USDA Natural Resources Conservation Service

Ecological site F044AF001MT
Lower Subalpine Moderately Warm and Moist Coniferous Pend Oreille-Kootenai Valleys grand fir/bride's bonnet

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Accessed: 05/12/2025

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): 044A–Northern Rocky Mountain Valleys

This ecological site resides within the NRCS land classification of MLRA 44A. This MLRA includes the northern portion of the Northern Rocky Mountain Valleys Province of the Rocky Mountain System. The mountain valleys are deeply dissected and are typically bordered by mountains trending north to south. The nearly level broad flood plains are bordered by gently to strongly sloping terraces and alluvial fans. The surrounding mountains and in some areas the valleys experienced glaciation. The average precipitation is 12 to 16 inches generally, though can vary widely. The dominant soil orders are Inceptisols, Mollisols and Andisols. The valleys support coniferous forests, shrublands and grasslands.

LRU notes

The landscape is valleys with landforms including floodplains, stream and outwash and lacustrine terraces, foothills and glacial moraines. Glaciation of this area was in the form of alpine, icecaps and valley outlet glaciers. It also includes associated alluvium and outwash features. This area includes valleys with elevation ranging 545 to 1680 m (average 855m).
The climate is cold and wet with mean annual air temperature of 8 degrees, mean frost free days of 106 days and mean annual precipitation of 863mm (effective annual precipitation is 880mm). The soil temperature regime is frigid and the soil moisture regime is udic and xeric. The geology of this area is predominantly alluvium and Belt series (Missoula group) and minor Glacial lake deposits. Soils are generally very deep, moderately to well developed and formed in alluvium, glacial outwash and till from metasedimentary parent materials. Soils tend to be well drained, slightly acidic to slightly alkaline soils with skeletal silt loam, loam and sandy loam textures. Poorly drained soils are present, but are generally confined to areas along riparian corridors. Volcanic ash influenced soils occur here as well, but tend to be limited to stable footslope positions above the valley floor. There are numerous large lakes and reservoirs including Pend Oreille Lake, Priest Lake, Noxon Reservoir, Cabinet Gorge Reservoir, Bull Lake and numerous short rivers and creeks.
This area is predominantly Western Hemlock and Western Red Cedar, with moderate Douglas Fir, Grand Fir, agricultural lands and minor Cottonwood-willow, Idaho fescue grasslands and Ponderosa Pine.

Classification relationships

LRU and ecological site is related to the EPA land classification framework of: Level 3- 15 Northern Rockies. Specifically, it includes Level 4-15q Purcell-Cabinet-North Bitterroot Mountains. This area is related predominantly to the USFS Provinces M333Ba Purcell-North Cabinet Mountains and M333Dc Clark Fork Valley and Mountains.

Ecological site concept

This ecological site is found west of the Continental Divide in moderately warm and moist mid-elevation sites, on

well drained lake and outwash terraces on toe and backslope positions. It occurs on low slopes generally one to 15 percent at elevations ranging from 600 to 800 m in the frigid soil temperature and udic soil moisture regimes. The soils associated with this ecological site are deep to very deep and derived from lacustrine deposits or ash over outwash material. Soil textures are loamy, commonly with loamy skeletal subsurface horizons, typically in the Inceptisol soil order. The vegetation is dominated by grand fir in the reference successional stage, but in earlier stages can be of Douglas fir and western larch. This ecological site has high plant diversity and is largely the result of the inland maritime climate and longer fire return interval. This ecological site is generally beyond the ecological and geographical limits of western redcedar and western hemlock, which are more shade tolerant and moisture dependent and comprise the bulk of the forested ecological sites found in this land resource unit (LRU).

Associated sites

F044AF006MT	**Lower Subalpine Moderately Cool and Moist Coniferous Pend Oreille-Kootenai Valleys western redcedar-western hemlock/bride's bonnet** This associated ecological site occurs in moister or wetter areas adjacent to this ecological site.
F044AF004MT	**Montane Moderately Warm Dry Coniferous Pend Oreille-Kootenai Valleys Douglas fir/common snowberry** This associated ecological site occurs in drier areas adjacent to this ecological site.

Similar sites

F044AP901MT	**Ashy Cool Moist Woodland Group** This similiar site is also in moist site conditions and the overstory is dominanted by Grand fir.

Table 1. Dominant plant species

Tree	(1) *Abies grandis* (2) *Larix occidentalis*
Shrub	(1) *Acer glabrum* (2) *Amelanchier alnifolia*
Herbaceous	(1) *Clintonia uniflora*

Physiographic features

This site is found in well drained lake and outwash terraces that span the lower elevations, on toe and backslope positions. At lower elevations it is bordered by ponderosa pine sites or grasslands, and at higher elevations by subalpine fir sites. It occurs on low slopes ranging one to 15 percent (rarely on moderate 30 percent slopes), at elevations ranging from 600 to 800 meters.

Table 2. Representative physiographic features

Landforms	(1) Lake terrace (2) Outwash terrace (3) Mountain slope
Elevation	600–800 m
Slope	1–15%
Water table depth	152 cm
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

This ecological site is found in the frigid soil temperature regime and the udic soil moisture regime. The soils that support this native plant community occur in the frigid soil temperature regime (average annual temperature less than 8 degrees C, with more than 5 degrees C summer-winter fluctuation). An udic soil moisture regime denotes that the rooting zone is usually moist throughout the winter and most of the summer. This site is found on the west side of the Continental Divide and has more maritime weather influences.

Table 3. Representative climatic features

Frost-free period (characteristic range)	69-87 days
Freeze-free period (characteristic range)	124-133 days
Precipitation total (characteristic range)	533-737 mm
Frost-free period (actual range)	65-107 days
Freeze-free period (actual range)	123-140 days
Precipitation total (actual range)	483-838 mm
Frost-free period (average)	81 days
Freeze-free period (average)	130 days
Precipitation total (average)	635 mm

