# Ecological site F043AX959MT
# Montane Warm Dry Coniferous Douglas fir/white spirea-common snowberry/pinegrass

Last updated: 9/08/2023
Accessed: 04/26/2024

## 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): 043A–Northern Rocky Mountains

This MLRA is located in Montana (43 percent), Idaho (34 percent), and Washington (23 percent). It makes up about 31,435 square miles (81,460 square kilometers). It has no large cities or towns. It has many national forests, including the Okanogan, Colville, Kootenai, Lolo, Flathead, Coeur d'Alene, St. Joe, Clearwater, and Kaniksu National Forests.

This MLRA is in the Northern Rocky Mountains Province of the Rocky Mountain System. It is characterized by rugged, glaciated mountains; thrust- and block-faulted mountains; and hills and valleys. Steep-gradient rivers have cut deep canyons. Natural and manmade lakes are common.

The major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA are: Kootenai-Pend Oreille-Spokane (1701), 67 percent; Upper Columbia (1702), 18 percent; and Lower Snake (1706), 15 percent. Numerous rivers originate in or flow through this area, including, the Sanpoil, Columbia, Pend Oreille, Kootenai, St. Joe, Thompson, and Flathead Rivers.

This area is underlain primarily by stacked slabs of layered sedimentary or metasedimentary bedrock. The bedrock formations range from Precambrian to Cretaceous in age. The rocks consist of shale, sandstone, siltstone, limestone, argillite, quartzite, gneiss, schist, dolomite, basalt, and granite. The formations have been faulted and stacked into a series of imbricate slabs by regional tectonic activity. Pleistocene glaciers carved a rugged landscape that includes sculpted hills and narrow valleys filled with till and outwash. Continental glaciation over road the landscape in the northern half of the MLRA while glaciation in the southern half was confined to montane settings.

The average annual precipitation is 25 to 60 inches (635 to 1,525 millimeters) in most of this area, but it is as much as 113 inches (2,870 millimeters) in the mountains and is 10 to 15 inches (255 to 380 millimeters) in the western part of the area. Summers are dry. Most of the precipitation during fall, winter, and spring is snow. The average annual temperature is 32 to 51 degrees F (0 to 11 degrees C) in most of the area, decreasing with elevation. In most of the area, the freeze-free period averages 140 days and ranges from 65 to 215 days. It is longest in the low valleys of Washington, and it decreases in length with elevation. Freezing temperatures occur every month of the year on high mountains, and some peaks have a continuous cover of snow and ice.

The dominant soil orders in this MLRA are Andisols, Inceptisols, and Alfisols. Many of the soils are influenced by Mount Mazama ash deposits. The soils in the area have a frigid or cryic soil temperature regime; have an ustic, xeric, or udic soil moisture regime; and dominantly have mixed mineralogy. They are shallow to very deep, are very poorly drained to well drained, and have most of the soil texture classes. The soils at the lower elevations include Udivitrands, Vitrixerands and Haplustalfs. The soils at the higher elevations include Dystrocryepts, Eutrocryepts, Vitricryands , and Haplocryalfs. Cryorthents, Cryepts, and areas of rock outcrop are on ridges and peaks above timberline

This area is in the northern part of the Northern Rocky Mountains. Grand fir, Douglas-fir, western red cedar, western hemlock, western larch, lodgepole pine, subalpine fir, ponderosa pine, whitebark pine, and western white pine are the dominant overstory species, depending on precipitation, temperature, elevation, and landform aspect. The understory vegetation varies, also depending on climatic and landform factors. Some of the major wildlife species in this area are whitetailed deer, mule deer, elk, moose, black bear, grizzly bear, coyote, fox, and grouse. Fish, mostly in the trout and salmon families, are abundant in streams, rivers, and lakes.

More than one-half of this area is federally owned and administered by the U.S. Department of Agriculture, Forest Service. Much of the privately-owned land is controlled by large commercial timber companies. The forested areas are used for wildlife habitat, recreation, watershed, livestock grazing, and timber production. Meadows provide summer grazing for livestock and big game animals. Less than 3 percent of the area is cropland.

## LRU notes

This ecological site resides in MLRA 43A in the Livingston-Lewis-Apgar Mountains which includes the bulk of Glacier National Park (GNP) and the lower western valley portions along the Flathead River. The landscape is mountains and landforms include glaciated mountains with associated features such as U-shaped valleys, mountain slopes, alpine ridges, cirques, valley floors and 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 low valleys to tall mountains with elevation ranging 989-2,762 m (3,250-9,050 ft.). The climate is cold and wet with mean annual air temperature of 3 degrees Celsius (37 degrees F.), mean frost free days of 65 days and mean annual precipitation of 1295 mm (51 in.) and relative effective annual precipitation is 169 cm (66 in.). The soil temperature regime is cryic and the soil moisture regime is udic. The geology of this area is dominated by metasedimentary rocks of the Belt Supergroup (Grinnell argillite and Siyeh limestone) with minor Tertiary sediments. Soils are generally weakly developed on mountain slopes within U-shaped valleys. Parent materials are commonly of colluvium, till, and residuum from metasedimentary rocks. Limestone bedrock within this part of the Belt Supergroup is not highly calcareous and due to high precipitation received in this area most carbonates at mid and upper elevations have been leached from the soil profiles. Bedrock depth varies greatly with location, landform and slope position. Volcanic ash is often found in the soil surface with various degrees of mixing. Thicker volcanic ash can be found on more stable positions on mid and upper elevation slopes that are protected from wind erosion. Volcanic ash is not typically found in low elevation areas on stream and outwash terraces associated with streams and rivers. There are numerous large lakes including St. Mary, Bowman, Kintla, Lake Sherburne, Logging, Upper Waterton and numerous creeks (

## Classification relationships

This ecological site relates to the USFS Habitat Type PSME/SYAL. This site relates to the USFS Habitat Type Group 2 and Fire Group 6. Both of these classification guides are specifically for the western Montana and northern Idaho region. It also relates to the National Park Service Vegetation Map, NatureServe classification *Pseudotsuga menziesii/Symphoricarpos albus* Forest CEGL000459.

## Ecological site concept

Ecological Site Concept
This site is found west of the Continental Divide, and to a smaller extent east, in well drained mountain slopes and valleys that span the lower elevations, and at higher elevations on southern and western aspects. At lower elevations it is bordered by ponderosa pine sites or grasslands, and at higher elevations by subalpine fir sites. It occurs primarily on ground moraines, lateral moraines and outwash terrace landforms, on backslope positions, on moderate to steep slopes ranging 5-35%, at elevations ranging 1,000 to 1,900 meters (3,300-6,230 feet). This ecological site is open growing stands of Douglas-fir (*Pseudotsuga menziesii*) at lower elevations, but also is found at higher elevations on southerly and westerly aspects. The overstory is dominated by Douglas-fir, with minor amounts of western larch (*Larix occidentalis*), or at lower elevations, it is of ponderosa pine (*Pinus ponderosa*). The understory has patchy white spirea, Rocky Mountain maple, and common snowberry with abundant rhizomatous grass species of pinegrass and/or Geyers sedge. The overstory can be multi-storied Douglas-fir or an open, park-like single story. Soils associated with this ecological site are very deep, well drained and derived from glacial till or outwash. Soil textures typically are loamy, but can have skeletal subsurface horizons that have a high amount of rock fragments (>35% by volume) and relatively lower water-holding capacity. They are typically classified as

Inceptisols or Alfisols. The very deep depth class means that there is no bedrock encountered within 150 cm. There is a thin surface layer of organic material that is less than 5 cm thick.

## Associated sites

| | |
|---|---|
| F043AX960MT | **Montane Deciduous Alluvial Flood Plain black cottonwood (paper birch)/redosier dogwood Populus balsamifera ssp. trichocarpa (Betula papyrifera)/Cornus sericea ssp. sericea**<br>The Montane Deciduous Floodplain ecological site resides on floodplain steps and drainageways, and would abut the outwash terraces that the montane loamy ecological site resides in. It is also a low elevation and flat ecological site. It is seasonally flooded at the surface (depth 0) during April-July with frequent flooding of long duration during April-July. There is no ponding. |
| F043AX951MT | **Lower Subalpine Cool Dry Coniferous subalpine fir- Engelmann spruce/ Sitka alder/ thinleaf huckleberry/ common beargrass**<br>The 43A Lower Subalpine Coniferous Cool Moderately Dry, (ABLA/CLUN2-XETE) ecological site is found in cool, moderately dry mid-elevations that span the lower subalpine areas. It is found primarily on lateral moraine and glacial valley wall landforms, on back or footslope positions, at elevations ranging 1,000 to 2,100 meters (3,300-6,900 feet)., on all aspects and on moderate to steep slopes ranging 10-35 percent.The 43A Lower Subalpine Coniferous Cool Moderately Dry, (ABLA/CLUN2-XETE) site has soils associated with this Ecological Site that are very deep and well drained. These soils have developed in glacial till or colluvium parent materials derived from metasedimentary rock that typically have varying amounts of influence of volcanic ash in the soil surface layers. The dominant taxonomic soil order associated with these soils is Inceptisols with Andic subgroups indicating that there is 18 to 37 centimeters (7-14.5 inches) of volcanic ash. The 43A Lower Subalpine Coniferous Cool Moderately Dry, (ABLA/CLUN2-XETE) ecological site has a reference vegetation community with an overstory of subalpine fir and Engelmann spruce with an understory of Sitka alder, huckleberry, beargrass and queencup bead lily. |
| R043AX966MT | **Montane Loamy Outwash Terrace Richardson's needlegrass (Achnatherum richardsonii)**<br>The 43A Montane Loamy Outwash Terrace is found at low elevations, ranging from 1,100-1,400 meters (3,600-4,600 feet). high, on very low to moderate slopes with all aspects on terraces in valleys. The terraces mainly consist of outwash or stream terraces. This site can also occur on ground moraines.The 43A Montane Loamy Outwash Terrace ecological site has soils that are very deep, well drained, and formed from alluvial or outwash parent materials. These soils typically have a gravelly loam surface texture and fine-loamy subsurface textures. The deep dark surface horizon with high base saturation, called a mollic epipedon, present in these soils indicate that they have consistently supported grassland vegetation over time. Their dark color is due to the incorporation of organic matter from the roots of grass and forb species. These soils are classified as Mollisols.The 43A Montane Loamy Outwash Terrace has a reference vegetation community of Richardson's needlegrass (Achnatherum richardsonii), rough fescue (Festuca campestris), Idaho fescue (Festuca idahoensis), old man's whiskers (Geum triflorum) and sticky purple geranium (Geranium viscosissimum). |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | (1) *Pseudotsuga menziesii var. glauca* |
| Shrub | (1) *Spiraea betulifolia*<br>(2) *Symphoricarpos albus* |
| Herbaceous | (1) *Calamagrostis rubescens*<br>(2) *Arnica cordifolia* |

