USDA Natural Resources Conservation Service

Ecological site F043CY603OR
Cool Wet Conifer Mountains and Plateaus (ABGR/VAME/LIBO)

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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.

MLRA notes

Major Land Resource Area (MLRA): 043C–Blue and Seven Devils Mountains

This MLRA covers the Blue and Seven Devils Mountains of Oregon, Washington and Idaho. The area is characterized by thrust and block-faulted mountains and deep canyons composed of sedimentary, metasedimentary, and volcanic rocks. Elevations range from 1,300 to 9,800 feet (395 to 2,990 meters). The climate is characterized by cold, wet winters and cool, dry summers. Annual precipitation, mostly in the form of snow, averages 12 to 43 inches (305 to 1,090 millimeters) yet ranges as high as 82 inches (2,085 millimeters) at upper elevations. Soil temperature regimes are predominately Frigid to Cryic and soil moisture regimes are predominately Xeric to Udic. Mollisols and Andisols are the dominant soil orders. Ecologically, forests dominate but shrub and grass communities may occur on south aspects and lower elevations as well as in alpine meadow environments. Forest composition follows moisture, temperature and elevational gradients and typically ranges from ponderosa pine and Douglas-fir plant associations at lower elevations, grand fir at middle elevations and subalpine fir and Engelman spruce at upper elevations. Historical fire regimes associated with these forest types range from frequent surface fires in ponderosa pine - Douglas Fir forest types to mixed and stand replacing fire regimes in grand fir and subalpine fir types. A large percentage of the MLRA is federally owned and managed by the U.S. Forest Service for multiple uses.

Classification relationships

U.S. National Vegetation Classification Standard (NVCS)
Central Rocky Mountain Grand fir - Douglas-fir Forest & Woodland Alliance (A-3362)
Central Rocky Mountain Grand fir - Douglas-fir-Western larch Forest Group (G211)

USDA Forest Service Ecological Sub-region
M332 “Blue Mountains”

LANDFIRE BpS model 10470:
Northern Rocky Mountain Mesic Montane Mixed-Conifer Forest

Plant Assoc. Of Blue and Ochoco Mountains (R6 E TP-036-92)
Grand fir/big huckleberry -CWS212 (modal)
Grand fir/grouse huckleberry - CWS811
Grand fir/grouse huckleberry/twinflower - CWS812
Grand fir/Pacific yew/twinflower - CWC812
Grand fir/Pacific yew/twinflower/queencup beadlily - CWC811
Grand fir/twinflower - CWF312 (modal)
Lodgepole pine(grand fir)/big huckleberry - CLS513
Lodgepole pine(grand fir)/big huckleberry/pinegrass - CLS512
Lodgepole pine(grand fir)/big huckleberry/twinflower - CLS5

Plant Assoc. Of Wallowa-Snake Province (R6 E 255-86)
Grand fir/big huckleberry - CWS211
Grand fir/queencup beadlily - CWF421
Grand fir/Rocky Mountain maple - CWS912
Grand fir/Rocky Mountain maple-ninebark - CWS412
Grand fir/twinflower - CWF311

Ecological site concept

This ecological site occurs mainly on forested backslopes of mid to high elevation mountain slopes, and plateaus. Typically, this site is found on soils with a frigid temperature regime and udic moisture regime. Parent materials are derived from basalt or other igneous extrusive geologies (andesite, dacite, ignimbrites, etc.) with a thick mantle of volcanic ash and loess. They are well drained with adequate available water capacity. Grand fir generally represents late seral stages however other species such as western larch and Douglas-fir, and lodgepole pine may be present. Major understory species may range from grouse whortleberry, thinleaf huckleberry, and twinflower, to elk sedge, pinegrass and Columbia brome.

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

F043CY605OR	**Cool Moist Conifer Mountains and Plateaus (PSME-PIPO/CARU)** Occupying adjacent soils with lower soil moisture due to aspect or landscape position
F043CY601OR	**Cold Wet Conifer Mountains and Plateaus (ABLA/VASC-VAME)** Occupying adjacent soils with cooler temperatures due to aspect or landscape position
F043CY503OR	**Mountain Riparian Forest (PIEN/ALIN)** Occupying adjacent moderate to high-energy riparian areas

Similar sites

F043CY605OR	**Cool Moist Conifer Mountains and Plateaus (PSME-PIPO/CARU)** Greater number of dry days (45 - 60), Engelman spruce and grand fir less common.
F043CY601OR	**Cold Wet Conifer Mountains and Plateaus (ABLA/VASC-VAME)** Cryic soil temperature regime, subalpine fir common

Table 1. Dominant plant species

Tree	(1) *Abies grandis*
Shrub	(1) *Vaccinium membranaceum*
Herbaceous	(1) *Linnaea borealis*

Physiographic features

This site occurs on forested backslopes of plateaus and mountain slopes within the Blue and Wallowa mountains of Oregon. This site occurs predominately on north aspects with typical slopes between 7.5 - 45% but occasionally as steep as 65%. Slope profiles are most commonly concave across slopes and linear down slope, and rarely convex. These surface features help to consolidate soil moisture and in combination with north aspects protected from solar radiation, preserve soil moisture longer into the summer season. Elevations are typically between 4,450 - 5,350 ft (1,350 - 1,625 m) but can range from 3,650 - 6,000 ft (1,100 - 1,825 m). This site does not experience flooding or ponding and no water table is present within the upper two meters of soil.

