USDA Natural Resources Conservation Service

Ecological site F044AF006MT
Lower Subalpine Moderately Cool and Moist Coniferous Pend Oreille-Kootenai Valleys western redcedar-western hemlock/bride's bonnet

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Accessed: 04/19/2024

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 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, icecap and valley outlet glaciers. It also includes associated alluvium and outwash features. This area includes valleys with elevation ranging 545 to1680m, with an average elevation of 855m. The climate is cold and wet with mean annual air temperature of 8 degrees C, mean frost free days of 106 days and mean annual precipitation of 863mm. The relative effective annual precipitation is 88cm. The soil temperature regime is frigid, and the soil moisture regime is udic and xeric. 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. The geology of this area is predominantly alluvium and Belt series (Missoula group) and minor Glacial lake deposits. 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

This ecological site resides within the NRCS land classification of MLRA 431 and LRU F Pend Oreille – Kootenai Valleys. MLRA 431 is referred to as the North Central Mountains and Foothills. Specifically, LRU K is the Pend Oreille – Kootenai Valleys.

This 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

The lower subalpine frigid coniferous site group is found west of the Continental Divide in moist areas within a maritime climate. It is found primarily in lake terrace and mountain slope landforms, on back, foot and toe slope positions, and on all aspects, spanning elevations from 650 to 850 meters.

The Reference Community is dominated by western cedar and western hemlock, with seral tree species constrained to less than 25 percent of the total overstory canopy. The ground cover consists predominantly of litter and duff with fairly high cover of moss and trace cover of embedded litter and stones. The vegetation structure is that of multistoried overstory trees ranging from 40 feet to over 120 feet tall of western redcedar, western hemlock, western larch and Douglas fir. The understory is multistoried though fairly sparse. The tallest understory layer is 20 to 40 inches tall and can include common snowberry (Symphoricarpos albus) and white spirea (Spiraea betulifolia). The lowest layer is less than 10 inches tall and can include fireweed (*Chamerion angustifolium*), pipsissewa (Chimaphila umbellata), queencup beadlily (Clintonia uniflora), western rattlesnake plantain (Goodyera oblongifolia), twinflower (Linnaea borealis), threeleaf foamflower (Tiarella trifoliata), and Oregon boxleaf (Paxistima myrsinites). The understory has less species diversity and canopy cover is very low in comparison to other forested ecological sites. Species are shade-loving and include princes plume, queencup beadlily, western rattlesnake plantain, twinflower, and a thick cover of moss.

Soils associated with this ecological site are very deep, loamy, usually ash-capped soils over rocky subsoils. Ash thickness on these soils varies and is mixed (not pure) and provides a boost in water-holding capacity to these sites. These soils generally belong in the Andic Eutrudepts soil subgroup, but also in the Andic Hapludafls and Typic Dystrudepts. There is a thin organic layer present in these soils, generally less than 5 cm thick.

Associated sites

F044AF001MT	**Lower Subalpine Moderately Warm and Moist Coniferous Pend Oreille-Kootenai Valleys grand fir/bride's bonnet** This associated ecological site resides in areas that are slightly less warm and moist than this ecological site due to aspect or elevation or other factors.

Similar sites

F044AP904MT	**Upland Cool Moist Woodland Group** This similiar ecological site is broader in scope but has similiar site conditions and the overstory is dominated by western redcedar and western hemlock.

Table 1. Dominant plant species

Tree	(1) *Thuja plicata* (2) *Tsuga heterophylla*
Shrub	(1) *Symphoricarpos albus* (2) *Spiraea betulifolia*
Herbaceous	(1) *Clintonia uniflora* (2) *Aralia nudicaulis*

Physiographic features

The lower subalpine frigid coniferous site group is found west of the Continental Divide in moist areas within a maritime climate. It is primarily located on lake terrace and mountain slope landforms on back, foot and toe slope positions, with linear slope shape down and across, and on all aspects, spanning elevations from 650 to 850 meters. In Montana, the site group is generally found at elevations ranging from 2,000 to 5,000 feet. The annual precipitation average is above 32 inches (USFS H.T. Guide, 1977).

Table 2. Representative physiographic features

Landforms	(1) Terrace--stream or lake (2) Outwash terrace (3) Ground moraine (4) Alluvial fan

Elevation	2,000–5,000 ft
Slope	5–35%
Water table depth	60 in
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). A 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)	68-79 days
Freeze-free period (characteristic range)	124-129 days
Precipitation total (characteristic range)	22-30 in
Frost-free period (actual range)	65-80 days
Freeze-free period (actual range)	122-130 days
Precipitation total (actual range)	19-33 in
Frost-free period (average)	73 days
Freeze-free period (average)	127 days
Precipitation total (average)	26 in