## Physiographic features

This site is found west of the Continental Divide in well drained mountain slopes and valleys that span the lower elevations, and at higher elevations on southern and western aspects. At lower elevations it is bordered by ponderosa pine sites or grasslands, and at higher elevations by subalpine fir sites. It occurs primarily on ground moraines, lateral moraines and outwash terrace landforms, on backslope positions, on moderate to steep slopes ranging 5-35%, at elevations ranging 1,000 to 1,900 meters (3,300-6,230 feet). .

**Figure 1. Landscape view of site.**

**Figure 2. Landscape view of site.**

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Mountains > Ground moraine<br>(2) Mountains > Lateral moraine<br>(3) Mountains > Outwash terrace |
| Elevation | 3,280–6,561 ft |
| Slope | 5–35% |
| Aspect | W, NW, N, NE, E, SE, S, SW |

## Climatic features

This ecological site is found in the cryic soil temperature regime and the udic soil moisture regime. Cryic soils have average annual temperature less than 8 degrees C, with less than 5 degrees C difference from winter to summer. The udic soil moisture regime denotes that the rooting zone is usually moist throughout the winter and the majority of summer. This site is found on the east side of the Continental Divide and has more continental weather influences.

Climate data from West Glacier Station:
Mean Average Precipitation 24-71 inches
Mean Average Annual Temperature 34-43 degrees
Frost free days: 30-70
Relative Effective Annual Precipitation: 20-24 inches

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (characteristic range) | 17-57 days |

| | |
|---|---|
| Freeze-free period (characteristic range) | 76-117 days |
| Precipitation total (characteristic range) | 20-26 in |
| Frost-free period (actual range) | 6-68 days |
| Freeze-free period (actual range) | 66-127 days |
| Precipitation total (actual range) | 20-28 in |
| Frost-free period (average) | 37 days |
| Freeze-free period (average) | 97 days |
| Precipitation total (average) | 23 in |

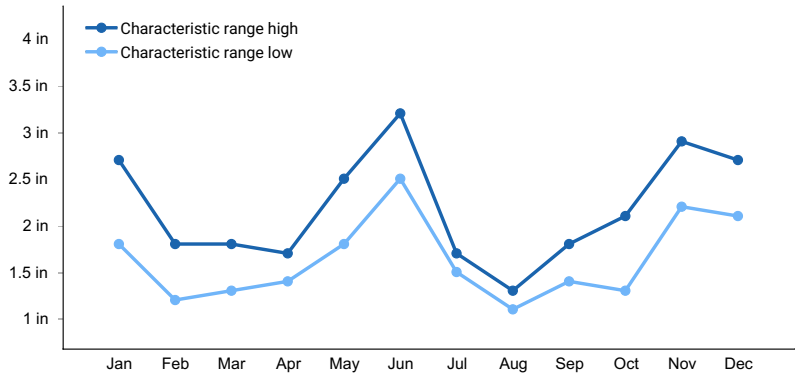



**Figure 3. Monthly precipitation range**

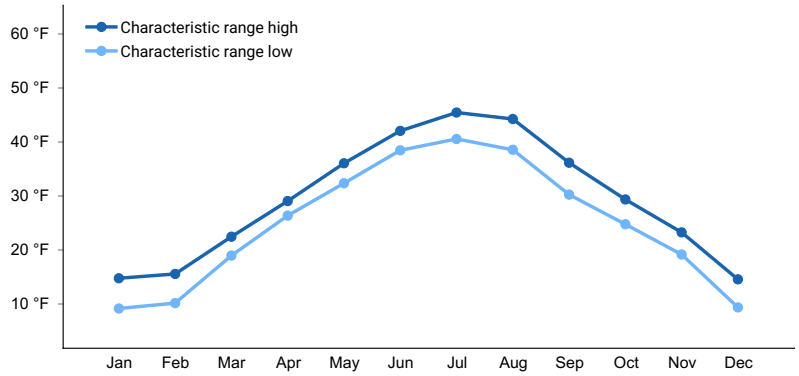



**Figure 4. Monthly minimum temperature range**

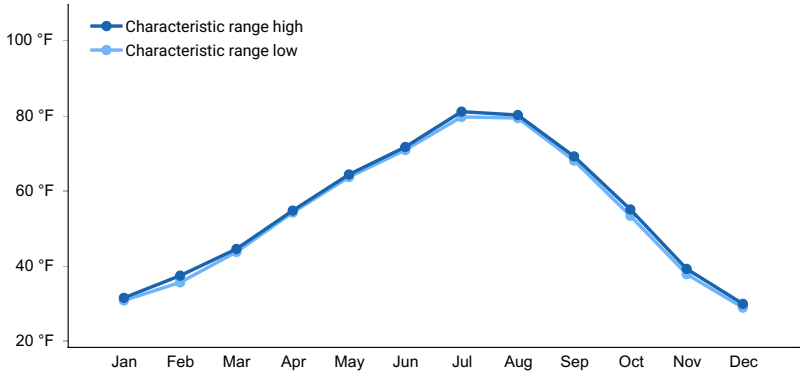



**Figure 5. Monthly maximum temperature range**

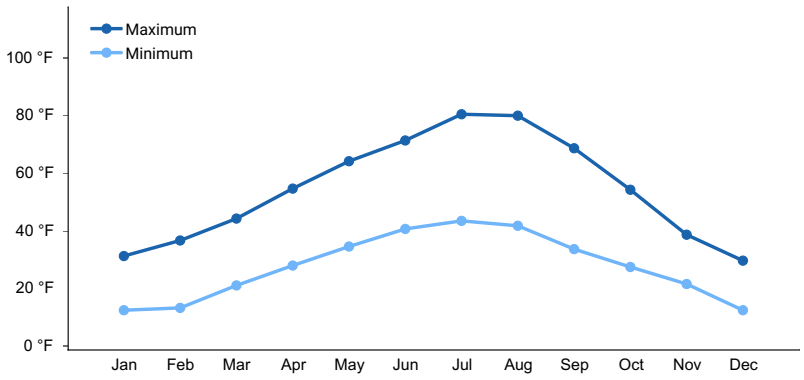



**Figure 6. Monthly average minimum and maximum temperature**

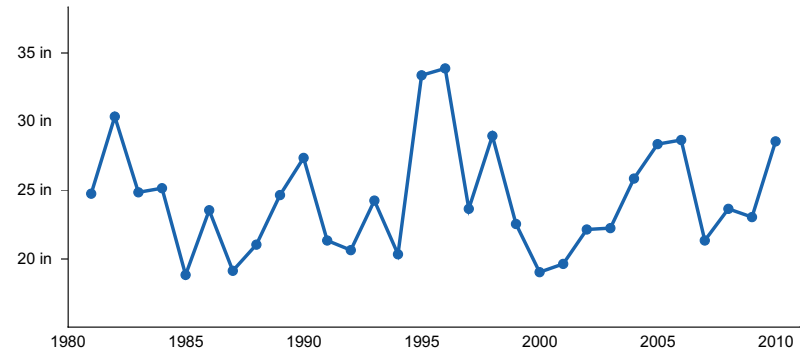



**Figure 7. Annual precipitation pattern**

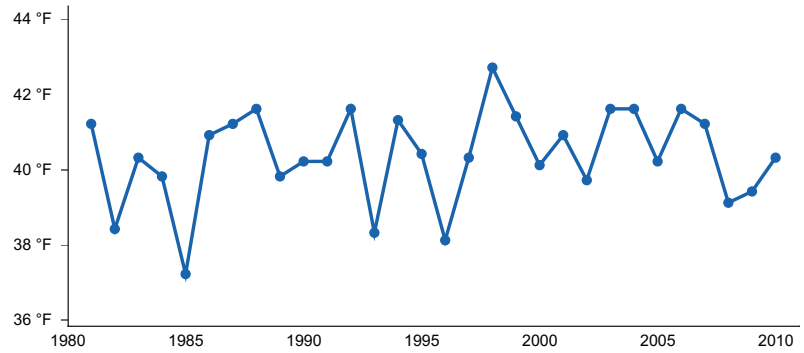



**Figure 8. Annual average temperature pattern**

## Climate stations used

- (1) POLEBRIDGE 1 N [USC00246618], Essex, MT
- (2) POLEBRIDGE [USC00246615], Essex, MT
- (3) WEST GLACIER [USC00248809], Kalispell, MT

## Influencing water features

## Soil features

Soils associated with this ecological site are very deep, well drained and derived from glacial till or outwash. Soil textures typically are loamy, but can have skeletal subsurface horizons that have a high amount of rock fragments (>35% by volume) and relatively lower water-holding capacity. They are typically classified as Inceptisols or Alfisols. The very deep depth class means that there is no bedrock encountered within 150 cm. There is a thin surface layer of organic material that is less than 5 cm thick. Diagnostic features for Inceptisols can include an ochric epipedon and a cambic horizon, while diagnostic features for Alfisols may include a zone of albic materials (a zone of leaching), and an argillic diagnostic horizon (a zone of clay accumulation) (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

