USDA Natural Resources Conservation Service

Ecological site F044AH001MT
Montane Warm Dry Coniferous Seeley, Swan, Flathead and Tobacco Valleys

Last updated: 3/11/2025
Accessed: 05/12/2025

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 044A–Northern Rocky Mountain Valleys

This ecological site currently resides in the Major Land Resource Area (MLRA) 44A 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. The area of MLRA 44A is huge and is in the process of being restructured into a new MLRAs further divided into new Land Resource Units (LRU). A detailed description of MLRA 44A can be found at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053624

LRU notes

This LRU includes the Flathead Valleys, with the predominant landscape as valleys with landforms including floodplains, stream terraces, outwash, lacustrine terraces, foothills, glacial moraines. The estimated acres are 1,412,271 and it is primarily private lands. Land use is development and agriculture. Climatically, this LRU has a cryic/frigid soil temperature regime and a xeric/udic soil moisture regime. It has a mean annual air temperature of 6, mean frost free days of 94 and mean annual precipitation of 590 and REAP of 58. Elevations range 751 to 1835m. Vegetation is predominantly Douglas Fir-Ponderosa Pine-Lodgepole Pine Forest and Woodland. Minor Engelmann Spruce-Subalpine Fir, open water, developed areas and agriculture. Trace Western Redcedar and Western Hemlock and Grand Fir. The geologic parent materials are predominantly fluvial deposits and bedform topography related to Cordilleran glaciation. Rock types are dominantly metasedimentary of the Belt Supergroup (Ravalli group) with some Tertiary sediments, eolian deposits, open water, Glacial lake deposits. The soils are dominantly very deep well developed soils formed in alluvium, lacustine deposits, glacial outwash and till from metasedimentary parent materials. These tend to be well drained, neutral to moderately alkaline soils with both skeletal and non-skeletal sandy loam, loam and clay loam textures. Poorly drained soils are present as well 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 marginal to the valley floor.
This is related to the EPA land classification framework of: Level 3 the Northern Rockies and includes numerous Level 4 including: Stillwater-Swan Wooded Valley, Tobacco Plains, Flathead Valley, a small part of the Western Canadian Rockies (Level 3 is Canadian Rockies) and a small part of the rattlesnake-Blackfoot-south Swan-Northern Garnet-Sapphire Mountains and the Foothill Potholes (both in the Middle Rockies Level 3 subdivision). This area is related predominantly to the USFS Provinces: Predominantly resides in the northern portion in M333Bc (Flathead River Valley), the middle portion of in M333Cb (Canadian Rockies-Whitefish-Swan Mountains) and the southern portion in M332Bp (Avon-Nevada Valleys).

Classification relationships

This ecological site relates to the USFS Habitat Type PIPO/FEID-FESC & PIPO/SYAL. This site relates to the USFS Habitat Type Group 2 and Fire Group 2. Both of these classification guides are specifically for the western Montana and northern Idaho region. It also relates to the NatureServe classification *Pinus ponderosa*/*Festuca campestris* Woodland CEGL000185 and *Pinus ponderosa*/*Symphoricarpos albus* CEGL000203.

Ecological site concept

• Vegetation is dominated in the overstory by Ponderosa pine with an understory that has patchy common snowberry, and abundant native perennial bunchgrasses (rough fescue, Idaho fescue, bluebunch wheatgrass and prairie junegrass) with a sparse ground hugging layer of prickly phlox, rosy pussytoes and kinnickinnik.
• Site is found in well drained valleys that span the lower elevations, and at moderate elevations on southern and western aspects.
• Site occurs primarily on dune and outwash terrace landforms, on footslope, toeslope and summit positions, on low slopes ranging 1-10%, at elevations averaging 800 meters.
• Surface not covered with >15% stones and/or boulders.
• Soils are:
o Very deep, well drained and derived from eolian sand. Soil textures typically are sandy, with surface textures ranging from fine sandy loam to sandy loam and subsurface textures range from sand to sandy loam

Associated sites

R044AH036MT	**Droughty Seeley, Swan, Flathead and Tobacco Valleys** This associated site is found lower in elevation to this ecological site on warmer and drier locations.
R044AH032MT	**Loamy Seeley, Swan, Flathead and Tobacco Valleys** This associated site is found lower in elevation to this ecological site on slightly warmer and moister locatlions with loamy soils.

Similar sites

F044AP905MT	**Upland Warm Woodland Group** This similiar ecological site has dry site conditions and is dominated by ponderosa pine in the overstory but has a broader scope than this ecological site.

Table 1. Dominant plant species

Tree	(1) *Pinus ponderosa*
Shrub	(1) *Symphoricarpos albus*
Herbaceous	(1) *Festuca campestris* (2) *Festuca idahoensis*

Physiographic features

This ecological site is found in well drained valleys that span the lower elevations, and at moderate elevations on southern and western aspects. Generally, the ponderosa pine zone is bordered at lower elevations by grasslands, and at higher elevations by Douglas fir sites. This ecological site occurs primarily on dune and outwash terrace landforms, on footslope, toeslope and summit positions, on low slopes ranging 1 to 10 percent, at elevations averaging 2624 feet.

Figure 1. A younger stand with abundant perennial bunchgrasses.

Figure 2. A site with very high coverage of common snowberry.

Table 2. Representative physiographic features

Landforms	(1) Valley > Dune (2) Valley > Outwash terrace
Elevation	732–823 m
Slope	1–10%
Water table depth	152 cm
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The dissected northern Rocky Mountain Valleys are considered to have a maritime climate. Precipitation is fairly evenly distributed throughout the year with less than about 35 percent of the annual precipitation occurring during the growing season in Montana. Rainfall occurs as high-intensity, convective thunderstorms in the spring and fall. Most of the precipitation in the winter is snow or rain on fully or partially frozen ground. Average precipitation is 14 to 19 inches, and the frost-free period averages 60 to 100 days. The soil moisture regime is xeric and the soil temperature regime is frigid. The majority of precipitation comes early in the form of snow and spring rain. Summers are usually dry. The growing season is short and cool; primary growth typically occurs between May and July, and dominant plants are those that have adapted to these conditions. There is abundant moisture available during the cooler months and very little during the period of mid-to late summer drought conditions, many native bunchgrasses and forbs are dormant in summer but photosynthetically active from autumn through spring. For example, throughout all the valleys of western Montana, the months with higher precipitation average were November to January and May to June.

Mean Average Precipitation Range 14-19 inches

Mean Average Annual Temperature Range 33-58 degrees
Frost free days Range: 60-100

Table 3. Representative climatic features

Frost-free period (characteristic range)	36-83 days
Freeze-free period (characteristic range)	99-124 days
Precipitation total (characteristic range)	381-483 mm
Frost-free period (actual range)	17-87 days
Freeze-free period (actual range)	90-127 days
Precipitation total (actual range)	381-533 mm
Frost-free period (average)	58 days
Freeze-free period (average)	111 days
Precipitation total (average)	432 mm

