USDA Natural Resources
Conservation Service

Ecological site AX006X01F101
Pumice Plateau, Volcanic Uplands (Ponderosa Pine / Antelope bitterbrush) 18-25 PZ

Last updated: 5/05/2025
Accessed: 03/12/2026

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.

MLRA notes

Major Land Resource Area (MLRA): 006X–Cascade Mountains, Eastern Slope

Stretching from northern Washington to southern Oregon, MLRA6 encompasses the mountain slopes, foothills, elevated plateaus and valleys on the eastern slopes of the Cascade mountains. This MLRA is a transitional area between the Cascade Mountains to the west and the lower lying Columbia Basalt Plateau to the east. Situated in the rain shadow of the Cascade Crest, this MLRA receives less precipitation than portions of the cascades further west and greater precipitation than the basalt plateaus to the east. Geologically, the majority of the MLRA is dominated by Miocene volcanic rocks, while the northern portion is dominated by Pre-Cretaceous metamorphic rocks and the southern portion is blanketed with a thick mantle of ash and pumice from Mount Mazama. The soils in the MLRA dominantly have a mesic, frigid, or cryic soil temperature regime, a xeric soil moisture regime, and mixed or glassy mineralogy. They generally are moderately deep to very deep, well drained, and loamy or ashy. Biologically, the MLRA is dominated by coniferous forest, large expanses of which are dominated by ponderosa pine, Douglas-fir or lodgepole pine. Areas experiencing cooler and moister conditions include grand fir, white fir, and western larch while the highest elevations include pacific silver fir, subalpine fir and whitebark pine. Economically, timber harvest and recreation are important land uses in these forests. Historically, many of these forests would have experienced relatively frequent, low and mixed severity fire favoring the development of mature forests dominated by ponderosa pine or Douglas-fir. In the southern pumice plateau forests, less frequent, higher severity fire was common and promoted the growth of large expanses of lodgepole pine forests.

LRU notes

This unit is characterized by a high, cold volcanic plateau with nearly level topography interspersed with numerous cinder cones. The defining characteristic of this unit is the thick mantle of geologically recent pumice and ash deposited by the eruptions of Mount Mazama and Newberry Caldera. These soils are often coarse textured, excessively drained and have low thermal conductivity and fertility. These qualities promote low botanical diversity and the dominance of relatively few tree, shrub and herbaceous species. Forests are dominated by lodgepole pine in flat areas where cold air pools and depressions with seasonal water tables; ponderosa pine on warmer slopes and rises with improved cold air drainage; and occasionally white fir or shasta red fir at higher elevations receiving greater precipitation. Dense stands of lodgepole pine promote a fire regime characterized by occasional stand replacing fires, whereas more open stands of ponderosa may experience more frequent, low severity fire. The climate of this unit is cold and dry with a soil climate defined by a cryic temperature regime and a xeric moisture regime. Geologically, vulcanism predominates with Quaternary deposits from Mount Mazama and Newberry Caldera in the west and north and Late Tertiary deposits from the Winema volcanic field and Bald mountain in the south and east.

Classification relationships

Plant Associations of the Central Oregon Pumice Zone (Volland 1985)
CPS212 - Ponderosa Pine/Bitterbrush/ Needlegrass

Forested Plant Associations of the Oregon East Cascades (Simpson 2007)
CPS210 – Ponderosa Pine/Bitterbrush
CPG125 - Pinus ponderosa/Stipa occidentalis
USFS PNV Subzone – Ponderosa/lodgepole

Plant Associations of the Fremont National Forest (Hopkins 1979)
CPS212 - Ponderosa Pine/Bitterbrush/ Needlegrass

Landfire Biophysical Setting (Landfire 2007)
0710531 - Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
0711670 - Rocky Mountain Poor-Site Lodgepole Pine Forest