CORRELATED SOIL SERIES & TAXONOMIC CLASS NAME
Apikuni Fine-loamy, mixed, superactive Typic Haplocryepts
Kegsprings Loamy-skeletal, mixed, superactive Typic Haplocryepts
Worock Loamy-skeletal, mixed, superactive Eutric Haplocryalfs

**Figure 9. Soils associated with this ecological site.**

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Till–metasedimentary rock<br>(2) Outwash–metasedimentary rock |
| Surface texture | (1) Very gravelly loam<br>(2) Silt |
| Family particle size | (1) Loamy-skeletal<br>(2) Fine-loamy |
| Drainage class | Well drained |
| Permeability class | Moderately slow to moderate |
| Soil depth | 60–100 in |
| Surface fragment cover <=3" | 0% |
| Surface fragment cover >3" | 0% |
| Available water capacity (2-6.6in) | Not specified |
| Soil reaction (1:1 water) (4.5-7.2in) | Not specified |

## Ecological dynamics

Ecological Dynamics of the Site
This ecological site is found west, and to a smaller extent east, of the Continental Divide in open growing stands of Douglas-fir (*Pseudotsuga menziesii*) at lower elevations, but also is found at higher elevations on southerly and westerly aspects. This ecological site is above the warmest coniferous zone dominated by ponderosa pine and below the cooler and moister zone dominated by subalpine fir and Engelmann spruce.

Management
There are various management strategies that can be employed for this ecological site, depending upon 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 and quantity, old growth, or endangered species. If a stand is managed for timber, 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.

This ecological site relates to the USFS Habitat Type PSME/SYAL. The USFS Habitat Type guide states that the basal area on the WEST side of the Continental Divide for is 172+/-23 ft2 per acre and site index at 50 years for Ponderosa pine=54, Douglas fir=52. The USFS Habitat Type guide states that the basal area on the east side of the Continental Divide is 196+/-26 ft2 per acre, and the site index is at 50 years for PIPO=43, PSME=41.

Timber production ranges from low to high and site preparation must take into account the abundance of rhizomatous grasses.

A 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. 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).

In Personal communication with sivicultural forester on the Flathead N.F.:
PSME/SYAL Habitat Type
This habitat type is a minority type on the Flathead N.F. and is found mainly in the WUI zone (wildland urban interface). It is managed so that disturbance such as fire do not cross ownership boundaries and impact private lands nearby. In order to achieve this, it is managed for open forest structure and to promote ponderosa pine (*Pinus ponderosa*) when possible. Fire suppression will increase Douglas fir density on this habitat type and Douglas fir is particularly prone to root disease. Root disease is very prevalent on the Flathead N.F. with pockets of effected stands throughout the area. This is a forest health issue. As well, lower density of Douglas fir allows for a fire regime conducive to maintaining ponderosa pine (frequent and lower intensity). If there were a severe stand replacement fire in this habitat type that destroyed mature ponderosa pine, it would be difficult to recover ponderosa pine since its seed dispersal radius is small due to heavy seed. In stands with good ponderosa pine presence, forest health concerns may require thinning of Douglas fir to reduce ladder fuels and increase resiliency of ponderosa pine, use of shelter wood harvests for seedling establishment and no uneven age management strategies (due to the shade tolerant nature of Douglas fir). Prescribed burning is also important to create and maintain resilient mature ponderosa pine (*Pinus ponderosa*) stands, but could be issue with WUI zone. Western larch is managed for the mesic phases of this habitat type. The forest does treat in old growth stands on this habitat type to maintain single story stand conditions that were traditionally maintained by frequent low intensity fire.

State 1.0
The overstory is dominated by Douglas-fir, with minor amounts of western larch (*Larix occidentalis*), or at lower elevations, it is of ponderosa pine (*Pinus ponderosa*). Douglas-fir and ponderosa pine are well adapted to fire, having thick bark at maturity which protects the cambium layer from overheating. The understory has patchy white spirea, Rocky Mountain maple, and common snowberry with abundant rhizomatous grass species of pinegrass and/or Geyer’s sedge. The overstory can be multi-storied Douglas-fir or an open, park-like single story. Douglas-fir is moderately shade-tolerant compared to associates ponderosa pine, western larch, and lodgepole pine (*Pinus contorta*), which are all intolerant of shade. Frequent, non-lethal wildfires had historically maintained open, park-like stands. All four species are adapted to the historic fire regime as they regenerate well following disturbance, especially when mineral soils were exposed, which is a key factor in regeneration of ponderosa pine and western larch (and, to a lesser degree, lodgepole pine). Ponderosa pine and western larch are long-living (300-400 years), while lodgepole pine survives only 150-200 years. In the absence of naturally occurring wildfire, Douglas-fir is the only species that continues to regenerate in any abundance and thus gradually becomes dominant in those undisturbed stands. In this ecological site, Douglas-fir is present in all seral stages with lodgepole pine and western larch, and ponderosa pine is present in the lower-elevation sites. The understory has an abundance of rhizomatous grasses, pinegrass, and Geyer’s sedge, and the medium-sized shrubs common snowberry (*Symphoricarpos albus*), Oregon boxleaf (*Paxistima myrsinites*), Saskatoon serviceberry (*Amelanchier alnifolia*), creeping barberry (*Mahonia repens*), white spirea (*Spiraea betulifolia*), snowbush ceanothus (*Ceanothus velutinus*), kinnikinnick (*Arctostaphylos uva-ursi*), and fireweed (*Chamerion angustifolium*). These shrubs are adapted to this fire regime of a frequent, low-severity type by having the ability to resprout from root crowns or rhizomes after the low-intensity fire removes the aboveground portion of the plants. Specifically, Saskatoon serviceberry, Rocky Mountain maple (*Acer glabrum*), resprout from root crowns. Common snowberry, white spirea, thimbleberry (*Rubus parviflorus*), and thinleaf huckleberry (*Vaccinium membranaceum*) sprout from rhizomes. McLean (1970) describes the response to fire for common snowberry, white spirea, Oregon boxleaf as “resistant,” with taproots or a fibrous root system with rhizomes 5-13 cm deep. Pinegrass (*Calamagrostis rubescens*), creeping barberry, and heartleaf arnica (*Arnica*

*cordifolia*) are considered “intermediate,” with shallower rhizomes. The “susceptible” category included the western rattlesnake plantain (*Goodyera oblongifolia*) and the Pyrola species, although these species are rarely found at this site. Twinflower (Linnea borealis) has rhizomes in duff, kinnikinnick has fibrous roots and stolons, and white hawkweed (*Hieracium albiflorum*) resprout with fibrous roots only. Snowbush ceanothus germinates from fire-stimulated seed, and fireweed produces many windborne seeds that will recolonize sites from unburned areas. Specifically, at the reference phase the understory has an abundance of rhizomatous grasses, pinegrass and Geyer’s sedge and the medium sized shrub, common snowberry. While primary data was collected in Glacier National Park, this site extends west onto the Flathead and Kootenai National Forests.

Fire Regime Description

This ecological site occurs on moderately warm and dry sites. The open, park-like stands of this ecological site were historically maintained by fires of low to moderate severity that had a return interval of approximately 36 (28-52) years and stand replacing fire frequency of 141 years (Barrett, 1991). This relates to Fire Group Six: moist Douglas fir habitat types with mean fire intervals of 16-42 years (Fischer, 1987). Douglas fir habitat type forests on the Bitterroot, Lolo and Flathead National Forests had historic mean fire intervals ranging 25-49 years (USFS, FEIS, PSEMENG page). This fire regime has been coined mixed severity, ranging from low to moderate severity surface fires at relatively frequent intervals (7-20 years) to severe crown fires at long intervals (50-400 years). Frequent fires of moderate intensity favor lodgepole pine and western larch survival and regeneration over Douglas-fir. In the absence of short-interval understory burns, severe stand-replacement fires can occur on this ecological site if a closed canopy configuration develops along with the development of dense understories, resulting in a build-up of hazardous fuels at all levels, especially in periods of severe drought. Stand-replacement fires can favor lodgepole pine, especially if there is a serotinous cone seedbank. The average fuel loading is 12 tons per acre, but can be much heavier. Fire as an agent for seedbed preparation is less important for this ecological site, since Douglas-fir can grow in multiple types of seedbeds.

Forest succession after disturbance follows the stand initiation phase of herbs, shrubs, and seedlings to the competitive exclusion phase of dense pole-sized seral tree species, to the maturing forest stage, and with no further disturbance, the Reference phase. Douglas-fir can be present in all seral stages along with lodgepole pine, western larch, and ponderosa pine, especially at lower elevations. Quaking aspen (*Populus tremuloides*) also has been found in seral succession on certain sites. After a stand-replacement fire, grass, forb, and shrub species dominate the site with seedlings of tree species, usually Douglas-fir, western larch, and lodgepole pine depending upon patch size and adjacent and soil-banked conifer seed sources. If another fire occurs, then this phase would be maintained for longer. Without disturbance, the seedlings grow into saplings. Fire in the sapling stage would thin stands if ponderosa pine or western larch are dominant or eliminate Douglas-fir and lodgepole pine where these are dominant. Pole-sized Douglas-fir, western larch, and ponderosa pine would survive low to moderate fires, whereas severe fires would kill all trees and return the site to the stand initiation phase. In the mature phase, low to moderate severity fires would thin the overstory and understory, while severe fire would return the site to the stand initiation phase. The Reference phase is rare, because of the presence of seral species whose longevity is greater than the usual fire return interval, except where Douglas-fir is also the dominant seral species. Frequent low to moderate severity fires create the open, park-like stands of the reference phase, but severe fire would return the site to the stand initiation phase. Significant fires that have occurred on the WEST side of the continental Divide that have effected this ecological site are: Wedge (2003, 53,570 acres), Red Bench (1988, 34,051 acres), Adair (1994, 9,753 acres), Anaconda (1999, 9,657 acres), Moose (2001, 66,688 acres), Robert (2003, 54,191 acres), Middle Fork Complex (2003, 11,996 acres), Crystal Creek (1984, 2,886 acres) and Rampage Complex (2003, 23,237 acres). One significant fire that occurred on the east side of the Continental Divide and has affected this ecological site is the Red Eagle fire in 2006 that burned 32,461 acres.