Table 2. Representative physiographic features

Landforms	(1) Mountains > Mountain slope (2) Mountains > Plateau
Flooding frequency	None
Ponding frequency	None
Elevation	4,450–5,350 ft
Slope	8–45%
Ponding depth	0 in
Water table depth	100 in
Aspect	W, NW, N, NE, E

Table 3. Representative physiographic features (actual ranges)

Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	3,650–6,000 ft
Slope	0–65%
Ponding depth	Not specified
Water table depth	Not specified

Climatic features

The climate of this site is characterized by intermountain weather patterns. Winters are cold and wet with considerable snowfall and summers are cool and dry with occasional convective thunderstorms bringing measurable precipitation. Compared to continental systems influencing interior Rocky Mountain landscapes, these storms are less frequent and therefore summer precipitation is lower. Mean annual precipitation is typically between 25 – 30 in (635 – 760 mm.) but ranges from 20 – 40 in (510 – 1,010 mm). Mean annual temperatures are typically 39 - 43 °F (3 - 6°C) but range from 37 – 45°F (2.5 - 7°C). The soil temperature regime is Frigid and the moisture regime is typically Udic with fewer than 45 dry days per year. Frost free days average 25 to 100 per year. Climate graphs are populated from the closest available weather stations and are included to represent general trends rather than representative values.

Table 4. Representative climatic features

Frost-free period (characteristic range)	25-100 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	25-30 in
Frost-free period (average)	70 days
Freeze-free period (average)	
Precipitation total (average)	26 in

