Natural Resources
Conservation Service

Ecological site F022BI106CA
Frigid Debris Flow Gentle Slopes

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General information

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

Figure 1. Mapped extent

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

MLRA notes

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

Site concept:
Landform: (1) Debris flow
Elevation (feet): 5,800-7,210
Slope (percent): 0-30
Water Table Depth (inches): n/a
Flooding-Frequency: None
Ponding-Frequency: None
Aspect: North, East, West
Mean annual precipitation (inches): 45.0-95.0
Primary precipitation: Winter months in the form of snow
Mean annual temperature: 40 and 42 degrees F (4 to 5.5 degrees C)
Restrictive Layer: None
Temperature Regime: Frigid
Moisture Regime: Xeric
Parent Materials: Debris flows from volcanic rocks
Surface Texture: (1) Very gravelly ashy loamy coarse sand, (2) Gravelly ashy loamy sand
Surface Fragments <=3" (% Cover): 20-45
Surface Fragments > 3" (% Cover): 0-20

Soil Depth (inches): 20-80
Vegetation: The initial colonizer on this site is primarily Sierra lodgepole pine (*Pinus contorta* var. murrayana). California red fir (*Abies magnifica*), western white pine (*Pinus monticola*) and/or Jeffrey pine (*Pinus jeffreyi*) dominate in the later stages of forest development. There are some forbs and grasses present, but they are sparse.
Notes: The eruptions during May of 1915 produced lahar deposits and mud flows that buried the area with 6 to 30 feet of material. In areas of shallower debris deposits, trees are able to reach the buried top soil and utilize the stored nutrients, enabling them to reestablish more quickly than those trees in deeper debris deposits. Trees in the deeper deposits must go through a slow progression of primary succession since the soils have not had time to develop.

Classification relationships

Forest Alliance = *Pinus jeffreyi* - Jeffrey pine forest; Association = *Pinus jeffreyi-Abies magnifica*. (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

F022BI115CA	**Frigid And Cryic Gravelly Slopes** This is a California red fir western white pine forest, portions of which were affected by debris flows.
R022BI213CA	**Frigid Sandy Flood Plains** This is a riparian site associated with the small stream channels in this area.

Similar sites

F022BI105CA	**Frigid Sandy Loam Debris Flow On Stream Terraces** This site is associated with debris flows on lower Hat Creek dominated by Sierra lodgepole pine and quaking aspen.
F022BI122CA	**Frigid Extremely Gravelly Sandy Landslides** This site is associated with a rock fall area called Chaos Jumbles.

Table 1. Dominant plant species

Tree	(1) *Pinus jeffreyi* (2) *Abies magnifica*
Shrub	Not specified
Herbaceous	(1) *Achnatherum* (2) *Lupinus*

Physiographic features

This ecological site encompasses the areas affected by debris deposits primarily from the May 1915 eruption of Lassen Peak. The site is situated on deep debris flows, and debris flows over outwash terraces. It is between 5,800 and 7,210 feet in elevation, on 0 to 30 percent slopes.

Table 2. Representative physiographic features

Landforms	(1) Debris flow
Flooding frequency	None
Ponding frequency	None
Elevation	5,800–7,210 ft
Slope	0–30%
Aspect	N, E, W

Climatic features

This ecological site receives most of its annual precipitation in the winter months in the form of snow. The mean annual precipitation is between 45 and 95 inches (1,143 mm to 2,413 mm) and the mean annual temperature is between 40 and 42 degrees F (4 to 5.5 degrees C). The frost free (> 32 degrees F) season is 60 to 85 days. The freeze free (> 28 degrees F) season is 75 to 190 days.

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

Table 3. Representative climatic features

Frost-free period (average)	85 days
Freeze-free period (average)	190 days
Precipitation total (average)	95 in

Influencing water features

This site is not influenced by water features.

