USDA Natural Resources Conservation Service

Ecological site F022AF004CA
Frigid, Shallow To Deep, Sandy Mountain Slopes

Accessed: 05/06/2024

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

MLRA22A
Major Land Resource Area 22A, Sierra Nevada Mountains, is located predominantly in California and a small section of western Nevada. The area lies completely within the Sierra Nevada Section of the Cascade-Sierra Mountains Province. The Sierra Nevada range has a gentle western slope, and a very abrupt eastern slope. The Sierra Nevada consists of hilly to steep mountains and occasional flatter mountain valleys. Elevation ranges between 1,500 and 9,000 ft throughout most of the range, but peaks often exceed 12,000 ft. The highest point in the continental US occurs in this MLRA (Mount Whitney, 14,494 ft). Most of the Sierra Nevada is dominated by granitic rock of the Mesozoic age, known as the Sierra Nevada Batholith. The northern half is flanked on the west by a metamorphic belt, which consists of highly metamorphosed sedimentary and volcanic rocks. Additionally, glacial activity of the Pleistocene has played a major role in shaping Sierra Nevada features, including cirques, arêtes, and glacial deposits and moraines. Average annual precipitation ranges from 20 to 80 inches in most of the area, with increases along elevational and south-north gradients. Soil temperature regime ranges from mesic, frigid, and cryic.

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

Forest Alliance = *Pinus jeffreyi* – Jeffrey pine forest; Association = tentatively *Pinus jeffreyi*/*Purshia tridentata* var. tridentata. (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 ecological site is found on south-facing mountain slopes, primarily on the eastern side of Lake Tahoe in the Carson Range, which receives the lowest precipitation in the Lake Tahoe Basin. Elevations are typically between 6,200 and 7,600 feet and slopes are typically between 15 and 50 percent. Soils are moderately deep to deep, or shallow over paralithic granitic bedrock (Cr), and sandy with low available water capacity and nutrients. This exposed, low-water environment supports an open canopy Jeffrey pine (*Pinus jeffreyi*) forest with a patchy shrub understory. Greenleaf manzanita (*Arctostaphylos patula*) and antelope bitterbrush (*Purshia tridentata*) are the most common shrub species. These coarse soils and exposed sites do not support an extensive herbaceous understory, and forbs and grasses are sparse on this site.

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.
F022AF005CA	**Frigid, Deep To Very Deep, Sandy-Loamy Mountain Slopes** Occurs on adjacent north-facing slopes with very deep soils. Jeffrey pine (Pinus jeffreyi) and white fir (Abies concolor) co-dominate.
F022AX100CA	**Frigid, Sandy, Moist, Outwash Fan** Occurs on adjacent outwash fans with very deep poorly drained soils. Sierra lodgepole pine forest (Pinus contorta var. murrayana) is dominant.

Similar sites

F022AF002CA	**Frigid, Sandy, Or Loamy Outwash** Occurs on gently sloping outwash, moraines and outwash fans with moderatley deep to very deep soils of mixed origin. Productivity is higher.
F022AC004CA	**Cryic Very Gravelly Loamy Mountain Slopes** This site occurs at higher elevations with a cryic soil temperature regime. Soils are very deep with loamy textures. Red fir (Abies magnifica) and Jeffrey pine (Pinus jeffreyi) dominate the canopy with a dense shrub layer of roundleaf snowberry (Symphoricarpos rotundifolia) and wax currant (Ribes cereum).
F022AF006CA	**Loamy Frigid Metamorphic Slopes** Occurs on very deep, fine loamy soils developed from metamorphic parent material. The forest is dominated by a denser, more productive Jeffrey pine (Pinus jeffreyi) and white fir (Abies magnifica) forest, and a diverse herbaceous understory is present.
F022AF005CA	**Frigid, Deep To Very Deep, Sandy-Loamy Mountain Slopes** Occurs on north-facing slopes with very deep soils. Species composition is similar, but there is a higher cover and basal area of Jeffrey pine (Pinus jeffreyi), and white fir (Abies magnifica) is more important on this site.
F022AE007CA	**Frigid, Sandy, Moraines And Hill Slopes** Occurs in higher precipitation zones on moderately deep to very deep soils derived from glacial outwash and till from mixed parent materials. This site supports a much denser Jeffrey pine (Pinus jeffreyi) and white fir (Abies magnifica) forest.

