USDA Natural Resources Conservation Service

Ecological site F022BI122CA
Frigid Extremely Gravelly Sandy Landslides

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General information

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

Figure 1. Mapped extent

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

MLRA notes

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

Site concept:
Landform: Rockfall avalanche
Elevation: (feet): 5,760-7200
Slope (percent): 2-30
Water Table Depth (inches): n/a
Flooding-Frequency: None
Ponding-Frequency: None
Aspect: North, East, West
Mean annual precipitation (inches): 39.0-93.0
Primary precipitation: Winter months in the form of snow
Mean annual temperature: 40 to 45 degrees F (4.4 to 7.2 degrees C)
Restrictive Layer: None
Temperature Regime: Frigid
Moisture Regime: Xeric
Parent Materials: Rockfall avalanche deposits derived from volcanic rock
Surface Texture: Extremely gravelly ashy coarse sand
Surface Fragments <=3" (% Cover): 15-60
Surface Fragments > 3" (% Cover): 12-100

Soil Depth (inches): 60
Vegetation: These older rockfall avalanche deposits are further along in forest development, the oldest exhibiting well-developed Jeffrey pine-white fir forests. All the tree species established in Lassen Volcanic National Park are found within the Chaos Jumbles, except whitebark pine.
Notes: A number of large rockfall avalanches have originated from Chaos Crags.. The majority of this site is associated with the Chaos Jumbles.

Classification relationships

Forest Alliance = *Pinus jeffreyi* – Jeffrey pine forest; Association = *Pinus jeffreyi-Abies concolor* (no matching understory species). (Sawyer, John O., Keeler-Wolf, Todd, and Evens, Julie M. 2009. A Manual of California Vegetation. 2nd ed. California Native Plant Society Press. Sacramento, California.)

Associated sites

F022BI108CA	**Frigid Moist Sandy Lake Or Stream Terraces** This is a wet lodgepole forest found around lake margins.

Similar sites

F022BI106CA	**Frigid Debris Flow Gentle Slopes** This site involves primary succession in the Devastated Area.
F022BI103CA	**Frigid Tephra Over Slopes And Flats** This is a white fir-Jeffrey pine forest unaffected by avalanche debris.

Table 1. Dominant plant species

Tree	(1) *Pinus jeffreyi* (2) *Abies concolor*
Shrub	(1) *Arctostaphylos patula*
Herbaceous	Not specified

Physiographic features

This ecological site is found on rockfall avalanche deposits. Located between 5,760 and 7,200 feet in elevation, slopes for this site range from 2 to 30 percent.

Table 2. Representative physiographic features

Landforms	(1) Landslide
Flooding frequency	None
Ponding frequency	None
Elevation	1,756–2,195 m
Slope	2–30%
Aspect	N, E, W

Climatic features

This ecological site receives most of its annual precipitation during the winter months in the form of snow. The mean annual precipitation ranges from 39 to 93 inches (991 to 2,362 mm) and the mean annual temperature is between 40 to 45 degrees F (4.4 to 7.2 degrees C). The frost free (>32 degrees F) season is 60 to 90 days. The freeze free (>28 degrees F) season is 75 to 200 days.

Table 3. Representative climatic features

Frost-free period (average)	90 days
Freeze-free period (average)	200 days
Precipitation total (average)	2,362 mm

Influencing water features

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

Soil features

The Chaos soil component associated with this site consists of very deep somewhat excessively drained soils. The surface texture is extremely gravelly ashy coarse sand, with gravelly ashy sand textures below. Most of the soil profile contains greater than 35 percent large and small rock fragments. These soils have very low AWC (available water capacity) in the upper 60 inches of soil. They are classified as Loamy-skeletal, isotic, nonacid, frigid Typic Xerorthents.

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

Map Unit Component/ Component %
134 Chaos/ 85

Table 4. Representative soil features

Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained
Permeability class	Moderately rapid
Soil depth	152 cm
Surface fragment cover <=3"	15–60%
Surface fragment cover >3"	12–100%
Available water capacity (0-101.6cm)	1.52–16.03 cm
Soil reaction (1:1 water) (0-101.6cm)	5.1–7
Subsurface fragment volume <=3" (Depth not specified)	12–85%
Subsurface fragment volume >3" (Depth not specified)	0–80%