Pest/Disease Description

Douglas-fir is subjected to a variety of diseases and insect pests including Armillaria and Annosus root diseases, Schweinitzii root and butt rot, laminated root rot, pouch and red belt fungus, pini rot, metallic wood borers, roundheaded borers, Douglas-fir beetle, blue-stain of sapwood, spruce canker, fir canker, Douglas-fir dwarf mistletoe, western spruce budworm, Douglas-fir needle midge, and Swiss and Rhabdocline needlecast.

Aerial photography is a good tool to use to discern the levels of insect and disease, the damage patterns, and whether these are at endemic or epidemic levels. These maps capture only moments in time, and infestations grow and move from location to location following their preferred habitat, so repeated photography can be necessary. For the northern region, the major impact is from defoliation by western spruce budworm, occurs mostly on subalpine

fir-Engelmann spruce forests, and to a lesser degree on Douglas-fir-dominated stands. As the name implies, the Douglas-fir beetle attacks Douglas-fir, with the greatest mortality occurring in stressed stands or on stressed individuals. Larch casebearer, a defoliator of western larch, and generalized needlecast of western larch was also found to a much lesser degree. Scattered smaller polygons were also found throughout the region, including mortality from mountain pine beetle on lodgepole pine.

Community Phase 1.1
Structure: Multistory with small gap dynamics

The overstory is dominated by Douglas fir with other seral tree species with small gap dynamics in which small numbers of trees are dead and regeneration is infilling. Overstory canopy cover can range from 25-75%. The understory has the most frequently occurring species including pinegrass, white spirea and common snowberry. Other common species include Oregon boxleaf, serviceberry, creeping barberry, snowbush ceanothus, kinnickinnik and fireweed. Infrequently, thimbleberry can have high cover. Foliar cover dataset of four sites indicates that the ground cover is predominantly duff (95%), and very low cover of moss and lichen. The vegetation structure is that of tall trees with average height of 20-31 m (67-100 feet) (Western larch and Douglas fir) and a multistoried understory. The top layer is 51-102 cm (20-40 inches) tall and includes russet buffaloberry (*Shepherdia canadensis*), common snowberry ( *Symphoricarpos albus*) and blue wildrye (*Elymus glaucus*). There are two lower layers that include diverse shrubs, forb and grass species. One layer is at an average height of 25-40 cm (10-16 inches) tall and can include white spirea (Spirea betulafolia), fireweed (Chamerian angustifolia), western meadowrue (Thalictrum occidentalis) and the lower layer up to 20 cm or 8 inches tall that can include lupine species, heartleaf arnica, erigeron species and fragaria species. The presence of root rot pockets can shift the composition of this community away from its host species, although the threat is low. The understory of this community is low storied with the medium shrub white spirea and common snowberry in clumps and the herbaceous layer varied but low growing with pinegrass that can have high cover. This community is prone to Armillaria root rot and defoliation by Western Spruce budworm on fir.

Community Phase Pathway 1.1A
This pathway represents a larger disturbance, such as an insect infestation, wind storm, or rot pocket to create this forest structure. Areas of regeneration range from approximately 2 to 5 acres.

Community Phase Pathway 1.1B
This pathway represents a major stand-replacement fire disturbance such as a high-intensity fire, large-scale wind event, or major insect infestation.

Forest Overstory
Forest canopy cover ranges from 25-75 percent and is dominated by Douglas-fir with western larch in minor amounts.
Site index for Douglas fir averages 40 feet at a base age of 50 years, and the Cumulative Mean Annual Index is 44 cubic feet per acre per year @ 60 years.

Community Phase 1.2
Douglas fir (western larch-ponderosa pine)/Serviceberry/white spirea-common snowberry/Creeping barberry/pinegrass
Structure: Mosaic of mature overstory and regenerating openings
Community Phase 1.2 retains some areas that resemble CP1.1 but also contains moderate sized (2-5 acres) openings. Canopy cover can range 30-50%. The overstory is a mixture of Douglas fir, western larch, Engelmann spruce, and ponderosa pine at low elevation sites and can have minor amounts of black cottonwood, paper birch and quaking aspen. The understory can have clumps of the tall shrub Saskatoon serviceberry, the medium statured shrubs white spirea and common snowberry, with a carpet of diverse herbaceous layer sometimes dominated by the rhizomatous grass pinegrass (*Calamagrostis rubescens*) and or Geyer's sedge (*Carex geyeri*). Douglas fir is susceptible to mortality from the Douglas fir beetle and is a host to organisms causing root rot and heart rot and with windthrow can cause large pockets of overstory mortality. These areas may take decades to become reforested, resulting in either patches of shrubs or seral species (western larch, lodgepole pine). As the organisms slowly die off due to a lack of host trees, Douglas fir will re-colonize these areas. This community is prone to Armillaria root rot and defoliation by Western Spruce budworm on fir.

Community Phase Pathway 1.2A

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 reinitiation—until they resemble the old-growth structure of the Reference Community.

Community Phase Pathway 1.2B
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.

Community Phase 1.3
(Douglas fir-Lodgepole pine-Aspen-Western larch)/white spirea-common snowberry/geyer's sedge
Structure: Thick carpet of regeneration, single story canopy.
Community Phase 1.3 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. Canopy cover is generally less than 10% as a mixture of conifers including Douglas fir, lodgepole pine, western larch, and resprouting aspen. If serotinous lodgepole seedbank is present, then this species will dominate the area. The understory is a mixture of shrubs and herbaceous species including: fireweed, common snowberry, pinegrass, Geyer's sedge and Scouler's woollyweed. Pinegrass and Geyer's sedge can have very high canopy cover.
Community Phase Pathway 1.3A
This pathway represents continued growth over time with no further major disturbance.

Community Phase 1.4: Lodgepole pine/common snowberry/pinegrass
Structure: Dense, single story canopy.
Community Phase 1.4 is a forest in the competitive exclusion phase, possibly with scattered remnant mature trees; there is increasing competition among individual trees for the available water and nutrients. The canopy cover can range from 60-100 percent. The overstory is dominated by lodgepole pine, with minor amounts of Douglas-fir, western larch, and ponderosa pine; and the understory can have clumps of common snowberry and pinegrass. Canopy closure is very high within the areas successfully reforested, leading eventually to a diminished graminoid community but also providing protection for those species which do well in the shade. The majority of Douglas-fir and ponderosa pine that reach this stage have increased resistance to fire kill with their thickening bark. This community is tolerant of Armillaria root rot due to the forest stand composition. Understory at the three sites in which canopy cover data was collected had high cover. The most frequently occurring species were serviceberry, heartleaf arnica, pinegrass, strawberry species, white spirea and common snowberry. Only common snowberry and pinegrass had moderate to high canopy cover.
Community Phase Pathway 1.4A
This pathway represents continued growth over time with no further major disturbance.

Community Phase Pathway 1.4B
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.

Community Phase 1.5
Douglas fir (western larch-Ponderosa pine)/Serviceberry/white spirea-common snowberry/creeping barberry/pinegrass
Structure: Single story canopy with few small openings
Community Phase 1.5 is a maturing forest which is starting to differentiate vertically. Canopy cover ranges 30-60%. The overstory is a mixture of Douglas fir, western larch, Engelmann spruce, and ponderosa pine at low elevation sites and can have minor amounts of black cottonwood, paper birch and quaking aspen. The understory can have clumps of the tall shrub Saskatoon serviceberry, the medium statured shrubs white spirea and common snowberry, with a carpet of diverse herbaceous layer sometimes dominated by the rhizomatous grass pinegrass and or geyer's sedge. Individual trees are dying (whether due to insects, disease, competition or windthrow) allowing some sunlight to reach the forest floor. This allows for an increase in the understory as well as some pockets of overstory tree species regeneration. This community is prone to Armillaria root rot and defoliation by Western Spruce budworm on fir.
Community Phase Pathway 1.5A
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.

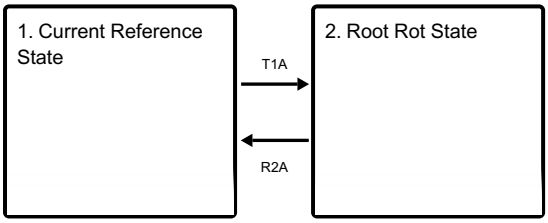
Community Phase Pathway 1.5B
This pathway represents a major stand-replacement fire disturbance leading to the stand initiation phase of forest development.

State 2.0
Another disease affecting this ecological site is root rot. Armillaria root disease is the most common root disease fungus in this region, and 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 most susceptible tree species first, leaving less susceptible tree species that mask the presence of disease. When root rot is severe, the pocket has abundant regeneration or dense brush growth in the center. In western Montana and northern Idaho, Armillaria is present in most stands with diffuse mortality and large and small root disease centers. The disease pattern is one of multiple clones merging to form essentially continuous coverage of sites. Grouped as well as dispersed mortality involves entire stands and drainages, and often is severe by age 40. A mosaic of brushy openings, patches of dying trees, and apparently unaffected trees may cover large areas. There can be highly significant losses, usually requiring species conversion in the active management approach. Management tactics include to correctly identify the type of root disease(s) on the management unit, and manage species such as late seral pine and larch. Pre-commercial thinning will improve growth and vigor of the residual stand. Thinning and harvest operations should remove susceptible species (Douglas-fir or true firs) to the degree practical, retaining late seral species such as western larch and pine (Hagle, 2010). Tree planting can be used to facilitate a shift in species composition to those conifers which have greater tolerance to root diseases. There has been a link determined between parent material and susceptibility to root disease.