Table 1. Dominant plant species

Tree	(1) *Pinus jeffreyi*
Shrub	(1) *Purshia tridentata* (2) *Arctostaphylos patula*
Herbaceous	Not specified

Physiographic features

This ecological site is situated on south-facing mountain and hillslopes that may range from 5 to 75 percent, but more typically are between 15 and 50 percent. Elevations range from 6,230 to 9,000 feet, but are typically below 7,600 feet. It is found primarily on the eastern side of Lake Tahoe in the Carson Range.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	1,899–2,743 m
Slope	5–75%
Aspect	S, W, NW

Climatic features

The average annual precipitation ranges from 19 to 57 inches, mostly in the form of snow in the winter (November through April). The average annual air temperature ranges from 36 to 46 degrees Fahrenheit. The frost-free season is 25 to 90 days, and the freeze-free (>28F) season is 70 to 120 days.

Table 3. Representative climatic features

Frost-free period (average)	95 days
Freeze-free period (average)	57 days
Precipitation total (average)	686 mm

Influencing water features

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

Soil features

The soils associated with this ecological site are moderately deep or shallow over paralithic granitic bedrock (Cr). These soils formed in colluvium and residuum or grus derived from granitic rock, and they are somewhat excessively to excessively drained with rapid permeability. The soil moisture regime is xeric and the soil temperature regime is frigid. Surface rock fragments smaller than 3 inches in diameter range from 1 to 25 percent cover, and larger fragments range from 6 to 20 percent. Surface textures are very bouldery coarse sand, gravelly loamy coarse sand, and gravelly coarse sand. Subsurface textures are very bouldery coarse sand, gravelly loamy coarse sand, and gravelly coarse sand. Subsurface rock fragments smaller than 3 inches in diameter range from 1 to 32 percent by volume, and larger fragments range from 0 to 26 percent (for a depth of 0 to 27 inches). The soils that are correlated to this ecological site include Cagwin (Mixed, frigid Dystric Xeropsamments), Toem (Mixed, frigid, shallow Dystric Xeropsamments), Shalgran (Sandy-skeletal, mixed, frigid, shallow Dystric Xerorthents), and a taxon above family component of Dystric Xerotherents. Paralithic bedrock occurs at depths of 10 to 20 inches in the shallow Toem and Shalgran soils, and at 20 to 40 in the moderately deep Cagwin soils.