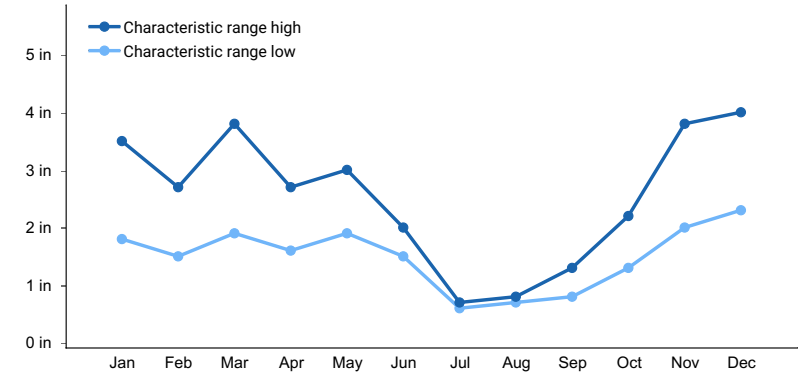


Figure 1. Monthly precipitation range

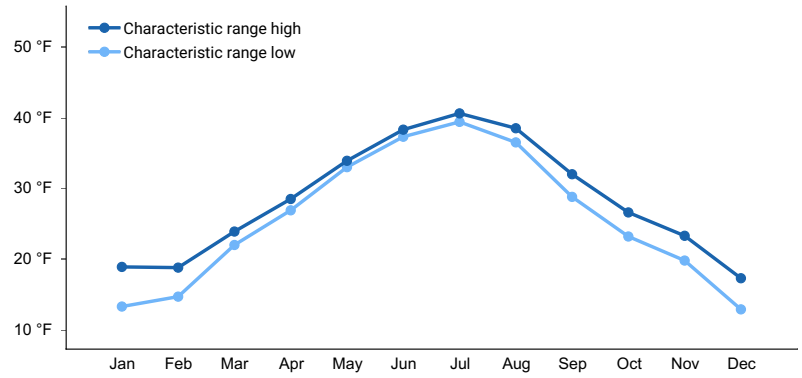


Figure 2. Monthly minimum temperature range

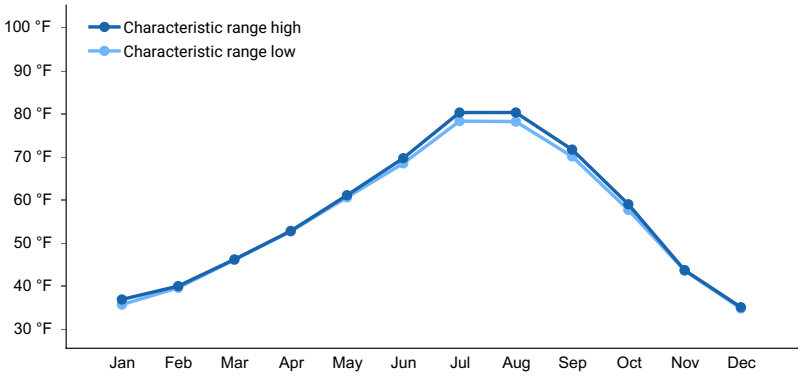


Figure 3. Monthly maximum temperature range

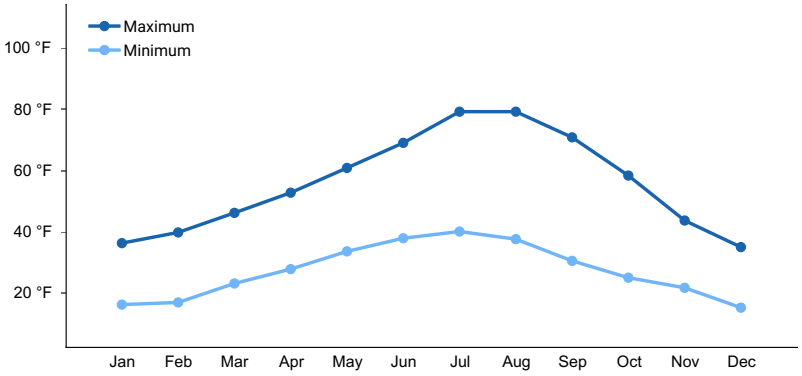


Figure 4. Monthly average minimum and maximum temperature

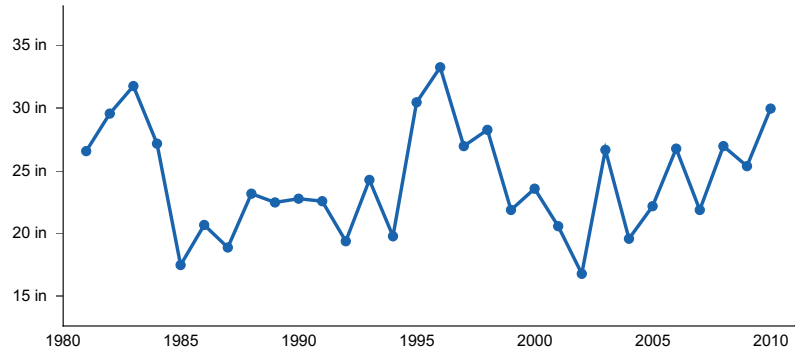


Figure 5. Annual precipitation pattern

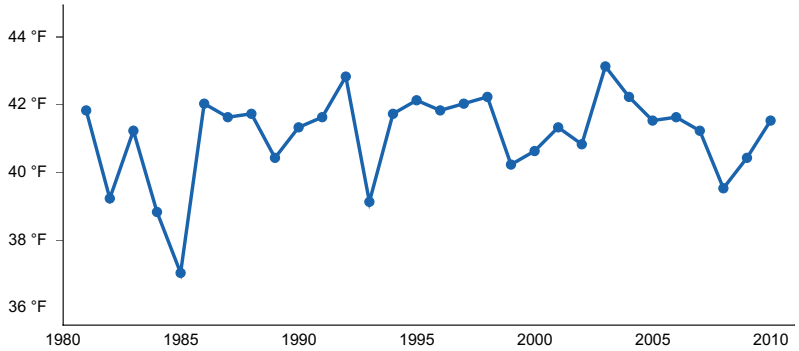


Figure 6. Annual average temperature pattern

Climate stations used

- (1) MEACHAM [USW00024152], Pendleton, OR
- (2) SENECA [USC00357675], Seneca, OR

Influencing water features

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

Soil features

Soils that typify this site concept are typically Andisols that are moderately deep to very deep and well drained. Surface textures are most commonly ashy silt loam but may range from silt loam, to gravelly ashy silt loam. Subsurface horizons are typically skeletal with coarse fragment ranges from very gravelly to extremely cobbly or stony. The family particle size is typically ashy over loamy skeletal but may vary. Soils moisture control sections are usually moist but are dry for less than 45 days following the summer solstice. These soils have developed in colluvium and/or residuum from basalt or other hard igneous extrusive geologies as well as metasedimentary and metavolcanic rocks. These soils are often mantled with a thick layer of ash from the eruption of Mount Mazama. See Limberjim, Syrupcreek and Gutridge for modal series concepts.