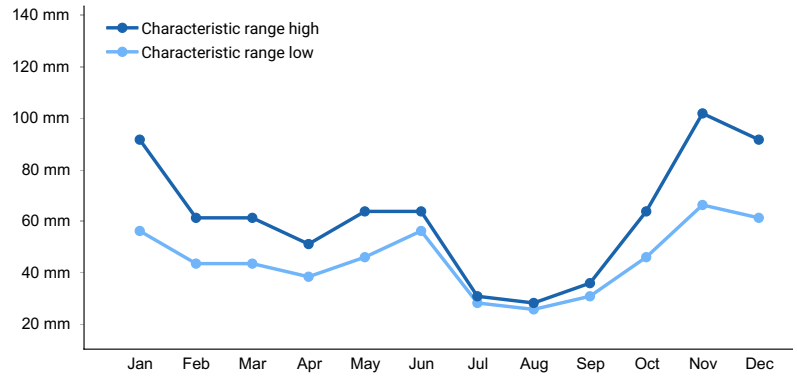


Figure 1. Monthly precipitation range

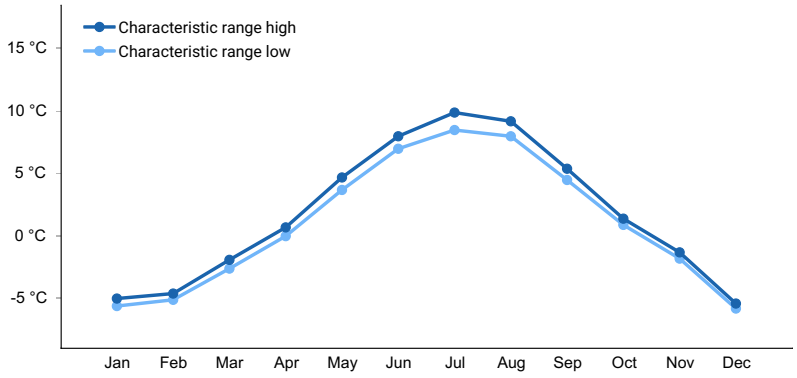


Figure 2. Monthly minimum temperature range

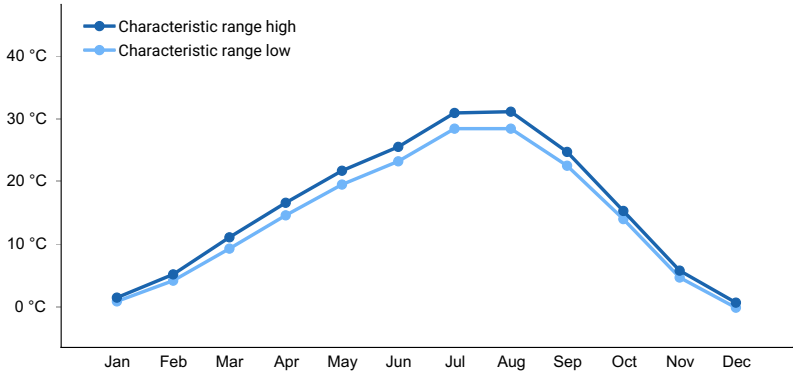


Figure 3. Monthly maximum temperature range

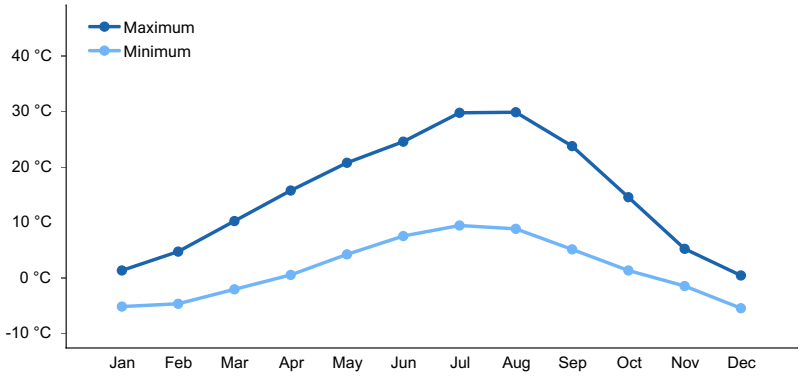


Figure 4. Monthly average minimum and maximum temperature

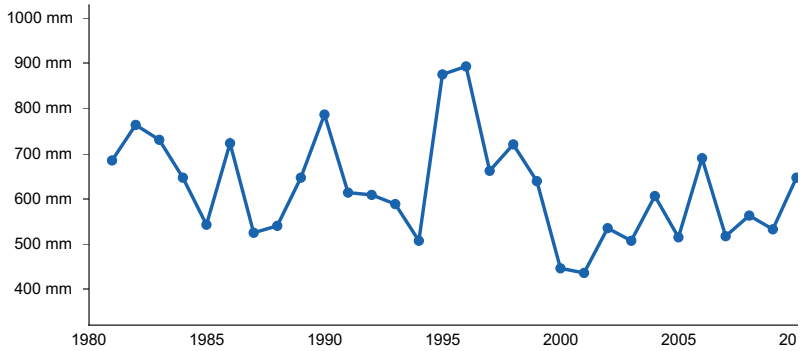


Figure 5. Annual precipitation pattern

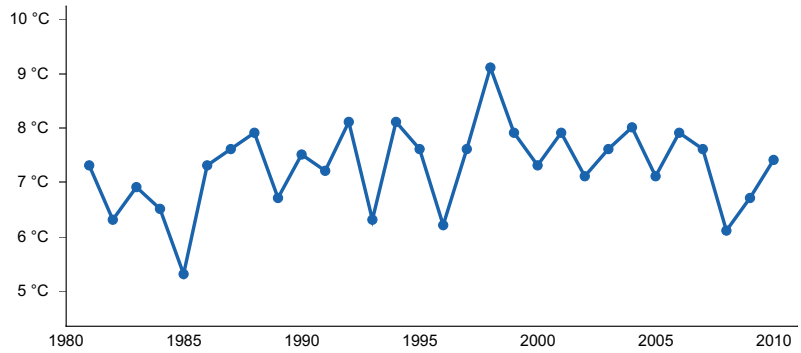


Figure 6. Annual average temperature pattern

Climate stations used

- (1) TROY [USC00248390], Troy, MT
- (2) LIBBY 1 NE RS [USC00245015], Libby, MT
- (3) HERON 2 NW [USC00244084], Heron, MT
- (4) TROUT CREEK RS [USC00248380], Trout Creek, MT
- (5) THOMPSON FALLS PH [USC00248211], Thompson Falls, MT

Influencing water features

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

Soil features

Soils associated with this ecological site are typically deep or very deep, well drained and derived from glacial till. Soil textures are loamy, but commonly contain some amount of rock fragments and can have skeletal subsurface horizons that have a high amount of rock fragments (greater than 35 percent by volume) and relatively lower water-holding capacity. The taxonomic particle size class is coarse-loamy. They are typically classified in Eutrudepts soil order. The deep and very deep depth class means that there is no bedrock encountered within 100 cm. As is

common with forested soils, there is often a thin surface layer of slightly decomposed organic material that is less than 5 cm thick (Soil Survey Staff, 2015).

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - from the mineral soil surface to 7 inches (A, Bw horizons);
Albic horizon - from 14 to 33 inches (2E horizon);
Cambic horizon - from 33 to 60 inches (2E/Bw, 2Bw/E horizons);
Particle-size control section - from 10 to 40 inches (Bw, 2E, 2E/Bw, 2Bw/E horizons).
Courville soils have a udic moisture regime and a frigid temperature regime.

For more information on soil taxonomy, please follow this link:
http://http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/?cid=nrcs142p2_053580

Table 4. Representative soil features

Parent material	(1) Till
Surface texture	(1) Ashy, gravelly silt loam
Drainage class	Well drained
Permeability class	Moderate
Soil depth	99–150 cm
Soil reaction (1:1 water) (0-101.6cm)	5.6–6.5

Ecological dynamics

►OVERVIEW:
This ecological site is relates to the Habitat Type Grand fir/brides bonnet, which is in the Fire Group 11, in the updated Region 1 Montana Potential Vegetation Type group of ABGR3 (4moderately warm and moist), in the old Habitat Type group (4) and in McDonald's grouping Cool Forest and Moderate Herb, in the Vegetation Response Unit 4, which includes historic western white pine and potential for root rot of the Armillaria complex.

This site is found west of the Continental Divide in moderately warm and moist mid-elevations sites, typically on bench and valley bottom landforms. It is largely the result of the inland maritime climate and longer fire return interval. This ecological site has high plant diversity in the overstory and understory. Grand fir is present in the reference and seral successional stages, but due to slow initial establishment and growth, it is subdominant to Douglas fir and western larch in early and mid-seral successional stages. Western white pine, Ponderosa pine, paper birch, western redcedar and western hemlock are scattered, occasional or incidentally occurring species present in all successional stages. This ecological site is generally beyond the ecological and geographical limits of western redcedar and western hemlock, which are more shade tolerant and moisture dependent and comprise the bulk of the forested ecological sites found in this land resource unit (LRU).