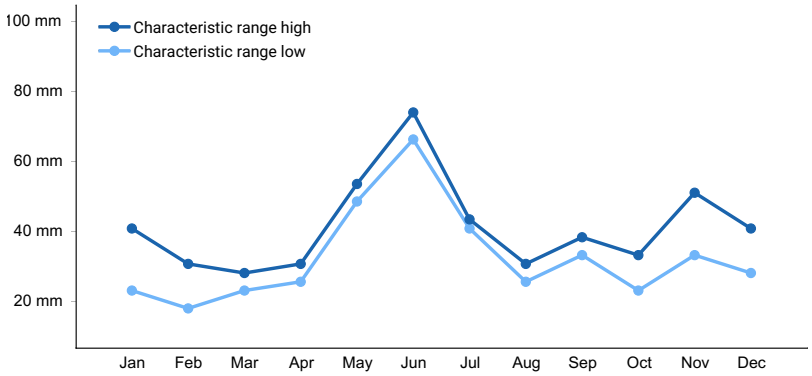


Figure 3. Monthly precipitation range

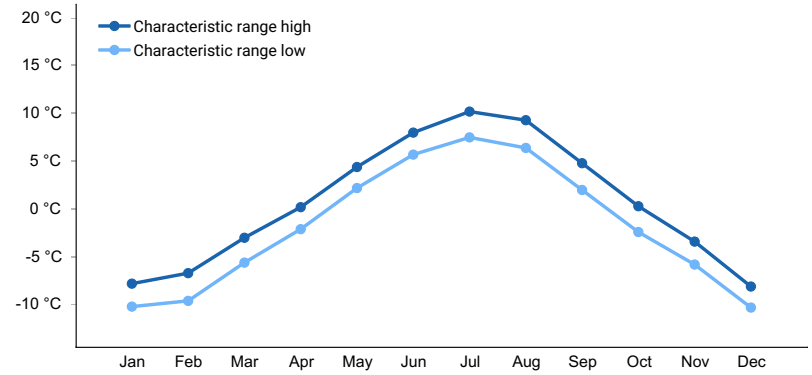


Figure 4. Monthly minimum temperature range

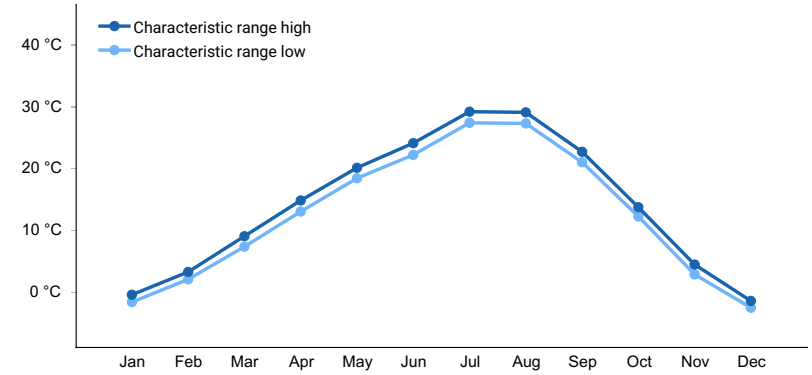


Figure 5. Monthly maximum temperature range

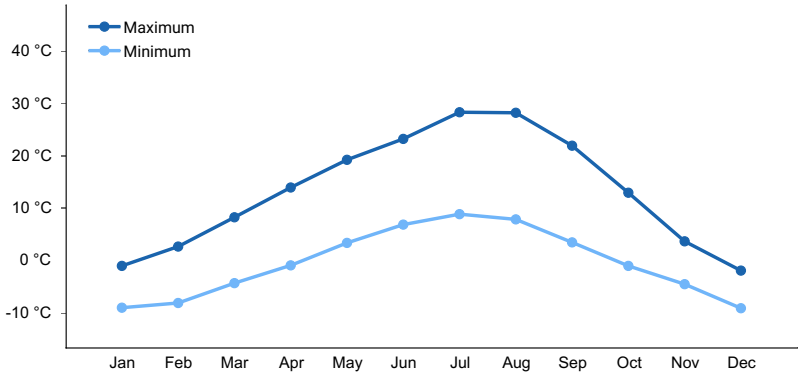


Figure 6. Monthly average minimum and maximum temperature

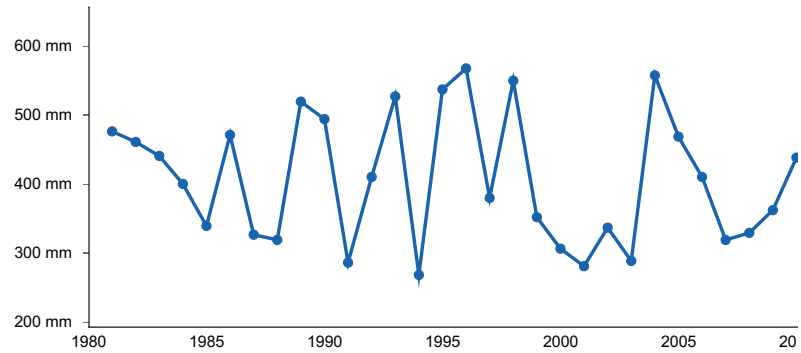


Figure 7. Annual precipitation pattern

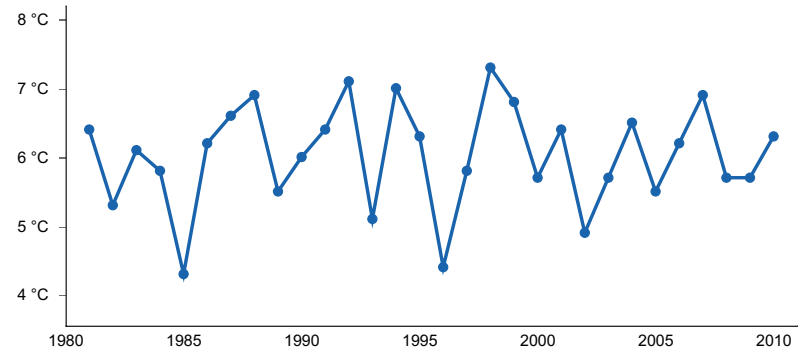


Figure 8. Annual average temperature pattern

Climate stations used

- (1) EUREKA RS [USC00242827], Eureka, MT
- (2) FORTINE 1 N [USC00243139], Eureka, MT
- (3) OLNEY [USC00246218], Whitefish, MT

Influencing water features

No associated water features.

Soil features

Soils associated with this ecological site are very deep, well drained and derived from eolian sand. Soil textures typically are sandy, with surface textures ranging from fine sandy loam to sandy loam and subsurface textures range from sand to sandy loam. These soils are in a very deep depth class, meaning that there is no bedrock encountered within 150 cm. Due to the windblown nature of these eolian deposits there are very few rock fragments in these soils. Typically classified as Typic Calcixerepts they have a light-colored ochric epipedon which is relatively low in organic matter and a weakly developed subsoil, with horizon variation often only distinguishable based on color differences or pH differences due to the accumulation of calcium carbonate in the subsoil. Typically, they have

a calcic diagnostic horizon in the subsoil (indicative of accumulation of calcium carbonate) below the ochric epipedon. On some sites, where eolian activity is still actively depositing material there may be calcium carbonates right at the soil surface. This indicates active deposition or additions to the soil because the soil has not been stable for a long enough time for precipitation to leach the carbonates downward to a depth below the soil surface. There is commonly a thin organic duff layer of pine needles that averages 3 cm in depth.

(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

Figure 9. Soils associated with the ponderosa pine ecological site.

Figure 10. Soils associated with this ecological site.

Table 4. Representative soil features

Parent material	(1) Eolian sands–metasedimentary rock
Surface texture	(1) Sandy loam (2) Fine sandy loam
Family particle size	(1) Sandy (2) Sandy over loamy
Drainage class	Well drained
Permeability class	Moderately rapid to rapid
Soil depth	51–152 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (2.5-12.4cm)	Not specified

Soil reaction (1:1 water) (17.8-21.8cm)	Not specified
Subsurface fragment volume <=3" (Depth not specified)	Not specified
Subsurface fragment volume >3" (Depth not specified)	Not specified

Ecological dynamics

Ecological Dynamics of the Site

This ecological site relates to the USFS Habitat Type Ponderosa pine/common snowberry (Pfister, 1977), which is in Fire Group 2 and in the updated USFS Region 1 Montana Potential Vegetation Type Group PIPO (moderately warm and dry) and in the old Habitat Type Group 2. In McDonald's grouping, it was in Ponderosa Pine-Dry Shrub without historic western white pine and low potential for root rot. It was in the Vegetation Response Unit 1.