Table 5. Representative soil features

Parent material	(1) Colluvium–volcanic rock (2) Residuum–volcanic rock (3) Residuum–metasedimentary rock (4) Residuum–metavolcanics (5) Volcanic ash–volcanic rock
Surface texture	(1) Ashy silt loam (2) Silt loam (3) Gravelly silt loam

Family particle size	(1) Ashy over clayey (2) Ashy over loamy (3) Loamy-skeletal
Drainage class	Well drained
Permeability class	Moderately slow to moderately rapid
Depth to restrictive layer	20–80 in
Soil depth	20–80 in
Surface fragment cover <=3"	0–45%
Surface fragment cover >3"	0–45%
Available water capacity (0-40in)	4.6–11 in
Soil reaction (1:1 water) (0-40in)	5.6–7.3
Subsurface fragment volume <=3" (4-60in)	0–40%
Subsurface fragment volume >3" (4-60in)	0–30%

Ecological dynamics

The modal plant associations that define this ecological site group concept are the widespread Grand fir/Twinflower and Grand fir/ Big huckleberry associations (as described in Johnson and Clausnitzer 1992, and Johnson and Simon 1987). Additional closely related plant associations include Grand fir/grouse huckleberry and Grand fir/queencup beadlily. Within MLRA 43c in Oregon, these communities exist in areas receiving greater moisture than ponderosa pine - Douglas-fir forests and at lower elevations and warmer conditions than subalpine fir dominated forests. This site group corresponds to the USFS potential vegetation group “Moist Upland Forest” and plant association group “Cool Moist Upland Forest”.

In its historical reference condition, the most widespread expression of this ecological site was a mature forest with a closed canopy. In this representative stage, mature grand fir (*Abies grandis*) dominates with Douglas-fir (Pseutotsuga menziesii) very common and Engelmann spruce (*Picea engelmannii*), western larch (*Larix occidentalis*) and scattered ponderosa pine (*Pinus ponderosa*) also commonly found. Limited amounts of western white pine (*Pinus monticola*) and lodgepole pine (*Pinus contorta* var. lat.) may also occur. Understory regeneration of grand fir is common. A diverse number of understory plants may be found, yet the presence of thinleaf huckleberry (*Vaccinium membranaceum*), especially in openings, and twinflower (*Linnaea borealis*), in shaded understories, characterizes the site. In this mature forest, shade tolerant forbs such as sidebells wintergreen (*Orthilia secunda*), miterwort (Mitella spp), bride's bonnet (*Clintonia uniflora*) and western rattlesnake plantain (*Goodyera oblongifolia*) are commonly found. Other herbaceous and shrub species may include Columbia brome (*Bromus vulgaris*), northwestern sedge (*Carex concinnoides*), pipsissewa (*Chimaphila umbellata*), pinegrass (Calamagrosis rubescens), elk sedge (*Carex geyeri*), strawberry (Fragaria spp.), heartleaf arnica (*Arnica cordifolia*), white hawkweed (*Hieracium albiflorum*), baldhip rose (*Rosa gymnocarpa*), birchleaf spirea (Spirea betulifolia) and violet (Viola spp.). Within the range of this site, dominance of either bride’s bonnet or grouse huckleberry (*Vaccinium scoparium*) can represent soil moisture microsites with higher or lower relative moisture respectively.

In comparison to adjacent and associated mixed conifer forests occupying drier aspects, lower elevations or droughty exposures, this forest type historically was subject to less frequent fire. Fire return interval estimates suggest that surface fires were rare, mixed fires occurred at a roughly 150 year cycle and replacement fires on a 200 year cycle approximating Landfire fire regime 3, 35-100+ year frequency, mixed severity (Landfire 2017). These conditions would have allowed the otherwise fire intolerant grand fir to attain canopy dominance overtime and reduced the relative cover of more fire tolerant species such as Douglas-fir and western larch. When fire does occur, lodgepole pine often responds and may dominate early regeneration phases. This may be especially common on gentle topography where cold air pooling favors this cold tolerant conifer. Western larch may also be highly successful during early forest development stages and is often more competitive on steeper slope positions than lodgepole pine. As a shade intolerant species, ponderosa pine will often be more common during early forest

development stages, yet may also withstand high severity fire and persist as mature trees in the canopy. Engelman spruce is common in mature stands and increases in areas with higher soil moisture.

Understory species in these forests were adapted to respond to the progression of forest changes from early to late successional phases. Many shrubs found on site including thinleaf huckleberry, spiraea and common snowberry (Symphoricarpus albus), would also resprout from crowns or rhizomes following fire. These and other shrub species may respond to high severity fire by forming dense shrubfields on sites where they were present prior to disturbance. Thinleaf huckleberry will often dominate following fire then decline as canopy closure progresses. Thinleaf huckleberry may provide solar cover for shade tolerant subshrubs and forbs such as twinflower to establish. Grazing by both livestock and native ungulates will decrease the cover of these two common species with subsequent increases in some forbs such as violets and longstalk clover (*Trifolium longipes*).