►MANAGEMENT:
Various management strategies can be employed for this ecological site group depending on the ownership of the particular land and which value is prioritized. The management of the forest determines the composition of the stand and the amount of fuel loading. A stand will be managed differently and look differently if it is managed for timber or ecological services like water quality, old growth, or endangered species. If a stand is managed for timber, then it may be missing certain attributes necessary for lynx habitat. If a stand is managed for lynx habitat, it may have increased fuels and therefore an increased risk of wildfires.

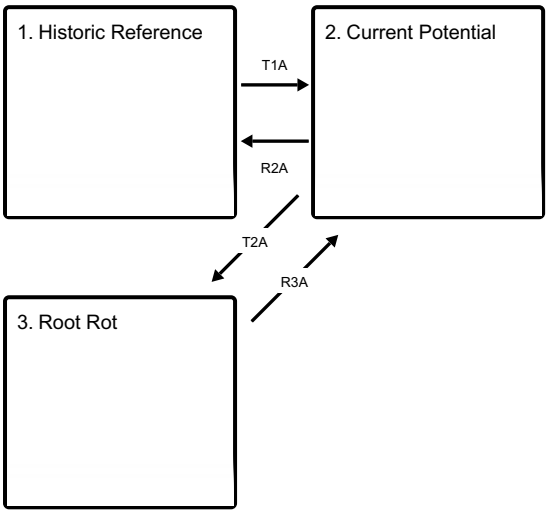
The USFS Habitat Type Guide (1973) states that the basal area on the western side of the Continental Divide for ABGR/CLUN2 is 254+/-94 ft2 per acre. The fifty-year site index for Douglas fir is 71, PICEA is 73, and grand fir is 58+-15.

Timber production on these sites is high to very high, particularly in the seral phases of this ecological site.

Each national forest has a specific management plan. The management plan for the Kootenai N.F. also has an Appendix B that gives specific management guidelines for habitat types (which relate to our forested ecological sites) found on the forest in relation to current and historic data on forest conditions (Kootenai N.F. Plan, 1997 and Appendix B). Another guiding USFS document is the Green et al. document (2005) which defines “Old Growth” forest for the northern Rocky Mountains. This document provides an ecologically-based classification of old growth based on forest stand attributes including numbers of large trees, snags, downed logs, structural canopy layers, canopy cover, age, and basal area. While this document finds that the bulk of the pre-settlement upland old growth in the northern Rockies was in the lower elevation, ground-fire maintained ponderosa pine/western larch/Douglas-fir types (Losensky, 1992), it does not mean that other types were not common or not important. This could apply to some of the areas of this ecological site.

State and transition model

Ecosystem states



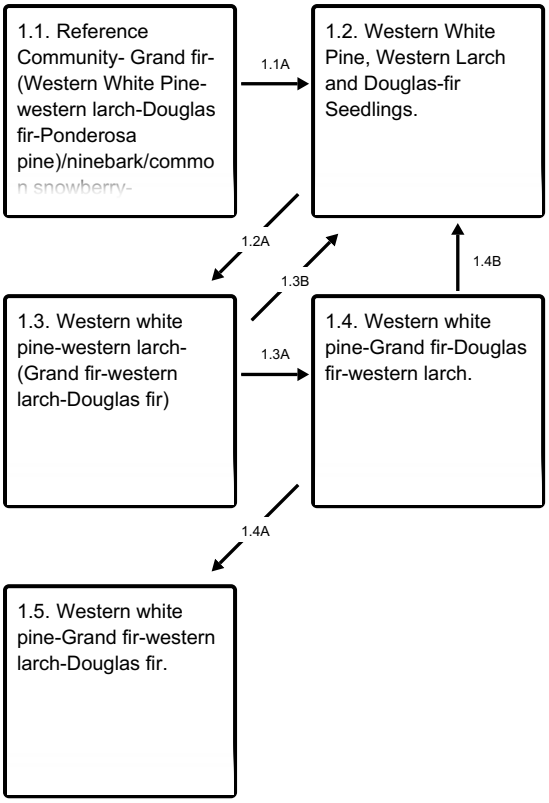
T1A - Substantial loss of western white pine as a major seral tree species.

R2A - Western white pine restored as a major seral tree species.

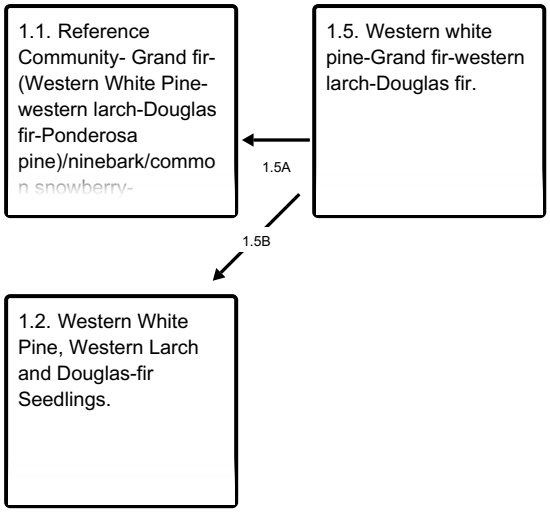
T2A - Significant loss of susceptible tee species at a site due to Armillaria root rot and conversion of the forest to a shrubland.

R3A - Conversion of the Armillaria root rot induced shrubland to forest, generally of less susceptible seral tree species and eventually to climax tree species.

State 1 submodel, plant communities



Communities 1, 5 and 2 (additional pathways)



1.1A - Severe wildfire kills overstory trees, except remnant western larch, and resets community to initiation phase.

1.2A - Time without disturbance allows tree seedlings to grow to pole sized trees and understory has less pioneering short lived species and more long lived perennial species.

1.3B - Severe wildfire kills trees, except maybe remnant western larch, and resets community to initiation phase.

1.3A - Time without disturbance allows pole sized trees to mature to larger tree diameters, gaps in overstory from windthrow and small single tree deaths allow remaining trees space and resources to grow.

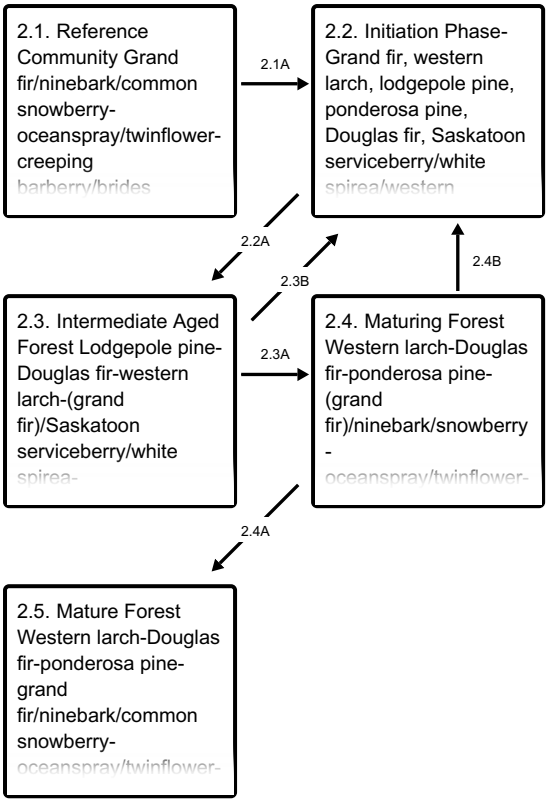
1.4B - Severe wildfire kills overstory trees, except remnant western larch, and resets community to initiation phase.

1.4A - Time without disturbance.