Soil features

The Vitrandic Xerorthents-debris fan and Vitrandic Xerofluvents soil components are associated with this site. These soils formed in debris flows from volcanic rocks. They are moderately deep to very deep and well drained. The Vitrandic Xerofluvents are found on debris flows and have about 50 inches of debris over the buried soil. The Vitrandic Xerorthents-debris fan component has more than 6 feet of debris material and buried soil was not encountered. Surface textures are very gravelly ashy loamy coarse sand and gravelly ashy loamy sand with coarse subsurface textures. These soils have very low to low AWC in their upper 60 inches.

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

Map unit Component, Component %
111 Vitrandic Xerorthents-debris fan, 95
133 Vitrandic Xerofluvents, 55
133 Vitrandic Xerofluvents(steeper), 5
133 Vitrandic Xerorthents-debris fan, 5
146 Vitrandic Xerorthents-debris fan, 2
153 Vitrandic Xerorthents-debris fan, 1
162 Vitrandic Xerorthents-debris fan, 3

Table 4. Representative soil features

Family particle size	(1) Sandy
Drainage class	Well drained
Permeability class	Moderately rapid to rapid
Soil depth	20–80 in
Surface fragment cover <=3"	20–45%
Surface fragment cover >3"	0–20%
Available water capacity (0-40in)	0.8–3.9 in
Soil reaction (1:1 water) (0-40in)	5.6–7.3

Subsurface fragment volume <=3" (Depth not specified)	20–60%
Subsurface fragment volume >3" (Depth not specified)	0–35%

Ecological dynamics

This is a unique ecological site because it is found on volcanic deposits from Lassen Peak. The largest extent of the site developed from the 1915 eruptions of Lassen Peak in an area referred to as the Devastated Area. It is an area of interest because it provides an opportunity to study true primary succession on a volcanic substrate. The eruptions during May of 1915 produced lahar deposits and mud flows that buried the area with 6 to 30 feet of material. In areas of shallower debris deposits, trees are able to reach the buried top soil and utilize the stored nutrients, enabling them to reestablish more quickly than those trees in deeper debris deposits. Trees in the deeper deposits must go through a slow progression of primary succession since the soils have not had time to develop. Other factors, such as proximity to a seed or water source, influence species composition and recovery time.

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 initiated by pioneering plant species and microorganisms. This process converts atmospheric nitrogen gas into ammonia (NH_4^+) through chemical and biological reactions. The resulting ammonia is converted to nitrate (NO_3^-) by microorganisms through a process called nitrification. 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 in 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 A horizon, in the upper horizons of the soil. The B horizon, located directly below, is influenced by the leaching of acids and other products from the A horizon.

The living and dead material of plants 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, 2009).

Trees and burrowing animal activity produce larger pores and mix soil at a greater scale. 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 down in the profile (NRCS, 2009).

The Natural Resources Conservation Service (NRCS) collected soil and vegetation data for this area in 2006, 91 years after the eruptions. While some of this area remains bare of vegetation, many stages of conifer succession are present in other areas.

The initial colonizer on this site is primarily Sierra lodgepole pine (*Pinus contorta* var. murrayana). 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.) with nitrogen fixing bacteria (Frankia spp. and Rhizobium spp. respectively) 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).