Ecological site concept

This site represents a commonly occurring cold ponderosa pine (Pinus ponderosa) dominant forest type on the Eastern Cascade pumice plateau. This area is overlaid by deep deposits of geologically recent Mount Mazama and Newberry volcanic tephra, which exerts considerable influence over vegetation community expression and ecological dynamics. The presence of bitterbrush (Purshia tridentata) and a largely depauperate herbaceous layer often only dominated by low cover of western needlegrass (Achnatherum occidentalis) characterizes the biotic community of this site. Abiotically, this

site is distinguished from dry ponderosa forests where herbaceous production is higher and Idaho fescue is common by having excessively drained, coarse textured soils and greater pumice mantle depth to buried soil which lowers available water capacity. Similar to other pumice plateau ponderosa forests, this site has a cryic soil temperature regime, yet receives lower precipitation (18 to 25 inches) favoring the more drought adapted bitterbrush over greenleaf manzanita (Arctostaphylos patula) and snowbrush (Ceanothus velutinus). Compared to sites that may favor white fir (Abies concolor) dominance over time, this site receives lower precipitation and occupies lower elevations. This site is often associated with sites that were historically dominated by lodgepole pine. It can be distinguished abiotically from these lodgepole sites by occupying the upslope positions and areas that receive less cold air pooling, creating favorable conditions for establishment and maturation of ponderosa pine. This ponderosa pine dominated site will often still contain a significant component of lodgepole pine (Pinus contorta), thanks to the higher water holding capacity of the soils, and shares a similar bitterbrush dominated understory to these sites, making identification of each site concept challenging at times. Evidence suggests that these lodgepole pine dominated forests experienced a historical fire regime characterized more by stand replacing fires than the frequent, low and mixed severity fires experienced by this site. Fire was historically a critical element of the disturbance regime of this site, acting to thin crowded understories, reduce lodgepole pine and bitterbrush densities and allow fire resistant ponderosa stands to attain an open, savanna-like appearance.

This is a provisional ecological site that groups characteristics at a broad scale with little to no field verification and is subject to extensive review and revision before final approval. All data herein was developed using existing information and literature and should be considered provisional and contingent upon field validation prior to use in conservation planning.

Associated sites

AX006X01F102	**Pumice Plateau, Flats and Frost Pockets (Lodgepole Pine / Antelope bitterbrush) 18-25 PZ** Occupying downslope positions where cold air pooling is common
AX006X01F100	**Pumice Plateau, Volcanic Uplands and Mountainbases (Ponderosa Pine / Greenleaf manzanita - Snowbrush) 20-30 PZ** Typically occupying positions upslope from this site
R006XB102OR	**Cold Wet Meadow** Occupying adjacent willow dominated meadows with water tables near the surface

Similar sites

AX006X01F100	**Pumice Plateau, Volcanic Uplands and Mountainbases (Ponderosa Pine / Greenleaf manzanita - Snowbrush) 20-30 PZ** Somewhat higher precipitation, greenleaf manzanita common

AX006X01F102	**Pumice Plateau, Flats and Frost Pockets (Lodgepole Pine / Antelope bitterbrush) 18-25 PZ** Occupying downslope positions where cold air pooling is common
AX006X03B101	**Oregon East Cascades, Outwash Plains and Volcanic Uplands (Ponderosa pine / Antelope bitterbrush / Idaho Fescue) 14-18 PZ** Occurring primarily in the ponderosa pine foothills LRU, frigid soil temperature regime

Table 1. Dominant plant species

Tree	(1) *Pinus ponderosa*
Shrub	(1) *Purshia tridentata*
Herbaceous	(1) *Achnatherum occidentale*

Legacy ID

F006XY712OR

Physiographic features

This site occurs on Eastern Cascade lava plateaus overlaid by deep pumice mantles from the eruption of Newberry Caldera and Mount Mazama approximately 4000 and 7700 years ago respectively. This region is characterized by broad, relatively flat terrain with numerous cinder cones and enclosed basins. Across this landscape the site occupies landforms that include volcanic fields, hillslopes, dunes, alluvial fans and pyroclastic flows. Critical to the competitive dominance of ponderosa, this site most commonly occurs on upslope positions with less cold air pooling relative to adjacent lodgepole dominated depressions. Slopes typically range from 2 to 15 percent but may be as steep as 50 percent. This site commonly occupies elevations between 4,500 to 5,000 feet (1,400 to 1,500 meters) but can be found from 4,000 to 6,000 feet (1,200 to 1,850 meters). This site occurs on all aspects. This site is not subject to ponding or flooding and no water table is present within 100 inches of the soil surface.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Backslope (4) Footslope
Landforms	(1) Volcanic field (2) Hillslope (3) Dune (4) Alluvial fan (5) Pyroclastic flow

Flooding frequency	None
Ponding frequency	None
Elevation	4,500–5,000 ft
Slope	2–15%
Ponding depth	0 in
Water table depth	100 in
Aspect	W, NW, N, NE, E, SE, S, SW

Table 3. Representative physiographic features (actual ranges)

Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	4,000–6,000 ft
Slope	2–50%
Ponding depth	Not specified
Water table depth	Not specified

Climatic features

The average annual precipitation ranges from 18 to 30 inches (450 to 750 mm) mainly between the months of November and April, mostly in the form of snow. Winters are long and growing seasons are generally short on this site. The average annual air temperature is 42 degrees Fahrenheit (5.5°C) but ranges from 39 to 43 degrees Fahrenheit (4 to 6°C) and the frost-free period ranges from 15 to 50 days. The soil temperature regime is cryic, soil moisture regime is xeric. The graphs below are populated from the closest available weather station to representative site locations and are provided to indicate general climate patterns.