Ecological dynamics

A number of large rockfall avalanches have tumbled down the slopes from Chaos Crags, primarily during 3 distinct episodes. The area is called Chaos Jumbles. The oldest event was the largest and has been roughly dated to 1,500 years ago. The middle event was smaller than the first, occurring approximately 750 years ago. The smallest and most recent event occurred around 300 years ago. Because the more recent events were consecutively smaller, the older rockfall avalanche deposits were not completely buried (Heath, 1967) and different stages of soil and forest development are visible. The hummocky rock-strewn debris from the youngest event is very noticeable and remains exposed across the landscape. Now 300 years after the event, scattered conifers, forbs, and sub-shrubs are slowly going through the process of primary succession. The hummocky landform from older deposits is still present, but the surface has smoothed and a mineral soil has formed due to physical weathering, microbial activity, and organic matter accumulation. These older rockfall avalanche deposits are further along in forest development, the oldest exhibiting well-developed Jeffrey pine-white fir forests. All the tree species established in Lassen Volcanic National Park are found within the Chaos Jumbles, except whitebark pine.

The initial colonization of plants on newly exposed parent material initiates a wide range of processes. Nitrogen fixation is commonly one of the first processes to be initiated by pioneering plant species and microorganisms. It converts atmospheric nitrogen gas into ammonia (NH_4^+) through chemical and biological reactions. The resultant ammonia is converted to nitrate (NO_3^-) by microorganisms via nitrification. In this process, plants assimilate inorganic nitrogen in the form ammonia and nitrate. As plants continue to establish on the new substrate, they absorb CO_2 from the atmosphere and convert it to plant carbon through the process of photosynthesis. The carbon is sequestered as either above-ground or below-ground biomass, or as soil carbon. Soil organisms are responsible for the decomposition of plant material. When soil organisms die and decompose, nutrients are processed back into the soil. Plant material and dead soil organisms provide the bulk of organic matter in soil. The process of CO_2 production and the accumulation of organic matter begin to transform freshly exposed parent material by providing nutrients and creating better water availability for plants and microorganisms, affecting pH and weathering minerals. Over time, as these organisms eat, grow and move through the soil, they transform it into a more vibrant biologic substrate. Most of these processes are concentrated in the upper A horizon of the soil. The B horizon, located directly below, is influenced by the leaching of acids and other products from the A horizon.

Living and dead plant material stabilize the soil surface by physically buffering raindrop impact and impeding surface runoff. Within the soil, plants, animals and microbes bind the soil together as aggregates with roots, hyphae, fecal pellets and decomposed organic matter. The micro-structure formed by the combined processes of buffering and binding increases soil stability, porosity, water infiltration and water holding capacity (NRCS, 2010).

Trees and burrowing animal activity produce rather large pores and mix soil on a greater scale than processes provided by buffering and binding. Ants and gophers transport soil material by depositing subsoil on the surface as they build tunnels and nests. Dead tree roots produce macropores that often accumulate surface material and incorporate organic matter deeper into the profile (NRCS, 2010).

Many of the trees in the center of this site are chloritic because they lack available plant nutrients. A variety of conifer species are present, some being outside their usual elevation range. Sierra lodgepole pine (*Pinus contorta* var. murrayana) is generally the dominant tree species during primary succession, but Jeffrey pine (*Pinus jeffreyi*), white fir (*Abies concolor*), California red fir (*Abies magnifica*), sugar pine (*Pinus lambertiana*), western white pine (*Pinus monticola*), and mountain hemlock (*Tsuga mertensiana*) are also present in small amounts. Commonly associated plants are western needlegrass (*Achnatherum occidentale*), rockcress (Arabis sp.), pinemat manzanita (*Arctostaphylos nevadensis*), greenleaf manzanita (*Arctostaphylos patula*), carex (Carex sp.), bush chinquapin (*Chrysolepis sempervirens*), buckwheats (Eriogonum spp.), and oceanspray (Holodiscus microphyllus).