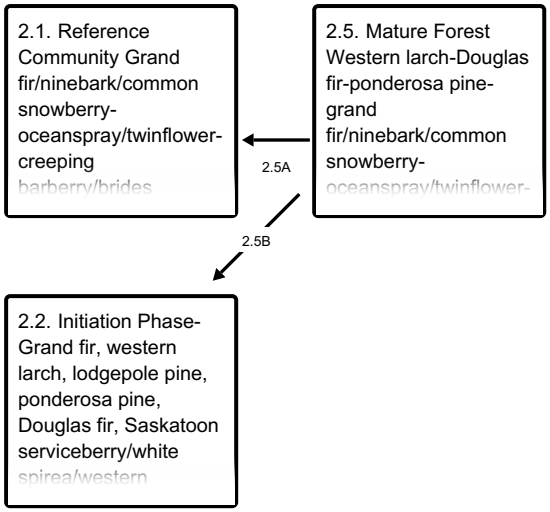
1.5A - Time without disturbance allows the maturing trees to grow and age into the reference phase with small gap dynamics and an understory dominated by perennial shrubs and herbaceous species.

1.5B - Severe wildfire kills overstory trees, except remnant western larch, and resets community to initiation phase.

State 2 submodel, plant communities



Communities 1, 5 and 2 (additional pathways)



2.1A - This pathway represents a major stand-replacement fire disturbance such as a high-intensity fire, large scale wind event, or major insect infestation.

2.2A - This pathway represents growth over time with no further significant disturbance. The areas of regeneration pass through the typical stand phases-competitive exclusion, maturation, understory reinitiating-until they resemble the old-growth structure of the reference community.

2.3B - This pathway represents a major stand-replacement fire disturbance such as a high-intensity fire, large scale wind event or major insect infestation.

2.3A - This pathway represents continued growth over time with no further major disturbance.

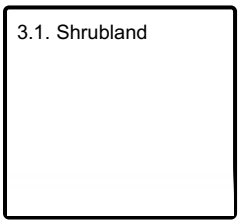
2.4B - This pathway represents a major stand-replacement fire disturbance, such as a major insect outbreak, or major fire event which leads to the stand initiation phase of forest development.

2.4A - This pathway represents continued growth over time with no further major disturbance.

2.5A - This pathway represents no further major disturbance. Continued growth over time, as well as ongoing mortality, leads to continued vertical diversification. The community begins to resemble the structure of the reference community, with small pockets of regeneration and a more diversified understory.

2.5B - This pathway represents a major stand-replacement fire disturbance leading to the stand initiation phase of forest development.

State 3 submodel, plant communities



State 1
Historic Reference

The historic State would have western white pine as a long-lived seral species in which the reference phase dominated by Grand fir would not be prevelant across landscape scales due to fire disturbance cycles and longevity of seral phases dominated by western white pine. Historically western white pine would have been within Lincoln County, which encompasses part of the Kootenai N.F., and in smaller islands stretching east to lower elevations, west of the Continental Divide in Glacier NP. The historic extent of western white pine in Glacier National Park was primarily along the western border. Originally, western white pine covered five million acres in the Inland Northwest. Western white pine is incredibly productive for timber with a very high growth rate, tall and deep–rooted, and competes best on highly variable, high resource sites. As well, it is tolerant to the native root rot diseases and other

native forest pests. Western white pine is susceptible to Armillaria root disease only when young, and to mountain pine beetle largely at advanced ages (over 140 years). It also has the capability to thrive in a wide variety of sites and environments, which means it has high ecological flexibility. It is a long-living seral species that tolerated intense timber harvesting practices and severe fire disturbance by its ability to regenerate heavily on mineral soil and full sunlight. Fire greatly influences the composition, structure, and function of vegetation across the landscape. Historically, it was mixed severity fire between severe stand replacement fires. Western larch and western white pine are long-lived, fire-adapted, shade-intolerant tree species that historically thrived. Also present in significant amounts particularly in young stands, but declined through time due to effects of insects and pathogens, were the shorter-lived, shade-intolerant, fire-adapted tree species such as Douglas-fir and lodgepole pine. Shade-tolerant, fire-intolerant tree species such as western cedar, western hemlock, grand fir, Engelmann spruce, and subalpine fir were present, but rarely survived long enough to dominate stands except in areas where the interval between fires was unusually long and where root disease was not severe. Prior to the 20th century, western white pine was a major component in forested ecosystems of the inland northwest U.S. It has been greatly reduced in distribution and abundance by white pine blister rust, mountain pine beetles, and anthropogenic fire exclusion (Tomback and Achuff, 2010). Western white pine has been replaced by Douglas-fir, grand fir, and western hemlock. Douglas-fir and grand fir are susceptible to a greater variety of insect and disease problems and western hemlock is more sensitive to drought and decay. More stands have also progressed to the climax species-dominated phase, which previously were rarely achieved due to the fire rotations and susceptibility of these species to disease and forest pests. In a study of pathogens and insects effects on forests within the Inland Empire found that, excluding fire, there were more than 90% of sample stands changed to a different cover type, structure stage, or both during a 40-year period that was coincident with the blister rust epidemic and fire suppression policy. Root pathogens, white pine blister rust, and bark beetle were the cause of most changes, and this accelerated succession of western white pine, ponderosa pine, and lodgepole pine to later successional, more shade-tolerant species. Structure was reduced in stand density or prevented canopy closure. Grand fir, Douglas-fir, and subalpine fir were the predominant cover types at the end of the period, and were highly susceptible to root diseases, bark beetles, fire, and drought. It is estimated that there will be continuation of this trend occurring in low-density mature stands and younger pole-sized stands that result from root disease and bark beetle-caused mortality (Byler and Hagel, 2000). These stands also are less productive in terms of timber. They are dominated by species with high nutrient demands, and therefore nutrient storage and cycling rates are increasingly depressed. This will likely lead to ever-increasing stress and destabilization by pests and diseases. Drought can further exacerbate the situation by stressing trees. The Inland Empire Tree Improvement Cooperative and the USFS have a breeding program for blister-resistant western white pine. Approximately 5 percent of the original acre range was re-planted with rust-resistant stock. Currently, the modified stock shows about 60 percent resistance to blister rust. A study modeling the effects of climate change found that warming temperatures would favor increased abundance of western white pine over existing climax and shade-tolerant species, mainly because warmer conditions potentiate fire dynamics, including increased wildfire frequency and extent, which facilitates regeneration (Loehman, et al., 2011

Community 1.1
Reference Community- Grand fir-(Western White Pine-western larch-Douglas fir-Ponderosa pine)/ninebark/common snowberry-oceanspray/ twinflower- creeping barberry/ bride’s bonnet /pinegrass-roughleaf ricegrass

Grand fir (western larch-Douglas fir-Western White Pine) overstory. Minor western white pine-western larch-grand fir. Rare phase due to disturbance rotations. Structure: Multistory with small gap dynamics. Age:140-Centuries

Community 1.2
Western White Pine, Western Larch and Douglas-fir Seedlings.

STRUCTURE: patchy clumps, single story. TIME: 1-50 years

Community 1.3
Western white pine-western larch-(Grand fir-western larch-Douglas fir)

STRUCTURE: dense, single-story with diminished understory. TIME: 50-100 years

Community 1.4
Western white pine-Grand fir-Douglas fir-western larch.

STRUCTURE: some vertical differentiation in stand TIME: 90-140 years-centuries

Community 1.5
Western white pine-Grand fir-western larch-Douglas fir.