This ecological site is typified by open growing stands of Ponderosa pine at lower elevations, but is also found at moderate elevations on southerly and westerly aspects. The overstory is dominated by open growing Ponderosa pine and the modal concept is that there are very few, if any, other tree species on the site. The dominance of Ponderosa Pine and the open growing structure is determined and maintained by a historically frequent fire regime. Commonly occurring, non-lethal wildfires have historically maintained open, park-like Ponderosa pine stands. Adapted to a frequent fire regime, Ponderosa pine can self-prune lower branches and has a loosely arranged open structured foliage and thick bark that contribute to its fire-resistant capabilities (Fischer, 1987). Regeneration occurs following disturbance, especially when mineral soils were exposed, which is a key factor in regeneration of ponderosa pine. Ponderosa pine is long-living (300 to 400 years). In this ecological site, Ponderosa pine is present in all seral stages. In transitional areas bordering Douglas fir stands, there can be a few clustered individual saplings or sparse regeneration of Douglas fir. Douglas fir seedlings and saplings are not as fire resistant as Ponderosa pine because they have clustered and highly flammable needles, thin bark, and resinous blisters. As well, Ponderosa pine accumulates needle litter around its base which favors slow moving, low severity ground fires that reduce Douglas fir and understory vegetation while maintaining an open grassy understory with an overstory of ponderosa pine. Therefore, in Ponderosa pine dominated areas, Douglas fir may be present, but is not the successional climax species on these sites. Clusters of Douglas fir can also occur in areas with altered fire regimes that are not as frequent or similar to historical occurrence due to fire suppression. Therefore, the modal concept is that Douglas fir is not successfully reproducing on this site to the extent that it will succeed Ponderosa pine in succession.

The understory has patchy common snowberry (*Symphoricarpos albus*) with abundant perennial native bunchgrasses such as rough fescue and Idaho fescue. Other grass species having lower cover include Idaho fescue, needle and thread grass, bluebunch wheatgrass, prairie junegrass, Richardson's needlegrass, blue wildrye, green needlegrass, Columbia needlegrass and slender wheatgrass. There are diverse forbs present at the site in very low cover including common yarrow, American vetch, white hawkweed, northern bedstraw, stiff yellow indian paintbrush, blanketflower, hairy false golden aster, rocky mountain goldenrod, smallflowered anemone, starry false lily of the valley, lotus milkvetch, threadleaf fleabane, western stoneseed and onion species. Subshrubs present at this site in very low cover include rosy pussytoes, prickly phlox and kinnickinick. Other shrubs present in very low cover at this site include Wood's rose, antelope bitterbrush, serviceberry, Saskatoon serviceberry and russet buffaloberry. These shrubs are adapted to this fire regime of a frequent, low-severity type by having the ability to resprout from root crowns, as in the case of common snowberry or from rhizomes after the low-intensity fire removes the aboveground portion of the plants as with Saskatoon serviceberry. McLean (1970) describes the response to fire for common snowberry as "resistant," with taproots or a fibrous root system with rhizomes 5 to 13 cm deep. Kinnickinnick has fibrous roots and stolons, and white hawkweed (*Hieracium albiflorum*) resprout with fibrous roots only.

This ecological site corresponds to the USFS Habitat Types of Ponderosa pine/common snowberry and Ponderosa pine/Idaho fescue phase rough fescue (Pfister, 1977). The difference between the habitat types is primarily the presence of bunchgrasses (Idaho or rough fescue) or common snowberry. These have management implications in that after disturbance common snowberry can resprout and dominate the understory for a period of time. The pure perennial bunchgrass habitat type has less or altogether lacks common snowberry (less than 5 percent) and post

disturbance management would not include shrub removal. The common snowberry habitat type has an understory that has at least 5 percent canopy cover of common snowberry, regardless of grass or forb abundance. These two habitat types can be very similar and are typically managed the same, unless common snowberry has very high cover which would increase post-disturbance and place more importance on the need to include shrub management in restoration activities.

Fire Regime Description
This ecological site occurs on warm or hot and dry sites. Fire is critical to this ecological site in that it maintains the grassland understory, and provides the open structure of the overstory and promotes regeneration of ponderosa pine. Ponderosa pine is well adapted to fire, having thick bark at maturity which protects the cambium layer from overheating. The fire regime of ponderosa pine in the Rocky Mountains is one of frequent surface fires and infrequent mixed-severity and stand-replacement fires.

In the northern Rocky Mountains, the frequent surface fires were primarily in the lowest elevation, hottest and driest site conditions while the mixed severity fires were more likely to occur at higher elevations with greater moisture. Open, park-like stands of Ponderosa Pine on this ecological site were historically maintained by fires of low to moderate severity that had a return interval of approximately 5 to 20 years and with maximum intervals of 21 to 30 years (Arno, 1980). These open stands typically had clusters of seedlings and saplings which regenerated after these fire events within them. This ecological sites relates to Fire Group Two - warm, dry ponderosa pine habitat types with mean fire intervals of 5 to 25 years (Fischer, 1987). Ponderosa pine habitat type forests on the Bitterroot National Forests had historic mean fire intervals ranging 2 to 20 years, with a mean of 6 to 12 years. The pre-settlement fire return interval was 5 to 30 years, specifically 2 to 46 years for Rocky Mountain ponderosa pine (USFS, FEIS, PINPON page). Native American burning influenced fire regimes by increasing fire frequency before European settlement.

There is also evidence that there was a mixed fire severity fire regime in the higher elevation Rocky Mountain ponderosa pine forests compared to the American Southwestern ones. The fire return interval for that type of fire was 14 to 24 years. This fire regime has been coined mixed severity, ranging from low to moderate severity surface fires at relatively frequent intervals (years) to severe crown fires at long intervals (years).

Fire suppression can also play a role in altering fire severity. 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 occurrence of a dense understory, resulting in a build-up of hazardous fuels at all levels. These conditions, especially in periods of severe drought, can lead to much larger and more severe fires. In the higher elevations, Ponderosa pine stands had mixed severity fire regimes and regeneration was often to thicker same-aged and dense stands. Other ecological consequences of fire suppression in ponderosa pine include decreases in soil moisture and nutrient availability, spring and stream flows, animal productivity and herbaceous and woody understory species and tree vigor. Increased mortality in the oldest age classes of trees and concentrations of potentially allelopathic terpenes in pine litter have resulted from fire suppression (Covington, 1996, 1997, White, 1991).

Regeneration of ponderosa pine is dependent on the subsequent seed crop, weather, and the continuity of the seedbed (Fischer, 1987). Competitive exclusion phase within Ponderosa pine can be dense pole sized trees in patches or throughout a stand. Fire suppression in the last century has impacted this ecological site along with logging that removed overstory pines, heavy livestock grazing and climate change have resulted in closed-canopy stands with dense understories and ladder fuels (USFS, FEIS, PINPON page).

The average fuel loading is light (1 ton per acre), but can be much heavier in dense pole stands. Fire is important to this site to maintain grasslands, open stands and to encourage ponderosa pine regeneration by exposing mineral soil, reducing seedling damaging cutworm populations, reducing competing vegetation and increasing nutrient availability (Fischer, 1987).

Forest succession after disturbance follows the stand initiation phase of herbs, shrubs, and seedlings to either the competitive exclusion phase of dense pole-sized saplings, or gradual establishment to create all aged and all sized stand, to the maturing forest stage, and with no further disturbance, the Reference phase (Fischer, 1987). Ponderosa pine is present in all seral stages. After a stand-replacement fire, grass, forb, and shrub species dominate the site with seedlings of ponderosa pine, and incidentally Rocky Mountain juniper, depending upon patch size. 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 of ponderosa pine. Pole-sized ponderosa pine would

survive low to moderate fires, whereas severe fires would kill all trees and return the site to the stand initiation phase. Depending on the severity of fire, stands of dense pole sized ponderosa pine can occur in patches or throughout the stand. Otherwise, this phase would be a gradual in-filling of pole-sized trees in patches throughout the stand. 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 with 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.