Conifers are rarely documented as the initial colonizers during primary succession. More common is a forb and grass phase with species that are able to fix nitrogen. An interesting study was conducted on an ectomycorrhizal association of the blue staining slippery jack fungi (Suillus tomentosus) with a variety of lodgepole pine (*Pinus contorta* var. latifolia) found north of California and extending into Canada and Alaska. Lodgepole pine (*Pinus contorta* var. latifolia) formed tuberculate ectomycorrhizae (TEM) with Suillus tomentosus, and the nitrogen-fixing bacteria Paenibacillus amylolyticus and Methylobacterium mesophilicum were shown to reside within the TEM (Paul, 2002). The results of the study indicate high nitrogenase activity, which was attributed to the TEM association. This indicates a symbiotic relationship similar to that of alder (Alnus spp.) and lupine (Lupinus spp.), wherein nitrogen fixing bacteria (Frankia spp. and Rhizobium spp. respectively) are found within root nodules. Several studies indicate a direct correlation between nitrogen fixation and nitrogen demand that varies depending upon season, soil chemistry, and stand age (Paul et al., 2007). The study of the symbiotic relationship between lodgepole pine (*Pinus contorta* var. latifolia) and Suillus tomentosus may not apply directly to this area, or to the Sierra lodgepole pine (*Pinus contorta* var. murrayana) variety; however, Suillus tomentosus is a common mushroom throughout the area and is documented in lodgepole pine forests in northern California and the Sierra Nevada (Arora, 1986).

Once the forest develops it has the same successional pattern as other Jeffrey pine-white fir forests. Sierra lodgepole pine and Jeffrey pine are shade intolerant species which dominate after disturbances. Jeffrey pine is generally a taller and longer-lived species than Sierra lodgepole pine, and will eventually overtop and shade it out. White fir will eventually establish in the understory in the absence of fire.

Sierra lodgepole pine grows tall and narrow with short branches. Needles are 1.2 to 2.4 inches long in fascicles of 2. Although its thin bark and shallow root system make Sierra lodgepole pine susceptible to fire, it is the only nonserotinous lodgepole pine. Therefore it does not need fire to open its cones to release seeds. The roots of Sierra lodgepole pine are generally shallow, which enable it to grow on this site. Sierra lodgepole pine produces a taproot that can atrophy or grow horizontally in cases of a high water table or a root restrictive layer. Sierra lodgepole pine is shade intolerant and is an early successional species on this site. Though it often reproduces abundantly after fire, it is unknown if it will dominate this site after fire.

Jeffrey pine dominates this site after the early stages of primary succession, and through later succession with reoccurring understory burns. Jeffrey pine produces 3 to 8-inch needles in bundles of 3. The female seed cones range from 4.7 to 12 inches in length. Jeffrey pine produces a deep taproot and extensive lateral roots (Gucker, 2007) that are intolerant of wet conditions. Jeffrey pine looks similar to ponderosa pine but has a vanilla-like odor in the bark, which is not as yellow. Jeffrey pine is shade intolerant and can be replaced over time by white fir if fire is excluded from the system. Older Jeffrey pines are somewhat adapted to fire because their bark is thick enough to provide protection from moderate intensity fires. Additionally, their branches tend to thin along the lower portion of the tree trunk, leaving the crown 65 to 100 feet above the forest floor.

White fir is common in the later successional stages if there is an absence of fire. White fir produces single needles 1.2 to 2.8 inches long that are distributed along young branches. The female cones open and fall apart while still attached to the tree, so cones are not often seen on the forest floor. White fir tends to develop a shallow root system that can graft to other white fir roots and spread root rots (Zouhar, 2001).

Fire regime studies based on tree rings and fire scars report historic median fire return intervals in Jeffrey pine-white fir forests of 14, 18.8, and 70 years (Bekker and Taylor; Skinner and Chang; Taylor and Solem respectively). Beaty and Taylor report that fire frequency and intensity is additionally associated with slope position, aspect, and climatic fluctuations. Fire return intervals are longer on north facing slopes than on south facing slopes. Stand-replacing fire is more common on upper slopes, while low to moderate intensity fires occur only along lower slopes. This is probably due to the tendency of fire to burn upslope, preheating the fuels as it goes (Beaty and Taylor, 2001). In July and August, thunderstorms are common in Lassen Volcanic National Park and the summer drought conditions begin, initiating the fire season. Large fires and multiple small fires in the same season are associated with dry and very dry years (Beaty and Taylor, 2001). Beaty and Taylor report that after a stand-replacing fire, evenly aged forests are formed. The current management practice of fire suppression has shifted forest density and composition by allowing the fire intolerant and shade tolerant firs to increase in cover and density, eventually out-competing the fire tolerant and shade intolerant pines (Taylor and Solem, 2001).

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

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

Pathogens that affect white fir are dwarf mistletoe (*Arceuthobium abietinum* f. sp. concoloris), Cytospora canker (Cytospora abietis), broom rust (Melampsorella caryophyllacearum), annosus root disease (Heterobasidium annosum), armillaria root disease (Armillaria sp.), trunk rot (Echinodontium tinctorium) and fir engravers (Scotylus ventralis). The most threatening of these is the combination of the fir engraver and annosus root disease. These pathogens can kill large areas of white fir (Bohne, 2006; Laacke, 1990).