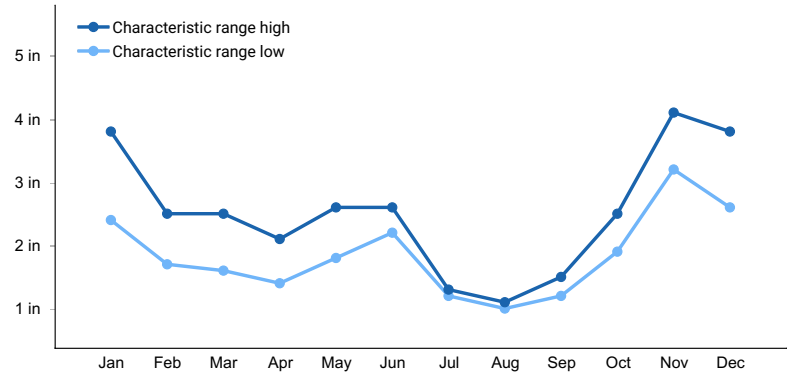


Figure 1. Monthly precipitation range

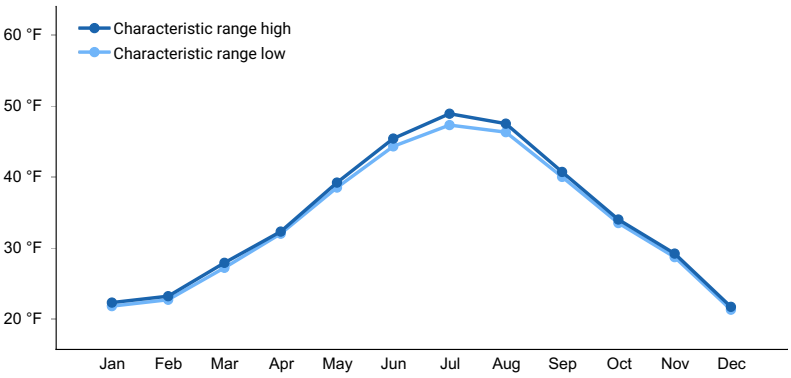


Figure 2. Monthly minimum temperature range

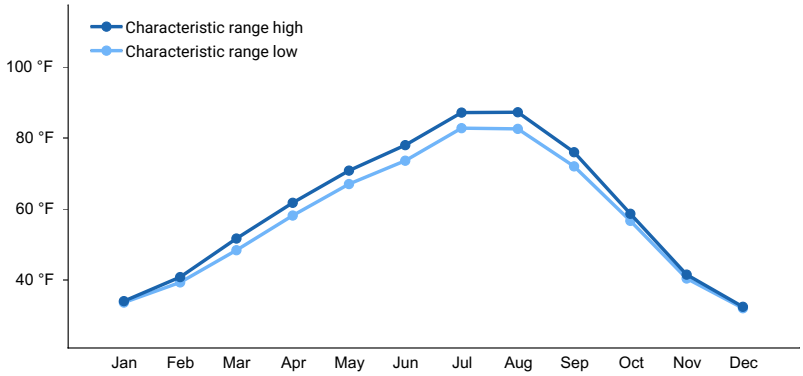


Figure 3. Monthly maximum temperature range

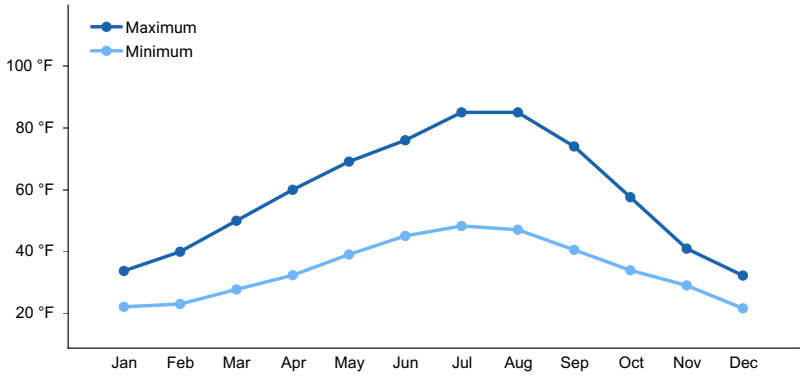


Figure 4. Monthly average minimum and maximum temperature

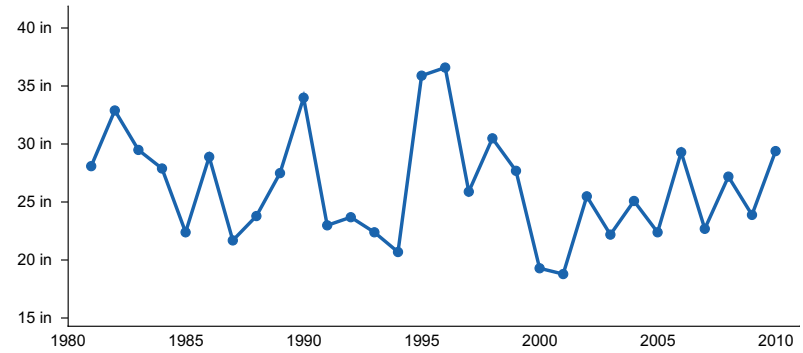


Figure 5. Annual precipitation pattern

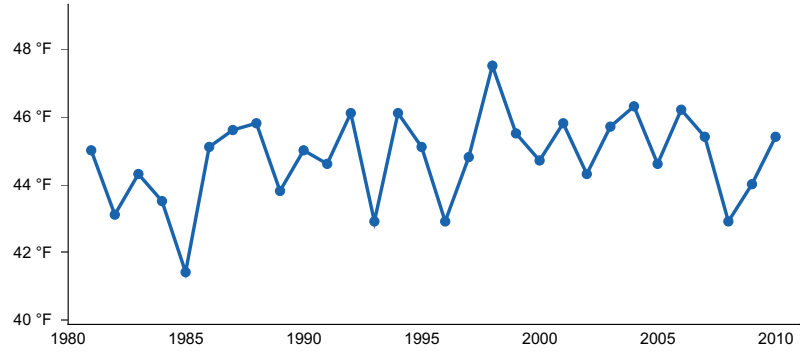


Figure 6. Annual average temperature pattern

Climate stations used

- (1) TROY [USC00248390], Troy, MT
- (2) TROUT CREEK RS [USC00248380], Trout Creek, MT
- (3) HERON 2 NW [USC00244084], Heron, MT

- (4) LIBBY 1 NE RS [USC00245015], Libby, MT

Influencing water features

This ecological site is not influenced by wetland or riparian water features but may be found on stream terraces or adjacent to wetland and riparian areas.

Soil features

Soils associated with this ecological site are very deep, loamy, commonly ash-capped soils sometimes over rocky subsoils. Ash thickness on these soils varies and is mixed (not pure) and provides a boost in water-holding capacity to these sites. These soils generally belong in the Andic Eutrudepts soil subgroup, but also in the Alfic Udivitrands and Udivitrands. There is a thin organic layer present in these soils, generally less than 5 cm thick.

Diagnostic horizons and features recognized in this pedon in the (Sunroad) - Andic Eutrudepts subgroup are:
Ochric epipedon -- from 0 to 16 cm (Oi, Oe, E horizons)
Andic soil properties -- 12 to 38 cm (E, Bw1, Bw2 horizons)
Cambic horizon -- from 16 to 38 cm (Bw1, Bw2 horizons)
Particle-size control section -- from 37 to 112 cm (part of the Bw2, 2C1, part of the 2C2 horizons)
Courvash soils -