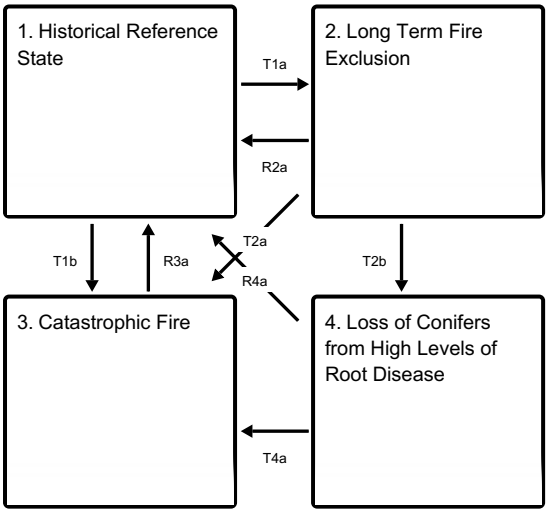
Douglas-fir is weakened or killed from Douglas-fir beetle (sometimes as secondary fire mortality), wood borers, tussock moth, and western spruce budworm. Western larch is susceptible to damage from dwarf mistletoe, needlecast and a host of fungi. Larch casebearer, sawfly, spruce budworm and tussock moth are common larch defoliators. Western white pine is greatly reduced from its historic expression by the impacts of white pine blister rust. Lodgepole pine is commonly impacted by western gull rust, mistletoe, and bark beetles, among other agents. Both Douglas-fir and grand-fir are very susceptible to root diseases (i.e. annosus and armillaria) and subsequent insect mortality, especially where stands become overstocked in combination with lower quality soils, and when seasonal climatic or weather conditions are poor. Common causes of insect damage to grand fir is from spruce budworm, tussock moth and the fir engraver beetle. Grand fir is also susceptible to a variety of pathogens and other injurious agents. Engelmann spruce is commonly impacted by wood-rotting fungi and broom rusts. Spruce beetle can cause serious mortality during outbreaks. The impact from diseases or subsequent insect infestation can be small and endemic, or larger scaled over time when these root disease and damage agents actually become epidemic.

Fire exclusion within the past 100 years has drastically changed the structural expression of the present forest in this ecological site, resulting in an increase in the proportion of mid to late seral tree species, and corresponding in increases in crown density and continuity. Fuel loads have increased at all levels on the majority of present day stands.

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 potential effects of climate change on ecosystem function or process. 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 evidence increases, this model will likely undergo alterations and updates to reflect our emerging understanding.

State and transition model

Ecosystem states



T1a - Long term fire exclusion

T1b - Widespread stand replacing fire

R2a - Treatment practices to reduce excessive ladder fuels

T2a - Time elapsed without major disturbance

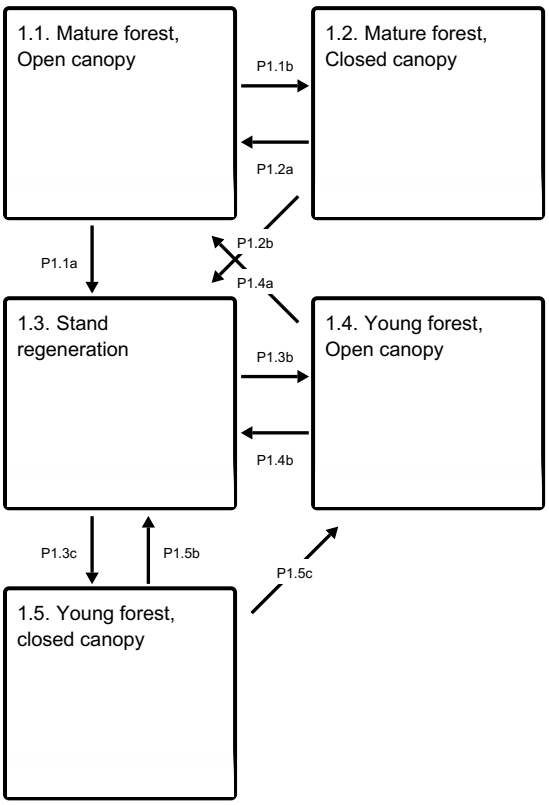
T2b - Time elapsed without major disturbance

R3a - Conifer planting

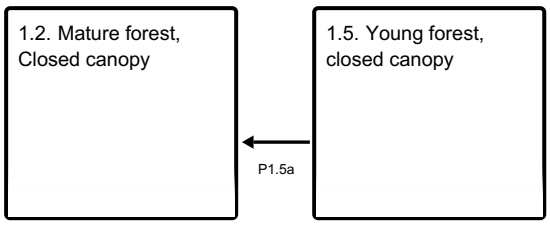
R4a - Significant time elapsed, and forest restoration efforts