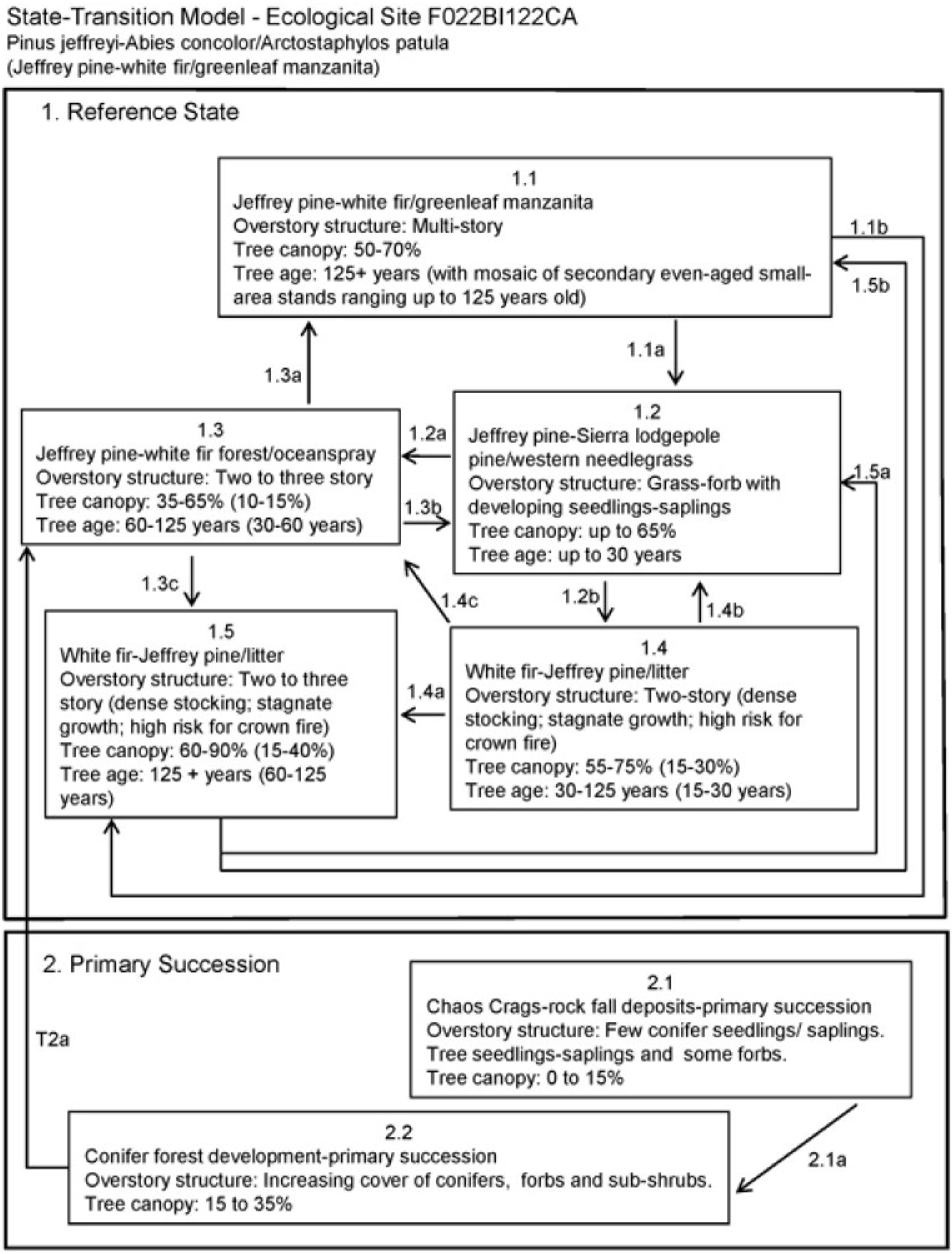
The most serious pest for Sierra lodgepole pine is the mountain pine beetle (Dendroctonus ponderosae). It is a natural pest that can kill a significant portion of the larger trees in a stand. Infestations can last for several years and often return in 20 to 40-year cycles (Cope, 1993). Prominent among the other insects to affect Sierra lodgepole pine is the Ips beetle (Ips spp.), which commonly develops in moist, shaded logging slash. Prompt slash disposal is an effective control measure. Ips also can build up in windthrows. Fungal diseases that affect lodgepole pine productivity include the stem cankers caused by atropelius canker (Atropellis piniphilia), comandra blister rust