Diagnostic horizons and features recognized in this pedon are: a volcanic ash mantle from the mineral soil surface to 18 inches (A, Bw1 and Bw2 horizons); an ochric epipedon from the mineral soil surface to 7 inches (A, Bw1 horizons); an albic horizon from 18 to 31 inches (2E horizon); an argillic horizon from 31 to 60 inches (2Bt/E, 2Bt horizons); a particle size control section from 0 to 40 inches below the mineral soil surface (A, Bw1, Bw2, 2E, and 2Bt/E horizons). Courvash soils have a udic moisture regime and a frigid temperature regime.
Dewberry soils -
Diagnostic horizons and features recognized in this pedon are: a volcanic ash mantle from 1 to 24 inches (A, Bw1 and Bw2 horizons); an ochric epipedon from the mineral soil surface to 7 inches (A, Bw1 horizons); a particle size control section from 0 to 40 inches below the mineral soil surface (A, Bw1, Bw2 and 2C horizons).

Soils have a frigid temperature regime and an udic moisture regime.

“Mount Mazama (Crater Lake, Oregon) violently erupted around 6,700 years ago. The massive plume of volcanic ash from the eruption drifted in a northwest direction through northwest Montana. Deposition was widespread throughout western Montana, but is greatest in the northwest corner of the state. The ash likely fell uniformly across the landscape and was then re-distributed by wind and water erosion. The resulting distribution, given the dominate winds from the south and southwest, favors thicker deposits of ash on slopes with north-facing aspects. Little ash is usually found on south-facing slopes except at the higher elevations in cirque basins. Volcanic ash has a large impact on overstory and understory plant productivity due to the increase in water-holding capacity that it adds to the soil. The ash is typically found as a surface mantle overlying whatever existing soil or parent material it was deposited on top of. The ash mantles exhibit varying amounts of mixing with the underlying material, but tend to lack the rock fragments commonly found in the sub-soils of the park. Ashy soil layers generally tend to have brighter colors than the underlying sub-soils and have a soft and very friable consistency.” (J. Skovlin, personal communication, 2015; Soil Survey Staff, 2015).