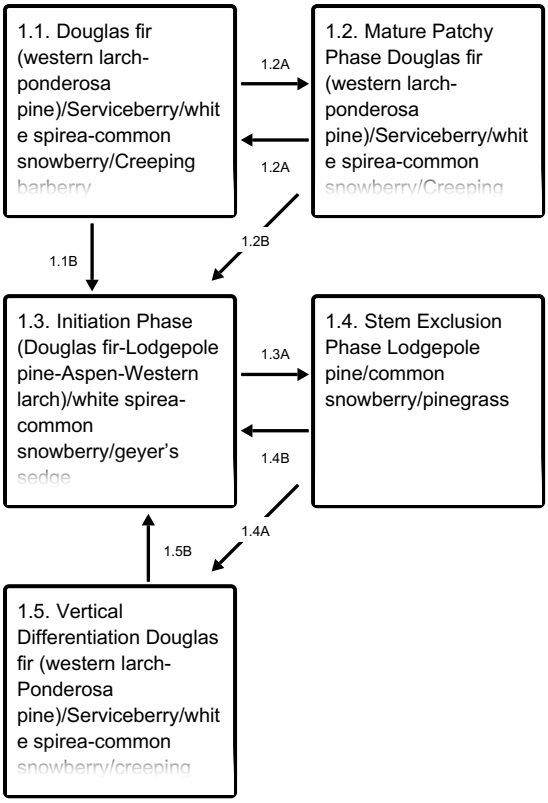
Metasedimentary parent material is thought to increase the risk of root disease. Glacier National Park is dominated by metasedimentary parent material and may be more at risk than other areas to root disease (Kimsey et al., 2012). If a stand sustains very high levels of roots disease mortality, then a forest stand could cross a threshold and become a shrubland, once all trees are gone (Kimsey et al., 2012). Persistent shrub fields may take a century or longer for the infected root mass to decline, which will return the root disease potential to background levels, and allow the reintroduction of resistant conifer species.

## State and transition model

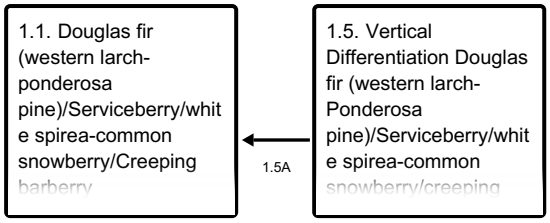
**Ecosystem states**



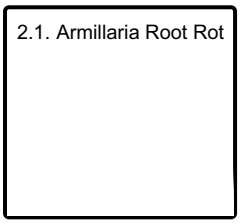
**State 1 submodel, plant communities**




**Communities 1 and 5 (additional pathways)**




**State 2 submodel, plant communities**




## State 1
## Current Reference State

The overstory is dominated by Douglas-fir, with minor amounts of western larch ( *Larix occidentalis*), or at lower elevations, it is of ponderosa pine (*Pinus ponderosa*). Douglas-fir and ponderosa pine are well adapted to fire, having thick bark at maturity which protects the cambium layer from overheating. The understory has patchy white spirea, Rocky Mountain maple, and common snowberry with abundant rhizomatous grass species of pinegrass and/or Geyer's sedge. The overstory can be multi-storied Douglas-fir or an open, park-like single story. Douglas-fir is moderately shade-tolerant compared to associates ponderosa pine, western larch, and lodgepole pine (*Pinus contorta*), which are all intolerant of shade. Frequent, non-lethal wildfires had historically maintained open, park-like stands. All four species are adapted to the historic fire regime as they regenerate well following disturbance, especially when mineral soils were exposed, which is a key factor in regeneration of ponderosa pine and western larch (and, to a lesser degree, lodgepole pine). Ponderosa pine and western larch are long-living (300-400 years), while lodgepole pine survives only 150-200 years. In the absence of naturally occurring wildfire, Douglas-fir is the only species that continues to regenerate in any abundance and thus gradually becomes dominant in those undisturbed stands. In this ecological site, Douglas-fir is present in all seral stages with lodgepole pine and western larch, and ponderosa pine is present in the lower-elevation sites. The understory has an abundance of rhizomatous grasses, pinegrass, and Geyer's sedge, and the medium-sized shrubs common snowberry (*Symphoricarpos albus*), Oregon boxleaf (*Paxistima myrsinites*), Saskatoon serviceberry (*Amelanchier alnifolia*), creeping barberry (*Mahonia repens*), white spirea (*Spiraea betulifolia*), snowbush ceanothus (*Ceanothus velutinus*), kinnikinnick (*Arctostaphylos uva-ursi*), and fireweed (*Chamerion angustifolium*). These shrubs are adapted to this fire regime of a frequent, low-severity type by having the ability to resprout from root crowns or rhizomes after the low-intensity fire removes the aboveground portion of the plants. Specifically, Saskatoon serviceberry, Rocky Mountain maple (*Acer glabrum*), resprout from root crowns. Common snowberry, white spirea, thimbleberry (*Rubus parviflorus*), and thinleaf huckleberry (*Vaccinium membranaceum*) sprout from rhizomes. McLean (1970) describes the response to fire for

common snowberry, white spirea, Oregon boxleaf as “resistant,” with taproots or a fibrous root system with rhizomes 5-13 cm deep. Pinegrass (*Calamagrostis rubescens*), creeping barberry, and heartleaf arnica (*Arnica cordifolia*) are considered “intermediate,” with shallower rhizomes. The “susceptible” category included the western rattlesnake plantain (*Goodyera oblongifolia*) and the Pyrola species, although these species are rarely found at this site. Twinflower (Linnea borealis) has rhizomes in duff, kinnikinnick has fibrous roots and stolons, and white hawkweed (*Hieracium albiflorum*) resprout with fibrous roots only. Snowbush ceanothus germinates from fire-stimulated seed, and fireweed produces many windborne seeds that will recolonize sites from unburned areas. Specifically, at the reference phase the understory has an abundance of rhizomatous grasses, pinegrass and Geyer’s sedge and the medium sized shrub, common snowberry. While primary data was collected in Glacier National Park, this site extends west onto the Flathead and Kootenai National Forests.

## Community 1.1
## Douglas fir (western larch-ponderosa pine)/Serviceberry/white spirea-common snowberry/Creeping barberry kinnickinik/pinegrass

The overstory is dominated by Douglas fir with other seral tree species with small gap dynamics in which small numbers of trees are dead and regeneration is infilling. Overstory canopy cover can range from 25-75%. The understory has the most frequently occurring species including pinegrass, white spirea and common snowberry. Other common species include Oregon boxleaf, serviceberry, creeping barberry, snowbush ceanothus, kinnickinnik and fireweed. Infrequently, thimbleberry can have high cover. Foliar cover dataset of four sites indicates that the ground cover is predominantly duff (95%), and very low cover of moss and lichen. The vegetation structure is that of tall trees with average height of 20-31 m (67-100 feet) (Western larch and Douglas fir) and a multistoried understory. The top layer is 51-102 cm (20-40 inches) tall and includes russet buffaloberry (*Shepherdia canadensis*), common snowberry ( *Symphoricarpos albus*) and blue wildrye (*Elymus glaucus*). There are two lower layers that include diverse shrubs, forb and grass species. One layer is at an average height of 25-40 cm (10-16 inches) tall and can include white spirea (Spirea betulafolia), fireweed (Chamerian angustifolia), western meadowrue (Thalictrum occidentalis) and the lower layer up to 20 cm or 8 inches tall that can include lupine species, heartleaf arnica, erigeron species and fragaria species. The presence of root rot pockets can shift the composition of this community away from its host species, although the threat is low. The understory of this community is low storied with the medium shrub white spirea and common snowberry in clumps and the herbaceous layer varied but low growing with pinegrass that can have high cover. This community is prone to Armillaria root rot and defoliation by Western Spruce budworm on fir.

## Community 1.2
## Mature Patchy Phase Douglas fir (western larch-ponderosa pine)/Serviceberry/white spirea-common snowberry/Creeping barberry/pinegrass

**Figure 10. Landscape view of site in community phase 1.1: Douglas fir/White spirea-common snowberry/pinegrass-heartleaf arnica.**

Structure: Mosaic of mature overstory and regenerating openings Community Phase 1.2 retains some areas that resemble CP1.1 but also contains moderate sized (2-5 acres) openings. Canopy cover can range 30-50%. The overstory is a mixture of Douglas fir, western larch, Engelmann spruce, and ponderosa pine at low elevation sites and can have minor amounts of black cottonwood, paper birch and quaking aspen. The understory can have

clumps of the tall shrub Saskatoon serviceberry, the medium statured shrubs white spirea and common snowberry, with a carpet of diverse herbaceous layer sometimes dominated by the rhizomatous grass pinegrass (*Calamagrostis rubescens*) and or Geyer's sedge (*Carex geyeri*). Douglas fir is susceptible to mortality from the Douglas fir beetle and is a host to organisms causing root rot and heart rot and with windthrow can cause large pockets of overstory mortality. These areas may take decades to become reforested, resulting in either patches of shrubs or seral species (western larch, lodgepole pine). As the organisms slowly die off due to a lack of host trees, Douglas fir will re-colonize these areas. This community is prone to Armillaria root rot and defoliation by Western Spruce budworm on fir.