STRUCTURE: Mature stand with patches. TIME: 100-140 years-centuries

Pathway 1.1A
Community 1.1 to 1.2

Severe wildfire kills overstory trees, except remnant western larch, and resets community to initiation phase.

Pathway 1.2A
Community 1.2 to 1.3

Time without disturbance allows tree seedlings to grow to pole sized trees and understory has less pioneering short lived species and more long lived perennial species.

Pathway 1.3B
Community 1.3 to 1.2

Severe wildfire kills trees, except maybe remnant western larch, and resets community to initiation phase.

Pathway 1.3A
Community 1.3 to 1.4

Time without disturbance allows pole sized trees to mature to larger tree diameters, gaps in overstory from windthrow and small single tree deaths allow remaining trees space and resources to grow.

Pathway 1.4B
Community 1.4 to 1.2

Severe wildfire kills overstory trees, except remnant western larch, and resets community to initiation phase.

Pathway 1.4A
Community 1.4 to 1.5

Time without disturbance.

Pathway 1.5A
Community 1.5 to 1.1

Time without disturbance allows the maturing trees to grow and age into the reference phase with small gap dynamics and an understory dominated by perennial shrubs and herbaceous species.

Pathway 1.5B
Community 1.5 to 1.2

Severe wildfire kills overstory trees, except remnant western larch, and resets community to initiation phase.

State 2
Current Potential

State 2 is different than State 1 in that western white pine no longer plays a significant role in the seral communities. It has been dramatically reduced in numbers and area by the epidemics of white pine blister rust and western spruce budworm, and by dramatic fire suppression. Therefore, climax species have been able to fill the seral role

that western white pine once held. As well, more forests are progressing to the climax or Reference Phase than historically, when most forests were in the fire-maintained western white pine-dominated seral phase. State 2 forests are now dominated by the shade-tolerant climax species Grand fir. While there is a tremendous effort to bolster the numbers of western white pine, it currently covers only 5 percent of its historic range. This ecological site is described as having moderately warm and moist site conditions in elevations between 731 to 1534 meters (2,400 to 5,000 feet) in valley bottoms and benches on all aspects in western Montana. The vegetation community is mainly determined by the inland maritime climate and long fire free interval. The Reference state is dominated by Grand fir which is a shade-tolerant climax conifer. After a major disturbance, numerous seral species can occur though Grand fir is the main shade tolerant species that continues to reproduce from the pole size to mature size phases. Moist site understory species are common including queencup beadlily, American trailplant, drops of gold, fragrant bedstraw, Rocky mountain maple, Saskatoon serviceberry, white spirea and common snowberry. The historic fire regime of these forests leads to a very diverse mosaic of landscapes due to various fire severities, intervals and patterns. It is a mixed severity regime with low and moderate severity fire more frequent and severe fire at much longer intervals. Therefore, it is one of generally low fire frequency, but fire severity can be highly variable. It can be low due to the most common moist conditions but can be severe during times of drought. Fire severity is enhanced due to the very high fuel loading in this ecological site. Historic fire return intervals were non-uniform, including mixed severity fires on 30-85-year intervals, as well as stand replacement fires on a 100-200 year intervals (VRU KOOTENAI). This finding is corroborated by the Landfire model. The Northern Rocky Mountain montane mixed-conifer forest, which spans through the north Idaho, western Montana and northeastern Washington, is based on the LANDFIRE Biophysical Settings (BpS) data layer of the forest succession model. This group had a fire interval of 10 to 80 years, with 11 to 52 percent of fires classified as of replacement severity and 14 to 69 percent of fires classed as mixed severity and 0 to 75 percent as low severity (USDA, USFS, FEIS, Fire Regime). This ecological site is in fire regime group 11 (Warm, Moist Grand fir, western redcedar, and western hemlock habitat types), of the western Montana fire ecology grouping (Pfister). Generalities for the role of fire in this moist environment with highly variable fire severities include: fire creates a mineral seedbed for climax and seral species regeneration, it creates a mosaic of seral and climax communities across the landscape and it affects within stand tree species composition. A fire history study of the Grand fir/queencup beadlily habitat type in the Swan Valley in western Montana, found fire return intervals of 100 to 200 years for stand replacing fires. The fuel loadings for this very productive ecological site can be very high (averaging 25 tons per acre, the highest of any fire group in western Montana) due to deadfall and natural thinning of small and medium-sized branches. In early and intermediate successional phases, the understory can have high cover adding to fuel loadings. Due to the generally moist conditions, fire return intervals can be long with fuels building up between fires. In general, the variability in fire regime and the high diversity of tree species present in most stands, allow this ecological site to form a diverse mosaic landscape with varying dominance or mixes of seral species. Species composition post fire is not solely determined by fire severity, rather species composition before fire, species within the onsite seedbank, offsite seeding and seedling establishment success play a larger role in this fire group than in others in western Montana. The general fire succession process is that after stand replacement fires in the reference phase of Grand fir with lesser Douglas fir, western white pine and western larch, the community reverts to an herbaceous one, then to shrubland. If fire is reoccurring in this phase, then the phase is maintained for a long time. The herbaceous community can be dominated by the disturbance-loving fireweed, beargrass, or numerous other species, depending upon the seedbank at the site and beyond. Duration of the herbaceous or shrubland phase is also dependent upon the availability of tree seed. There are different seral communities that will develop depending on seedling establishment. If serotinous lodgepole pine seeds are available, then the site will become dominated by it and a lodgepole pine stand will develop for about 10 to 25 years (Habeck, 1968). After that time, other species become established including western larch and other conifers. A fire in the early pole sized stage, severe enough to kill young western larch will return the site to an herb and then shrubland and then to a pure lodgepole pine seral forest. If serotinous lodgepole pine seeds are not present, then the seedlings are a very diverse mixture of conifers. These seedlings form a thick carpet on the site shared with shrub species such as Scouler’s willow, white spirea, thinleaf huckleberry, thimbleberry, and Oregon boxwood. Forbs present include ferns, beargrass and fireweed. Moss cover can be variable. If fire does not occur, the seedlings will grow to saplings and then pole-sized trees of diverse seral species. Low to moderate fires in this stage would favor fire-tolerant seral species over grand fir, which is less fire-resistant. Severe fires will return these to the herbaceous or shrubland phase. Various scenarios can result if one seral species is more successful in seedling establishment than other species. If lodgepole pine is not present, or the seeds are non-serotinous and or low in number, and western larch is present, numerous and has successful seedling establishment, it will dominate the post fire regeneration with lesser Douglas fir, western white pine, lodgepole pine and grand fir. Douglas fir will establish quickly, and later grand fir will establish as well and in time become co-dominant with western larch. If neither western larch nor lodgepole pine seedlings establish, then Douglas fir with seedlings present, will dominate the early seral seedling establishment. In the pole-sized phase,