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) Volcanic ash (2) Till (3) Lacustrine deposits (4) Alluvium–metasedimentary rock
Surface texture	(1) Very gravelly sandy clay loam (2) Silt loam (3) Fine sandy loam
Drainage class	Well drained

Soil depth	39–59 in
Soil reaction (1:1 water) (0-40in)	5.6–6.4
Subsurface fragment volume <=3" (0-40in)	0–15%
Subsurface fragment volume >3" (0-40in)	0–35%

Ecological dynamics

►OVERVIEW:
This group is found throughout this MLRA/LRU unit and in the Kootenai NF.

This ecological site relates to the USFS Habitat Types of western redcedar/brides bonnet and western hemlock/brides bonnet which are in Fire Group 11 and are in the updated USFS Region 1 Montana Potential Vegetation Type THPL2 (moderately cool and moist) and in the old Habitat Type Group 5. McDonald had these Habitat Types in the western redcedar-western hemlock grouping which had historical western white pine and potential for root rot Armillaria complex. In the Vegetation Response Unit these were in group 5.

►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.

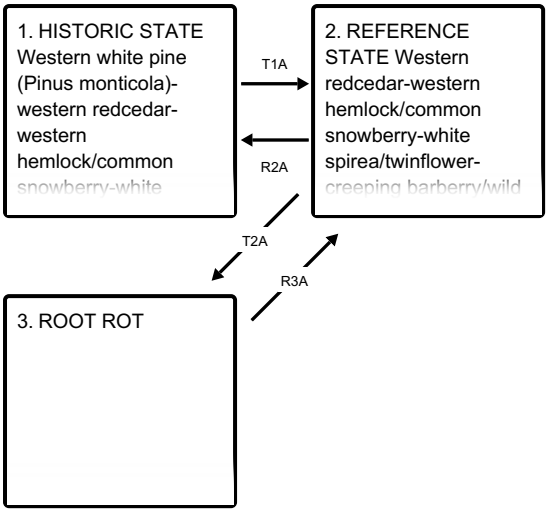
The USFS Habitat Type Guide (1973) states that the basal area on the western side of the Continental Divide for TSHE/CLUN2 is 267+/-55 ft2 per acre. The fifty-year site index for western white pine is 62, western larch is 80, PICEA is 77, and grand fir is 50. Basal area for THPL/CLUN2 is 305+/-96 ft2 per acre and the site index for Douglas-fir is 66, western larch is 63, PICEA is 72+/-14, grand fir is 61, and ABLA is 74.

Timber production on these sites is 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 National Forest. 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, 2001 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 may apply to some of the areas of this ecological site.

State and transition model

Ecosystem states



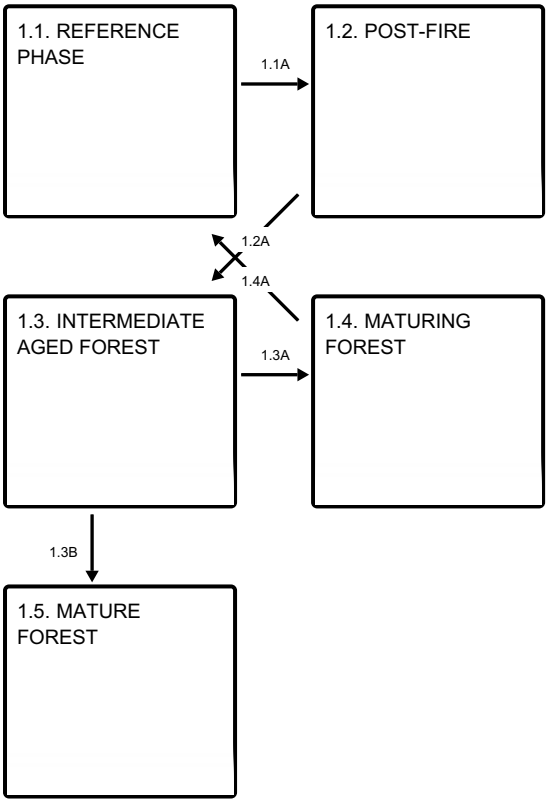
T1A - Substantial loss of western white pine as a major seral tree species.

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

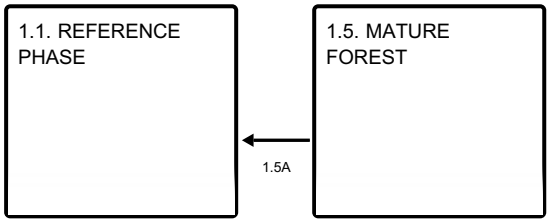
T2A - Significant loss of susceptible tee species at a site due to Armillaria root rot and conversion of the forest to a shrubland.

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 and 5 (additional pathways)



1.1A - Fire and post fire recovery

1.2A - Aging and density increase in stand due to the process of forest in the absence of fire.