## Community 1.3
## Initiation Phase (Douglas fir-Lodgepole pine-Aspen-Western larch)/white spirea-common snowberry/geyer's sedge

**Figure 11. Plant Community 1.3 - Post Fire Regeneration Phase**

Structure: Thick carpet of regeneration, single story canopy. Community Phase 1.3 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. Canopy cover is generally less than 10% as a mixture of conifers including Douglas fir, lodgepole pine, western larch, and resprouting aspen. If serotinous lodgepole seedbank is present, then this species will dominate the area. The understory is a mixture of shrubs and herbaceous species including: fireweed, common snowberry, pinegrass, Geyer's sedge and Scouler's woollyweed. Pinegrass and Geyer's sedge can have very high canopy cover.

## Community 1.4
## Stem Exclusion Phase Lodgepole pine/common snowberry/pinegrass

**Figure 12. Plant Community 1.4 – Thick, Pole Sized Tree Stand**

Structure: Dense, single story canopy. Community Phase 1.4 is a forest in the competitive exclusion phase, possibly with scattered remnant mature trees; there is increasing competition among individual trees for the available water and nutrients. The canopy cover can range from 60-100 percent. The overstory is dominated by

lodgepole pine, with minor amounts of Douglas-fir, western larch, and ponderosa pine; and the understory can have clumps of common snowberry and pinegrass. Canopy closure is very high within the areas successfully reforested, leading eventually to a diminished graminoid community but also providing protection for those species which do well in the shade. The majority of Douglas-fir and ponderosa pine that reach this stage have increased resistance to fire kill with their thickening bark. This community is tolerant of Armillaria root rot due to the forest stand composition. Understory at the three sites in which canopy cover data was collected had high cover. The most frequently occurring species were serviceberry, heartleaf arnica, pinegrass, strawberry species, white spirea and common snowberry. Only common snowberry and pinegrass had moderate to high canopy cover.

### Community 1.5
### Vertical Differentiation Douglas fir (western larch-Ponderosa pine)/Serviceberry/white spirea-common snowberry/creeping barberry/pinegrass

**Figure 13. Plant Community 1.5 – Vertical Differentiation in Stand, Phase Before Reference**

Structure: Single story canopy with few small openings Community Phase 1.5 is a maturing forest which is starting to differentiate vertically. Canopy cover ranges 30-60%. The overstory is a mixture of Douglas fir, western larch, Engelmann spruce, and ponderosa pine at low elevation sites and can have minor amounts of black cottonwood, paper birch and quaking aspen. The understory can have clumps of the tall shrub Saskatoon serviceberry, the medium statured shrubs white spirea and common snowberry, with a carpet of diverse herbaceous layer sometimes dominated by the rhizomatous grass pinegrass and or geyer's sedge. Individual trees are dying (whether due to insects, disease, competition or windthrow) allowing some sunlight to reach the forest floor. This allows for an increase in the understory as well as some pockets of overstory tree species regeneration. This community is prone to Armillaria root rot and defoliation by Western Spruce budworm on fir.

### Pathway 1.2A
### Community 1.1 to 1.2

This pathway represents a larger disturbance, such as an insect infestation, wind storm, or rot pocket to create this forest structure. Areas of regeneration range from approximately 2 to 5 acres.

### Pathway 1.1B
### Community 1.1 to 1.3

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

### Pathway 1.2A
### Community 1.2 to 1.1

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 reinitiation—until they resemble the old-growth structure of the Reference Community.

## Pathway 1.2B
## Community 1.2 to 1.3

**Mature Patchy Phase Douglas fir (western larch-ponderosa pine)/Serviceberry/white spirea-common snowberry/Creeping barberry/pinegrass**

**Initiation Phase (Douglas fir-Lodgepole pine-Aspen-Western larch)/white spirea-common snowberry/geyer's sedge**

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 1.3A
## Community 1.3 to 1.4

**Initiation Phase (Douglas fir-Lodgepole pine-Aspen-Western larch)/white spirea-common snowberry/geyer's sedge**

**Stem Exclusion Phase Lodgepole pine/common snowberry/pinegrass**

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

## Pathway 1.4B
## Community 1.4 to 1.3

**Stem Exclusion Phase Lodgepole pine/common snowberry/pinegrass**

**Initiation Phase (Douglas fir-Lodgepole pine-Aspen-Western larch)/white spirea-common snowberry/geyer's sedge**

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 1.4A
## Community 1.4 to 1.5

**Stem Exclusion Phase Lodgepole pine/common snowberry/pinegrass**

**Vertical Differentiation Douglas fir (western larch-Ponderosa pine)/Serviceberry/white spirea-common snowberry/creeping barberry/pinegrass**

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

### Pathway 1.5A
### Community 1.5 to 1.1

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 1.5B
### Community 1.5 to 1.3

**Vertical Differentiation Douglas fir (western larch-Ponderosa pine)/Serviceberry/white spirea-common snowberry/creeping barberry/pinegrass**

**Initiation Phase (Douglas fir-Lodgepole pine-Aspen-Western larch)/white spirea-common snowberry/geyer's sedge**

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

## State 2
## Root Rot State

Another disease affecting this ecological site is root rot. Armillaria root disease is the most common root disease fungus in this region, and 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 most susceptible tree species first, leaving less susceptible tree species that mask the presence of disease. When root rot is severe, the pocket has abundant regeneration or dense brush growth in the center. In western Montana and northern Idaho, Armillaria is present in most stands with diffuse mortality and large and small root disease centers. The disease pattern is one of multiple clones merging to form essentially continuous coverage of sites. Grouped as well as dispersed mortality involves entire stands and drainages, and often is severe by age 40. A mosaic of brushy openings, patches of dying trees, and apparently unaffected trees may cover large areas. There can be highly significant losses, usually requiring species conversion in the active management approach. Management tactics include to correctly identify the type of root disease(s) on the management unit, and manage species such as late seral pine and larch. Pre-commercial thinning will improve growth and vigor of the residual stand. Thinning and harvest operations should remove susceptible species (Douglas-fir or true firs) to the degree practical, retaining late seral species such as western larch and pine (Hagle, 2010). Tree planting can be used to facilitate a shift in species composition to those conifers which have greater tolerance to root diseases. There has been a link determined between parent material and susceptibility to root disease. 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 roots disease mortality, then a forest stand could cross a threshold and become a shrubland, once all trees are gone (Kimsey et al., 2012). Persistent shrub fields may take a century or longer for the infected root mass to decline, which will return the root disease potential to background levels, and allow the reintroduction of resistant conifer species.

### Community 2.1
### Armillaria Root Rot

### Transition T1A
### State 1 to 2

High density fir becomes infected

## Restoration pathway R2A
## State 2 to 1

Active management and seeding of true pine and larch species

## Additional community tables

**Table 5. Community 1.1 forest understory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (Ft) | Canopy Cover (%) |
|---|---|---|---|---|---|
| **Grass/grass-like (Graminoids)** | | | | | |
| pinegrass | CARU | *Calamagrostis rubescens* | – | – | 8–40 |
| golden sedge | CAAU3 | *Carex aurea* | – | – | 1 |
| **Forb/Herb** | | | | | |
| heartleaf arnica | ARCO9 | *Arnica cordifolia* | – | – | 2–15 |
| lupine | LUPIN | *Lupinus* | – | – | 3 |
| feathery false lily of the valley | MARA7 | *Maianthemum racemosum* | – | – | 3 |
| Virginia strawberry | FRVI | *Fragaria virginiana* | – | – | 0.5–3 |
| sweetcicely | OSBE | *Osmorhiza berteroi* | – | – | 0.5–3 |
| silvery lupine | LUAR3 | *Lupinus argenteus* | – | – | 1–2 |
| western meadow-rue | THOC | *Thalictrum occidentale* | – | – | 0.5–2 |
| starry false lily of the valley | MAST4 | *Maianthemum stellatum* | – | – | 0.5 |
| beardtongue | PENST | *Penstemon* | – | – | 0.5 |
| fragrant bedstraw | GATR3 | *Galium triflorum* | – | – | 0.5 |
| white hawkweed | HIAL2 | *Hieracium albiflorum* | – | – | 0.5 |
| twinflower | LIBO3 | *Linnaea borealis* | – | – | 0.5 |
| onion | ALLIU | *Allium* | – | – | 0.5 |
| summer coralroot | COMA25 | *Corallorhiza maculata* | – | – | 0.5 |
| yellow avalanche-lily | ERGR9 | *Erythronium grandiflorum* | – | – | 0.5 |
| western showy aster | EUCO36 | *Eurybia conspicua* | – | – | 0.5 |
| **Shrub/Subshrub** | | | | | |
| white spirea | SPBE2 | *Spiraea betulifolia* | – | – | 12–37.5 |
| common snowberry | SYAL | *Symphoricarpos albus* | – | – | 3–20 |
| Woods' rose | ROWO | *Rosa woodsii* | – | – | 3–15 |
| thimbleberry | RUPA | *Rubus parviflorus* | – | – | 15 |
| russet buffaloberry | SHCA | *Shepherdia canadensis* | – | – | 5 |
| Saskatoon serviceberry | AMAL2 | *Amelanchier alnifolia* | – | – | 1–5 |
| rose | ROSA5 | *Rosa* | – | – | 2 |
| kinnikinnick | ARUV | *Arctostaphylos uva-ursi* | – | – | 0.5–1 |
| creeping barberry | MARE11 | *Mahonia repens* | – | – | 0.5–1 |
| grouse whortleberry | VASC | *Vaccinium scoparium* | – | – | 0.5 |
| **Tree** | | | | | |
| Rocky Mountain maple | ACGL | *Acer glabrum* | – | – | 0.5–15 |
| paper birch | BEPA | *Betula papyrifera* | – | 0–39 | 3 |