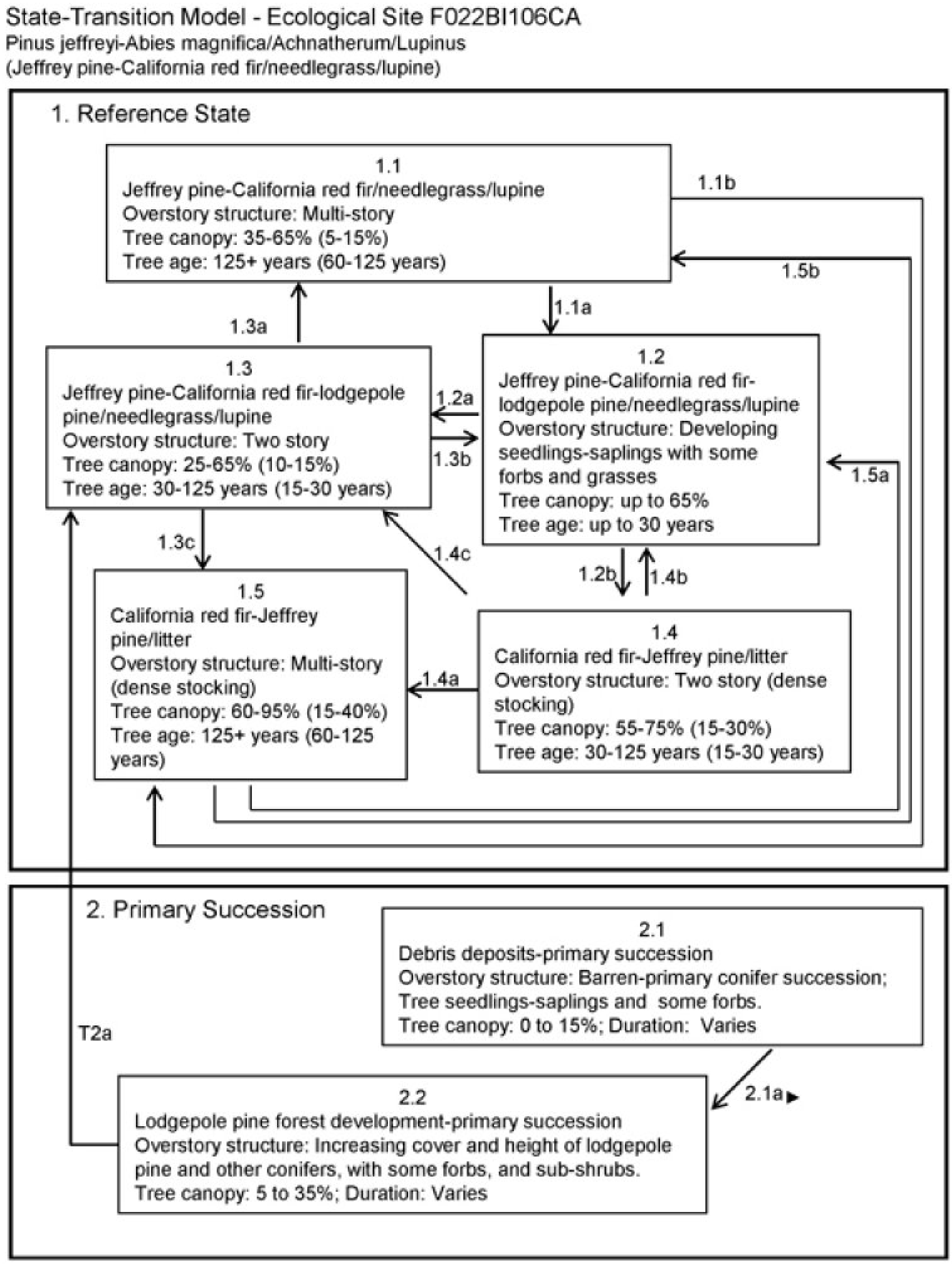
All the tree species found in Lassen Volcanic National Park are found within the Devastated Area except whitebark pine. California red fir (*Abies magnifica*), western white pine (*Pinus monticola*) and/or Jeffrey pine (*Pinus jeffreyi*) dominate in the later stages of forest development. There are some forbs and grasses present, but they are sparse.

The debris flows buried what would have been several ecological sites. Historical records indicate that Jessen Meadow was buried by debris in 1915. Several streams and outwash terraces must have been buried as well. Due to deep coarse infertile debris deposits, most of the area is now an upland site that needs time for soil development. The small stream corridors that developed within the debris deposits are a wet exception. Please see the Sandy Floodplains ecological site, R022BI213CA for more information.

The reference state consists of the most successionally advanced community phase (numbered 1.1) as well as other community phases which result from natural and human disturbances. Community phase 1.1 is deemed the phase representative of the most successionally advanced pre-European plant/animal community including periodic natural surface fires that influenced its composition and production. Because this phase is determined from the oldest modern day remnant forests and/or historic literature, some speculation is necessarily involved in describing it.