(Cronartium comandrae), and western gall rust (Peridermium harknessii). The honey mushroom (Armillaria mellea) and annosus root disease (Heterobasidion annosum) are sources of root rot, and wood decay is caused by such fungi as red rot (Phellinus pini) and red heart wood stain (Peniophora pseudo-pini). Dwarf mistletoe (*Arceuthobium americanum*) is a common parasite that affects large areas of lodgepole pine (Lotan and Critchfield, 1990).

The reference state consists of the anticipated most successionally advanced community phase (numbered 1.1) as well as other community phases which result from natural and human disturbances. Community phase 1.1 is deemed the phase representative of the most successionally advanced plant/animal community including periodic natural surface fires that would influence its composition and production. Because this phase is estimated from historic literature and other nearby similar sites that have gone through secondary succession, some speculation is necessarily involved in describing it.

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

State and transition model



State 1
Reference

Community 1.1
Jeffrey pine-white fir/greenleaf manzanita

Large openly spaced Jeffrey pine trees dominate this forest. Community Phase 1.1 (and community phase 1.5 described later) are found on the older rockfall avalanches. This community phase is maintained by low and moderate intensity fires that remove fire intolerant seedlings and saplings from the understory. Moderate intensity fires can kill some of the overstory trees as well, leaving canopy openings that are favorable for Jeffrey pine and western white pine regeneration. These moderate intensity fires breakup the uniformity of the older stands with pockets of young forests intermixed.

Community 1.2
Jeffrey pine-Sierra lodgepole pine/western needlegrass

This regeneration community phase develops after a severe crown fire. It differs from primary succession in that the soil has developed structure and accumulated organic matter, providing nutrients in the upper horizon. Seeds may survive onsite after the fire, allowing tree seedlings, grasses, and forbs to establish quickly. The few surviving canopy trees are a valuable source of seed for tree regeneration. Nearby trees disperse their seed downwind to distances about twice their height, and possibly farther under windy conditions.

Community 1.3
Jeffrey pine-white fir forest/oceanspray

As this community phase develops from primary succession, Jeffrey pine and white fir overtop the older but shorter Sierra lodgepole pines and the understory is covered with a thin layer of pine needles. A young forest develops with several canopy layers. This community phase also represents the young forest that would develop from Community Phase 1.2, the post fire conifer regeneration community phase. These forests would have some differences in structure and development but are combined to simplify the state and transition models. The conifer species diversity may be higher after primary succession than secondary succession. Seedling establishment and forest structure will most likely develop more quickly during secondary succession because the soil has developed better structure and accumulated organic matter, microbes, and other physical properties that enhance seedling survival and plant growth. Low to moderate intensity fire maintains an open forest structure. The fires kill many of the young fire intolerant seedlings in the understory, which reduces the competition between trees and lowers the potential for a severe canopy fire. The structure, composition, age, and moisture of this forest at the time of fire would determine the fire intensity and extent of damage to the young trees. Slope position, season of burn, and aspect also affect fire intensity and frequency.

Community 1.4
White fir-Jeffrey pine/litter

Jeffrey pine dominates the upper canopy, but there is heavy recruitment of white fir in the understory. This community is defined by a dense canopy and high basal area of white fir and Jeffrey pine dominates the upper canopy, but there is heavy recruitment of white fir in the understory. This community phase is defined by a dense canopy and high basal area of white fir and Jeffrey pine. Canopy cover ranges from 50 to 80 percent. The trees are overcrowded and often diseased and stressed due to competition for water and nutrients, making them more susceptible to death. Fire hazard is potentially high in this community phase due to the deep accumulation of litter, the standing dead and downed trees, and the dense multi-layered structure of the forest.

Community 1.5
White fir-Jeffrey pine/litter

This community phase develops with the continued exclusion of fire. Community Phase 1.5 (and community phase 1.1 described above) are found on the older rockfall avalanches. White fir dominates during this phase and eventually shades-out the associated pine species. This community phase is defined by a dense canopy and high basal area. Canopy cover ranges from 60 to 95 percent. The trees are overcrowded and often diseased and stressed due to competition for water and nutrients. The understory is almost absent because of lack of sunlight on the forest floor. Fire hazard is high in this community phase, caused by the deep accumulation of litter, standing dead and downed trees, and the dense multi-layered structure of the forest.