Pest/Disease Description
Ponderosa pine is subject to various diseases and insect damage. Stem decay include red belt fungus and Pini rot and bark beetles and wood borers include roundheaded pine beetle, Western pine beetle and Mountain pine beetle and pine engraver beetle (Hagle, 2003). Other stem damagers include blue stain of sapwood, comandra blister rust, and Western gall rust and peridermium limb rust. Western dwarf mistletoe and Elytroderma needle cast can damage branches and terminals. Lophodermium needle cast and defoliating weevil can affect foliage. Armillaria root disease is the most common root disease fungus in this region, and especially prevalent west of the Continental Divide. The primary hosts are Douglas fir and true firs, but all conifers may be attacked particularly at ages less than 30 years (Hagle, 2003). Since this ecological site has warm and dry site conditions and is dominated by ponderosa pine, the likelihood of Armillaria root rot disease is very low, but worth mentioning. The main stressor for this ecological site is moisture deficits, particularly in drought years.

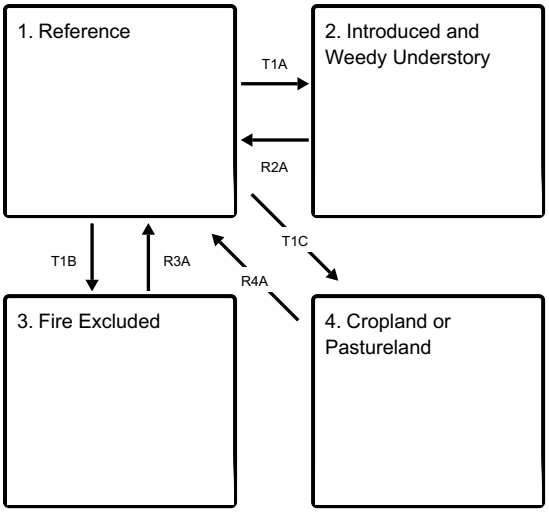
Aerial photography is a good tool to use to discern the levels of insect and disease, the damage patterns, and whether these are at endemic or epidemic levels. These maps capture only moments in time, and infestations grow and move from location to location following their preferred habitat, so repeated photography can be necessary. For the northern region in general, 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. For Ponderosa pine stands specifically, Mountain pine beetle causes large acres of damage, with smaller acreage damaged by Western pine beetle, Pine engraver, Elytroderma needle blight, Lophodermium needle cast and Western gall rust.

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 versus other ecological services like water quality and quantity, old growth, or endangered species. Losensky (1992) found 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. Due to the fragmentation of these low elevation forests and the intensity of fire suppression applied in these areas, the habitat potential of these forests have been greatly modified. Management for timber production ranges from very low to moderate with stockability limitations and slow growth rates.

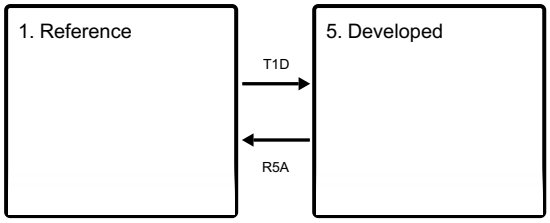
This ecological site relates to the USFS Habitat Type PIPO/FEID-FESC and PIPO/SYAL (Pfister, 1977). The USFS Habitat Type guide states that the basal area on the WEST side of the Continental Divide for is 139+/-21 sq ft per acre (PIPO/FEID), and 170 sq ft per acre (PIPO/SYAL) (Pfister, 1987). The basal area taken at eight sites in the Tobacco Valley averaged 160 square feet per acre of basal area.

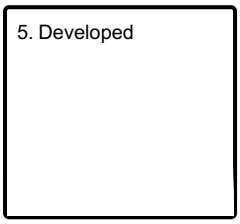
State and transition model

Ecosystem states



States 1 and 5 (additional transitions)





T1A - Introduced grasses and/or weedy species dominate the understory with overstory of Ponderosa pine.

T1B - Fire exclusion over long periods allowing stands to grow into homogenous, dense, multi-storied stands.

T1C - Forest stands converted to cropland or pastureland by cutting trees down and planting introduced grasses

T1D - Housing and road development within Ponderosa pine forest that reduces forest patch size, increases edge and decreases interior acreage of intact forest and ecological services

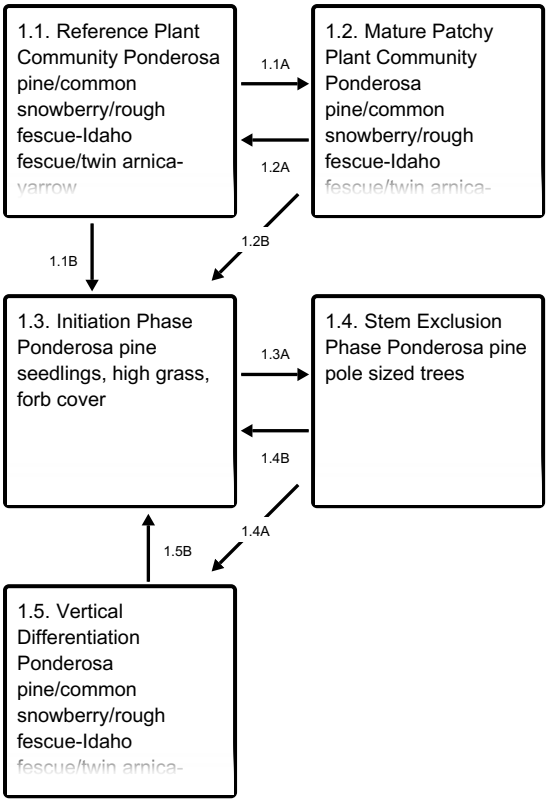
R2A - Range management practices to convert introduced grass and/or weedy species dominated understory to native perennial bunchgrasses.

R3A - Forest stand structure, composition and historical fire regime restored by overstory thinning, ground and ladder fuels reduction, and prescribed fire.

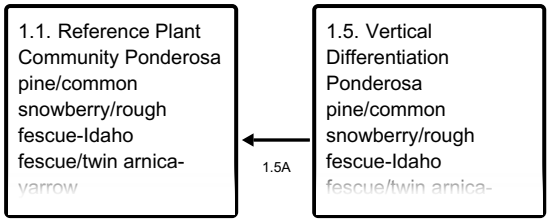
R4A - Overstory restoration through forestry management practices of afforestation through planting of native trees and range management practices of seeding of native grasses, forbs, and shrubs and treatment of invasive plants and Time

R5A - Potentially not feasible; removal of housing and road development and restoration for Ponderosa pine overstory and perennial native bunchgrass understory.

State 1 submodel, plant communities



Communities 1 and 5 (additional pathways)



1.1A - Moderate to large size patches of tree mortality due to fire, insect, disease, windthrow.

1.1B - This is a severe stand replacing fire event that returns the community to the initiation phase.

1.2A - Time and infilling of moderate sized patches with trees to a reference condition of an open stand with a historic fire regime of high frequency and low severity fire.

1.2B - This is a severe stand replacing fire event that returns the community to the initiation phase

1.3A - Time with fire return interval extended to allow natural tree regeneration to grow into dense pole stands

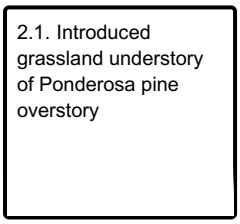
1.4B - This is a severe stand replacing fire event that returns the community to the initiation phase

1.4A - Time without fire to allow vertical differentiation of stand through small gaps from death due to disease, insects, small fires, windthrow.