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

State and transition model



State 1
Reference

Community 1.1
Jeffrey pine-California red fir/needlegrass/lupine

This community phase is considered to be the likely future reference community phase. It is difficult to determine the exact species that will dominate this community phase. Within the Devastated Area Jeffrey pine (*Pinus jeffreyi*), white fir (*Abies concolor*), California red fir (*Abies magnifica*), and western white pine (*Pinus monticola*) coexist. It is likely that the upper elevation tree species (California red fir and western white pine) will not persist on the lower elevation debris flows and will be replaced by a Jeffrey pine-white fir forest. California red fir and western white pine may persist at the upper elevations of this site. There are a few areas with older debris deposits mapped in the Manzanita Lake drainage. The older areas have developed mature Jeffrey pine or Jeffrey pine- California red fir forests. A small portion of the older debris material is located at higher elevations and is currently vegetated with dense California red fir thickets. The California red fir forests would normally be considered a separate ecological site, but is not in this case since the extent of debris deposits at upper elevations is minimal. The upper slope of the eruption is generally associated with debris flows, rather than debris fans and deposits. The ecological site associated with the upper elevations is F022BI115CA, a California red fir western white pine forest. 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.

Forest overstory. Expected ovestory canopy will range from 35 to 65% with the possibility of multiple canopies beneath ranging from 5 to 15% cover. Age would be 125+ years and 60-125 years for lower tree canopies.

Forest understory. A number of species could develop with needlegrass and lupine expected.

Community 1.2
Jeffrey pine-California red fir-lodgepole pine/needlegrass/lupine

This regeneration community phase develops after a severe crown fire. It differs from primary succession because the soil has developed structure and accumulated organic matter, providing nutrients in the upper horizon. Seeds may be onsite that survived 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.

Forest overstory. Developing seedlings and saplings of Jeffrey pine, California red fir and lodgepole pine.

Forest understory. Forbs and grasses develop concurrently with the trees and include needlegrass and lupine.

Community 1.3
Jeffrey pine-California red fir-lodgepole pine/needlegrass/lupine

As this community phase develops during primary succession Jeffrey pine, white fir, California red fir and/or western white pine 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 1.2 the post fire conifer regeneration community. The conifer species diversity may be higher after primary succession than secondary succession. Seedling establishment and forest structure will most likely develop quicker during secondary succession because the soil has developed better structure, accumulated organic matter, microbes, and other physical properties which enhance seedling survival and plant growth. This community phase develops over time and benefits from low to moderate intensity fire to maintain 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.

Forest overstory. Total forest canopy cover ranges from 25 to 65 percent. Jeffrey pine and white fir are dominant.

Forest understory. Needlegrass and lupine are represented among other understory species.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	0	47	108
Forb	0	10	50
Tree	0	8	20
Grass/Grasslike	0	2	4
Total	**–**	**67**	**182**

Table 6. Ground cover

Tree foliar cover	25-65%
Shrub/vine/liana foliar cover	0-3%
Grass/grasslike foliar cover	0-2%
Forb foliar cover	0-9%
Non-vascular plants	0%
Biological crusts	0%
Litter	30-70%
Surface fragments >0.25" and <=3"	20-40%
Surface fragments >3"	0-20%
Bedrock	0%
Water	0%
Bare ground	2-15%

Community 1.4
California red fir-Jeffrey pine/litter

Jeffrey pine and either California red for or white fir dominate over the Sierra lodgepole pines, with heavy recruitment of California red fir or white fir in the understory. This community phase is defined by a dense canopy and high basal area of mixed conifers. Canopy cover ranges from 55 to 75 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 high in this community phase due to the deep accumulation of litter, the standing dead and down trees, and the dense multi-layered structure of the forest.

Community 1.5
California red fir-Jeffrey pine/litter

This community phase develops with the continued exclusion of fire. Depending upon the microclimate, seed source, snow load, elevation and other variables, California red fir or white fir will tend to dominate during this phase. They eventually shade out the associated pine species. This community 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, caused by the deep accumulation of litter, standing dead and down trees, and the dense multi-layered structure of the forest.

Pathway 1.1a
Community 1.1 to 1.2

If this forest has a severe canopy fire, it will initiate forest regeneration (Community 1.2).