Table 4. Representative climatic features

Frost-free period (characteristic range)	15-50 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	18-30 in
Frost-free period (average)	35 days
Freeze-free period (average)	
Precipitation total (average)	24 in

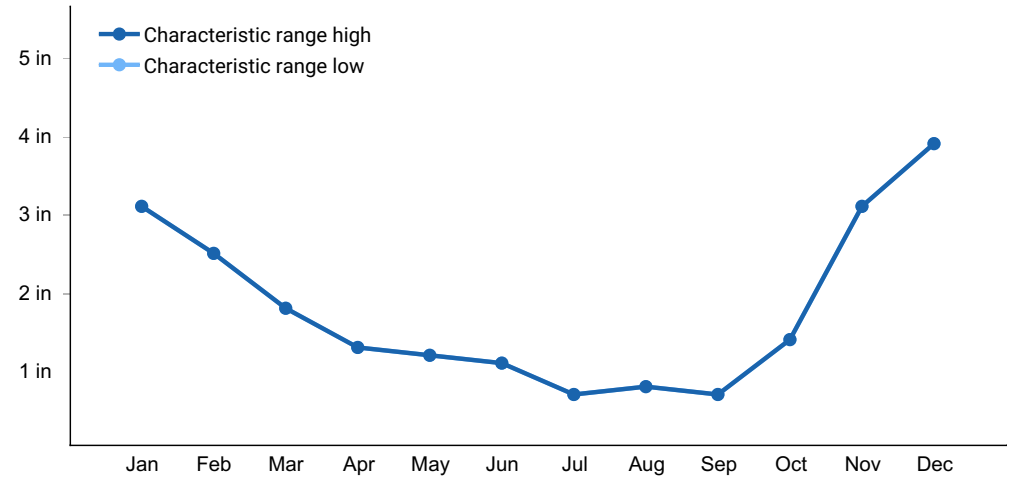


Figure 1. Monthly precipitation range

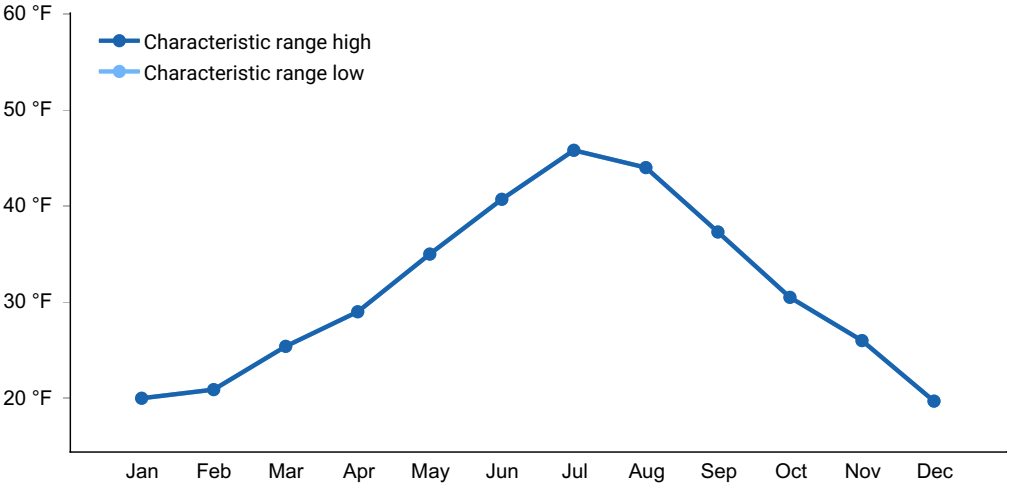


Figure 2. Monthly minimum temperature range

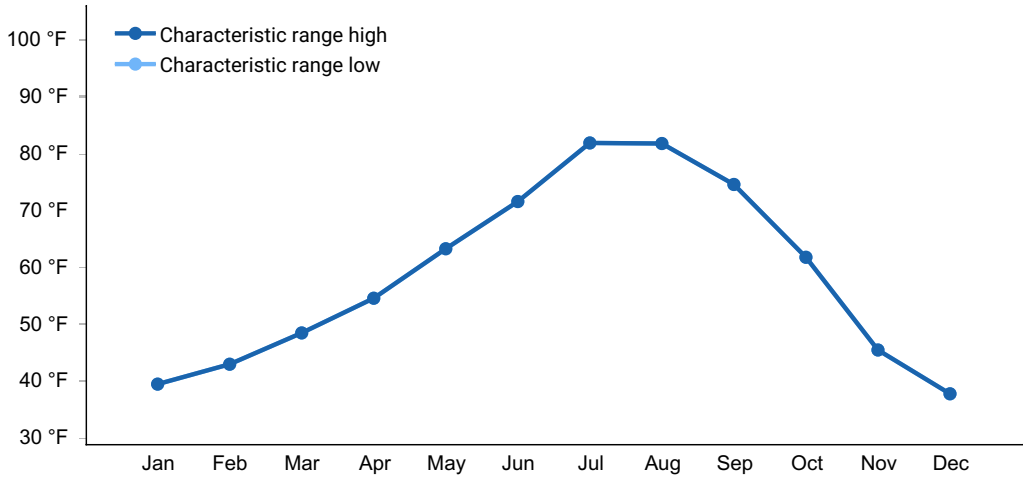


Figure 3. Monthly maximum temperature range

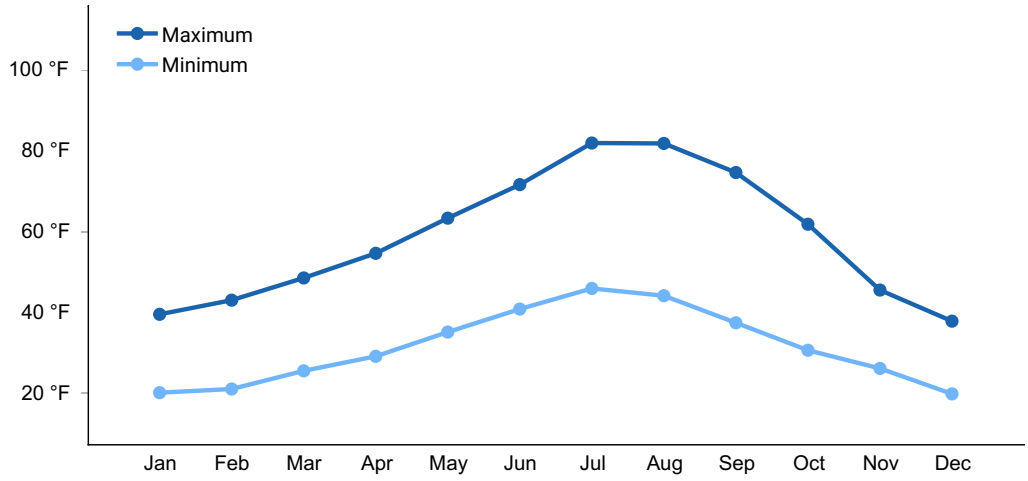


Figure 4. Monthly average minimum and maximum temperature

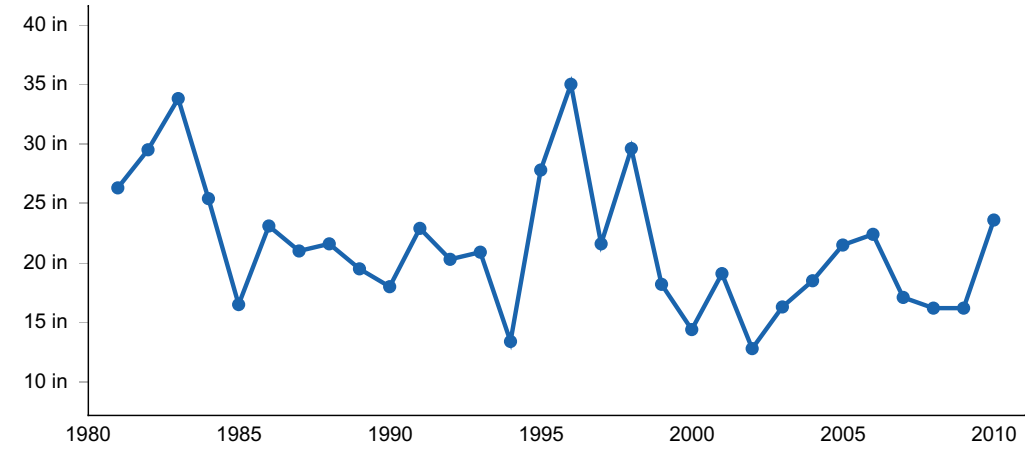


Figure 5. Annual precipitation pattern

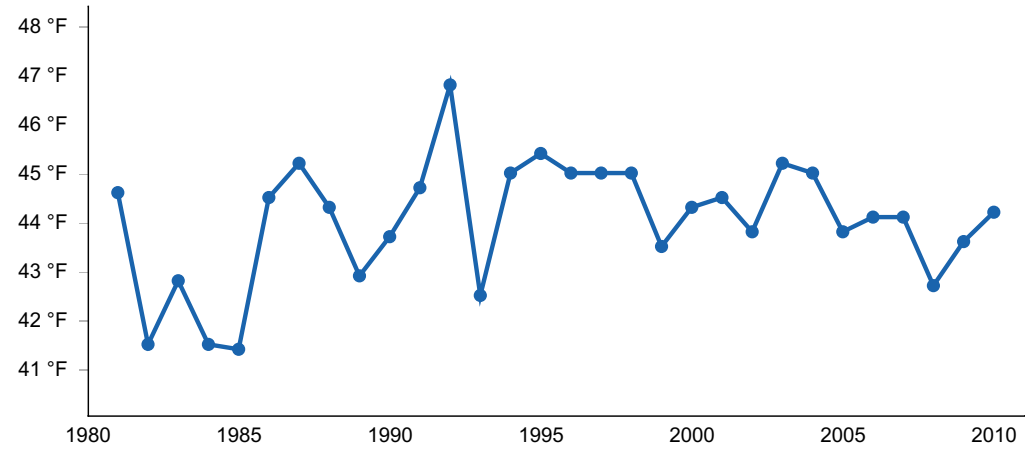


Figure 6. Annual average temperature pattern

Climate stations used

- (1) WICKIUP DAM [USC00359316], La Pine, OR

Influencing water features

This site is not influenced by water from a wetland or stream.

Wetland description

N/A

Soil features

The soils that typify this site concept are very deep and formed in thick deposits of volcanic ash and pumice derived from dacite over volcanic residuum. Characteristic of these deep pumice and ash deposits, these soils are generally low in