T4a - Widespread catastrophic fire

State 1 submodel, plant communities



Communities 2 and 5 (additional pathways)



P1.1b - Time elapsed without major disturbance event

P1.1a - Stand replacing fire

P1.2a - Small or mid-scale level, mixed fire events or endemic/epidemic insect outbreaks

P1.2b - Stand replacing fire

P1.3b - The absence of larger scale fire disturbance, yet with low severity disturbance

P1.3c - Absence of larger scale fire disturbance for several decades, with abundant conifer recruitment

P1.4a - Time elapses with short disturbance intervals allowing stand maturation toward an open stand

P1.4b - Large scale stand disturbance such as stand replacing fire

P1.5a - Time elapses with long disturbance intervals allowing stand maturation toward a closed stand

P1.5b - Large scale stand disturbance such as stand replacing fire

P1.5c - Mixed fire events or endemic insect/disease impacts

State 1
Historical Reference State

The historical reference state existed across the landscape as a spatially complex forest mosaic of plant communities in various stages of development and with varying composition. The most common expression was the mature closed canopy stand (community 1.2), yet young closed canopy stands (community 1.5) were also common. Open canopy conditions were less common (1.1 and 1.4) due to conditions favoring long intervals between mixed or high severity fire. At the landscape scale, these historic stand structures were represented by a combination of patch openings, clumpy (dense or overstocked) tree groups which were often pole size or smaller, and as well-spaced mature overstory trees encompassing larger stand groups. A wide range of conifer

establishment and expression was possible due to the influence of a mixed fire regime. Following a disturbance in which large representatives of individual conifers were eliminated, the key to conifer re-establishment in the reference state relied on the recruitment of seed from adjacent sites, or from the few remnant surviving seed bearing sources. In a replacement fire of an older, mature stand, the trees that did survive tended to be the mature and over-mature early seral species because they have the most resistance to fire induced mortality.

Dominant plant species

- grand fir (*Abies grandis*), tree
- Douglas-fir (*Pseudotsuga menziesii*), tree
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub
- twinflower (*Linnaea borealis*), shrub

Community 1.1
Mature forest, Open canopy

This community phase was uncommon in the Pre-European reference state. The class size of the overstory layer is large, but overall canopy closure is low. Sites may be single or multi-canopied. Douglas-fir, Ponderosa pine, grand fir and Western larch are well represented. Reproduction varies with disturbance history. Patch mortality and mixed fire episodes also shape this phase. Thinleaf huckleberry is common in openings.

Community 1.2
Mature forest, Closed canopy

Large, mature trees dominate this community phase, which is the most common representation of the mature forest ecological site in the historic Pre-European context. Grand fir is the dominant conifer with Douglas-fir and Engelman spruce also very common. Twinflower and other shade tolerant subshrubs and forbs are common understory components. This state may be at higher risk of a stand replacement fire due to the contribution of excessive ladder fuels. Fire suppression may exacerbate this condition within this state and at sustained levels may promote a transition to alternative state 2 or 3. The Ecological Dynamics description (above) details this community phase.

Community 1.3
Stand regeneration

Following a stand replacement fire or other wide-spread disturbance (i.e. epidemic outbreaks, etc.) resprouting species such as grasses, forbs and shrubs will dominate. In some cases, dense shrubfields including species such as thinleaf huckleberry and spiraea may develop. Post-disturbance older (relict) seed trees such as mature Ponderosa pine, western larch and Douglas-fir, may survive to provide a seed source. In other cases, young patches of conifer seedlings and saplings, along with banked viable conifer seed in the surface of the soil, provide the source for initial conifer recruitment (e.g. lodgepole pine) within the stand. A short fire return interval of repeat fires can eliminate virtually all young conifer reproduction when they are still relatively small and susceptible to damage (recruitment is most prone to fire caused mortality in the seedling/sapling stage).

Community 1.4
Young forest, Open canopy

This was a historically an uncommon community type in the reference state. Canopy closure does not occur for a number of reasons. Initial seedling/sapling development may have been at a lower density, or localized mortality from disturbance events may have reduced the stocking levels of the developing stand. In this community phase, fuels are discontinuous, resulting in a lower probability of a stand replacement fire. Shade intolerant species remain dominant components in the subcanopy. Shade intolerant species remain dominant components canopy and subcanopy.

Community 1.5
Young forest, closed canopy

This was a common phase in the historical reference state. Early development conifer reproduction is high, resulting in a high density of Douglas-fir and grand fir in addition to Engelman spruce, ponderosa pine and western

larch. These species will often develop to occupy the understory mid-layer canopy position as the general stand ages. Lodgepole pine can be found on colder micro-sites across the landscape. This state may be at higher risk of a stand replacement fire due to the contribution of excessive ladder fuels. Fire suppression may exacerbate this condition within this state and at sustained levels may promote a transition to alternative state 2 or 3.