Pathway 1.1b
Community 1.1 to 1.5

This pathway is created when fire is excluded from this old growth community. White fir and/or California red fir continues to regenerate in the understory, increasing tree density and shifting this community toward the closed fir and Jeffrey pine forest (Community 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 and fir forest. This pathway is followed with 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 closed red fir and 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 and/or moderate severity fires, and/or partial tree mortality from a pest outbreak. This pathway leads to the mature Jeffrey pine and 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 closed fir and 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 if it had developed with fire over time. Manual treatments to thin out the white fir and fuels in the understory, and/or prescribed burns, could be implemented to shift this forest back to its natural state of a young open mixed conifer forest (Community Phase 1.3). A partial mortality disease or pest infestation could also create a shift toward Community Phase 1.3 but with an increase to the already high fuel amounts.

Pathway 1.4a
Community 1.4 to 1.5

If fire continues to be excluded from this system, the mature closed fir and 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 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 treatments to thin out the understory trees and fuels, and/or prescribed burns, could be implemented to shift this forest back to its natural state of an open Jeffrey pine and fir forest (Community Phase 1.1). A partial mortality disease or pest infestation could also create a shift toward Community Phase 1.1 but tree mortality will increase the already high fuel amounts.

Pathway 1.5a
Community 1.5 to 1.2

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

State 2
Primary succession

Community 2.1
Debris deposits-primary succession

The 1915 eruptions of Lassen Peak left large swaths of debris material. This material has been subject to the slow processes of primary succession described in the ecological dynamics above. Historic photos and research data reveal a 30 year delay in conifer establishment on the lahar and debris flow. The delay in conifer establishment could be due to several factors including: 1. The proximity to a nearby seed source. 2. Thick layers of ash may have inhibited tree establishment until the ash was washed away or weathered. 3. The trees may have been physiologically stressed to soil infertility (Kruh et al, 2000). The dissemination of conifer seed and seedling establishment began from the periphery of the devastated area and has been moving inward. The intact forests adjacent to the debris flows provided the seeds for early colonization. As the forest on the periphery developed, more seed was produced and disseminated further into the debris flows. Heath, 1967 reports that strong winter winds come from the southwest, which would bring seed from the upper elevation forests dominated by red fir and western white pine and deposit them on the devastated area. Jeffrey pine and white fir seed would be blown away from the majority of the devastated area under this scenario. With normal wind conditions Jeffrey pine, red fir, white fir, Sierra lodgepole pine and western white 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.). After the 30 year delay, Sierra lodgepole pine was the initial invader, with Jeffrey pine, red fir and western white pine generally establishing later. However, Heath states that due to the complex interactions of seed dispersal, microsite characteristics, and climatic and other environmental variables, it is difficult to define a clear successional trend or even to determine the historic reference community phase. With time, primary succession continues as conifers increase in abundance and size.

Community 2.2
Lodgepole pine 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 produced some litter accumulation, shade, and have reached reproductive maturity. Sierra lodgepole pine is the dominant tree and is about 10 to 12 feet tall. Total canopy cover may reach up to 35 percent. The ground is mostly bare of organic matter except directly under the young lodgepole pines. White fir or California red fir seedlings are present in the shadow of the lodgepole pines. The understory is limited, with some scattered forbs on the bare soil. There may be a range in tree age due to the continual establishment of seedlings in the open areas. As time progresses, forest canopy and structure develops. When this community phase develops it eventually becomes a forest capable of spreading fire and will undergo frequent natural understory burns. As forest structure develops, this forest resembles the young Jeffrey pine-fir forest (Community Phase 1.3 in the state and transition model) and follows the same community phase pathways.

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	0	52	97
Tree	8	15	26
Forb	0	10	12
Grass/Grasslike	0	0	4
Total	**8**	**77**	**139**

Table 8. Ground cover

Tree foliar cover	10-35%
Shrub/vine/liana foliar cover	0-4%
Grass/grasslike foliar cover	0-2%
Forb foliar cover	0-4%
Non-vascular plants	0%
Biological crusts	0%
Litter	5-30%
Surface fragments >0.25" and <=3"	20-40%
Surface fragments >3"	0-20%
Bedrock	0%
Water	0%
Bare ground	5-30%

Pathway 2.1a
Community 2.1 to 2.2

Seedlings and saplings making the barren, primary conifer community phase succeeds to a more developed predominantly lodgepole pine forest. Canopy at 0 to 15% slowly develops to 15 to 35% with concurrent infill of forbs and sub-shrubs.