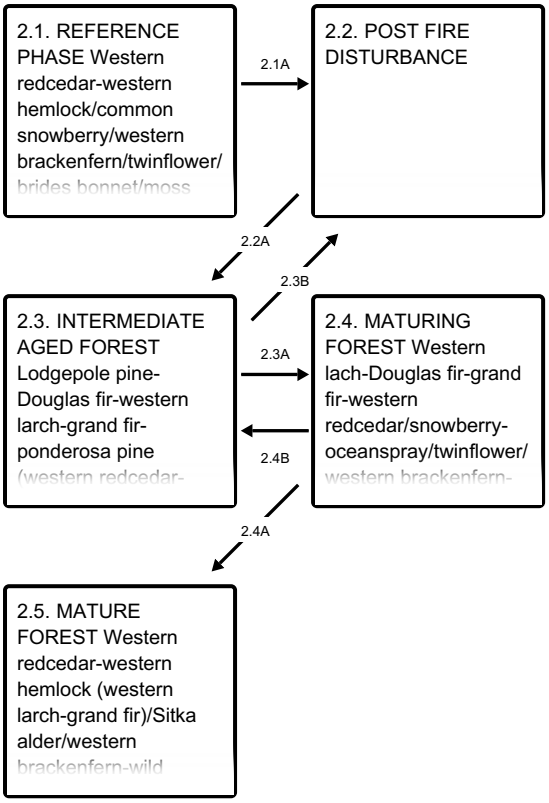
1.3A - Maturing of the forest stand in the absence of fire or disturbance.

1.3B - The mature stand dynamics with the absence of fire and aging stand opening processes.

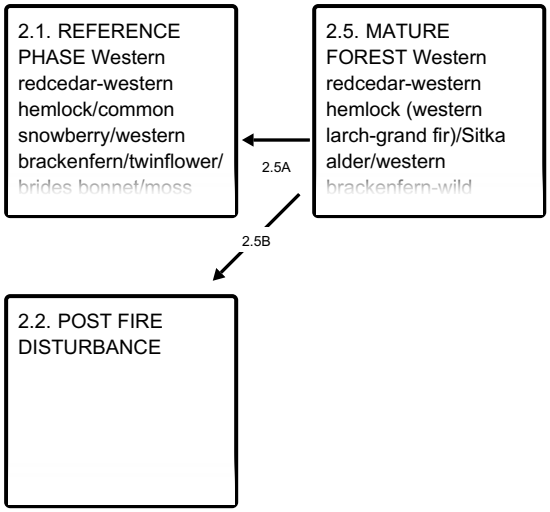
1.4A - Fire, controlled or wild, or other stand renewing practices that spark a renewal of early seral trees.

1.5A - Fire, controlled or wild, or other stand renewing practices that spark a renewal of early seral trees.

State 2 submodel, plant communities



Communities 1, 5 and 2 (additional pathways)



2.1A - This pathway represents a major, stand-replacement disturbance such as a high-intensity fire, large-scale wind event, or a large 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, namely: competitive exclusion, maturation, understory reinitiating.

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

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

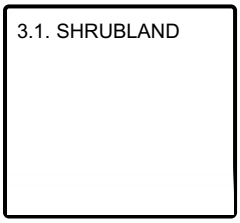
2.4B - This pathway represents a major, stand-replacement disturbance, such as a large insect outbreak, or major fire event which leads to the stand initiation phase of forest development.

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.

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 STATE Western white pine (Pinus monticola)-western redcedar-western hemlock/common snowberry-white spirea/twinflower-creeping barberry/wild sarsaparilla-bride's bonnet

Historically western white pine would have been throughout this MLRA/LRU unit and Kootenai NF. Western white pine covered five million acres in the Inland Northwest. Western white pine is incredibly productive for timber due to a fast growth rate, tall stature, deep roots, and the ability to compete best on highly variable, high resource sites. Additionally, 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 with its ability to regenerate 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, were the shorter-lived, shade-intolerant and 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 United States. However, it has now 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. Out of these tree species, Douglas-fir and grand fir are susceptible to a greater variety of insect and disease problems, whereas 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. A study of pathogen and insect effects on forests within the Inland Empire found that 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. This accelerated the succession of western white pine, ponderosa pine, and lodgepole pine to later successional, more shade-tolerant species. Furthermore, structure was reduced in stand density and 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, which can be further exacerbated by drought. 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 in Glacier NP, mainly because warmer conditions may increase wildfire frequency and extent, which helps western white pine regeneration (Loehman, et al 2011).

Community 1.1
REFERENCE PHASE

Reference phase of multi-storied forest canopy dominated by western redcedar and western hemlock. Subalpine fir-Engelmann spruce overstory. Minor western white pine-western larch-grand fir. Rare phase due to disturbance rotations. ►STRUCTURE: Multistory with small gap dynamics.

Community 1.2
POST-FIRE

Post fire disturbance community of herb and shrub species. Western white pine-western larch-(lodgepole pine) seedlings. ►STRUCTURE: Patchy clumps, single story. ►TIME: 1 to 50 years

Community 1.3
INTERMEDIATE AGED FOREST

Intermediate aged forest, dense thick pole sized trees. Western white pine-western larch-(subalpine fir-grand fir-Engelmann spruce). ►STRUCTURE: Dense single story with diminished understory. ►TIME: 50 to 140 years.