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

Area_sym ; Musym ; MUname ; Compname ; Local_phase ; Comp_pct
CA693 ; 7511 ; Shalgran-Rock outcrop complex, 30 to 75 percent slopes ; Shalgran ; ; 70
CA693 ; 7411 ; Cagwin-Rock outcrop complex, 5 to 15 percent slopes, extremely stony ; Cagwin ; 50 ; Toem ; 10
CA693 ; 7412 ; Cagwin-Rock outcrop complex, 15 to 30 percent slopes, extremely stony ; Cagwin ; 50 ; Toem ; 10
CA693 ; 7413 ; Cagwin Rock outcrop complex, 30 to 50 percent slopes, extremely stony ; Cagwin ; 50 ; Toem ; 10
CA693 ; 7414 ; Cagwin-Rock outcrop complex, 50 to 70 percent slopes, extremely stony ; Cagwin ; 50 ; Toem ; 10
CA693 ; 7531 ; Toem-Rock outcrop complex, 9 to 30 percent slopes ; Toem ; 45 ; Cagwin ; 10
CA693 ; 7532 ; Toem-Rock outcrop complex, 30 to 50 percent slopes ; Toem ; 45 ; Cagwin ; 5
CA693 ; 7533 ; Toem-Rock outcrop complex, 50 to 70 percent slopes ; Toem ; 45 ; Cagwin ; 10
CA693 ; 7011 ; Beaches ; Cagwin ; 1 ; Toem ; 1
CA693 ; 7101 ; Caverock sandy loam, 9 to 50 percent slopes ; Cagwin ; 5
CA693 ; 7111 ; Deerhill gravelly fine sandy loam, 9 to 30 percent slopes, very stony ; Cagwin ; ; 3
CA693 ; 7112 ; Deerhill gravelly fine sandy loam, 30 to 50 percent slopes, very stony ; Cagwin ; ; 3
CA693 ; 7211 ; Southcamp very gravelly fine sandy loam, 50 to 70 percent slopes ; Cagwin ; ; 2
CA693 ; 7241 ; Zephyrcove-Southcamp-Genoapeak complex, 9 to 30 percent slopes ; Cagwin ; ; 5
CA693 ; 7242 ; Zephyrcove-Southcamp-Genoapeak complex, 30 to 70 percent slopes ; Cagwin ; ; 5
CA693 ; 7421 ; Cassenai gravelly loamy coarse sand, 5 to 15 percent slopes, very stony ; Cagwin ; 12 ; Toem ; 4
CA693 ; 7422 ; Cassenai gravelly loamy coarse sand, 15 to 30 percent slopes, very stony ; Cagwin ; 12 ; Toem ; 4
CA693 ; 7423 ; Cassenai gravelly loamy coarse sand, 30 to 50 percent slopes, very stony ; Cagwin ; 12 ; Toem ; 4
CA693 ; 7424 ; Cassenai gravelly loamy coarse sand, 50 to 70 percent slopes, very stony ; Cagwin ; 12 ; Toem ; 5
CA693 ; 7425 ; Cassenai cobbly loamy coarse sand, moist, 5 to 15 percent slopes, very bouldery ; Cagwin ; 5 ; Toem ; 2
CA693 ; 7426 ; Cassenai cobbly loamy coarse sand, moist, 15 to 30 percent slopes, very bouldery ; Cagwin ; 5 ; Toem ; 2
CA693 ; 7427 ; Cassenai cobbly loamy coarse sand, moist, 30 to 50 percent slopes, very bouldery ; Cagwin ; 5 ; Toem ; 5
CA693 ; 7428 ; Cassenai cobbly loamy coarse sand, moist, 50 to 70 percent slopes, very bouldery ; Cagwin ; 5 ; Toem ; 5
CA693 ; 7487 ; Meeks gravelly loamy coarse sand, 5 to 15 percent slopes, rubbly ; Cagwin ; ; 2
CA693 ; 7488 ; Meeks gravelly loamy coarse sand, 15 to 30 percent slopes, rubbly ; Cagwin ; ; 2
CA693 ; 7489 ; Meeks gravelly loamy coarse sand, 30 to 70 percent slopes, rubbly ; Cagwin ; 1 ; Toem ; 1
CA693 ; 7522 ; Tallac gravelly coarse sandy loam, 15 to 30 percent slopes, very stony ; Cagwin ; ; 1
CA693 ; 7523 ; Tallac gravelly coarse sandy loam, 30 to 70 percent slopes, very stony ; Cagwin ; ; 1
CA693 ; 9401 ; Dagget very gravelly loamy coarse sand, 15 to 30 percent slopes, extremely bouldery ; Cagwin ; 2 ; Toem ; 2
CA693 ; 9402 ; Dagget very gravelly loamy coarse sand, 30 to 50 percent slopes, extremely bouldery ; Cagwin ; 2 ; Toem ; 2
CA693 ; 9403 ; Dagget very gravelly loamy coarse sand, 50 to 70 percent slopes, extremely bouldery ; Cagwin ; 2 ; Toem ; 2
CA693 ; 9441 ; Temo-Witefels complex, 5 to 15 percent slopes ; Cagwin ; ; 4
CA693 ; 9442 ; Temo-Witefels complex, 15 to 30 percent slopes ; Cagwin ; ; 4
CA693 ; 9443 ; Temo-Witefels complex, 30 to 50 percent slopes ; Cagwin ; ; 4
CA693 ; 9444 ; Temo-Witefels complex, 50 to 70 percent slopes ; Cagwin ; ; 4
CA693 ; 7511 ; Shalgran-Rock outcrop complex, 30 to 75 percent slopes ; Dystric Xerorthents ; ; 3
CA693 ; 7511 ; Shalgran-Rock outcrop complex, 30 to 75 percent slopes ; Shalgran ; ; 70
CA693 ; 9421 ; Jobsis-Whittell-Rock outcrop complex, cool, 8 to 30 percent slopes ; Shalgran ; ; 2
CA693 ; 9431 ; Sofgran-Klauspeak-Temo association, 15 to 50 percent slopes ; Shalgran ; ; 4
CA693 ; 9451 ; Waterpeak-Rock outcrop complex, 30 to 75 percent slopes ; Shalgran ; ; 4
CA693 ; 9461 ; Whittell-Jobsis-Rock outcrop complex, cool, 30 to 75 percent slopes ; Shalgran ; ; 2
CA693 ; 7500 ; Rock outcrop, granitic ; Toem ; ; 2