seral species are abundant and grand fir is just becoming established and usually has low cover (3 to 15 percent of the stand). Without further disturbance, this phase will continue to the maturing forest in which grand fir becomes more evident in the stand and eventually has higher cover than the seral tree species. Western larch may survive severe fires in the maturing or mature phases. These trees would then provide seed for the stand initiation phase after a fire. As well, after frequent low to moderate fires in the mature phase, a relict western larch stand could occur. Reference stands in which only grand fir occur can be rare, as seral species are long-lived and fire occurs frequently enough that stands seldom develop beyond the mature phase. Reference stands may withstand low fires that thin the stand, but moderate or severe fires would return the site to the herbaceous or shrubland phase. Significant fires have occurred within this land resource unit in 1889 and in 1910. These fires were huge in size and severity. Since that time there have been extremely few fires of any substantial size (over 10 acres), except in 2015 in which one fire did encroach on this valley area from the adjoining mountains. Grand fir is subject to a variety of diseases and insect pests. Most notably, Armillaria and Annosus root diseases affect the roots with the former causing death of trees in patches. Stem decays are also a concern, including Pouch fungus, Indian paint fungus and red belt fungus. Other stem damagers include blue stain of sapwood and fir canker, the latter also affects branches and terminals. Wood borers include metallic wood borers, roundheaded borers and fir engravers. Damage to the foliage can be caused by Western spruce budworm, Delphinella shoot blight, black mildew, fir needle cast, snow blight, fir-fireweed rust and fir-blueberry rust. This is a list of the common species affecting Grand Fir, but abundance of each is determined by location. A good tool to use to discern the levels of insects and diseases, the damage patterns, and whether these are at endemic or epidemic levels is aerial photography. These maps (USFS Aerial Detection) capture only moments in time, and infestations grow and move from location to location following their preferred habitat, so repeated photography can be necessary. Specifically, for this LRU, the most common damage was Lophodermium needle cast of pines by Lophodermium species. This foliage disease affected ponderosa pine by defoliation and the severity was low, defined as equal to or less than 50 percent defoliation of an area. The pattern was defined as relatively continuous. To a minor extent, there was tree mortality due to the western pine beetle on ponderosa pine. Generally, in the northern region, the USFS Stand Health map shows, via many very large polygons throughout the area, that the major impact is defoliation by western spruce budworm. The defoliation was categorized as mostly of low severity (equal to or less than 50 percent defoliation) and some of high severity (with greater than 50 percent defoliation) on Abies species, and the damage is contiguous or nearly continuous. The forest type was categorized as W. Fir-Spruce. There also was defoliation by western spruce budworm on Douglas-fir, but to a much lesser degree. Larch casebearer, a defoliator of western larch, and generalized needlecast disease of western larch also was found, to a much lesser degree. Scattered small polygons showing damage were found throughout the region, including mortality from mountain pine beetle on lodgepole pines, Douglas-fir beetle on Douglas-fir, spruce beetle on Engelmann spruce, fir engravers and woolly adelgid on Abies species, and general Abies species mortality. These would affect the seral tree species of this ecological site and field notes corroborate these findings.

Community 2.1
Reference Community Grand fir/ninebark/common snowberry-oceanspray/twinflower-creeping barberry/brides bonnet/pinegrass roughleaf ricegrass.

Structure: Multistory with small gap dynamics of tall trees (40 to 120 plus feet), that are generally larger (DBH average 15 to 20 plus inches) and older and are dominated by grand fir through seral tree species are present to a minor extent. Time: 200 plus years The Reference Community is dominated by Grand fir (assumed to be proportionately 75 percent total overstory canopy cover with seral tree species constrained to 25 percent). The total overstory absolute cover is high and multi-storied (in height classes from 40 to 120 plus feet tall). Proportionately, there are more trees in the taller height classes (7 and 8 which are taller than 40 feet, than in the shorter class 6 which ranges 13 to 40 feet). The vegetation structure is that of tall multi-storied overstory trees from 40 to 120 plus feet tall, predominantly Grand fir. The most common seral tree species is western larch. Seral tree species that may be present include Ponderosa pine and Douglas fir and less cover (5 percent or less each species) of lodgepole and western white pine.

Forest overstory. This ecological site corresponds to Pfister (1977) habitat type Grand fir/brides bonnet which has the following dominant plant species including Douglas fir (constancy 10, average canopy cover 13%), lodgepole (5, 11%), Grand fir (10, 54%), ninebark (2, 15%), white spirea (7, 8%), common snowberry (7, 8%), twinflower (10, 5%), pinegrass (7, 14%), heartleaf arnica (3, 8%), broadleaf arnica (7, 8%), brides bonnet (10, 4%), Idaho goldthread (3, 8%), threeleaf foamflower (10, 3%) and starry false lily of the valley (8, 4%). Constancy values divided into classes including 1=5-15%, 2=15-25%, 3=25-35%, 4=35-45%, 5=45-55%, 6=55-65%, 7=65-75%, 8=75-85%, 9=85-95%, 10=95-100%.

Forest understory. The understory is moderately diverse in species and cover is moderate. The understory is multistoried. The tallest understory layer (4.5-13 feet) includes ninebark and Saskatoon serviceberry. The next lower layer (2-4.5 feet) includes common snowberry and oceanspray. The next layer (1-2 feet) includes rose and white spirea. The low layer (0.5-1 foot) has moderate cover and includes creeping barberry, pinegrass and roughleaf ricegrass. The lowest layer The understory is moderately diverse in species and cover is moderate. The understory is multistoried. The tallest understory layer (4.5-13 feet) includes ninebark and Saskatoon serviceberry. The next lower layer (2-4.5 feet) includes common snowberry and oceanspray. The next layer (1-2 feet) includes rose and white spirea. The low layer (0.5-1 foot) has moderate cover and includes creeping barberry, pinegrass and roughleaf ricegrass. The lowest layer (

Dominant plant species

- grand fir (*Abies grandis*), tree
- western larch (*Larix occidentalis*), tree
- Douglas-fir (*Pseudotsuga menziesii*), tree
- ponderosa pine (*Pinus ponderosa*), tree
- mallow ninebark (*Physocarpus malvaceus*), shrub
- oceanspray (*Holodiscus discolor*), shrub
- twinflower (*Linnaea borealis*), shrub
- creeping barberry (*Mahonia repens*), shrub
- pinegrass (*Calamagrostis rubescens*), grass
- roughleaf ricegrass (*Oryzopsis asperifolia*), grass
- bride's bonnet (*Clintonia uniflora*), other herbaceous

Table 5. Soil surface cover

Tree basal cover	0-10%
Shrub/vine/liana basal cover	0-15%
Grass/grasslike basal cover	0-5%
Forb basal cover	0-5%
Non-vascular plants	0-5%
Biological crusts	0-2%
Litter	40-70%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	0-10%

Table 6. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-5%	0-10%	0-5%	0-10%
>0.15 <= 0.3	0-5%	0-10%	0-5%	0-10%
>0.3 <= 0.6	0-5%	0-10%	–	–
>0.6 <= 1.4	0-5%	0-10%	–	–
>1.4 <= 4	0-5%	0-20%	–	–
>4 <= 12	0-10%	–	–	–
>12 <= 24	0-15%	–	–	–
>24 <= 37	20-50%	–	–	–
>37	–	–	–	–

Community 2.2
Initiation Phase-Grand fir, western larch, lodgepole pine, ponderosa pine, Douglas fir, Saskatoon serviceberry/white spirea/western brackenfern-starry false lily of the valley