nitrogen, phosphorus and sulfur, have high water holding capacity, low bulk density and low thermal conductivity. These are somewhat excessively to excessively drained soils with very rapid permeability. Surface soil textures are ashy and commonly very coarse, ranging from paragravelly coarse sandy loam, paragravelly loamy coarse sand, to ashy or gravelly loamy coarse sand. Paragravels in the upper horizons are almost exclusively pumice fragments and can make up a large portion of the soil volume. Beneath these recent pumice and ash deposits, buried soil layers generally occur at depths greater than 40 inches but may occur as shallow as 20 inches. These soils are often of loamy texture classes and have lower permeability compared to upper horizons, altering hydrologic dynamics. Soils of this site are classified as xeric Vitricryands (cold, dry soils formed in volcanic parent materials).

Representative soil associated with this site:

Lapine paragravelly ashy coarse sandy loam, 2 to 12 percent slopes

Table 5. Representative soil features

Parent material	(1) Volcanic ash (2) Pumice–dacite (3) Residuum–volcanic rock
Surface texture	(1) Ashy, paragravelly coarse sandy loam (2) Ashy, paragravelly loamy coarse sand (3) Ashy loamy coarse sand (4) Gravelly loamy coarse sand
Family particle size	(1) Ashy-pumiceous (2) Ashy (3) Ashy over loamy-skeletal
Drainage class	Somewhat excessively drained to excessively drained
Permeability class	Very rapid
Depth to restrictive layer	60–80 in
Soil depth	60–80 in

Surface fragment cover <=3"	0–45%
Surface fragment cover >3"	0–45%
Available water capacity (0-40in)	3.3–6 in
Soil reaction (1:1 water) (0-40in)	5.6–7.3
Subsurface fragment volume <=3" (4-60in)	10–50%
Subsurface fragment volume >3" (4-60in)	0–15%

Table 6. Representative soil features (actual values)

Drainage class	Not specified
Permeability class	Not specified
Depth to restrictive layer	Not specified
Soil depth	Not specified
Surface fragment cover <=3"	Not specified
Surface fragment cover >3"	Not specified
Available water capacity (0-40in)	2.5–7 in
Soil reaction (1:1 water) (0-40in)	Not specified
Subsurface fragment volume <=3" (4-60in)	Not specified
Subsurface fragment volume >3" (4-60in)	Not specified

Ecological dynamics

Reference Plant community:

The reference native plant community under the natural disturbance regime, is characterized by an open stand of mature ponderosa pine, with a shrub layer dominated by bitterbrush.