Table 4. Representative soil features

Parent material	(1) Colluvium–granodiorite

Surface texture	(1) Very bouldery coarse sand (2) Gravelly loamy coarse sand (3) Gravelly coarse sand
Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained to excessively drained
Permeability class	Moderate to rapid
Soil depth	25–99 cm
Surface fragment cover <=3"	1–25%
Surface fragment cover >3"	6–20%
Available water capacity (0-101.6cm)	1.52–7.11 cm
Soil reaction (1:1 water) (0-101.6cm)	5.1–6.5
Subsurface fragment volume <=3" (Depth not specified)	1–32%
Subsurface fragment volume >3" (Depth not specified)	0–26%

Ecological dynamics

Abiotic Factors
This ecological site is found primarily on south-facing mountain slopes on the eastern side of Lake Tahoe in the Carson Range, which receives the lowest precipitation in the Lake Tahoe Basin, but may also occur on warm exposed aspects with droughty soils in more westerly locations. Soils are moderately deep to deep, or shallow over paralithic bedrock (Cr), and sandy with low available water capacity and nutrients. These dry environmental conditions tend to support Jeffrey pine (*Pinus jeffreyi*) over other conifer species (Vasek 1978, Burns and Honkala 1990, Gray et al. 2005, North et al. 2005). These conditions also support a montane shrubland community. Greenleaf manzanita (*Arctostaphylos patula*) and antelope bitterbrush (*Purshia tridentata*) are the most common shrub species, but there is a high degree of variability in shrub composition and abundance with precipitation gradient, microsite dryness, and disturbance history. This variation occurs at finer scales than is found within a soil series. Antelope bitterbrush is less common in more westerly locations with higher precipitation, while huckleberry oak (Quercus vaccinifolia) becomes more abundant. Overall shrub cover is higher where drier microsites exist, such as where outcrop percentage is higher and soils are shallower. The droughty, nutrient poor soils of this site do not support an extensive herbaceous community, and grasses and forbs are of low importance on this site.

Ecological factors
Fire, 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 with a multiple age class distribution, with an open canopy allowing for the growth of patchy shrubs in the understory (Beardsley et al. 1999, Murphy and Knopp 2000, Barbour et al. 2002, Taylor 2004, Stephens and Fry 2005). 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 (Murphy, 2000; Skinner, 1996; Stephens, 2002}. These frequent patchily distributed fires kept the understory open and clear of shade-tolerant and fire-intolerant white fir (*Abies concolor*) and red fir (*Abies magnifica*), while providing bare mineral soil and canopy openings necessary for Jeffrey Pine recruitment, and maintaining a multiple age-class forest structure. Frequent fire would have limited abundant shrub cover and the accumulation of litter, thus reducing the occurrence of high severity, stand-clearing fire, although such fires did infrequently occur.

This pre-settlement phase is rare due to either fire suppression or clear-cutting. This ecological site was almost entirely clear-cut during the 1870s to 1890s during the period known as the Comstock Era (Elliot-Fisk et al. 1996, Murphy and Knopp 2000, Barbour et al. 2002, Taylor 2004), and forests that have developed since have higher density and basal area, and are comprised of younger and smaller trees with a more even age-class distribution, with all 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). White and red fir are more important in the understory, and shrub abundance is likely higher than would have historically occurred. Understory trees provide ladder fuels, and higher abundance of highly flammable shrubs increase the likelihood of large high severity fire.