Transition T2a
State 2 to 1

As forest structure develops, this forest resembles the young Jeffrey pine-fir forest (Community Phase 1.3)and follows the same community phase pathways. The forest matures in both cover and species diversity.

Additional community tables

Table 9. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Tree					
0	**Tree (understory only)**			0–20	
	Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	0–6	0–5
	white fir	ABCO	*Abies concolor*	0–5	0–2
	California red fir	ABMA	*Abies magnifica*	0–5	0–2
	Jeffrey pine	PIJE	*Pinus jeffreyi*	0–2	0–2
	western white pine	PIMO3	*Pinus monticola*	0–2	0–2
Shrub/Vine					
0	**Shrub**			0–108	
	Lemmon's willow	SALE	*Salix lemmonii*	0–70	0–2
	goldenbush	ERICA2	*Ericameria*	0–20	0–2
	pinemat manzanita	ARNE	*Arctostaphylos nevadensis*	0–10	0–1
	buckwheat	ERIOG	*Eriogonum*	0–8	0–5
Grass/Grasslike					
0	**Grass/Grasslike**			0–4	
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–4	0–2
Forb					
0	**Forb**			0–50	
	bluntlobe lupine	LUOB	*Lupinus obtusilobus*	0–50	0–2

Table 10. Community 1.3 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	12–30	–	–
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	5–13	–	–
white fir	ABCO	*Abies concolor*	Native	–	4–11	–	–
California red fir	ABMA	*Abies magnifica*	Native	–	3–8	–	–
western white pine	PIMO3	*Pinus monticola*	Native	–	1–3	–	–

Table 11. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
western needlegrass	ACOC3	*Achnatherum occidentale*	Native	–	0–2
Forb/Herb					
bluntlobe lupine	LUOB	*Lupinus obtusilobus*	Native	–	0–2
Shrub/Subshrub					
buckwheat	ERIOG	*Eriogonum*	Native	–	0–5
goldenbush	ERICA2	*Ericameria*	Native	–	0–2
Lemmon's willow	SALE	*Salix lemmonii*	Native	–	0–2
pinemat manzanita	ARNE	*Arctostaphylos nevadensis*	Native	–	0–1

Table 12. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Tree					
0	**Tree**			8–26	
	Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	8–17	5–10
	Jeffrey pine	PIJE	*Pinus jeffreyi*	0–2	0–2
	California red fir	ABMA	*Abies magnifica*	0–2	0–2
	western white pine	PIMO3	*Pinus monticola*	0–1	0–1
	white fir	ABCO	*Abies concolor*	0–1	0–1
Shrub/Vine					
0	**Shrub**			0–97	
	Lemmon's willow	SALE	*Salix lemmonii*	0–70	0–2
	goldenbush	ERICA2	*Ericameria*	0–12	0–1
	oceanspray	HODI	*Holodiscus discolor*	0–10	0–2
	buckwheat	ERIOG	*Eriogonum*	0–5	0–2
Grass/Grasslike					
0	**Grass/Grasslike**			0–4	
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–2	0–1
	sedge	CAREX	*Carex*	0–2	0–1
Forb					
0	**Forg**			0–12	
	bluntlobe lupine	LUOB	*Lupinus obtusilobus*	0–12	0–1

Table 13. Community 2.2 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	3–29	–	–
white fir	ABCO	*Abies concolor*	Native	–	1–2	–	–
California red fir	ABMA	*Abies magnifica*	Native	–	1–2	–	–
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	0–1	–	–
western white pine	PIMO3	*Pinus monticola*	Native	–	0–1	–	–