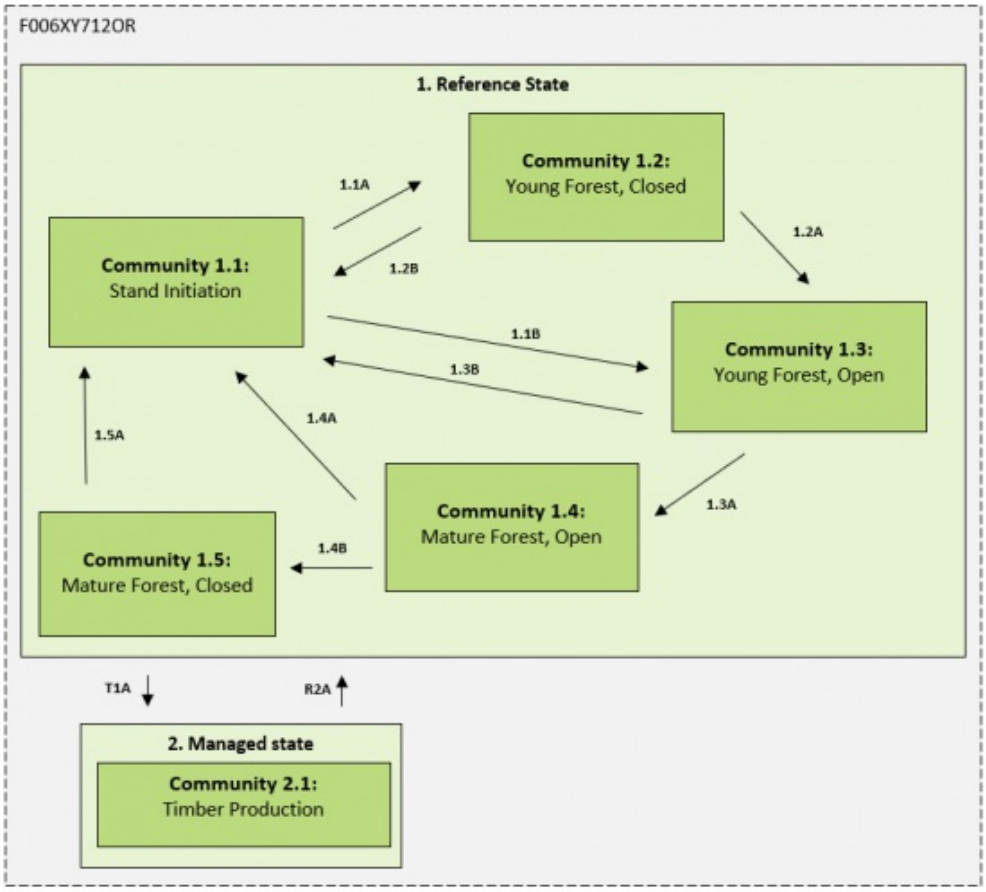
Disturbance:

Cold ponderosa pine forests on the pumice plateau were historically subject to frequent low and mixed severity fires. Low severity fires would have decreased the density of young