Contemporary forests, with more crowded conditions and a higher frequency of drought (e.g. Jones et al. 2004) are more susceptible to pathogen induced mortality (Barbour et al. 2002). Jeffrey pine bark beetle (Dedroctonus jeffreyi), is the most significant disease agent for Jeffrey pine. Fire damage increases the likelihood of bark beetle infestation and mortality (Bradley and Tueller 2001, 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

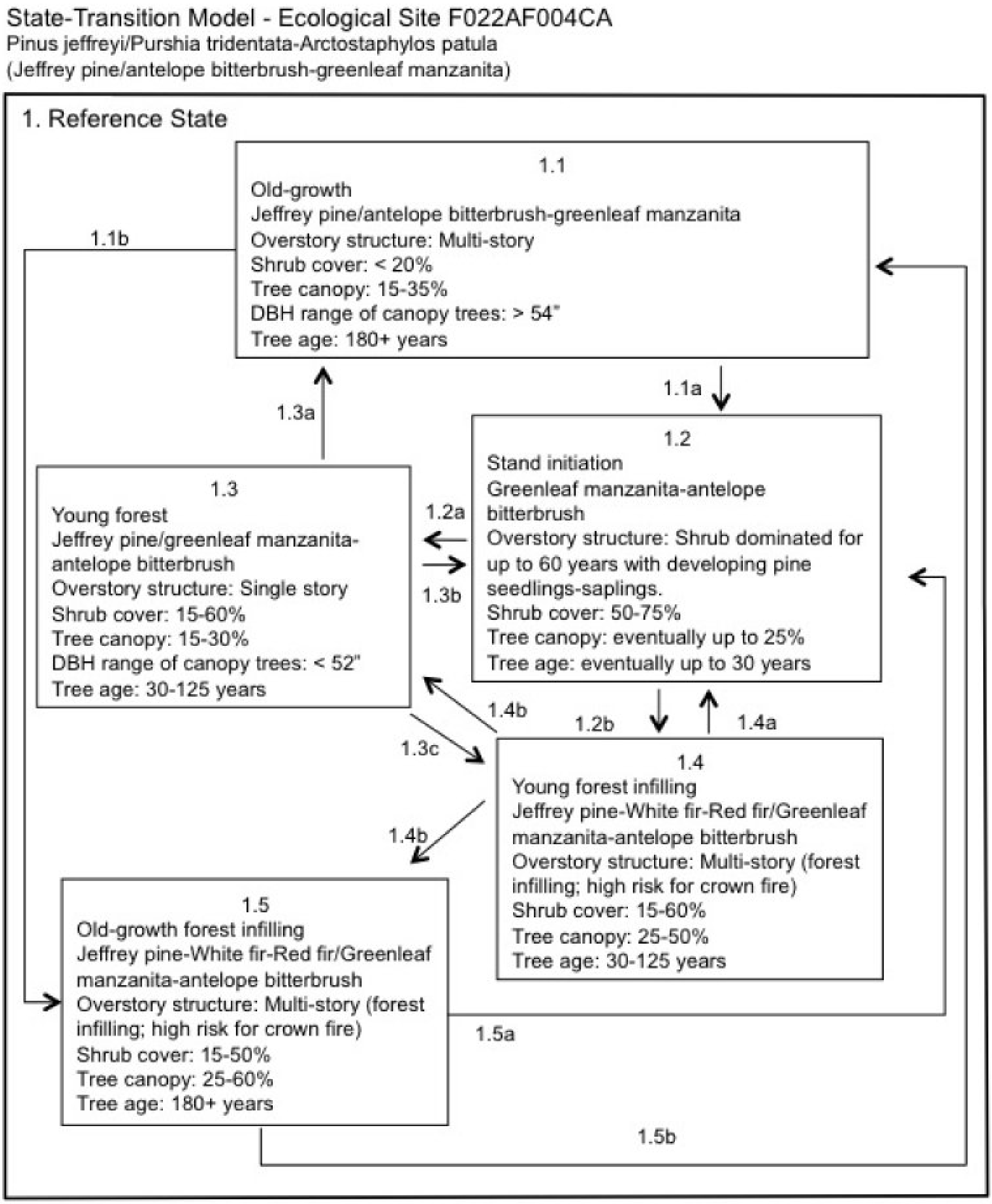

Figure 6. F022AF004CA

State 1
Reference

Community 1.1
Old-growth

This community phase represents the most successionally advanced community for this ecological site and was dominated by a multi-story canopy of Jeffrey Pine, with dominant canopy trees over 180 years old, and total canopy cover 15 to 35 percent. White fir and red fir would have occurred at low levels in the understory and mid-canopy. Canopy openings would have supported patchy shrubs, with higher shrub abundance around rock outcrops where soils were shallower and water deficit more severe. Average shrub cover was probably under 20 percent. Because the reference phase was largely either clear-cut during the Comstock era or impacted by fire suppression, plot data representing this phase are not available.