Forest overstory. This forest is dominated by younger strata of white fir. Older Jeffrey pines still stand above most of the white fir. The Jeffrey pine trees cored for site index were 180 to 400 years old, and the white fir were 150 to 170 years old. (These trees do not reflect the oldest trees or necessarily a specific canopy age, and white fir has limited data.) The upper canopy is about 100 to 130 feet tall. Dbh (diameter at breast height) of the overstory trees ranges from 20 to 32 inches. Basal area data is limited, but is greater than 190-ft2/acre.

Forest understory. The understory is sparse due to dense shade and heavy accumulations of litter and woody debris. Plants encountered on the site include greenleaf manzanita (Arctostaphylos patula), pioneer rockcress, (Arabis platysperma), carex sp. (Carex sp.), little prince's pine (Chimaphila menziesii), Chrysolepis sempervirens (bush chinquapin), naked buckwheat (Eriogonum nudum), and oceanspray (Holodiscus discolor).

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	–	21	62
Tree	–	16	41
Grass/Grasslike	–	3	7
Forb	–	–	1
Total	**–**	**40**	**111**

Pathway 1.1a
Community 1.1 to 1.2

A severe canopy fire will initiate forest regeneration (Community Phase 1.2).

Pathway 1.1b
Community 1.1 to 1.5

This pathway is created when fire is excluded from the old growth community phase. White fir continues to regenerate in the understory, increasing tree density and shifting this community phase toward the white fir-Jeffrey pine forest (Community Phase 1.5).

Pathway 1.2a
Community 1.2 to 1.3

The natural pathway is to Community Phase 1.3, a young open Jeffrey pine-white fir forest. This pathway is followed with a natural fire regime. Manual thinning and 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 regime of relatively frequent surface to moderate severity fires and/or pest outbreaks that create partial tree mortality. This pathway leads to the mature Jeffrey pine-white fir forest (Community Phase 1.1).

Pathway 1.3b
Community 1.3 to 1.2

A severe canopy fire would initiate forest regeneration (Community Phase 1.2).

Pathway 1.3c
Community 1.3 to 1.5

If fire does not occur, then the density of the forest increases. The increased density shifts this community phase toward the white fir-Jeffrey pine forest (Community Phase 1.5).

Pathway 1.4b
Community 1.4 to 1.2

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

Pathway 1.4c
Community 1.4 to 1.3

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

Pathway 1.4a
Community 1.4 to 1.5

If fire continues to be excluded from this system, the dense white fir-Jeffrey pine forest develops (Community Phase 1.5).

Pathway 1.5b
Community 1.5 to 1.1

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

Pathway 1.5a
Community 1.5 to 1.2

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

State 2
Primary Succession (preceding the Reference State)

Community 2.1
Chaos Crags- rock-fall deposits-primary succession

It may take a century of physical and biological weathering before the debris material can create conditions suitable for primary conifer succession. Once plants pioneer into the rocky substrate, they begin to accumulate organic matter and provide limited shade. Sierra lodgepole pine is an early pioneer on the exposed debris, commonly accompanied by Jeffrey pine. Other conifer species generally establish later, in the shade and litter of the early pioneer species. The intact forests adjacent to the debris deposits provide seeds for colonization. As those forests on the periphery develop, more seed is produced and disseminated further into the debris deposits. With normal wind conditions, Jeffrey pine, red fir, white fir, Sierra lodgepole pine and western white pine disperse seed within 200 feet of the source. One report states that western white pine seed can be windblown over 2,000 feet. In addition to the wind, animals often cache the pine seeds. The presence of Sierra lodgepole pine in the early succession may be in part due to its high production of viable seeds and the tolerance of the seedlings to open sunlight (Cope, 1993; Jenkinson, 1990; and Zouhar, 2001.).

Community 2.2
Conifer forest development-primary succession

This community phase slowly develops as conditions become more hospitable for tree growth. The trees that established on the barren debris deposits have increased in size, creating a layer of litter and a zone of shade under the canopy. Many of the trees have reached reproductive maturity, providing a local seed source for continual seedling establishment. Sierra lodgepole pine and Jeffrey pine are the dominant trees. White fir seedlings are present in the shadow of the pines. The understory is limited, with scattered forbs and subshrubs among the rock fragments. The forbs and subshrubs create fertile pockets of organic matter. There is a range in tree age due to the continual establishment of seedlings in the open areas. As time progresses, forest canopy and structure develops. Eventually it develops into a relatively open Jeffrey pine-white fir forest (Community Phase 1.3), and follows the community pathways outlined in the state and transition model.