Community 1.4
MATURING FOREST

Maturing forest phase of seral tree species and western redcedar and western hemlock. Western white pine-

(western hemlock-western redcedar-grand fir). ►STRUCTURE: Some vertical differentiation in stand. ►TIME: 140 years to centuries.

Community 1.5
MATURE FOREST

Mature forest with some small gap dynamics, remnant seral trees species and western redcedar and western hemlock dominant. Western white pine-(western hemock-western redcedar-grand fir). ►STRUCTURE: Mature stand with patches of open canopy cover. ►TIME: 140 years to centuries.

Pathway 1.1A
Community 1.1 to 1.2

Fire and post fire recovery

Pathway 1.2A
Community 1.2 to 1.3

Aging and density increase in stand due to the process of forest in the absence of fire.

Pathway 1.3A
Community 1.3 to 1.4

Maturing of the forest stand in the absence of fire or disturbance.

Pathway 1.3B
Community 1.3 to 1.5

The mature stand dynamics with the absence of fire and aging stand opening processes.

Pathway 1.4A
Community 1.4 to 1.1

Fire, controlled or wild, or other stand renewing practices that spark a renewal of early seral trees.

Pathway 1.5A
Community 1.5 to 1.1

Fire, controlled or wild, or other stand renewing practices that spark a renewal of early seral trees.

State 2
REFERENCE STATE Western redcedar-western hemlock/common snowberry-white spirea/twinflower-creeping barberry/wild sarsaparilla-bride's bonnet

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, western spruce budworm, and by dramatic fire suppression. As a result, climax species have been able to fill the seral role that western white pine once held. Additionally, more forests are progressing toward this state 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 western redcedar and western hemlock. While there is a large effort to bolster the numbers of western white pine, it currently covers only 5 percent of its historic range. State 2 is dominated by western redcedar and western hemlock, both of which are shade-tolerant climax conifers that grow in similar environments. Western redcedar has a larger geographic extent in Montana, but western hemlock usually is capable of dominating over western redcedar and other species at climax because it is better able to reproduce under a dense forest canopy. Western redcedar is able to maintain itself indefinitely as a minor climax species because of its shade tolerance and longevity (average lifespan of 600-1,000 years). Within Glacier NP, these species are co-dominant in nearly all of the sites visited. The seral successional stages have very diverse overstory

tree composition and can be very productive in terms of basal area. Douglas fir, western larch and, to a lesser extent, spruce are often dominants in seral stands with lodgepole, western white pine, and paper birch as minor components. Grand fir and subalpine fir can be either minor seral or climax components. Western redcedar and western hemlock will regenerate after disturbance along with seral species, and it will take centuries for these species to gain dominance in the overstory over the seral species. The early successional phase can be dominated by fireweed (*Chamerion angustifolium*). The understory in seral successional phases have moisture-loving forbs or shrubs including Scouler's willow, thimbleberry, serviceberry, Rocky Mountain maple, thinleaf huckleberry, and snowbush ceanothus. The historic fire regime of these forests is one of low fire frequency, but fire severity can be highly variable. It can be low due to the most common moist conditions and can be severe during times of drought. Fire return intervals range from 50 to greater than 200 years, but include mixed severity fires on 50-85 year intervals, as well as stand replacement fires on 150 to 250 year intervals. Western redcedar can thrive for centuries on this ecological site without disturbance. The Northern Rocky Mountain mesic-montane-mixed-conifer-forest-cedar groves are in fire regime group 5 and have a fire interval of 334 years, with 87 percent of fires classified as of replacement severity and 13 percent of fires classed as mixed severity and none as low severity (USDA, USFS, FEIS, Fire Regime). Fuel loadings for this ecological site can be very high due to deadfall and natural thinning of small and medium-sized branches. In early and intermediate successional phases, the understory can have high cover, which adds to fuel loadings. In general, the variability in fire regime and the high diversity of tree species present in most stands, except the reference phase, allow this ecological site group to form a diverse mosaic landscape with varying dominance or mixes of seral species. The general fire succession process is that after stand replacement fires, 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. If serotinous lodgepole pine seeds are available, then the site will become dominated by it and a lodgepole pine stand will develop for about 10-25 years (Habeck, 1968). After that time, other species become established including western larch and other conifers. 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 pole-sized trees of diverse seral species. Low to moderate fires in this stage would favor fire-tolerant seral species over western redcedar, grand fir, or western hemlock, which are less fire-resistant. Severe fires will return these to the herbaceous or shrubland phase. In the pole-sized phase, seral species are abundant and western redcedar and western hemlock are just becoming established and usually have low cover (3-15 percent of the stand).Without further disturbance, this phase will continue to the maturing forest in which western redcedar and western hemlock become more evident in the stand and eventually have 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. Additionally, after frequent low to moderate fires in the mature phase, a relict western larch stand could occur. Reference stands in which only western redcedar and western hemlock occur can be rare, as seral species are long-lived and fire occurs frequently enough that stands seldom develop beyond the mature phase. However, there were abundant reference phase stands along the shores of Lake McDonald in Glacier NP. The Robert fire in 2003 heavily impacted some areas on the west side of Lake McDonald, but other areas close to the shore were not affected. Reference stands may withstand low fires that thin the stand, but severe fires would return the site to the herbaceous or shrubland phase. Significant fires that have occurred on the west side of the Continental Divide that have affected this ecological site are the Robert Fire in 2003 that burned 54,191 acres, the Moose Fire in 2001 that burned 66,688 acres, and the Middle Fork Complex Fire in 2003 that burned 11,996 acres. There were historic fires within the area of this ecological site that burned significant portions in 1735 and another portion in 1926 (NPS Stand Age spatial layer). Both western hemlock and western redcedar are subjected to a variety of diseases and insect pests including Armillaria root disease, Annosus root disease, pouch fungus, red belt fungus, pini rot, metallic wood borers, and roundheaded borers. Western redcedar is also susceptible to cedar laminated butt rot, cedar brown pocket rot, and cedar bark beetles. Western hemlock is also susceptible to Indian paint fungus.