Community 1.2
Stand initiation

This shrubland community phase thrives in openings created by large high-severity fire that burns the forest canopy and kills the majority of overstory trees, or when canopy trees are removed by clear-cutting. Remnant overstory trees that escaped fire or logging may be present in limited numbers. Fire dependent shrubs such as greenleaf Manzanita, huckleberry oak, mountain whitethorn, and prostrate ceanothus 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). Huckleberry oak is a fire-adapted species that is highly flammable and vigorously resprouts from the root crown after fire (Howard 1992, Nagal and Taylor 2005, Odion et al. 2009). Mountain whitethorn is an obligate resprouter after low to medium intensity fire, and seeds require heat for germination (Reeves 2006). 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). With rapid regeneration of fire-adapted shrubs, shrubs may dominate in 7 to 9 years (Risser and Fry 1988). Scattered Jeffrey pine and white fir seedlings sprout but may take 50 to 60 years to dominate over the shrubland community phase (Smith 1994, Azuma et al. 2004). Perennial bunchgrasses and some forbs cover small portions of the area.

Community 1.3
Young forest

Figure 7. Secondary growth open Jeffrey pine forest

This forest community phase is dominated by an even-aged stand of Jeffrey pine (*Pinus jeffreyi*). The trees exceed 125 years in age. Canopy cover ranges from 15 to 35 percent, with an average of 25 percent cover. Greenleaf manzanita *Arctostaphylos patula*), antelope bitterbrush (*Purshia tridentata*), mountain whitethorn (*Ceanothus cordulatus*), and prostrate ceanothus (ceanothus prostrates) are common species in the understory. The open canopy and diverse understory is maintained by natural fire intervals. The absence of fire would favor mountain big sagebrush (*Artemisia tridentata* ssp. vaseyana) and antelope bitterbrush (*Purshia tridentata*).

Forest overstory. Jeffrey pine (Pinus jeffreyi) is dominant in the overstory with a range of 15 to 35 percent cover, and an average of 25 percent cover. White fir and red fir occur in small percentages in the understory and mid-canopy.

Forest understory. Understory cover and diversity decreases as the overstory canopy increases, but with fire suppression may remain dense on this site, up to 50 percent cover. Greenleaf manzanita and antelope bitterbrush are the most common shrub species. Huckleberry oak may be abundant, and occurs more frequently in westerly geographic locations where precipitation is higher. Mountain big sagebrush (Artemisia tridentata ssp. vaseyana) is present in some areas where fire has been suppressed for many years. Prostrate ceanothus (Ceanothus prostrates), whitethorn ceanothus (Ceanothus cordulatus) are common secondary shrubs. Herbaceous cover is low, averaging three percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	258	583
Grass/Grasslike	–	–	9
Forb	–	–	8
Tree	–	1	1
Total	**168**	**259**	**601**

Community 1.4
Young forest infilling

This community phase is characterized by forest infilling with increasing cover of white fir and red fir in the understory, and higher density and basal area. Canopy cover remains relatively open due to the harsh abiotic conditions of this ecological site, and may range from 25 to 50 percent. Forest age ranges from 30 to 125 years for the main stand. Shrub cover declines with increasing canopy, but may remain high due to a lack of fires and the relative openness of the site. The presence of ladder fuels, abundant flammable shrubs, and increasing litter accumulation makes this phase high-risk for high severity fire. Increased tree density also makes this phase more susceptible to insect outbreaks, which can increase mortality after fire or during drought.