Forest overstory. Jeffrey pine and Sierra lodgepole pine dominate during the early successional phases of this site. Sugar pine, western white pine, white fir and mountain hemlock are scattered throughout the area but with low cover. Canopy cover ranges from 10 to 35 percent. Trees generally grow less than 40 feet in height, although some are taller.

Forest understory. There is some diversity of species present, but understory cover is generally less than 10 percent. Common species are western needlegrass (Achnatherum occidentale), serviceberry (Amelanchier sp.), pioneer rockcress (Arabis platysperma), sedge (Carex sp.), squirreltail (Elymus elymoides), marumleaf buckwheat (Eriogonum marifolium), rubber rabbitbrush (Ericameria nauseosa ssp. nauseosa var. nauseosa), sulphur-flower buckwheat (Eriogonum umbellatum), oceanspray (Holodiscus discolor), granite prickly phlox (Linanthus pungens), and whiteveined wintergreen (Pyrola picta).

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	–	9	46
Tree	2	12	26
Grass/Grasslike	–	–	7
Forb	–	–	1
Total	**2**	**21**	**80**

Pathway 2.1a
Community 2.1 to 2.2

With time primary succession continues, and a conifer forest slowly develops (Community Phase 2.2).

Transition T2a
State 2 to 1

As time progresses, forest canopy and structure develops. Eventually it develops into a relatively open Jeffrey pine-white fir forest (Community Phase 1.3), and follows the community pathways outlined in the state and transition model.

Additional community tables

Table 7. Community 1.5 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
0	**Tree (understory only)**			0–41	
	white fir	ABCO	*Abies concolor*	0–22	0–5
	Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	0–4	0–2
	California red fir	ABMA	*Abies magnifica*	0–3	0–1
	sugar pine	PILA	*Pinus lambertiana*	0–2	0–1
Shrub/Vine					
0	**Shrub**			0–62	
	greenleaf manzanita	ARPA6	*Arctostaphylos patula*	0–22	0–2
	bush chinquapin	CHSE11	*Chrysolepis sempervirens*	0–20	0–2
	oceanspray	HODI	*Holodiscus discolor*	0–17	0–1
	naked buckwheat	ERNU3	*Eriogonum nudum*	0–1	0–1
	little prince's pine	CHME	*Chimaphila menziesii*	0–1	0–1
Grass/Grasslike					
0	**Grass/Grasslike**			0–7	
	sedge	CAREX	*Carex*	0–7	0–2
Forb					
0	**Forb**			0–1	
	pioneer rockcress	ARPL	*Arabis platysperma*	0–1	0–1

Table 8. 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	–	40–50	–	–
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	20–35	–	–
California red fir	ABMA	*Abies magnifica*	Native	–	0–2	–	–
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	0–2	–	–
sugar pine	PILA	*Pinus lambertiana*	Native	–	0–1	–	–

Table 9. Community 1.5 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
sedge	CAREX	*Carex*	Native	–	0–2
Forb/Herb					
pioneer rockcress	ARPL	*Arabis platysperma*	Native	–	0–1
Shrub/Subshrub					
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	0–2
bush chinquapin	CHSE11	*Chrysolepis sempervirens*	Native	–	0–2
naked buckwheat	ERNU3	*Eriogonum nudum*	Native	–	0–1
oceanspray	HODI	*Holodiscus discolor*	Native	–	0–1
little prince's pine	CHME	*Chimaphila menziesii*	Native	–	0–1
Tree					
white fir	ABCO	*Abies concolor*	Native	–	0–5
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	0–4
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	0–2
California red fir	ABMA	*Abies magnifica*	Native	–	0–1
sugar pine	PILA	*Pinus lambertiana*	Native	–	0–1