**Table 6. Community 1.3 forest understory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (Ft) | Canopy Cover (%) |
|---|---|---|---|---|---|
| **Grass/grass-like (Graminoids)** | | | | | |
| Geyer's sedge | CAGE2 | *Carex geyeri* | – | – | 15–62.5 |
| pinegrass | CARU | *Calamagrostis rubescens* | – | – | 37.5 |
| Idaho fescue | FEID | *Festuca idahoensis* | – | – | 3 |
| alpine timothy | PHAL2 | *Phleum alpinum* | – | – | 3 |
| bluebunch wheatgrass | PSSP6 | *Pseudoroegneria spicata* | – | – | 3 |
| **Forb/Herb** | | | | | |
| streambank wild hollyhock | ILRI | *Iliamna rivularis* | – | – | 15 |
| fireweed | CHAN9 | *Chamerion angustifolium* | – | – | 0.5–15 |
| western showy aster | EUCO36 | *Eurybia conspicua* | – | – | 3–15 |
| Scouler's woollyweed | HISC2 | *Hieracium scouleri* | – | – | 15 |
| common yarrow | ACMI2 | *Achillea millefolium* | – | – | 3 |
| western pearly everlasting | ANMA | *Anaphalis margaritacea* | – | – | 3 |
| heartleaf arnica | ARCO9 | *Arnica cordifolia* | – | – | 3 |
| bluebell bellflower | CARO2 | *Campanula rotundifolia* | – | – | 3 |
| Indian paintbrush | CASTI2 | *Castilleja* | – | – | 3 |
| western blue virginsbower | CLOC2 | *Clematis occidentalis* | – | – | 3 |
| eastern pasqueflower | PUPA5 | *Pulsatilla patens* | – | – | 3 |
| western meadow-rue | THOC | *Thalictrum occidentale* | – | – | 3 |
| northern bedstraw | GABO2 | *Galium boreale* | – | – | 3 |
| autumn dwarf gentian | GEAM3 | *Gentianella amarella* | – | – | 3 |
| roundleaf alumroot | HECY2 | *Heuchera cylindrica* | – | – | 3 |
| feathery false lily of the valley | MARA7 | *Maianthemum racemosum* | – | – | 3 |
| woolly groundsel | PACA15 | *Packera cana* | – | – | 3 |
| **Shrub/Subshrub** | | | | | |
| white spirea | SPBE2 | *Spiraea betulifolia* | – | – | 15 |
| Oregon boxleaf | PAMY | *Paxistima myrsinites* | – | – | 3–15 |
| willow | SALIX | *Salix* | – | – | 15 |
| rose | ROSA5 | *Rosa* | – | – | 3 |
| snowbrush ceanothus | CEVE | *Ceanothus velutinus* | – | – | 3 |
| creeping barberry | MARE11 | *Mahonia repens* | – | – | 3 |
| Saskatoon serviceberry | AMAL2 | *Amelanchier alnifolia* | – | – | 3 |
| common snowberry | SYAL | *Symphoricarpos albus* | – | – | 3 |
| chokecherry | PRVI | *Prunus virginiana* | – | – | 3 |
| sticky currant | RIVI3 | *Ribes viscosissimum* | – | – | 3 |
| **Tree** | | | | | |
| paper birch | BEPA | *Betula papyrifera* | – | – | 3 |
| Rocky Mountain maple | ACGL | *Acer glabrum* | – | – | 0.5–3 |
| quaking aspen | POTR5 | *Populus tremuloides* | – | 0–39 | 3 |
| Scouler's willow | SASC | *Salix scouleriana* | – | – | 3 |
| western larch | LAOC | *Larix occidentalis* | – | 0–39 | 0.5 |

**Table 7. Community 1.4 forest understory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (Ft) | Canopy Cover (%) |
|---|---|---|---|---|---|
| **Grass/grass-like (Graminoids)** | | | | | |
| pinegrass | CARU | *Calamagrostis rubescens* | – | – | 3–37.5 |
| mountain brome | BRMA4 | *Bromus marginatus* | – | – | 3 |
| sedge | CAREX | *Carex* | – | – | 3 |
| **Forb/Herb** | | | | | |
| yellow avalanche-lily | ERGR9 | *Erythronium grandiflorum* | – | – | 15 |
| heartleaf arnica | ARCO9 | *Arnica cordifolia* | – | – | 3–15 |
| common yarrow | ACMI2 | *Achillea millefolium* | – | – | 3 |
| lupine | LUPIN | *Lupinus* | – | – | 3 |
| vetch | VICIA | *Vicia* | – | – | 3 |
| sunflower mule-ears | WYHE2 | *Wyethia helianthoides* | – | – | 3 |
| green false hellebore | VEVI | *Veratrum viride* | – | – | 3 |
| darkwoods violet | VIOR | *Viola orbiculata* | – | – | 3 |
| Virginia strawberry | FRVI | *Fragaria virginiana* | – | – | 0.5–3 |
| sweetcicely | OSBE | *Osmorhiza berteroi* | – | – | 3 |
| narrowleaf hawkweed | HIUM | *Hieracium umbellatum* | – | – | 3 |
| cream pea | LAOC2 | *Lathyrus ochroleucus* | – | – | 3 |
| feathery false lily of the valley | MARA7 | *Maianthemum racemosum* | – | – | 3 |
| pipsissewa | CHUM | *Chimaphila umbellata* | – | – | 3 |
| American trailplant | ADBI | *Adenocaulon bicolor* | – | – | 3 |
| Pacific anemone | ANMU | *Anemone multifida* | – | – | 3 |
| bride's bonnet | CLUN2 | *Clintonia uniflora* | – | – | 0.5 |
| northern bedstraw | GABO2 | *Galium boreale* | – | – | 0.5 |
| greenflowered wintergreen | PYCH | *Pyrola chlorantha* | – | – | 0.5 |
| **Shrub/Subshrub** | | | | | |
| common snowberry | SYAL | *Symphoricarpos albus* | – | – | 15 |
| western meadow-rue | THOC | *Thalictrum occidentale* | – | – | 3 |
| Woods' rose | ROWO | *Rosa woodsii* | – | – | 3 |
| rose | ROSA5 | *Rosa* | – | – | 3 |
| Greene's mountain ash | SOSC2 | *Sorbus scopulina* | – | – | 0.5–3 |
| white spirea | SPBE2 | *Spiraea betulifolia* | – | – | 3 |
| claspleaf twistedstalk | STAM2 | *Streptopus amplexifolius* | – | – | 3 |
| kinnikinnick | ARUV | *Arctostaphylos uva-ursi* | – | – | 3 |
| creeping barberry | MARE11 | *Mahonia repens* | – | – | 3 |
| Saskatoon serviceberry | AMAL2 | *Amelanchier alnifolia* | – | – | 3 |
| **Tree** | | | | | |
| quaking aspen | POTR5 | *Populus tremuloides* | – | – | 3 |
| Rocky Mountain maple | ACGL | *Acer glabrum* | – | – | 0.5 |

**Table 8. Community 1.5 forest understory composition**

| Common Name | Symbol | Scientific Name | Nativity | Height (Ft) | Canopy Cover (%) |
|---|---|---|---|---|---|
| **Grass/grass-like (Graminoids)** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| pinegrass | CARU | *Calamagrostis rubescens* | – | – | 3–62.5 |
| prairie Junegrass | KOMA | *Koeleria macrantha* | – | – | 37.5 |
| Geyer's sedge | CAGE2 | *Carex geyeri* | – | – | 3–15 |
| smooth brome | BRIN2 | *Bromus inermis* | – | – | 15 |
| timothy | PHPR3 | *Phleum pratense* | – | – | 3 |
| **Forb/Herb** | | | | | |
| redosier dogwood | COSES | *Cornus sericea ssp. sericea* | – | – | 15 |
| common yarrow | ACMI2 | *Achillea millefolium* | – | – | 0.5–15 |
| heartleaf arnica | ARCO9 | *Arnica cordifolia* | – | – | 3–15 |
| wild sarsaparilla | ARNU2 | *Aralia nudicaulis* | – | – | 15 |
| spotted knapweed | CEST8 | *Centaurea stoebe* | – | – | 15 |
| fireweed | CHAN9 | *Chamerion angustifolium* | – | – | 3–15 |
| goldenrod | SOLID | *Solidago* | – | – | 15 |
| vetch | VICIA | *Vicia* | – | – | 3–15 |
| violet | VIOLA | *Viola* | – | – | 3 |
| claspleaf twistedstalk | STAM2 | *Streptopus amplexifolius* | – | – | 3 |
| western meadow-rue | THOC | *Thalictrum occidentale* | – | – | 3 |
| common mullein | VETH | *Verbascum thapsus* | – | – | 3 |
| bride's bonnet | CLUN2 | *Clintonia uniflora* | – | – | 3 |
| maiden blue eyed Mary | COPA3 | *Collinsia parviflora* | – | – | 3 |
| western Indian paintbrush | CAOC4 | *Castilleja occidentalis* | – | – | 3 |
| western showy aster | EUCO36 | *Eurybia conspicua* | – | – | 0.5–3 |
| strawberry | FRAGA | *Fragaria* | – | – | 0.5–3 |
| woodland strawberry | FRVE | *Fragaria vesca* | – | – | 3 |
| Virginia strawberry | FRVI | *Fragaria virginiana* | – | – | 3 |
| cream pea | LAOC2 | *Lathyrus ochroleucus* | – | – | 3 |
| lupine | LUPIN | *Lupinus* | – | – | 3 |
| feathery false lily of the valley | MARA7 | *Maianthemum racemosum* | – | – | 3 |
| slender cinquefoil | POGR9 | *Potentilla gracilis* | – | – | 3 |
| roundleaf alumroot | HECY2 | *Heuchera cylindrica* | – | – | 3 |
| narrowleaf hawkweed | HIUM | *Hieracium umbellatum* | – | – | 3 |
| bracted lousewort | PEBR | *Pedicularis bracteosa* | – | – | 3 |
| northern bedstraw | GABO2 | *Galium boreale* | – | – | 0.5 |
| fragrant bedstraw | GATR3 | *Galium triflorum* | – | – | 0.5 |
| pointedtip mariposa lily | CAAP | *Calochortus apiculatus* | – | – | 0.5 |
| aster | ASTER | *Aster* | – | – | 0.5 |
| **Shrub/Subshrub** | | | | | |
| common snowberry | SYAL | *Symphoricarpos albus* | – | – | 3–62.5 |
| Woods' rose | ROWO | *Rosa woodsii* | – | – | 3–37.5 |
| thimbleberry | RUPA | *Rubus parviflorus* | – | – | 0.5–37.5 |
| white spirea | SPBE2 | *Spiraea betulifolia* | – | – | 3–15 |
| chokecherry | PRVI | *Prunus virginiana* | – | – | 0.5–15 |
| rose | ROSA5 | *Rosa* | – | – | 0.5–15 |