►STRUCTURE: 1. HERB/SHRUB stage can be maintained long due to fires or herbivory. 2. STAND INITIATION PHASE: western larch/Saskatoon serviceberry/white spirea/western brackenfern-starry false lily of the valley. Single story overstory canopy that has high canopy cover (average 70 percent) of shorter (less than 40ft), smaller (average DBH less than 11 inches) and younger seral tree species with grand fir generally less than 5 percent canopy cover. There are cases of young, shorter, smaller treed forests where grand fir occurs with higher canopy cover (15 to 35 percent) and the average DBH is small. ►TIME: 50 to 60 years COMMUNITY PHASE 2.2: STAND INITIATION. REGEN: Post- fire 1 to 5 years Structure: Initially this post fire disturbance community is dominated by herbaceous and shrub species most commonly fireweed, species with a resident seedbank or disturbance loving species. Tree species that could be present include Grand fir, western larch, lodgepole pine, ponderosa pine, Douglas fir, quaking aspen, western white pine and incidental presence of western redcedar and western hemlock only. Structure: Continuous cover of regeneration-single story mixed tree species or pure lodgepole pine. Tree height is highly dependent on the species present, but is generally less than fifteen feet tall. Grand fir can grow tall quickly. Post-fire 5 to 50 years Structure: This is a forest in the stand initiation phase, possibly with scattered remnant mature trees; the composition of the seedlings depends on the natural seed sources available. Herbaceous species can include fireweed. Moss cover is variable. Tree species that could be present include Grand fir, western larch, lodgepole pine, ponderosa pine, Douglas fir, quaking aspen, western white pine and incidental presence of western redcedar and western hemlock only. Tree height is highly dependent on the species present, but is generally less than thirty feet tall. Grand fir is very fast growing and can be 100 feet tall by fifty years of age. COMMUNITY PHASE PATHWAY 2.2A This pathway represents growth over time with no further significant disturbance. The areas of regeneration pass through the typical stand phases-competitive exclusion, maturation, understory reinitiating-until they resemble the old-growth structure of the reference community. LATER EARLY SERAL STAGE: LAOC-PICO/AMAL2/SPBE2/PTAQ-SMST Single story overstory canopy that has high canopy cover (average 70 percent absolute canopy cover) of shorter (less than 40 feet), smaller (average DBH equal to or less than 11 inches) and younger seral tree species with Grand fir generally less than 5 percent canopy cover. There are cases of young, shorter, smaller treed forests where Grand fir occurs with higher canopy cover (10t o 35 percent) and the average DBH is small (less than 11 inches). Overstory of trees predominantly of shorter, smaller and younger trees with a few large remnant trees from previous fires. Total overstory canopy cover in the height classes 6 to 8 (13 to 120 feet) is high (average 73 percent). The majority of tree cover falls within height classes 6 and 7 (13 to 80 feet), as opposed to the taller height classes which dominate the mature and reference phase communities. These trees are young and have girths measured in diameter at breast height (DBH) generally less than 10 inches, except for remnant fire seral trees that are larger. These stands are dominated by western larch and lodgepole pine, with low cover of Grand fir. The tree species present on the site depends on the resident fire remnant species and tree species close to the site to disperse seeds onto site. The dataset is completely comprised of post logging operation sites that mimic the post-disturbance early seral phase of this ecological site. HISTORIC WOOD 5 DATASET (8 SITES): FOREST OVERSTORY Basal Area Average = 179 Average Absolute canopy cover = 73% Range= 50-85% Average Relative Canopy Cover by species when it occurs: LAOC=37%; PICO=78%; PIPO=8%; PSME=18%; POTR5=5%; ABGR=15%; TSHE=TRACE; PIMO3=TRACE Predominantly Height Class 6&7 (13-80 feet) DBH Average/Range: LAOC=11(10-11)”; PICO=9(7-15)”; ABGR=9 (9-10)”; PSME=10(9-11)” LAOC SITE INDEX=74 118

cubic feet 443 board feet PICO SITE INDEX=95 96 cubic feet 339 board feet.

Community 2.3
Intermediate Aged Forest Lodgepole pine-Douglas fir-western larch-(grand fir)/Saskatoon serviceberry/white spirea-snowberry/pinegrass

►STRUCTURE: Single story, high canopy over (average 70 percent) of moderately sized (average DBH 13 to 20 inches), seral tree species dominant forests with much less grand fir than in the mature or reference community phase (5 to 10 percent canopy cover). These trees are larger and taller than the late early community phase, but much smaller than the reference phase. ►TIME: 55 to 75 years This community phase is dominated by seral tree species that have matured to pole size and are in the competitive exclusion phase of forest succession. Overstory tree canopy is dense and competition for resources is very high. Canopy cover averages 60 percent. This community is incredibly diverse in tree species including: Lodgepole pine, Douglas fir, Ponderosa pine, Western larch, Western white pine. The overstory canopy of Grand fir averages 5 to 10 percent as they are just beginning to become established. The understory can include the tall shrub Saskatoon serviceberry, the medium statured shrubs common snowberry and white spirea and medium statured pinegrass. The herbaceous layer is diverse, though pinegrass does occur frequently and sometimes in high cover. Other herbaceous species include the short statured prince's plume, queencup beadlily, trailplant and twinflower. HISTORIC WOOD 5 DATASET: ALL SERAL DOMINANT STANDS SUMMARIZED (8 sites) There are variations within seral dominant forests within the Grand fir ecological site. One species may be dominant in terms of canopy cover over the other seral tree species at each specific site. Taken as a whole, these forests are dominated by seral tree species with Grand fir present with minimal cover. The trees in general are pole sized, with few remnant large seral trees that survived previous fires. Grand fir has very low canopy cover (5 to 10 percent). All of these sites have been previously logged. MIXED SERAL LAOC-PICO-ABGR-PSME-PIPO/SYAL-SPBE2 (HODI)/PTAQ/MARE11-LIBO3/CARU/COOC2 FOREST OVERSTORY METRICS Total Canopy Cover Average = 63% Range = 40-75% Relative Canopy Cover by species = PICO = 19% PSME =41% LAOC = 27% PIPO = 21% DBH Average/Range: LAOC =14 (9-22)" PSME =15 (9-24)" PIPO =17 (8-29)" Basal Area Average (all species included): 189 Range = 150-230 SITE INDEX, CUBIC FEET, BOARD FEET BY SPECIES LAOC: Site Index= 72 114 Cubic Feet 413 Board Feet PSME: Site Index= 72 115 Cubic Feet 447 Board Feet PIPO: Site Index= 115 131 Cubic Feet 543 Board Feet PICO: Site Index=102 88 Cubic Feet 304 Board Feet PRODUCTION (2sites) Total annual production at two sites at this community phase had 525 pounds/acre and 56 pounds per acre. There is no production by species for the historic Wood 5 dataset.

Community 2.4
Maturing Forest Western larch-Douglas fir-ponderosa pine-(grand fir)/ninebark/snowberry-oceanspray/twinflower-creeping barberry/brides bonnet/pinegrass-roughleaf ricegrass

►STRUCTURE: Multistory with small gap dynamics of tall trees (40 to 120+ feet), that are generally larger (DBH average 13 to 20 inches) and older and have more grand fir proportionately (15 to 30%), though seral tree species dominate. ►TIME: 58 to 90 (125) years The Maturing Forest Community is dominated by seral tree species (proportionately 70 to 85% total overstory canopy cover), with Grand fir constrained to 15 to 30 percent. The total overstory absolute cover averages 75 percent and ranges from 60 to 90 percent in height classes from 70 to 90 feet tall. The vegetation structure is that of tall single story forest with small dynamics from tree fall to create small patches of multi-storied overstory. The most common seral tree species are Douglas fir, Ponderosa pine and western larch. The understory is moderately diverse in species and cover is moderate. The understory is multistoried. The tallest understory layer (4.5-13 feet) includes ninebark and Saskatoon serviceberry. The next lower layer (2-4.5 feet) includes common snowberry and oceanspray. The next layer (1-2 feet) includes rose and white spirea. The low layer (0.5-1 foot) has moderate cover and includes creeping barberry, pinegrass and roughleaf ricegrass. The lowest layer (

Forest overstory. NRCS HISTORIC WOOD 5 DATASET (5 Sites); These have complete soil pedon descriptions and vegetation field sampling data of ocular estimation of canopy cover and tree production including site index and basal area and canopy cover, but are not GPS located, rather are historic and use township, section, range information.