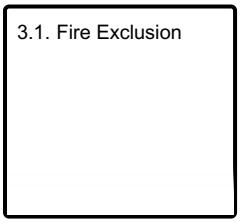
1.5A - Time with no major disturbance to transition to the reference phase community

1.5B - This is a severe stand replacing fire event that returns the community to the initiation phase

State 2 submodel, plant communities



State 3 submodel, plant communities



State 4 submodel, plant communities

4.1. Tame grasses

State 5 submodel, plant communities

5.1. Housing and road construction

State 1
Reference

Ponderosa Pine/common snowberry/Idaho fescue-Rough fescue *Pinus ponderosa*/*Symphoricarpos albus*/*Festuca idahoensis-Festuca campestris* Structure: Multistory with small gap dynamics

Community 1.1
Reference Plant Community Ponderosa pine/common snowberry/rough fescue-Idaho fescue/twin arnica-yarrow

Community Phase 1.1-Reference Plant Community. Ponderosa pine/common snowberry/rough fescue-Idaho fescue/twin arnica-yarrow. Structure: Multistory with small gap dynamics or open park-like single story, patchy shrubs, high grass/forb cover. The following description is data supported from samples taken in the Tobacco Valley Montana. Canopy cover is sampled via ocular estimation of cover in a 100th acre circle centered on the soil pit. The overstory is dominated by Ponderosa pine in an open growing stand or moderate stocked stand with small gap dynamics in which small numbers of trees are dead and regeneration is infilling. There can be very low cover of Rocky Mountain juniper (*Juniperus scopulorum*) and common juniper (*Juniperus communis*). Overstory canopy cover averages 20 percent, and can range from 15 to 37 percent. The understory has the most frequently occurring species including common snowberry (average canopy cover is 6 percent), rough fescue (21 percent), yarrow (4 percent) and rosy pussytoes (2 percent). Other common shrub species include Wood's rose (1 percent), russet buffaloberry (2 percent), and kinnickinick (6 percent). Common forbs include smallflowered anemone (3 percent), blanketflower (trace), northern bedstraw (trace), western stoneseed (1 percent), false lily of the valley (3 percent) and American vetch (*Vicia americana*, 6 percent). Foliar canopy cover is sampled via line point intercept method taken on a 100 foot line placed perpendicular to the slope. Foliar cover dataset of four sites indicates that the understory foliar cover is high (82 percent), ground cover is predominantly duff (62 percent), and moss (21 percent) and little bare soil (11 percent). Species with the highest foliar cover include rough fescue (37 percent), prairie junegrass (9 percent) and bluebunch wheatgrass (9 percent). The vegetation structure is that of tall trees with average height of 800 to 1200 inches and a multistoried understory. The top layer is 20 to 40 inches tall and includes common snowberry, bitterbrush, rough fescue, and Richardson's needlegrass. There are two lower layers that include diverse shrubs, forb and grass species. One layer is at an average height of 10 to 18 inches tall and can include needle and thread grass, western stoneseed, false lily of the valley, bluebunch wheatgrass, white hawkweed, prairie junegrass, smallflowered anemone, blanketflower and the lower layer up to 10 inches tall that can include common yarrow, American vetch, northern bedstraw and onion species. The lowest layer, at the ground surface, includes prickly phlox, rosy pussytoes and kinnickinnik.

Resilience management. Natural fire regime: high frequency, low severity, 10 to 30 yr return. Tree Age: 75 to 100+ years This reference phase is maintained by frequent and low severity fires that do not significantly harm overstory, older, larger ponderosa pine trees but does reduce seedling and shrub cover to patches and reinitiates growth in the herbaceous cover. The open forest structure found in the reference phase allows for some resistance and resilience from insect pest and diseases. Although the threat is very low or rare because ponderosa pine is not a primary host, the presence of root rot pockets can shift the composition of this community away from its host

species and create small patches of mortality. The understory of this community is low storied with the medium shrub common snowberry in clumps and the herbaceous layer varied but low growing with perennial bunchgrasses that can have high cover. This community is rarely prone to Armillaria root rot and highly prone to defoliation by various beetles on pine.

Forest overstory. The overstory is dominated by Ponderosa pine in an open growing stand or moderate stocked stand with small gap dynamics in which small numbers of trees are dead and regeneration is infilling. Overstory canopy cover averages 20%, and can range from 10-37%.

Forest understory. The forest understory is diverse and includes: The understory has the most frequently occurring species including common snowberry (average canopy cover is 6%), rough fescue (21%), yarrow (4%) and rosy pussytoes (2%). Other common shrub species include Wood's rose (1%), russet buffaloberry (2%), and kinnickinick (6%). Common forbs include smallflowered anemone (3%), blanketflower (trace), northern bedstraw (trace), western stoneseed (1%), false lily of the valley (3%) and American vetch (Vicia americana, 6%).

Dominant plant species

- ponderosa pine (*Pinus ponderosa*), tree
- common snowberry (*Symphoricarpos albus*), shrub
- rough fescue (*Festuca campestris*), grass
- Idaho fescue (*Festuca idahoensis*), grass
- common yarrow (*Achillea millefolium*), other herbaceous
- twin arnica (*Arnica sororia*), other herbaceous

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	1170	1723	2204
Forb	138	203	259
Shrub/Vine	68	101	130
Total	**1376**	**2027**	**2593**

Table 6. Soil surface cover

Tree basal cover	0-10%
Shrub/vine/liana basal cover	0-10%
Grass/grasslike basal cover	0-20%
Forb basal cover	0-5%
Non-vascular plants	0-20%
Biological crusts	0-5%
Litter	40-62%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-5%
Bedrock	0%
Water	0%
Bare ground	0-10%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-10%	0-10%	0-10%	0-10%
>0.15 <= 0.3	0-5%	0-10%	5-20%	0-10%
>0.3 <= 0.6	0-5%	0-10%	10-40%	0-10%
>0.6 <= 1.4	0-5%	0-10%	–	–
>1.4 <= 4	0-10%	–	–	–
>4 <= 12	0-10%	–	–	–
>12 <= 24	5-20%	–	–	–
>24 <= 37	10-40%	–	–	–
>37	0-10%	–	–	–

Community 1.2
Mature Patchy Plant Community Ponderosa pine/common snowberry/rough fescue-Idaho fescue/twin arnica-yarrow

Pinus ponderosa/*Symphoricarpos albus*/*Festuca idahoensis*-*Festuca campestris* Structure: Mosaic of mature overstory and regenerating openings Community Phase 1.2-Mature Patchy Phase Ponderosa pine/common snowberry/rough fescue-Idaho fescue/twin arnica-yarrow Sturcture: Mature stand with moderate patches from disease, insects, competition. Tree Age: 0 to 25 and 75 to 100+ years This is a reconstructed plant community based on data found for the reference phase community in Tobacco Valley. The overall community concepts remain the same. Community Phase 1.2 retains some areas that resemble CP1.1 but also contains moderate sized (2 to 5+ acres) openings. Canopy cover can range 10 to 40 percent, but with large size openings. The understory is similar to that found in the reference phase, but with large sized openings that are dominated by herbaceous species. Ponderosa pine is susceptible to mortality from mountain and western pine beetles, pine engraver, elytroderma needle blight, lophodermium needle cast and western gall rust and can be (though rare) 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 herbaceous species. As the organisms slowly die off due to a lack of host trees, Ponderosa pine will re-colonize these areas. This community is rarely prone to Armillaria root rot and very prone to defoliation by various beetles. These large patch size areas can also be caused high severity fire in areas that were overstocked with ponderosa pine and/or Douglas fir.

Community 1.3
Initiation Phase Ponderosa pine seedlings, high grass, forb cover

(Ponderosa pine seedlings)/common snowberry/perennial bunchgrasses Structure: Patchy clumps (or thick carpet in mixed severity fire areas) of regeneration, single story canopy. Community Phase 1.3-Initiation Phase Ponderosa pine seedlings, high grass, forb cover Structure: patchy clumps, single story regeneration. Tree Age: 0 to 20 years Ponderosa pine saplings, grass, shrub, forb cover Tree Age: 20 to 30 years This is a reconstructed plant community. The overall community concepts remain the same. Community Phase 1.3 is a forest in the stand initiation phase, possibly with scattered remnant mature trees (with low severity fire then most mature trees survive); the composition of the seedlings generally Ponderosa pine but depends on the natural seed sources available (proximity to Douglas fir forests). Canopy cover is generally less than 10% as dominated by Ponderosa pine and sometimes Rocky Mountain Juniper (*Juniperus scopulorum*) or Douglas fir. The understory is a mixture of shrubs and herbaceous species.