trees (such as lodgepole pine) and reduced shrub understories, both of which can act as ladder fuels to ignite crown fires and lead to stand replacing events (Hessberg et al. 2005). Overtime, these events, as well as mixed severity fires, would have favored the development of large, mature, even-aged ponderosa pine stands with open canopies (Landfire 2007). Fire-resistant ponderosa pine is well adapted to these conditions, developing increasing fire resistance with age by growing thick bark and self-thinning lower limbs (Fryer 2008). Lodgepole pine has thin bark and shallow roots which render the tree very susceptible to mortality from fire; however, as a prolific seed producer with a relatively long seed viability, it is a highly aggressive post fire colonizer (Cope 1993). While bitterbrush may re-sprout following low severity fire, high severity fire may lead to mortality and long-term response of bitterbrush to intact or altered fire regimes may vary (Agee 1993, Busse and Riegel 2009, Heyerdahl et al. 2014). With longer time between fire, increased development of understory fuels such as young lodgepole pine and dead woody fuels, along with the development of a closed canopy, may promote an increased frequency of stand replacing fires and insect outbreaks. This condition characterizes much of the current condition of this historically open canopy, dry ponderosa forests due primarily to a history of selective logging and fire suppression (Hessberg et al. 2005, Ritchie et al. 2005). Prolonged anthropogenic fire suppression may lead to cycles of overstocking and high severity fires, yet evidence is insufficient for the characterization of this pattern as an alternative state. Mountain pine beetle (Dendroctonus ponderosae) outbreaks are especially common in ponderosa/lodgepole forests and drought conditions and high stand densities may render stands more vulnerable to these outbreaks (Agee 1993). Since pumice soils have low thermal conductivity and are subject to frost heave, ponderosa recovery on cooler sites may require the establishment of lodgepole and the consequent creation of thermal refugia (Geist and Cochran 1991). Individual locations within this site with higher productivity may be used for commercial timber harvesting which will have varying effects on stand structure and composition depending on harvest type.

The state and transition model below represents a generalized and simplified version of forest change in response to major disturbance types in this ecological site. It does not attempt to model the complex effects of forestry practices or insect outbreaks on ecosystem change. Emerging evidence is suggesting that climate change is leading to hotter and drier conditions in western forests that will increase fire frequency and extent and lengthen fire seasons (Halofsky et al. 2020). When combined with the interacting impacts of fire suppression, drought, and insect outbreaks, it is possible that this ecological system will experience unpredictable ecosystem shifts and additional alternative states. As this site is updated in future iterations, descriptions will include more thorough treatments of disturbance and ecological change. It is largely based on Landfire biophysical settings models 710531 and 711670 and US Forest Service TEUI “PIPO/PUTR2/ACOC3 Pumice Lapine Ecological Type” landtype (Landfire 2007, USFS 2008).

State and transition model



Community Pathways

1.1A	Fire cycle(s) missed
1.1B	Historical disturbance regime sustained for 150+ years
1.2A	Mixed severity fire, insect or disease outbreak
1.2B	High severity, stand replacing fire occurs
1.3A	Frequent, low severity fire regime maintained for extended duration
1.3B	High severity, stand replacing fire occurs
1.4A	High severity, stand replacing fire occurs
1.4B	Fire cycle(s) missed
1.5A	High severity, stand replacing fire occurs

Transitions / Restoration Pathways

T1A	Extensive timber harvest
R2A	Forest restoration, stand replacing fire

State 1
Historic Reference

A forested community, this site occurs across the landscape as a mosaic of plant community phases characterized by variation in forest structural stage (tree age, density and cover) and plant community. Pathways between these phases are defined by historic fire regimes and insect outbreaks. Many of these cold pine forests would have cycled from a shrub-bunchgrass young tree stand initiation phase (1.1) to a young forest stage (1.2) to a mature forest phase (1.3) with a disturbance regime characterized by frequent surface and mixed fires and insect outbreaks. Fire exclusion can lead to closed canopy and dense understory stocking conditions represented by Community 1.4 which can be more vulnerable to stand replacing fires and insect outbreaks. The Reference Community within this state is that of an open, mature, savanna like ponderosa stand represented by Community Phase 1.3. Historical evidence suggests that this community type was common across the landscape prior to selective logging and widespread fire suppression, which can alter fire regimes and lead to a greater frequency of high severity fire. Given the likelihood that this state, even in the best condition and highest potential, will almost always include at least some component of exotic species regardless of management inputs, this may also be referred to as the “Current Potential State”. In this document, the term “Reference State” is used synonymously with “Current Potential State” for the sake of simplicity.

Dominant plant species

- ponderosa pine (*Pinus ponderosa*), tree
- antelope bitterbrush (*Purshia tridentata*), shrub
- western needlegrass (*Achnatherum occidentale*), grass

Community 1.1
Stand Initiation

Shrub and grass dominated community, lodgepole seedlings and saplings regenerating, ponderosa following thermal cover creation by other lodgepole and shrubs. Frequent, severe fire will maintain this community. All other communities may transition to this phase after stand replacing fires. Tree regeneration will depend on local seed sources and climate cycles and may follow grass and shrub establishment.