Pathway P1.1b
Community 1.1 to 1.2

In the absence of low/mixed severity fire events or disease/insect outbreaks regeneration and recruitment, especially of shade tolerant species such as grand fir and Engelman spruce, will continue to occur in the stand eventually leading to densely stocked closed canopy conditions.

Pathway P1.1a
Community 1.1 to 1.3

A stand replacement fire of significant size and impact shift the stand to the early development stage. Viable seed sources of adapted conifers must be present in order for stand initiation to occur.

Pathway P1.2a
Community 1.2 to 1.1

At a small or mid-scale level, mixed fire events or endemic/epidemic insect outbreaks shift the nature of the stand to the open phase (1.1).

Pathway P1.2b
Community 1.2 to 1.3

Stand replacement fire transitions the stand to the early development plant community phase; Secondary succession is initiated. Re-establishment of the conifer portion of the stand is dependent on successful seedling recruitment and establishment, similar to community pathway 1.1B

Pathway P1.3b
Community 1.3 to 1.4

The absence of larger scale fire disturbance, yet with low severity disturbance and with low levels of regeneration for several decades allows seedlings to develop and progress to the open canopy (low density) mid development phase.

Pathway P1.3c
Community 1.3 to 1.5

Absence of larger scale fire disturbance for several decades, with abundant conifer recruitment (with low levels of other disturbance events), results in the progression to the closed mid-development structure phase.

Pathway P1.4a
Community 1.4 to 1.1

The canopy density remains low as the stand grows towards maturity, with limited levels of additional seedling recruitment of early seral species (seedbed conditions become less favorable to the establishment of those species). In some cases, additional tree by tree mortality keeps the stand density low, and in other situations plant competition from grass or shrub understory species will inhibit establishment.

Pathway P1.4b
Community 1.4 to 1.3

Large scale stand disturbance (most often a stand replacement fire) shifts the stand back to community phase 1.3 (early development). As that happens, re-establishment of the conifer portion of the site is again dependent on the

factors described in phase 1.3.

Pathway P1.5a
Community 1.5 to 1.2

The stand develops in age and size to the closed late development phase (1.2). Shade and closed canopy conditions continue to favor grand fir establishment over the early to mid-seral species which include Ponderosa pine, larch, and Douglas fir. However, Douglas fir will reproduce in small patch openings created by local level disturbances.

Pathway P1.5b
Community 1.5 to 1.3

A large-scale stand disturbance (such as a stand replacement fire shifts the stand back to community phase 1.3 (early development). The re-establishment of the conifer portion of the site is dependent on the factors described in phase 1.3.

Pathway P1.5c
Community 1.5 to 1.4

Mixed fire events or endemic insect/disease impacts shift the stand structure to the young forest open canopy structural phase. In order for this to occur, the impacts of the disturbance would have to by patchy and small scale in nature.

State 2
Long Term Fire Exclusion

Conditions favorable to the development of this alternative state began to occur within the Reference State around the turn of the twentieth century. The impacts of fire exclusion, a management goal of post-European settlers and land managers, allowed many stands to progress without the natural occurrence of any fire, including frequent surface fires. Fire suppression shifted the age expression and density of the younger stands and changed the composition of understory vegetation, leading to reduced spatial variation. Fuel levels and fuel stratum layers increased, shifting the fire regime/condition class toward a greater likelihood of stand replacement fire episodes. The overall consequences of the changes to the forest structure and function due to the combined management actions in the last century are: INCREASED • Stand Density • Shift towards mid and late seral species • Amount of understory and secondary stand levels of conifers • Fuel loads and risk of catastrophic high severity fires DECREASED • Large old pine and other fire adapted early seral species • Regeneration of early seral species • Habit for species of open stands of old pine forests • Decreased levels of snags and large organic debris • Reduction in soil quality due to loss of soil wood and organic matter • Decrease in genetic variation of early seral species

Dominant plant species

- grand fir (*Abies grandis*), tree
- Douglas-fir (*Pseudotsuga menziesii*), tree
- twinflower (*Linnaea borealis*), shrub
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub

State 3
Catastrophic Fire

State 3 represents conditions immediately following a stand replacement fire. Short- and long-term detrimental impacts to wildlife, hydrology and soil quality begin to occur immediately due to the abnormally high intensity of the catastrophic burn. Microbial populations, organic matter levels, soil hydrophobicity and other structural elements of the native soil resources are negatively impacted. These types of fires, when they occurred within the historic context of the reference state, transitioned the stand to this alternative state if and when the vast majority of the cone producing conifers were eliminated by the fire, and when other sources of conifer recruitment are also absent (i.e. resulting in unstocked stand conditions). State 3 would infer a much longer post-fire stand recovery period

compared to situations that normally existed in the reference state (where older relict, seed producing early and mid-seral seed sources existed). The basic natural resource values (especially soil quality) were generally preserved or quickly restored in these instances. State 3 could also result from catastrophic stand replacement fires that originate from conditions found in alternative state 2.1 and 4.1 (as shown on the state and transition diagram by the T2A and T4A transition symbols). The destructive heat generated impacts of these events are much greater than naturally occurring replacement fires, and in these instances the basic natural resource values (plants, animals, hydrology and especially soil quality elements) have been degraded and are very slow to recover. Natural sources for conifer recruitment are absent.