Community 1.5
Old-growth forest infilling

This community phase is characterized by old-growth Jeffrey pine with canopy trees over 180 years old, with forest infilling with increasing cover of white fir and red fir in the understory, and higher density and basal area. Canopy cover remains relatively open due to the harsh abiotic conditions of this ecological site, and may range from 25 to 60 percent, with 20-45% of the total canopy subdominant trees. Shrub cover declines with increasing canopy and shrub decadence, but may remain high due to a lack of fires and the relative openness of the site. Longer-lived fire-intolerant shrubs such as mountain big sagebrush and antelope bitter brush increase in importance, while fire-adapted species such as greenleaf manzanita and huckleberry oak decline. The presence of ladder fuels, litter accumulation, and shrub density makes this phase high-risk for high severity fire. Increased tree density also makes this phase more susceptible to insect outbreaks, which can increase mortality after fire or during drought.

Pathway 1.1
Community 1.1 to 1.2

In the event of a severe canopy fire or a clear-cut the old, growth forest would transition to stand initiation (Community phase 1.2). Canopy fire would have been a relatively rare occurrence, since frequent low severity fires typically keep the understory clear of fuels, but it could occur after a long fire return interval where shrub density had reached high levels. The majority of the reference phase was clear-cut during the Comstock era.

Pathway 1.1b
Community 1.1 to 1.5

This pathway occurs when fire is excluded from the system, and leads to forest infilling with white fir and red fir increasing in the understory, and an increase in tree density and basal area (Community phase 1.5).

Pathway 1.2a
Community 1.2 to 1.3

This pathway occurs with time with a natural fire regime, with frequent low severity fire ranging from 5 to 39 years. 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

This pathway occurs when fire is excluded from the system, and leads to forest infilling with white fir and red fir increasing in the understory (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 low severity fires. This will occur with time with frequent low severity fire ranging from 5 to 39 years. 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

Severe canopy fire or clear-cut would transition the young forest to stand initiation (Community phase 1.2).

Pathway 1.3c
Community 1.3 to 1.4

This pathway occurs when fire is excluded from the system, and leads to forest infilling with white fir and red fir increasing in the understory (Community phase 1.4).

Pathway 1.4a
Community 1.4 to 1.2

Severe canopy fire or clear-cut would transition the young forest to stand initiation (Community phase 1.2).

Pathway 1.4b
Community 1.4 to 1.3

The natural event of a low severity fire in this forest is unlikely due to the high fuels present in this site, and intervention is most likely required to return this phase to an open forest. Manual thinning of understory trees, with reintroduction of late season low intensity surface fires could return this community to open, second-growth Jeffrey pine forest (Community phase 1.3).

Conservation practices

Prescribed Burning
Forest Stand Improvement

Pathway 1.5a
Community 1.5 to 1.2

Severe canopy fire or clear-cut would transition the old growth forest to stand initiation - the Greenleaf manzanita-antelope bitterbrush shrubland community (Community phase 1.2).

Additional community tables

Table 6. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Tree					
1	**Trees**			0–1	
	Jeffrey pine	PIJE	*Pinus jeffreyi*	0–1	13–40
	white fir	ABCO	*Abies concolor*	–	0–3
	California red fir	ABMA	*Abies magnifica*	–	0–1
Shrub/Vine					
2	**Shrubs**			168–583	
	greenleaf manzanita	ARPA6	*Arctostaphylos patula*	17–577	1–33
	huckleberry oak	QUVA	*Quercus vacciniifolia*	0–560	0–60
	antelope bitterbrush	PUTR2	*Purshia tridentata*	7–168	1–45
	prostrate ceanothus	CEPR	*Ceanothus prostratus*	0–112	0–5
	whitethorn ceanothus	CECO	*Ceanothus cordulatus*	0–40	0–18
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	0–34	0–25
	snowbrush ceanothus	CEVE	*Ceanothus velutinus*	0–17	0–5
Forb					
3	**Forbs**			0–8	
	Brewer's fleabane	ERBR4	*Erigeron breweri*	0–4	0–1
	sanddune wallflower	ERCA14	*Erysimum capitatum*	0–1	0–1
	naked buckwheat	ERNU3	*Eriogonum nudum*	0–1	0–1
	spreading groundsmoke	GADI2	*Gayophytum diffusum*	0–1	0–1
	spreading phlox	PHDI3	*Phlox diffusa*	0–1	0–1
	silverleaf phacelia	PHHA	*Phacelia hastata*	0–1	0–1
	Holboell's rockcress	ARHO2	*Arabis holboellii*	0–1	0–1
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	0–1	0–1
Grass/Grasslike					
4	**Grasses and Grasslike**			0–9	
	Ross' sedge	CARO5	*Carex rossii*	0–18	0–1
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–9	0–1
	squirreltail	ELEL5	*Elymus elymoides*	0–1	0–1

