierra Nevada. Sierra Nevada Ecosystems Project: Final report to Congress. . University of California, Centers for Water and Wildland Resources, Davis, CA.

Stephens, S. L. 2001. Fire history differences in adjacent Jeffrey pine and upper montane forests in the eastern Sierra Nevada. International Journal of Wildland Fire 10:161-167.

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.

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

Vasek, F. C. 1978. Jeffrey pine [*Pinus jeffreyi*] and vegetation of the southern Modoc National Forest [California]. Madroño 25:9-30.

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:**