Community 2.1
REFERENCE PHASE Western redcedar-western hemlock/common snowberry/western brackenfern/twinflower/brides bonnet/moss

►STRUCTURE: Multistory with small gap dynamics of tall trees (40 to 120+ ft) that are larger (DBH average 17 to 21in) and older. Dominated by western redcedar and western hemlock, though seral tree species are present.

►TIME: 200+ years The Reference Community is dominated by western cedar and western hemlock (proportionately 75 percent total overstory canopy cover), with seral tree species constrained to 25 percent. The total overstory absolute cover averages 66 percent and ranges from 55 to 82 percent in height classes from 40 to 120+ feet tall. Proportionately, there are more trees in the taller height classes (greater than 40 feet). The vegetation structure is that of tall multi-storied overstory trees from 40 to 120+ feet tall, predominantly western redcedar and western hemlock. The most common seral tree species is western larch. Seral tree species that may be present include western larch and Douglas fir (average canopy cover is 8 percent absolute cover each) and less cover (5 percent or less each species) of Grand fir, lodgepole, Englemann spruce and western white pine. The understory is moderately diverse in species and cover is low to moderate. Species are shade-loving and include prince's plume, queencup beadlily, western rattlesnake plantain, and twinflower. The understory is multistoried though fairly to very sparse. Species with the highest frequency of occurrence include common snowberry, white spirea, twinflower, creeping barberry, wild sarsaparilla, and queencup beadlily. The ground cover consists predominantly of litter and duff with fairly high cover of moss and trace cover of gravel, cobbles and stones. Foliar cover at three sites indicate that the foliar cover can be moderate to low (averaging 41%; range 9 to 95 percent) and the ground cover is primarily litter (98 percent) and moss (2 percent). Two of the three sites with foliar cover had total foliar cover of 9 percent and 18 percent which seems typical compared to reference sites of this ecological site in Glacier NP, whereas the one site with foliar cover of 95 percent seems an anomaly. The tallest understory layer (4.5 to 13 feet) is very sparse (averages 5 percent) and includes Rocky Mountain maple and serviceberry. The next lower layer (2 to 4.5 feet) is sparse (averages 10 percent cover) and includes thinleaf huckleberry. The next layer (1 to 2 feet) has moderate cover (10 to 35 percent) and includes wild sarspirilla, rose, thimbleberry, white spirea and common snowberry. The low layer (0.5 to 1 foot) has moderate cover and includes dwarf bilberry, creeping barberry, sweet cicely and threeleaf foamflower.

Community 2.2
POST FIRE DISTURBANCE

►STRUCTURE: 1. HERB/SHRUB stage that can be maintained for a longer period of time due to repeated fires or herbivory. 2. STAND INITIATION stage consisted of thick sapling coverage while maintaining a large cover of shrubs. 3. LATER EARLY SERAL stage consists of a single story overstory canopy that has high canopy cover of shorter (less than 40 ft), smaller (DBH less than 10 in) and younger seral species. Western redcedar and western hemlock comprise less than 10 percent canopy cover. This is a forest in the stand initiation phase, possibly with scattered remnant mature trees. Habeck found that in the vicinity of Lake Mcdonald in Glacier N.P., the dominant seral tree species is Lodgepole pine for 10 to 25 years post-fire. Afterwards, Western Larch will co-dominant from 25 to 50 years post-fire with other seral tree species at lower cover. Throughout the entire area of this ecological site, the regeneration will likely be a mixture. Overstory canopy cover is generally less than 10 percent, but the regeneration tree cover is very high forming a thick carpet. It is a mixture of species including: lodgepole pine, western larch, subalpine fir, paper birch, Engelmann spruce, western white pine, black cottonwood, Quaking aspen, Douglas fir, western redcedar and western hemlock. The understory is a diverse mixture of herbaceous and shrub species including tall willow species, particularly Scouler's willow, medium statured shrubs white spirea and thinleaf huckleberry, the low statured shrubs thimbleberry and Oregon boxwood. Herbaceous species include: fireweed, beargrass. Moss cover is variable.