Table 14. Community 2.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
western needlegrass	ACOC3	*Achnatherum occidentale*	Native	–	0–1
sedge	CAREX	*Carex*	Native	–	0–1
Forb/Herb					
bluntlobe lupine	LUOB	*Lupinus obtusilobus*	Native	–	0–1
Shrub/Subshrub					
Lemmon's willow	SALE	*Salix lemmonii*	Native	–	0–2
buckwheat	ERIOG	*Eriogonum*	Native	–	0–2
oceanspray	HODI	*Holodiscus discolor*	Native	–	0–2
goldenbush	ERICA2	*Ericameria*	Native	–	0–1
Tree					
Sierra lodgepole pine	PICOM	*Pinus contorta var. murrayana*	Native	–	5–10
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	0–2
California red fir	ABMA	*Abies magnifica*	Native	–	0–2
white fir	ABCO	*Abies concolor*	Native	–	0–1
incense cedar	CADE27	*Calocedrus decurrens*	Native	–	0–1
mountain hemlock	TSME	*Tsuga mertensiana*	Native	–	0–1
western white pine	PIMO3	*Pinus monticola*	Native	–	0–1

Animal community

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

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. The young leaves and shoots are foraged by small mammals and deer. The dead down logs provide nesting cavities for small mammals, and snags 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 volcanic disturbance.

Wood products

Site productivity is highly variable on this site. Site index was higher in areas where trees were able to tap into the buried soils, which have more organic matter and nutrient development. Site index was lowest for the early pioneer trees, which are struggling to get the nutrients they need.

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

Cones of western white pine are collected for novelty items. The tree is also planted as an ornamental (Griffin, 1992).

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).

Native Americans chewed the resin of western white pine, wove baskets from the bark, concocted a poultice for dressing wounds from the pitch, and collected the cambium in the spring for food (Griffith, 1992).

Other information

Alexander (1966), Haig (1932), Schumacher (1928) and Meyer (1961) were used to determine forest site productivity for lodgepole pine, western white pine, California red 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 1.4 and 1.5. They are selected according to guidance listed in the site index publications.

Site index for Sierra lodgepole pine was variable on this site, depending upon access to buried soils and soil development. One site index plot, in the area where Sierra lodgepole pines are younger and still developing on unvegetated debris material, the average site index was 38. This is very low compared to the other plots on the debris material. The Sierra lodgepole pine trees are older on the other sites and may have passed the slow establishment period of primary succession, or have been able to tap into other resources.

Table 15. Representative site productivity

Common Name	Symbol	Site Index Low	Site Index High	CMAI Low	CMAI High	Age Of CMAI	Site Index Curve Code	Site Index Curve Basis	Citation
California red fir	*ABMA*	61	61	218	218	140	050	–	
Sierra lodgepole pine	*PICOM*	73	82	75	91	100	520	–	
western white pine	*PIMO3*	43	43	89	89	100	570	–	
Sierra lodgepole pine	*PICOM*	73	82	62	71	–	–	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*	80	81	69	71	40	600	–	

Inventory data references

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

789141- Vitrandic Xerorthents, debris fan modal and ESD site location
789145
789196
789232- Vitrandic Xerofluvents modal

Similar sites at higher elevation are:
789273
789324
789337

Type locality

Location 1: Shasta County, CA	
Township/Range/Section	T31 N R4 E S24
UTM zone	N
UTM northing	4486387
UTM easting	629343
General legal description	The site location is about 0.75 miles north-northwest of Hat Lake, on the west side of HW 89 in the Devastated Area.

Location 2: Shasta County, CA	
Township/Range/Section	T31 N R4 E S14
UTM zone	N
UTM northing	4436250
UTM easting	629524
General legal description	The site location is about 0.35 mile north northeast of the Hot Rock (next to Highway 89).

Other references

Alexander, Robert R. 1966. Site indexes for Lodgepole pine, with corrections for stand density: instructions for field use. USDA, Forest Service. Rocky Mountain Forest and Range Experiment Station Research Paper RM-24. NASIS ID 520

Arora, David. 1986. Mushrooms Demystified. Ten Speed Press, Berkeley, CA.