Table 10. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
0	**Tree (understory only)**			2–26	
	Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	2–7	1–3
	white fir	ABCO	*Abies concolor*	0–6	0–2
	Jeffrey pine	PIJE	*Pinus jeffreyi*	0–4	0–2
	sugar pine	PILA	*Pinus lambertiana*	0–4	0–2
	mountain hemlock	TSME	*Tsuga mertensiana*	0–3	0–1
Shrub/Vine					
0	**Shrub**			0–46	
	oceanspray	HODI	*Holodiscus discolor*	0–28	0–5
	rubber rabbitbrush	ERNAN5	*Ericameria nauseosa ssp. nauseosa var. nauseosa*	0–7	0–2
	serviceberry	AMELA	*Amelanchier*	0–3	0–1
	marumleaf buckwheat	ERMA4	*Eriogonum marifolium*	0–2	0–1
	sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	0–2	0–1
	granite prickly phlox	LIPU11	*Linanthus pungens*	0–2	0–1
	whiteveined wintergreen	PYPI2	*Pyrola picta*	0–1	0–1
Grass/Grasslike					
0	**Grass/Grasslike**			0–7	
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–2	0–1
	sedge	CAREX	*Carex*	0–2	0–1
	squirreltail	ELEL5	*Elymus elymoides*	0–2	0–1
Forb					
0	**Forb**			0–1	
	pioneer rockcress	ARPL	*Arabis platysperma*	0–1	0–1

Table 11. Community 2.2 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	–	5–15	–	–
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	2–9	–	–
sugar pine	PILA	*Pinus lambertiana*	Native	–	2–6	–	–
white fir	ABCO	*Abies concolor*	Native	–	1–4	–	–
mountain hemlock	TSME	*Tsuga mertensiana*	Native	–	0–1	–	–

Table 12. Community 2.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
western needlegrass	ACOC3	*Achnatherum occidentale*	Native	–	0–1
sedge	CAREX	*Carex*	Native	–	0–1
squirreltail	ELEL5	*Elymus elymoides*	Native	–	0–1
Forb/Herb					
pioneer rockcress	ARPL	*Arabis platysperma*	Native	–	0–1
Shrub/Subshrub					
oceanspray	HODI	*Holodiscus discolor*	Native	–	0–5
rubber rabbitbrush	ERNAN5	*Ericameria nauseosa ssp. nauseosa var. nauseosa*	Native	–	0–2
sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	Native	–	0–1
whiteveined wintergreen	PYPI2	*Pyrola picta*	Native	–	0–1
granite prickly phlox	LIPU11	*Linanthus pungens*	Native	–	0–1
marumleaf buckwheat	ERMA4	*Eriogonum marifolium*	Native	–	0–1
serviceberry	AMELA	*Amelanchier*	Native	–	0–1
Tree					
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	1–3
white fir	ABCO	*Abies concolor*	Native	–	0–2
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	0–2
sugar pine	PILA	*Pinus lambertiana*	Native	–	0–2
mountain hemlock	TSME	*Tsuga mertensiana*	Native	–	0–1

Animal community

Wildlife habitat changes as the forest develops. The mature open forest provides the best shelter and habitat for wildlife as the young open stands have very little available forage or cover.

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

The seeds of the conifer species associated with this site are valued for food by small mammals and birds. Young leaves and shoots are foraged by small mammals and deer. Standing dead trees and downed logs provide nesting cavities for small mammals and are utilized by a variety of birds.

Recreational uses

This ecological site provides a great opportunity to view several stages of plant succession after a major disturbance.

Wood products

Jeffrey pine wood is used for lumber. No commercial distinction is made between ponderosa pine and Jeffrey pine lumber.

The wood of Sierra lodgepole pine is used for light framing materials, interior paneling, exterior trim, posts, railroad ties, pulp and paper (Cope, 1993).

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

Other products

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

Other information

Forest Site Productivity:

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.

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

Table 13. 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*	51	51	95	95	70	030	–	
white fir	*ABCO*	51	51	95	95	–	–	100TA	Meyer, Walter H. 1961. Yield of even-aged stands of ponderosa pine. USDA Technical Bulletin 630. (1938 version revised in 1961).
Jeffrey pine	*PIJE*	76	76	63	63	–	–	100TA	Meyer, Walter H. 1961. Yield of even-aged stands of ponderosa pine. USDA Technical Bulletin 630. (1938 version revised in 1961).
Jeffrey pine	*PIJE*	76	76	63	63	44	600	–	

Inventory data references

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

789124
789276
789359- site location
Chaos Jumbles- vegetation only

Type locality

Location 1: Shasta County, CA	
Township/Range/Section	T31 N RR 4 S18

UTM zone	N
UTM northing	4488443
UTM easting	621830
General legal description	The type location is about 0.13 miles southeast of Lily Pond in Lassen Volcanic National Park.

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Contributors

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:**