Community 1.4
Stem Exclusion Phase Ponderosa pine pole sized trees

Ponderosa pine/common snowberry/perennial bunchgrasses Structure: Dense, single story canopy of pole sized trees, ranging in age from 40 to 70 years. Community Phase 1.4-Stem Exclusion Phase Ponderosa pine pole sized trees Structure: dense single story with diminished understory or mixed aged structure. Tree Age: 30 to 50 years There are two possible communities at this stage: a dense pole sized competitive exclusion phase or a community of slow regeneration with in-filling of the stand creating a multi-aged structure. The in-filling patches would resemble

the dense pole sized phase within the multi-aged patches. The dense stand 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 40-60 percent. The overstory is dominated by ponderosa pine; and the understory can have clumps of common snowberry and perennial bunchgrasses. 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 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 and very prone to defoliation by various beetles on pine.

Community 1.5
Vertical Differentiation Ponderosa pine/common snowberry/rough fescue-Idaho fescue/twin arnica-yarrow

Ponderosa pine/common snowberry/perennial bunchgrasses Structure: Single story canopy with few small openings Community Phase 1.5-Vertical Differentiation Ponderosa pine/common snowberry/rough fescue-Idaho fescue/twin arnica-yarrow Structure: some vertical differentiation in stand from insects, disease, root rot, tree competition. Tree Age: 50 to 75+ years Community Phase 1.5 is a maturing forest which is starting to differentiate vertically. Canopy cover ranges 30 to 60 percent. The overstory is ponderosa pine. The understory can have clumps of common snowberry, with a carpet of diverse herbaceous layer sometimes dominated by perennial bunchgrasses. 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 rarely prone to Armillaria root rot and very prone to defoliation by various beetles on pine.

Pathway 1.1A
Community 1.1 to 1.2

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. Moderate to large size patches of tree mortality due to fire, insect, disease, windthrow. These patches are larger than those found in the reference phase and are due to larger and/or more severe fire severity in areas that are: overstocked, or with insect damage or competition for resources due to overstocked conditions. This occurs in areas with mixed severity fire (higher elevation, moister site conditions), and/or Douglas fir thickets (transition zones with Douglas fir forests or areas with fire suppression).

Pathway 1.1B
Community 1.1 to 1.3

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. This is a severe stand replacing fire event that returns the community to the initiation phase. This severe fire is in contrast to the high frequency and low severity fire that perpetuates the reference community which reduces shrub and seedling cover to patches, reinitiates forb and grass growth but does not significantly harm overstory ponderosa pine trees which are adapted to this historic fire regime.

Pathway 1.2A
Community 1.2 to 1.1

1.2A – Time and infilling of moderate sized patches with trees to a reference condition of an open stand with a historic fire regime of high frequency and low severity fire. 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

1.2B – This is a severe stand replacing fire event that returns the community to the initiation phase 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

1.3A – Time with fire return interval extended to allow natural tree regeneration to grow into dense pole stands This pathway represents continued growth over time with no further major disturbance.

Pathway 1.4B
Community 1.4 to 1.3

1.4B – This is a severe stand replacing fire event that returns the community to the initiation phase 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

1.4A – Time without fire to allow vertical differentiation of stand through small gaps from death due to disease, insects, small fires, windthrow. This pathway represents continued growth over time with no further major disturbance.

Pathway 1.5A
Community 1.5 to 1.1

1.5A – Time with no major disturbance to transition to the reference phase community 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

1.5B – This is a severe stand replacing fire event that returns the community to the initiation phase This pathway represents a major stand-replacement fire disturbance leading to the stand initiation phase of forest development.

State 2
Introduced and Weedy Understory

Alternative State 2. Introduced and Weedy Understory State 2.1 Ponderosa pine overstory with introduced grasses and/or weedy species dominated understory.

Dominant plant species

- ponderosa pine (*Pinus ponderosa*), tree
- common snowberry (*Symphoricarpos albus*), shrub
- cheatgrass (*Bromus tectorum*), grass
- smooth brome (*Bromus inermis*), grass
- rush skeletonweed (*Chondrilla juncea*), other herbaceous
- leafy spurge (*Euphorbia esula*), other herbaceous
- knapweed (*Centaurea*), other herbaceous
- Dalmatian toadflax (*Linaria dalmatica*), other herbaceous
- sulphur cinquefoil (*Potentilla recta*), other herbaceous

Community 2.1
Introduced grassland understory of Ponderosa pine overstory

2.1 Ponderosa pine overstory with introduced grasses and/or weedy species dominated understory. This state has

sustained an invasion of and dominance by introduced grasses and/or weedy species into the understory of the Ponderosa pine forest. The native, cool season, perennial bunchgrasses have been out-competed by introduced grasses/weedy species and are in minimal cover. The introduction may have occurred from residential or commercial areas abutting the native ponderosa pine forest or occurred from overgrazing by cattle that transported introduced seeds into the understory. In either case, the introduced grasses establish and out-compete the native perennial bunchgrasses. Other weedy or increaser species may be a problem including: slender crupina, rush skeletonweed, musk thistle, leafy spurge, knapweed species, tansy ragwort, dalmatian and yellow toadflaxes, common St. John's wort and sulphur cinquefoil (Gautreaux, Russ. 1999).

State 3
Fire Excluded

This State has been shaped by fire exclusion in which the forest structure and fuel loading has been dramatically increased due to a dramatic reduction or elimination of fire from the ecological site. Tree density and fuel loading have reached a point in which fire if it did occur would be of very high severity. The suppression of fire has allowed Douglas fir to establish and share the limited site resources with ponderosa pine. Therefore, an increase of fuel accumulation attributable to the thickets of Douglas fir trees and its dense, continuous fuels. As well, in the absence of frequent fire, ponderosa pine is not able to regenerate well and is very susceptible to crown fires due to understory ladder fuels (Gautreaux, Russ. 1999). There is an increased susceptibility of these dense multi-storied Douglas fir and ponderosa pine stands to western spruce budworm which results in severe defoliation and mortality. Douglas fir is also a major host for root disease, especially Armillaria, and dwarf mistletoe. These diseases and pathogens will increase fire hazard on-site. Additionally, other factors have changed forest structure including years of hygrading (harvesting largest best trees on site), overgrazing, prevalence of many roads which create fire breaks, and tree plantations. Dense multi-layered forests of ponderosa pine now exist and is homogenous on the landscape. Intensive forest management practices can reduce the risk of severe fire.

Dominant plant species

- ponderosa pine (*Pinus ponderosa*), tree
- Saskatoon serviceberry (*Amelanchier alnifolia*), shrub
- common snowberry (*Symphoricarpos albus*), shrub
- Woods' rose (*Rosa woodsii*), shrub

Community 3.1
Fire Exclusion

Multi-storied stands of Douglas fir/Ponderosa pine with dense understory of shrubs and/or young trees Multi-level canopy of mature Douglas fir and ponderosa pine over sapling/pole/seedling stands of Douglas fir and ponderosa pine. In areas without tree regeneration dense stands of shrubs will occur, mainly serviceberry, Wood's rose or snowberry. Forest management practices which include selective overstory removal along with understory fuel load management, including prescribed fire, can transition the forest into a more drought, insect and fire resilient condition.

State 4
Cropland or Pastureland

Alternative State 4 (Cropland or Pastureland) 4.1 Community Tame grasses used for crop or pasture. Forest converted to crop or pastureland.

Community 4.1
Tame grasses

4.1 Community Tame grasses used for crop or pasture. Forest converted to crop or pastureland.

State 5
Developed

Alternative State 5 Developed State 5.1 Community Housing and road construction throughout forest stand creating

small patch sizes, changes in stand structure and/or composition.

Community 5.1
Housing and road construction

Housing and road construction throughout forest stand creating small patch sizes, changes in stand structure and/or composition

Transition T1A
State 1 to 2

T1A – Introduction, establishment and dominance of introduced grasses/weedy species into the understory of native, cool season, perennial bunchgrass understory Introduced grasses and/or weedy species dominate the understory with overstory of Ponderosa pine. This occurs with the introduction of these introduced/weedy species (through human or livestock use, proximity to development or other means), establishment and dominance of the native perennial bunchgrass community.