Dominant plant species

- lodgepole pine (*Pinus contorta*), tree
- western larch (*Larix occidentalis*), tree
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub
- common snowberry (*Symphoricarpos albus*), shrub
- spirea (*Spiraea*), shrub

State 4
Loss of Conifers from High Levels of Root Disease

This state may seem to mimic the conditions of Alternative state 3 in that forest stocking is virtually non-existent, but the underlying cause leading to the unstocked condition and the recovery options are vastly different. In this state, immediate restoration by planting is not feasible because the root mass is still active in the soil, and young developing conifer seedlings will succumb to root disease mortality in a short period of time. Poorer quality sites are at greater risk of root disease occurrence and impacts, and species such as grand fir and Douglas-fir are most susceptible. Note that Alternative State 4 is at risk of catastrophic wildfire while fuel levels are in excess, which would transition the site to Alternative State 3 (by way of T4A.).

Dominant plant species

- western larch (*Larix occidentalis*), tree
- lodgepole pine (*Pinus contorta*), tree
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub
- twinflower (*Linnaea borealis*), shrub

Transition T1a
State 1 to 2

Long term fire exclusion (50-100+) years (resulting in Alternative State 2).

Transition T1b
State 1 to 3

A widespread stand replacing fire event occurs as a natural event in any phase of the reference state. Approximately ¾ or more of the cone producing age conifer species are killed across all age/size classes. There is a potential of a long-term deficiency of seed source(s) necessary for the re-establishment of the early, mid and late seral species (this results in Alternative State 3).

Restoration pathway R2a
State 2 to 1

Treatment practices that reduce excessive ladder fuels (low thinning) and reduce overstory bulk density and continuity (crown and selective thinning) may provide immediate benefits in terms of reducing the potential of catastrophic wildfire. Other practices which reduce overstocking, or which shift species towards early seral species (pre-commercial and commercial thinning, tree planting), as well as introducing understory prescribed burning as a maintenance practice, can contribute to increased resiliency and will improve the ecologic function of the stand if done properly.

Transition T2a
State 2 to 3

In the absence of catastrophic fire, the long-term build-up of mid to late seral Douglas-fir and grand-fir leads to increased levels of root disease, especially on poor quality sites (i.e. lower fertility soils or soils with depth/water holding limitations, sites with late summer excessive heat and drought). The eventual loss of all conifer species results in the development of long-term persistent brush fields.

Transition T2b
State 2 to 4

In the absence of catastrophic fire, the long-term build-up of mid to late seral Douglas-fir and grand-fir leads to increased levels of root disease, especially on poor quality sites (i.e. lower fertility soils or soils with depth/water holding limitations, sites with late summer excessive heat and drought). The eventual loss of all conifer species results in the development of long-term persistent brush fields.

Restoration pathway R3a
State 3 to 1

Conifers are planted in order to overcome the virtual lack of adequate seed source of surviving Ponderosa pine, larch, or Douglas-fir of any size or age class. Natural recovery will be extremely long without tree planning efforts, up to many 100’s of years as trees may slowly re-establish perimeter areas and migrate inwards by natural reproduction and under favorable circumstances. It is likely that persistent brush or grass/brush cover would exist for hundreds of years if un-planted. Soil quality is slow to respond to pre-fire levels, especially with the lack of soil organic wood input and other contributors to soil health.

Restoration pathway R4a
State 4 to 1

These impacted stands will need to be left alone for a long period of time, up to 100’s of years (where they remain protected from erosion by grass/shrub vegetation) until the sub-surface level of fungi naturally declines as infected roots decompose. At that time, forest restoration efforts similar to those described in Restoration Pathway 3A can be applied. Early seral species (Ponderosa pine, western larch and blister resistant western white pine) are most resistant to lingering root disease root threats and are also well adapted to establishing in full sunlight conditions. These species also acquire fire resistance attributes as they establish and grow. Site preparation will need to be done prior to planting.

Transition T4a
State 4 to 3

Widespread catastrophic fire occurs similar to that of T2A, with varying levels of live and dead conifer individuals, along with abnormal levels of native brush species.

Additional community tables

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Andrew Neary - Concept development for 2020 PES initiative
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Approval

Kirt Walstad, 9/08/2023

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	05/05/2024
Approved by	Kirt Walstad
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:**