Community 1.2
Young Forest, Closed

Closed canopy, densely stocked with young to intermediate aged lodgepole and ponderosa. Shrub and bunchgrass decreasing. Competition for limited soil moisture and light will result in declining tree densities overtime.

Community 1.3
Young Forest, Open

Open overstory of uneven aged ponderosa, lodgepole in the subcanopy and understory regeneration of ponderosa and lodgepole. Shrub and bunchgrass cover increased.

Community 1.4
Reference plant community. Mature forest, Open

This is the reference community. Mature, open canopy. Uneven-aged stand with mostly mature ponderosa pine trees. Shrub and bunchgrass cover patchy in understory. Frequent, low severity fires maintain this community, lack of fire will increase understory infill and vulnerability to severe fire. The reference native plant community under the natural disturbance regime is characterized by an open stand of mature ponderosa pine, with a shrub layer dominated by bitterbrush. Lodgepole pine may occupy a significant component of the subcanopy vegetation, especially given longer intervals between fire. The herbaceous layer often occupies low cover and ranges from depauperate for densely stocked closed canopy forests, to predominantly western needlegrass. Forbs do not make up a substantial component of the groundcover, yet strawberry (Fragaria spp.), velvet lupine (*Lupinus leucophyllus*) and common yarrow (*Achillea millefolium*) may be common. Other common yet sparsely distributed species may include bottlebrush squirreltail (*Elymus elymoides*), Ross' sedge (*Carex rossii*), and wax currant (*Ribes cereum*). Lodgepole pine density will increase as time since fire lengthens, and will have a more competitive presence at the higher elevation margins of this site concept or at the

microtopographic scale in pockets where cold air pools. Overstory canopy cover typically ranges between 15 and 50 %. Understory canopy cover often ranges from 10 – 15 % for shrubs, and 5-10 % for grasses.

Community 1.5
Mature Forest, Closed

Mature ponderosa overstory, closed canopy stand with dense understory stocking of lodgepole pine where light is available. Herbaceous cover decreased.

Pathway 1.1A
Community 1.1 to 1.2

Fire cycle(s) missed

Pathway 1.2B
Community 1.2 to 1.1

High severity, stand replacing fire occurs

Pathway 1.2A
Community 1.2 to 1.3

Mixed severity fire, insect or disease outbreak

Pathway 1.3B
Community 1.3 to 1.1

High severity, stand replacing fire occurs

Pathway 1.3A
Community 1.3 to 1.4

Frequent, low severity fire regime maintained for extended duration

Pathway 1.4B
Community 1.4 to 1.1

High severity, stand replacing fire occurs

Pathway 1.4A
Community 1.4 to 1.5

Fire cycle(s) missed

Pathway 1.5A
Community 1.5 to 1.1

High severity, stand replacing fire occurs

State 2
Managed

In this state the stand is used primarily for timber harvesting. This may result in a number of manipulated community types and pathways depending on strategies surrounding harvest, weed control and replanting. Broadcast burning of bitterbrush may help increase ponderosa pine reestablishment. Clear cuts may favor lodgepole pine dominance, given an altered disturbance regime, if fire, selective thinning, and ponderosa replanting does not follow. Selective harvesting of large ponderosa pine may also favor lodgepole pine dominance overtime.

Dominant plant species

- ponderosa pine (*Pinus ponderosa*), tree
- lodgepole pine (*Pinus contorta*), tree

Transition T1A
State 1 to 2

Extensive timber harvest followed by management prioritizing timber production.

Context dependence. Timber harvest

Restoration pathway R2A
State 2 to 1

Ecological forestry practices may promote a return to Reference State. Selective thinning, prescribed burning or shelter-wood production systems may increase chances of forest restoration. Stand replacing fire may return to Community 1.1 of the Reference State if soil compaction is not severe and seed source is available.

Context dependence. Soil compaction due to large machine use combined with the loss of thermal cover during clearcutting may make ponderosa pine reestablishment challenging.

Additional community tables

Inventory data references

Information presented here has been derived from NRCS data. Field observations from

range trained personnel were also used. Other sources used as references include USDA NRCS Water and Climate Center, USDA NRCS National Range and Pasture Handbook, and USDA NRCS Soil Surveys from various counties.

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Contributors

Andrew Neary - Original PES site concept

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	04/01/2025
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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5. **Number of gullies and erosion associated with gullies:**

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6. **Extent of wind scoured, blowouts and/or depositional areas:**

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7. **Amount of litter movement (describe size and distance expected to travel):**

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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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:**