Transition T1B
State 1 to 3

T1B - Fire exclusion over long periods allowing stands to grow into homogenous multi-storied stands Fire exclusion over long periods allowing stands to grow into homogenous, dense, multi-storied stands. This dense forest structure can increase fuel loads of ladder fuels in live trees, standing dead trees and woody and herbaceous litter on the ground. This increase in fuel loading and dense forest structure can change fire severity once fire occurs. In transitional areas close to Douglas fir forests, there may be thickets of Douglas fir occurring in ponderosa pine stands.

Transition T1C
State 1 to 4

T1C – Forest stands converted to cropland or pastureland Forest stands converted to cropland or pastureland by cutting trees down and planting introduced grasses

Transition T1D
State 1 to 5

T1D – Forest stands converted to housing and road development causing increased forest gaps and less intact interior forest areas Housing and road development within Ponderosa pine forest that reduces forest patch size, increases edge and decreases interior acreage of intact forest and ecological services

Restoration pathway R2A
State 2 to 1

R2A – Forest management practices to convert introduced grass/weedy understory back to native, cool season, perennial bunchgrass understory Various management practices can be employed to convert non-native understory to native, perennial bunchgrass understory including application of herbicides, mowing, and planting of native perennial bunchgrasses. Range management practices to convert introduced grass and/or weedy species dominated understory to native perennial bunchgrasses. This may not be feasible if the native plant composition is less than 10 percent and may be economically infeasible. As well, feasibility is dependent on the type of weed species and amount i.e. extreme cheatgrass or smooth brome coverage may be impossible to restore; soil condition and ability to restore must be taken into account.

Restoration pathway R3A
State 3 to 1

R3A – Forest stands restored by overstory thinning, ground and ladder fuels reduction, prescribed fire and seeding of native grasses and forbs. Forest stand structure, composition and historical fire regime restored by overstory

thinning, ground and ladder fuels reduction, and prescribed fire. This may be economically infeasible, and is completely dependent on site conditions and will require numerous entries into a forest stand.

Restoration pathway R4A
State 4 to 1

R4A – Afforestation through planting of native trees /shrubs and seeding of native grasses and forbs, treatment of invasive plants and Time. Overstory restoration through forestry management practices of afforestation through planting of native trees and range management practices of seeding of native grasses, forbs, and shrubs and treatment of invasive plants and Time. This restoration may not be feasible and is dependent on: soil condition and feasibility of restoration with amendments and other practices, amount and type of introduced grasses and weed species on site and feasibility of restoration, and economic feasibility.

Restoration pathway R5A
State 5 to 1

R5A – Removal of houses and road with restoration of areas with afforestation through planting of native trees /shrubs and seeding of native grasses and forbs, treatment of invasive plants and Time. This pathway is site dependent and may not be feasible in all situations and may be cost prohibited. Potentially not feasible; removal of housing and road development and restoration for Ponderosa pine overstory and perennial native bunchgrass understory. This is probably the least feasible restoration pathway for this ecological site due to lack of public support to curb private home building and desire to restore developed areas back to forest. The feasibility of restoration depends on size of development i.e. if there is one house on 10 acres with only one dirt road, this may be restored with removal of structures, forestry management practices for the overstory and range management practices for the understory whereas more developed areas will not be feasible to restore.

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**cool season bunchgrasses**			1121–2242	
	rough fescue	FECA4	*Festuca campestris*	50–2130	10–60
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	50–1009	0–20
	prairie Junegrass	KOMA	*Koeleria macrantha*	50–1009	0–20
	Idaho fescue	FEID	*Festuca idahoensis*	50–1009	0–10
	needle and thread	HECO26	*Hesperostipa comata*	50–1009	0–10
	Columbia needlegrass	ACNEN2	*Achnatherum nelsonii ssp. nelsonii*	50–1009	0–5
	Richardson's needlegrass	ACRI8	*Achnatherum richardsonii*	50–1009	0–5
	blue wildrye	ELGL	*Elymus glaucus*	50–1009	0–5
	green needlegrass	NAVI4	*Nassella viridula*	50–1009	0–5
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	50–1009	–
	Kentucky bluegrass	POPR	*Poa pratensis*	–	0–5
	western fescue	FEOC	*Festuca occidentalis*	–	0–5
	field brome	BRAR5	*Bromus arvensis*	–	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	–	0–5
Forb					
2	**forbs**			138–258	
	common yarrow	ACMI2	*Achillea millefolium*	50–101	0–10

	strawberry	FRAGA	*Fragaria*	50–101	0–5
	blanketflower	GAAR	*Gaillardia aristata*	50–101	0–5
	white hawkweed	HIAL2	*Hieracium albiflorum*	50–101	0–5
	starry false lily of the valley	MAST4	*Maianthemum stellatum*	50–101	0–5
	American vetch	VIAM	*Vicia americana*	50–101	–
	western stoneseed	LIRU4	*Lithospermum ruderale*	50–101	–
	thinleaved owl's-clover	ORTE2	*Orthocarpus tenuifolius*	50–101	–
	northern bedstraw	GABO2	*Galium boreale*	50–101	–
	lotus milkvetch	ASLO4	*Astragalus lotiflorus*	50–101	–
	pointedtip mariposa lily	CAAP	*Calochortus apiculatus*	50–101	–
	fleabane	ERIGE2	*Erigeron*	50–101	–
	twin arnica	ARSO2	*Arnica sororia*	–	0–5
	smallflowered anemone	ANPA	*Anemone parviflora*	–	0–5
	threadleaf fleabane	ERFI2	*Erigeron filifolius*	–	0–5
	blue flax	LIPE2	*Linum perenne*	–	0–5
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	–	0–5
	yellow penstemon	PECO6	*Penstemon confertus*	–	0–5
	Scouler's St. Johnswort	HYSCS2	*Hypericum scouleri ssp. scouleri*	–	0–5
	limestone hawksbeard	CRIN4	*Crepis intermedia*	–	0–5
	twolobe larkspur	DENU2	*Delphinium nuttallianum*	–	0–5
	Rocky Mountain goldenrod	SOMU	*Solidago multiradiata*	–	0–5
	Nuttall's rockcress	ARNU	*Arabis nuttallii*	–	0–5
	Indian paintbrush	CASTI2	*Castilleja*	–	0–5
	mouse-ear chickweed	CERAS	*Cerastium*	–	0–5
	wavyleaf thistle	CIUN	*Cirsium undulatum*	–	0–5
	yellow owl's-clover	ORLU2	*Orthocarpus luteus*	–	0–5
	catchfly	SILEN	*Silene*	–	0–5
Shrub/Vine					
3	**shrubs**			68–130	
	common snowberry	SYAL	*Symphoricarpos albus*	26–50	0–10
	spiny phlox	PHHO	*Phlox hoodii*	26–50	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	26–50	0–5
	rosy pussytoes	ANRO2	*Antennaria rosea*	26–50	0–5
	antelope bitterbrush	PUTR2	*Purshia tridentata*	–	0–5
	kinnikinnick	ARUV	*Arctostaphylos uva-ursi*	–	0–5

Table 9. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
ponderosa pine	PIPO	*Pinus ponderosa*	Native	18.3–36.6	15–37	38.1–88.9	–
Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	Native	18.3–36.6	0–3	38.1–88.9	–
Rocky Mountain Douglas-fir	PSMEG	*Pseudotsuga menziesii var. glauca*	Native	18.3–36.6	0–2	38.1–88.9	–