Table 3. Forest overstory dataset. All sites had been historically logged. These forests have an overstory with more Grand fir in the tallest height classes (8 and 9 or 80+feet) and larger girth (DBH averages 15-20 inches) than in the intermediate stage.

ABSOLUTE CANOPY: AVERAGE=75% RANGE=60-90%
AVERAGE RELATIVE CANOPY COVER BY SPECIES: LAOC=27%; PSME=31%; PIPO=16%; ABGR=24%; PICO=3%

DBH Average/Range: ABGR = 14/11-20”; LAOC = 16/10-23”; PSME = 15/12-20”; PIPO=19/13-25”
SITE INDEX, CUBIC FEET, BOARD FEET BY SPECIES:
LAOC 63 102 345
PSME 63 98 357
PIPO 108 116 466
ABGR 44

Forest understory. The understory is multistoried. The tallest understory layer (4.5-13 feet) includes ninebark and Saskatoon serviceberry. The next lower layer (2-4.5 feet) includes common snowberry and oceanspray. The next layer (1-2 feet) includes rose and white spirea. The low layer (0.5-1 foot) has moderate cover and includes creeping barberry, pinegrass and roughleaf ricegrass. The lowest layer (

Community 2.5
Mature Forest Western larch-Douglas fir-ponderosa pine-grand fir/ninebark/common snowberry-oceanspray/twinflower-creeping barberry/brides bonnet/pinegrass-roughleaf ricegrass

►STRUCTURE: Mature forest with vertical differentiation in the stand. The overstory canopy cover is comprised of taller (over 40 feet tall), moderately large (DBH over 15 inches) and older trees of predominantly Grand fir and seral tree species. These trees are smaller and younger than those in the reference phase, but significantly larger than the later early phase or intermediate phase. These forests are dominated by Grand fir, far more than in the intermediate community phase. ►Time: 125 to 200 years.

Pathway 2.1A
Community 2.1 to 2.2

This pathway represents a major stand-replacement fire disturbance such as a high-intensity fire, large scale wind event, or major insect infestation.

Pathway 2.2A
Community 2.2 to 2.3

This pathway represents growth over time with no further significant disturbance. The areas of regeneration pass through the typical stand phases-competitive exclusion, maturation, understory reinitiating-until they resemble the old-growth structure of the reference community.

Pathway 2.3B
Community 2.3 to 2.2

This pathway represents a major stand-replacement fire disturbance such as a high-intensity fire, large scale wind event or major insect infestation.

Pathway 2.3A
Community 2.3 to 2.4

This pathway represents continued growth over time with no further major disturbance.

Pathway 2.4B
Community 2.4 to 2.2

This pathway represents a major stand-replacement fire disturbance, such as a major insect outbreak, or major fire event which leads to the stand initiation phase of forest development.

Pathway 2.4A
Community 2.4 to 2.5

This pathway represents continued growth over time with no further major disturbance.

Pathway 2.5A
Community 2.5 to 2.1

This pathway represents no further major disturbance. Continued growth over time, as well as ongoing mortality, leads to continued vertical diversification. The community begins to resemble the structure of the reference community, with small pockets of regeneration and a more diversified understory.

Pathway 2.5B
Community 2.5 to 2.2

This pathway represents a major stand-replacement fire disturbance leading to the stand initiation phase of forest development.

State 3
Root Rot

Another disease affecting this ecological site is root rot. Douglas-fir, grand fir, and subalpine fir are the most susceptible species. Armillaria root disease is the most common root disease fungus in this region, and is especially prevalent west of the Continental Divide. It may be difficult to detect until it has killed enough trees to create large root disease pockets or centers, ranging in size from a fraction of an acre to hundreds of acres. The root disease spreads from an affected tree to its surrounding neighbors through root contact. The root disease effects the tree species most susceptible first, leaving less susceptible tree species that mask its presence. When root rot is severe, the pocket has abundant regeneration or dense brush growth in the center. The common disease expression is some mortality in saplings, and residuals of partial harvests often develop severe infections but are very slow to die (Hagle, 2010). There has been a link determined between parent material and susceptibility to root disease (Kimsey et al., 2012). Metasedimentary parent material is thought to increase the risk of root disease. Areas dominated by metasedimentary parent material may be more at risk than other areas to root disease (Kimsey et al., 2012). If a stand sustains very high levels of root disease mortality, then a coniferous stand could cross a threshold and become a shrubland, once all conifers are gone (Kimsey et al., 2012). Management tactics include to identify the type of Armillaria root disease, and manage for pines and larch. Pre-commercial thinning may improve growth and survival of pines and larch. Avoid harvests that leave susceptible species (usually Douglas-fir or true firs) as crop trees (Hagel, 2010).

Community 3.1
Shrubland

Structure: Shrub-dominated area. Time: 50+ years

Transition T1A
State 1 to 2

Substantial loss of western white pine as a major seral tree species.

Restoration pathway R2A
State 2 to 1

Western white pine restored as a major seral tree species.

Transition T2A
State 2 to 3

Significant loss of susceptible tee species at a site due to Armillaria root rot and conversion of the forest to a shrubland.

Restoration pathway R3A
State 3 to 2

Conversion of the Armillaria root rot induced shrubland to forest, generally of less susceptible seral tree species and eventually to climax tree species.

Additional community tables

Table 7. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Forb					
1	**Perennial and annual forbs**			–	
	heartleaf arnica	ARCO9	*Arnica cordifolia*	–	0–33
	bride's bonnet	CLUN2	*Clintonia uniflora*	–	0–25
	sweetcicely	OSBE	*Osmorhiza berteroi*	–	0–12
	feathery false lily of the valley	MARA7	*Maianthemum racemosum*	–	0–10
	starry false lily of the valley	MAST4	*Maianthemum stellatum*	–	0–5
	western rattlesnake plantain	GOOB2	*Goodyera oblongifolia*	–	0–3
	violet	VIOLA	*Viola*	–	0–3
	woodland strawberry	FRVE	*Fragaria vesca*	–	0–2
	fragrant bedstraw	GATR3	*Galium triflorum*	–	0–2
	western meadow-rue	THOC	*Thalictrum occidentale*	–	0–2
	roughfruit fairybells	PRTR4	*Prosartes trachycarpa*	–	0–1
	darkwoods violet	VIOR	*Viola orbiculata*	–	0–1
Grass/Grasslike					
2	**Grasses**			–	
	mountain brome	BRMA4	*Bromus marginatus*	–	0–2
Shrub/Vine					
3	**Shrubs and subshrubs**			–	
	twinflower	LIBO3	*Linnaea borealis*	–	0–25
	redosier dogwood	COSES	*Cornus sericea ssp. sericea*	–	0–17
	common snowberry	SYAL	*Symphoricarpos albus*	–	0–5
	pipsissewa	CHUM	*Chimaphila umbellata*	–	0–3
	red baneberry	ACRU2	*Actaea rubra*	–	0–2
	Woods' rose	ROWO	*Rosa woodsii*	–	0–2
	Saskatoon serviceberry	AMAL2	*Amelanchier alnifolia*	–	0–1
	Oregon boxleaf	PAMY	*Paxistima myrsinites*	–	0–1
	thimbleberry	RUPA	*Rubus parviflorus*	–	0–1

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Approval

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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	10/25/2023
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:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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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:**