Table 7. 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	–	12–28	–	–
white fir	ABCO	*Abies concolor*	Native	–	3–7	–	–

Table 8. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
Ross' sedge	CARO5	*Carex rossii*	Native	–	0–1
squirreltail	ELEL5	*Elymus elymoides*	Native	–	0–1
western needlegrass	ACOC3	*Achnatherum occidentale*	Native	–	0–1
Forb/Herb					
arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	Native	–	0–1
Brewer's fleabane	ERBR4	*Erigeron breweri*	Native	–	0–1
sanddune wallflower	ERCA14	*Erysimum capitatum*	Native	–	0–1
naked buckwheat	ERNU3	*Eriogonum nudum*	Native	–	0–1
spreading groundsmoke	GADI2	*Gayophytum diffusum*	Native	–	0–1
Holboell's rockcress	ARHO2	*Arabis holboellii*	Native	–	0–1
spreading phlox	PHDI3	*Phlox diffusa*	Native	–	0–1
silverleaf phacelia	PHHA	*Phacelia hastata*	Native	–	0–1
Shrub/Subshrub					
huckleberry oak	QUVA	*Quercus vacciniifolia*	Native	–	0–60
antelope bitterbrush	PUTR2	*Purshia tridentata*	Native	–	1–45
greenleaf manzanita	ARPA6	*Arctostaphylos patula*	Native	–	1–33
whitethorn ceanothus	CECO	*Ceanothus cordulatus*	Native	–	0–18
prostrate ceanothus	CEPR	*Ceanothus prostratus*	Native	–	0–5
snowbrush ceanothus	CEVE	*Ceanothus velutinus*	Native	–	0–5
mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	Native	–	1–3
Tree					
Jeffrey pine	PIJE	*Pinus jeffreyi*	Native	–	0.5–1
white fir	ABCO	*Abies concolor*	Native	–	0–0.5

Animal community

This forest provides food and shelter for squirrels, birds, deer and bear. The Jeffrey pine seeds are eaten by birds, and the roots and young stems are eaten by small mammals. The standing dead and down trees provides a 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 has many trails for walking, biking and cross-country skiing.

Wood products

Jeffrey pine and white fir provide many 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

The 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 restoration projects.

Other information

Site index documentation:

Schumacher (1926) and Meyer (1961) were used to determine forest site productivity for white 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 phase 1.3. 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.

Table 9. 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
Jeffrey pine	*PIJE*	70	80	55	69	45	600	–	
white fir	*ABCO*	35	40	57	64	70	030	–	

Inventory data references

The following NRCS plots represent this ecological site (all plots occur within CA693, Tahoe Basin):

RcF04127 (Type location)
8-19
8-29
99CA693-028
CaE03007
CaF04203
RcF04128
RcF04130
mtg03009

Type locality

Location 1: Douglas County, NV	
Township/Range/Section	T14N R18E S23
UTM zone	N
UTM northing	4325784
UTM easting	245893
General legal description	Take HW 50 to Logan House Road. Follow to dead end near Logan House Creek, then head south over ridge.

Other references

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

Beardsley, D., C. Bolsinger, and R. Warbington. 1999. Old-growth forest in the Sierra Nevada: By type in 1945 and

1993 and ownership in 1999. PNW-RP-516, USDA Forest Service, Pacific Northwest Research Station.

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 adn 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. 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. 1992. Quercus vaccinifolia. Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

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.

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.

Odion, D. C., M. A. Moritz, and D. A. DellSala. 2009. Alternative community states maintained by fire in the Klamath Mountains, USA. Journal of Ecology 98:96-105.

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 Sequioa and Kings Canyon National Parks. JAPCA 37:906-912.

Reeves, S. L. 2006. *Ceanothus cordulatus*. Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Risser, R. J. and M. E. Fry. 1988. Montane chaparral. California wildlife habitat relationships system., California Department of Fish and Game. California Interagency Wildlife Task Group.

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.

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

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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:

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17. **Perennial plant reproductive capability:**