Table 10. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
rough fescue	FECA4	*Festuca campestris*	–	–	0–40
Idaho fescue	FEID	*Festuca idahoensis*	–	–	0–16
cheatgrass	BRTE	*Bromus tectorum*	–	–	0–10
prairie Junegrass	KOMA	*Koeleria macrantha*	–	–	0–9
bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	–	–	0–8
field brome	BRAR5	*Bromus arvensis*	–	–	0–7
blue wildrye	ELGL	*Elymus glaucus*	–	–	0–4
Richardson's needlegrass	ACRI8	*Achnatherum richardsonii*	–	–	0–4
	STIPA	*Stipa*	–	–	0–4
green needlegrass	NAVI4	*Nassella viridula*	–	–	0–2
Kentucky bluegrass	POPR	*Poa pratensis*	–	–	0–1
foxtail barley	HOJU	*Hordeum jubatum*	–	–	0–1
Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	–	–	0–1
smooth brome	BRIN2	*Bromus inermis*	–	–	0–1
slender wheatgrass	ELTR7	*Elymus trachycaulus*	–	–	0–1
Forb/Herb					
spiny phlox	PHHO	*Phlox hoodii*	–	–	0–13
American vetch	VIAM	*Vicia americana*	–	–	0–10
needle and thread	HECO26	*Hesperostipa comata*	–	–	0–8
prairie sagewort	ARFR4	*Artemisia frigida*	–	–	0–8
common yarrow	ACMI2	*Achillea millefolium*	–	–	0–8
smallflowered anemone	ANPA	*Anemone parviflora*	–	–	0–6
starry false lily of the valley	MAST4	*Maianthemum stellatum*	–	–	0–6
twin arnica	ARSO2	*Arnica sororia*	–	–	0–5
rosy pussytoes	ANRO2	*Antennaria rosea*	–	–	0–4
American licorice	GLLE3	*Glycyrrhiza lepidota*	–	–	0–4
thinleaved owl's-clover	ORTE2	*Orthocarpus tenuifolius*	–	–	0–3
lotus milkvetch	ASLO4	*Astragalus lotiflorus*	–	–	0–3
threadleaf fleabane	ERFI2	*Erigeron filifolius*	–	–	0–2
strawberry	FRAGA	*Fragaria*	–	–	0–2
twolobe larkspur	DENU2	*Delphinium nuttallianum*	–	–	0–2
western Indian paintbrush	CAOC4	*Castilleja occidentalis*	–	–	0–2

yellow penstemon	PECO6	*Penstemon confertus*	–	–	0–2
woolly plantain	PLPA2	*Plantago patagonica*	–	–	0–2
slender cinquefoil	POGR9	*Potentilla gracilis*	–	–	0–2
wild bergamot	MOFI	*Monarda fistulosa*	–	–	0–2
western stoneseed	LIRU4	*Lithospermum ruderale*	–	–	0–2
northern bedstraw	GABO2	*Galium boreale*	–	–	0–2
vetch	VICIA	*Vicia*	–	–	0–2
alpine leafybract aster	SYFO2	*Symphyotrichum foliaceum*	–	–	0–1
common dandelion	TAOF	*Taraxacum officinale*	–	–	0–1
yellow salsify	TRDU	*Tragopogon dubius*	–	–	0–1
largeflower triteleia	TRGR7	*Triteleia grandiflora*	–	–	0–1
clover	TRIFO	*Trifolium*	–	–	0–1
old man's whiskers	GETR	*Geum triflorum*	–	–	0–1
hairy false goldenaster	HEVI4	*Heterotheca villosa*	–	–	0–1
white hawkweed	HIAL2	*Hieracium albiflorum*	–	–	0–1
Scouler's St. Johnswort	HYSCS2	*Hypericum scouleri ssp. scouleri*	–	–	0–1
Utah honeysuckle	LOUT2	*Lonicera utahensis*	–	–	0–1
feathery false lily of the valley	MARA7	*Maianthemum racemosum*	–	–	0–1
common mullein	VETH	*Verbascum thapsus*	–	–	0–1
sweetclover	MEOF	*Melilotus officinalis*	–	–	0–1
phacelia	PHACE	*Phacelia*	–	–	0–1
sweetcicely	OSBE	*Osmorhiza berteroi*	–	–	0–1
spearleaf stonecrop	SELA	*Sedum lanceolatum*	–	–	0–1
catchfly	SILEN	*Silene*	–	–	0–1
Rocky Mountain goldenrod	SOMU	*Solidago multiradiata*	–	–	0–1
pointedtip mariposa lily	CAAP	*Calochortus apiculatus*	–	–	0–1
stiff yellow Indian paintbrush	CALU14	*Castilleja lutescens*	–	–	0–1
wavyleaf thistle	CIUN	*Cirsium undulatum*	–	–	0–1
tiny trumpet	COLI2	*Collomia linearis*	–	–	0–1
limestone hawksbeard	CRIN4	*Crepis intermedia*	–	–	0–1
blanketflower	GAAR	*Gaillardia aristata*	–	–	0–1
fleabane	ERIGE2	*Erigeron*	–	–	0–1
slender buckwheat	ERMI4	*Eriogonum microthecum*	–	–	0–1
arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	–	–	0–1
flexile milkvetch	ASFL2	*Astragalus flexuosus*	–	–	0–1
Nuttall's rockcress	ARNU	*Arabis nuttallii*	–	–	0–1
anemone	ANEMO	*Anemone*	–	–	0–1
Pacific anemone	ANMU	*Anemone multifida*	–	–	0–1
Shrub/Subshrub					
kinnikinnick	ARUV	*Arctostaphylos uva-ursi*	–	–	0–12
common snowberry	SYAL	*Symphoricarpos albus*	–	–	0–10
antelope bitterbrush	PUTR2	*Purshia tridentata*	–	–	0–8

russet buffaloberry	SHCA	*Shepherdia canadensis*	–	–	0–4
Saskatoon serviceberry	AMAL2	*Amelanchier alnifolia*	–	–	0–3
Woods' rose	ROWO	*Rosa woodsii*	–	–	0–2
common juniper	JUCO6	*Juniperus communis*	–	–	0–1
creeping barberry	MARE11	*Mahonia repens*	–	–	0–1
blue flax	LIPE2	*Linum perenne*	–	–	0–1
rubber rabbitbrush	ERNAS2	*Ericameria nauseosa ssp. nauseosa var. speciosa*	–	–	0–1

Inventory data references

Wood 5 historic dataset – 2 sites in reference phase
Forest Overstory Metrics –
Overstory is 100% canopy cover of ponderosa pine
Each site described:
Site 1:
Ponderosa pine tree ages are 102-135 years with heights 97-113 feet tall, site index is 92, total canopy cover is 58%. Understory species by percent cover include: rough fescue=10%, pinegrass=35%, needlegrass=3%, mountain brome=15%, blue wildrye= 4%. Forbs are 15% and include geranium species, strawberry species, northern bedstraw, and western stoneseed. Shrubs is 5% and include creeping barberry, kinnikinick, common snowberry, rose species. Ponderosa pine regeneration is 10%.

Site 2:
Ponderosa pine tree ages are 124-131 years with heights 67-91 feet tall, site index is 70, total canopy cover is 30%, basal area is 47. Understory species by cover class include: rough fescue=5; chokecherry=2.Saskatoon serviceberry=2;arrowleaf balsamroot=4;lupine species=2;old man’s whiskers=1;Idaho fescue=3;cheatgrass=2;tall fringed bluebells=1;bluebunch wheatgrass=3;mountain brome=1;white hawkweed (*Hieracium albiflorum*)=1
Where cover classes are:
0 ABSENT
T RARE-1%
1 1-5%
2 5-25%
3 25-50%
4 50-75%
5 75-95%
6 95-100%

WOOD 5 HISTORIC DATASET – PIPO/SYAL, PIPO/FECA4-FEID
19 SITES
TREE SPECIES IS ONLY PONDEROSA PINE
TREE AGE RANGE= 41-72 years (outliers include 26-38 years old at one site; 75-87 years at another site).
TREE HEIGHT RANGE =45-72 feet (outliers include 97-103 ft and 74-80 feet at two sites).
SITE INDEX AVERAGE=77 RANGE =64-94 (outliers include sites with 104 and 119 site index).
UNDERSTORY SPECIES (presence/absence data only):
Grasses: pinegrass, mountain brome, blue wildrye, rough fescue, bluebunch wheatgrass, green needlegrass
Forbs: strawberry species, geranium species, micheaux’s wormwood, heartleaf arnica, northern bedstraw, western stoneseed, slender cinquefoil
Shrubs: common snowberry, rose species, Saskatoon serviceberry, kinnikinick, creeping barberry

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Approval

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	10/25/2023
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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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):**

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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

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17. **Perennial plant reproductive capability:**