ASH Web Team, June 2006. Volcanic Ash: Effects and Mitigation Strategies. U.S. Department of the Interior, U.S. Geological Survey, Menlo Park, California, USA
URL http://volcanoes.usgs.gov/ash/agric/index.html

Azuma, David L; Donnegan, Joseph; and Gedney, Donald. (2004). Southwest Oregon Biscuit Fire: An Analysis of Forest Resources and Fire Severity. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP-560

Bekker, Mathew F. and Tayler, Alan H. (2001). Gradient Analysis of Fire Regimes in Montane Forest of the Southern Cascade Range, Thousand Lakes Wilderness, California, USA. Plant Ecology 155: 15-23.

Bohne, Michael (eds.) 2006. California Forest Pest Conditions – 2006. Forest Health Protection, USDA Forest Service, Pacific Southwest Region in cooperation with other member organizations. California Forest Pest Council.

Cope, Amy B. 1993. *Abies magnifica*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2009, September 21].

Cope, Amy B. 1993. *Pinus contorta* var. murrayana. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2009, September 21].

Gucker, Corey L. 2007. *Pinus jeffreyi*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2008, March 5].

Haig 1932, Western White Pine. USDA Tech. bul. 323 from black book. NASIS ID 570

Heath, James P. (1967). Primary Conifer Succession, Lassen Volcanic National Park. Ecology, Vol. 48, No. 2. (Mar., 1967), pp. 270-275.

Jenkinson, James L., (1990). *Pinus jeffreyi* Grev. & Balf. Jeffrey Pine. In. Burns, Russell M; Honkala, Barbara H.; [Technical coordinators] 1990. Silvics of North America: Volume 1. Conifers. United States Department of Agriculture (USDA), Forest Service, Agriculture Handbook 54.

Kroh, Glenn C.; White, Joseph D.; Heath, Shelly K.; Pinder III, John E. (2000). Colonization of a Volcanic Mudflow by an Upper Montane Coniferous Forest at
Lassen Volcanic National Park, California. American Midland Naturalist, Vol. 143, No. 1. (Jan., 2000), pp. 126-140.

Laacke, Robert J. (1990). *Abies concolor* (Gord. & Glend) Lindl. Ex Hildebr. White Fir. In. Burns, Russell M; Honkala, Barbara H.; [Technical coordinators] 1990. Silvics of North America: Volume 1. Conifers. United States Department of Agriculture (USDA), Forest Service, Agriculture Handbook 54.

NRCS, 2009. Soil Survey of Lassen Volcanic National Park, United States Department of Agriculture, Natural Resources Conservation Service, 2009.

Meyer, Walter H. 1961. Yield of even-aged stands of ponderosa pine. USDA Technical Bulletin 630. (revised 1961). NASIS ID 600

Paul LR. 2002. Nitrogen fixation associated with tuberculate ectomycorrhiza on lodgepole pine (*Pinus contorta*). PhD thesis, University of British Columbia, Vancouver, BC, Canada.

Paul, L. R.; Chapman, B. K.; and Chanway, C. P.; 2007. Nitrogen Fixation Associated with Suillus tomentosus Tuberculate Ectomycorrhizae on *Pinus contorta* var. latifolia. Annals of Botany 99: 1101–1109, 2007. Available online at www.aob.oxfordjournals.org

Schumacher, Francis X. 1928. Yield, stand and volume tables for red fir in California. University of California Agricultural Experiment Station Bulletin 456. NASIS ID 050

Skinner, Carl N. and Chang Chi-Ru, (1996) Fire Regimes, Past and Present. Sierra Nevada Ecosystems Project: Final Report to Congress, Vol 2, Assessments and scientific basis for management options. Davis: University of California, Centers for Water and Wildland Resources. Chapter 38, p. 1041.

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

Tayler, A. H. (2000) Fire Regimes and Forest Changes in Mid and Upper Montane Forest of the Southern Cascades, Lassen Volcanic National Park, California, U.S.A. Journal of Biogeography, 27, 87-104.

USDA, (2003). Forest Insect Conditions, Forest Pest Conditions in California -2003, 2003. http://www.fs.fed.us/r5/spf/ publications/cond2003/4-2003rpt-insects.pdf

Zouhar, Kris. 2001. *Abies concolor*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

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:**