Community 2.3
INTERMEDIATE AGED FOREST Lodgepole pine-Douglas fir-western larch-grand fir-ponderosa pine (western redcedar-western hemlock)/white spirea-snowberry-oceanspray/creeping barberry-kinnickinik/western brackenfern-Idaho goldenthread/pinegrass

►STRUCTURE: Single-story, dense canopy cover (70 percent). Pole-sized (DBH 10 to 15 in), young (median age 55 to 65 years), seral tress. Western redcedar and western hemlock comprise 5 to 15 percent of total canopy cover. The trees in this community are larger and taller than the later early community phase. ►TIME: 50 to 80 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 50 percent. This community has a diverse community of tree species including: lodgepole pine, Douglas fir, Engelmann spruce, western larch, paper birch, subalpine fir, western white pine, western redcedar and western hemlock. The overstory canopy of western redcedar and western hemlock averages 5 percent as they are just beginning to become established. The understory can have high cover of the medium sized shrubs white spirea, snowberry, Oregon boxleaf, common snowberry and thinleaf huckleberry. The short statured thimbleberry

can have high cover. The herbaceous layer is diverse, with medium statured beargrass occurring frequently and sometime in high cover. Other herbaceous species include the short statured prince's plume, queencup beadlily, trailplant and twinflower.

Community 2.4
MATURING FOREST Western lach-Douglas fir-grand fir-western redcedar/snowberry-oceanspray/twinflower/western brackenfern-Idaho goldenthread

►STRUCTURE: Single-story overstory canopy cover of predominantly pole-sized trees of seral species. Western redcedar and western hemlock are more abundant than in previous intermediate phases (7 o 18 percent canopy cover), but still less abundant that the mature or reference community phases. ►TIME: 80 to 125 years. This community is a maturing forest with vertical differentiation in the overstory tree canopy. Canopy cover averages 57 percent. The median age for these stands is 75 years old and average heights range 75 to 100 feet tall. This community has diverse tree species with western redcedar and western hemlock ranging 7 to 18 percent total canopy cover and other seral tree species about equally distributed. These species include: subalpine fir, lodgepole pine, Engelmann spruce, western white pine. The understory has patchy medium sized shrubs including: thinleaf huckleberry, snowberry, white spirea. There is a diverse understory of herbaceous species including: wild sarsaparilla, heartleaf arnica, queencup beadlily, twinflower and beargrass. There can be high cover of moss.

Community 2.5
MATURE FOREST Western redcedar-western hemlock (western larch-grand fir)/Sitka alder/western brackenfern-wild sarsaparilla/pinegrass

►STRUCTURE: Mature forest with vertical differentiation of stand. The overstory is comprised of taller (greater than 40 ft tall), moderately large (DBH greater than 15 inches) and older trees. Predominantly wester redcedar and western hemlock and seral tree species. ►TIME: 125 to 200 years Overstory is dominated by western redcedar and western hemlock (72 percent of total canopy cover) although seral tree species are present (28 percent total canopy cover). Overstory canopy cover averages 75 percent and ranges from 74 to 85 percent. The trees are predominantly in the taller height classes 7 and 8, over 40 feet tall. These trees are smaller girth or diameter at breast height than trees in the reference state. Western larch is the most common seral species but others include: grand fir, subalpine fir, paper birch, lodgepole pine, western white pine, and Douglas fir. The understory is diverse but generally has low overall cover. Thinleaf huckleberry occurs in clumps and queencup beadlily and western rattlesnake plantain are common. All of the sites used to represent this community phase have been previously logged.

Pathway 2.1A
Community 2.1 to 2.2

This pathway represents a major, stand-replacement disturbance such as a high-intensity fire, large-scale wind event, or a large 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, namely: competitive exclusion, maturation, understory reinitiating.

Pathway 2.3B
Community 2.3 to 2.2

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

This pathway represents a major, stand-replacement disturbance, such as a large 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. While Douglas-fir, grand fir, and subalpine fir are most susceptible, western redcedar and western hemlock can be affected as well. 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 may mask its presence from land managers. When root rot is severe, the pocket has abundant regeneration or dense brush growth in the center. Western redcedar is moderately resistant to Armillaria root rot in Idaho and Montana. 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. Glacier National Park is dominated by metasedimentary parent material and 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 conifer 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. Harvests that leave susceptible species, such as Douglas-fir or true firs, as crop trees should be avoided (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

Contributors

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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	04/19/2024
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:**

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

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

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

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

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

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

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

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

---

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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

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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:**