| | | | | | |
|---|---|---|---|---|---|
| russet buffaloberry | SHCA | *Shepherdia canadensis* | – | – | 3–15 |
| kinnikinnick | ARUV | *Arctostaphylos uva-ursi* | – | – | 15 |
| Saskatoon serviceberry | AMAL2 | *Amelanchier alnifolia* | – | – | 3–15 |
| creeping barberry | MARE11 | *Mahonia repens* | – | – | 3–15 |
| redstem ceanothus | CESA | *Ceanothus sanguineus* | – | – | 3 |
| snowbrush ceanothus | CEVE | *Ceanothus velutinus* | – | – | 3 |
| dwarf red blackberry | RUPU | *Rubus pubescens* | – | – | 3 |
| willow | SALIX | *Salix* | – | – | 3 |
| Scouler's willow | SASC | *Salix scouleriana* | – | – | 3 |
| **Tree** | | | | | |
| paper birch | BEPA | *Betula papyrifera* | – | 0–39 | 37.5 |
| Rocky Mountain maple | ACGL | *Acer glabrum* | – | – | 3–37.5 |
| quaking aspen | POTR5 | *Populus tremuloides* | – | 0–39 | 3 |
| black cottonwood | POBAT | *Populus balsamifera ssp. trichocarpa* | – | 0–39 | 3 |

## References


Arno, S. Forest Regions of Montana. USDA Forest Service Research Paper INT-218. USFS, USDA.

Arno, S. and R. Hammerly. 2007. Northwest Trees. in The Mountaineers Books.

Arno, S., D. Parsons, and R. Keane. 2000. Mixed-Severity Fire Regimes in the Northern Rocky Mountains: Consequences of Fire Exclusion and Options for the Future. USDA Forest Service Proceedings RMRS-P-15-VOL-5.2000. USDA.

Barrett, S.W., S. Arno, and C. Key. 1991. Fire regimes of western larch-lodgepole pine forests in Glacier National Park, Montana.

Byler, J. and S. Hagle. 2000. Succession functions of pathogens and insects.

Fischer, W. and A. Bradley. 2000. Fire Ecology of Western Montana Forest Habitat Types. Intermountain Research Station. GTR-INT-223. US Department of Agriculture. Forest Service..

Garrison-Johnston, R., R. Lewis, and L. Johnson. 2007. Northern Idaho and Western Montana Nutrition Guidelines by Rock Type. Intermountain Forest Tree Nutrition Cooperative. Forest Resources Department, University of Idaho.

Green, P., D. Sirucek, W. Hann, A. Zack, and B. Naumann. 1992. Old Growth Criteria. R-1 SES 4/92. Northern Region. USDA USFS.

Hagle, S. 2008. Management Guide for Armillaria Root Disease. USFS, Forest Health Protection and State Forestry Organizations. USFS, USDA.

Jones, G.P. 2004 (Date accessed). U.S. National Vegetation Classification Standard: Terrestrial Ecological Classifications.

Kimsey, M., T. Shaw, M. Johnson, and P. McDaniel. 2012. Ecological and physiological overview of volcanic soils and their influence on tree growth and vegetation.

Kimsey, M. 2012. Geospatial tools for estimating and maintaining soil-site productivity. in Northwest Forest Soils Council Meeting, February 28, 2012. Intermountain Forest Tree Nutrition Cooperative.

Losensky, J.L. 1992. Personal communication. Jack Losensky.

McDonald, G.I., A.E. Harvey, and J.R. Tonn. 2000. Fire, Competition and Forest Pests: Landscape Treatment to Sustain Ecosystem Function. Pages 165–211 in Proceedings from the Joint Fire Science Conference and Workshop: crossing the millennium: integrating spatial technologies and ecological principles for a new age in fire management; the Grove Hotel, Boise, Idaho, June 15-17, 1999.. University of Idaho, Moscow, Idaho.

McKenzie, D. and D. Tinker. 2012. Fire-induced shifts in overstory tree species composition and associated understory plant composition in Glacier National Park, Montana. Plant Ecology. Plant Ecology. 207–224.

McLean, A. and S. Wikeem. 1985. Influence of season and intensity of defoliation on bluebunch wheatgrass survival and vigor in southern British Columbia. Journal of Range Management 38:21–26.

Pfister, R., B. Kovalchik, S. Arno, and R. Presby. 1977. Forest Habitat Types of Montana. USDA Forest Service General Technical Report INT-34. Intermountain Forest and Range Experiment Station, US Department of Agriculture. Intermountain Forest and Range Experiment Station, US Department of Agriculture.

Soil Survey Staff. 2015. Illustrated guide to soil taxonomy. National Soil Survey Center. U.S. Department of Agriculture, Natural Resources Conservation Service, Lincoln, Nebraska.

Zack, A. 2005. Region One, Vegetation Classification, mapping, inventory and analysis report. U.S. Department of Agriculture, US Forest Service, Northern Region. Report 09-08 v1.0. 1997, revised 2005. U.S. Department of Agriculture, US Forest Service, Northern Region.

## Other references

References

Arno, S. Forest Regions of Montana. USDA Forest Service Research Paper INT-218. USFS. USDA.

Arno, S. and R. Hammerly. Northwest Trees, by Stephen F. Arno and Ramona P. Hammerly. Anniversary Edition, the Mountaineers Books, 2007.

Arno S., D. Parsons and R. Keane. Mixed-Severity Fire Regimes in the Northern Rocky Mountains: Consequences of Fire Exclusion and Options for the Future. USDA Forest Service Proceedings RMRS-P-15-VOL-5.2000.

Barrett, S., S. Arno and C. Key. Fire regimes of western larch-lodgepole pine forests in Glacier National Park, Montana. 1991.

Byler, James and Hagle, Susan. 2000. Succession functions of pathogens and insects. FHP Report No. 00-09.

Fischer W., A. Bradley. Fire Ecology of Western Montana Forest Habitat Types. US Department of Agriculture. Forest Service. Intermountain Research Station. GTR-INT-223.

Garrison-Johnston, R. Lewis, L. Johnson. 2007. Northern Idaho and Western Montana Nutrition Guidelines by Rock Type. Intermountain Forest Tree Nutrition Cooperative. Forest Resources Department, University of Idaho.

Green, P. J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. April 1992. Old Growth Criteria. R-1 SES 4/92. Northern Region. USDA USFS.

Hagle S., USFS, Forest Health Protection and State Forestry Organizations. Management Guide for Armillaria Root Disease. February 2008. WEB July 2010.

Kimsey M., T. Shaw, M. Johnston, P. McDaniel. 2012. Intermountain Forest Tree Nutrition Cooperative. Ecological and physiological overview of volcanic soils and their influence on tree growth and vegetation.

Kimsey M. Intermountain Forest Tree Nutrition Cooperative. Geospatial tools for estimating and maintaining soil-site productivity. Northwest Forest Soils Council Meeting, February 28, 2012.

Losensky, J. L. "Personal communication. Jack Losensky." Ecologist, Lolo National Forest, Missoula, MT (1992).

McDonald, A. Harvey and J. Tonn. USDA U.S.F.S., Rocky Mountain Research Station. Fire, competition and forest pests: landscape treatment to sustain ecosystem function.

McKenzie, D. and D. Tinker. 2012. Fire-induced shifts in overstory tree species composition and associated understory plant composition in Glacier National Park, Montana. Plant Ecology 2012: 213:207-224.

McLean, Alastair. 1970. Plant communities of the Similkameen Valley, British Columbia. Ecological Monographs. 40(4): 403-424.

NatureServe, 2007. U.S. National Vegetation Classification Standard: Terrestrial Ecological Classifications. Waterton-Glacier International Peace Park, Local and Global Association Descriptions.

N.P.S. Fire Ecology Annual Report, Calendar Year 2014.

Soil Survey Staff. 2015. Illustrated guide to soil taxonomy. U.S. Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska.

Pfister, R., B. Kovalchik, S. Arno, R. Presby. Forest Habitat Types of Montana. USDA Forest Service General Technical Report INT-34. Intermountain Forest and Range Experiment Station, US Department of Agriculture. May 1977.

Zack, A. Region One, Vegetation Classification, mapping, inventory and analysis report. U.S. Department of Agriculture, US Forest Service, Northern Region. Report 09-08 v1.0. 1997, revised 2005.

## 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 | 12/18/2020 |
| Approved by | Kirt Walstad |

| | |
|---|---|
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

## Indicators

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

   _____

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

   _____

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

   _____

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

   _____

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

   _____

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

   _____

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

   _____

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

   _____

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

   _____

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

    _____

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

    _____

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

    Dominant:

    Sub-dominant:

Other:

Additional:

---

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

---

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

---

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

---

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

---

17. **Perennial plant reproductive capability:**

---